

# **Public Debt, R-G and Equity Market Returns: An Investigation of the Short-run and Long-run Effects**

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# Table of Contents

LIST OF TABLES.....	IV
TABLE OF FIGURES.....	IV
ACKNOWLEDGEMENTS .....	V
SUMMARY .....	VI
<b>1. INTRODUCTION.....</b>	<b>1</b>
1.1 OVERVIEW .....	1
1.2 GROWTH IN PUBLIC DEBT .....	3
1.3 RISING PUBLIC DEBT AND R-G .....	4
1.4 EFFECTS OF COVID-19 ON PUBLIC DEBT AND FINANCIAL MARKETS .....	5
1.5 PRELIMINARY LITERATURE REVIEW .....	7
1.6 RESEARCH OBJECTIVES.....	12
1.7 RESEARCH CONTRIBUTIONS.....	13
<b>2. LITERATURE REVIEW .....</b>	<b>16</b>
2.1 OVERVIEW .....	16
2.2 GOVERNMENT DEBT DEFINITIONS .....	17
2.3 STATISTICS ON DEBT AND BORROWING COSTS .....	19
2.4 GOVERNMENT DEBT IMPLICATIONS FOR FINANCIAL MARKETS .....	21
2.5 THEORETICAL PERSPECTIVES: KEYNESIAN AND RICARDIAN VIEWS.....	23
2.6 MONETARY POLICY, FISCAL POLICY, AND FINANCIAL MARKETS .....	25
2.7 STUDIES ON PUBLIC DEBT AND STOCK RETURNS .....	27
2.8 PUBLIC DEBT, ECONOMIC GROWTH, AND STOCK RETURNS.....	33
2.9 GOVERNMENT DEBT, INFLATION, AND STOCK RETURNS.....	40
2.10 PUBLIC DEBT, INTEREST RATES, AND EQUITY RETURNS .....	49
2.11 PUBLIC DEBT AND EXCHANGE RATE RELATION .....	55
2.12 SUMMARY OF THE LITERATURE REVIEW.....	63
<b>3. THEORETICAL FRAMEWORK .....</b>	<b>64</b>
3.1 THEORETICAL BACKGROUND.....	64
3.2 NEOCLASSICAL, KEYNESIAN, AND RICARDIAN FRAMEWORK .....	64
3.3 THE DEBT OVERHANG HYPOTHESIS .....	67
3.4 THEORY OF CROWDING OUT EFFECTS.....	67
3.5 THEORY FROM A FINANCE PERSPECTIVE.....	68
3.6 PUBLIC DEBT AND EQUITY RETURNS: THEORETICAL FRAMEWORK.....	70
3.7 RESEARCH MODEL AND HYPOTHESES .....	71
<b>4. RESEARCH METHODS .....</b>	<b>73</b>
4.1 STUDY VARIABLES AND SAMPLE DATA .....	73
4.2 ECONOMETRIC DATA ANALYSIS .....	75
4.3 ECONOMETRIC MODEL SPECIFICATION: ANNUAL TIME SERIES .....	75
4.4 POST ESTIMATION DIAGNOSTIC TESTS .....	76
4.5 VAR SPECIFICATION.....	77
4.6 ARDL SPECIFICATION.....	78
4.7 THE ARDL MODEL ESTIMATION PROCEDURE.....	79
4.8 QUARTERLY PANEL DATA.....	81
4.9 STANDARD LINEAR PANEL DATA MODELS .....	82
4.10 PANEL ARDL MODEL SPECIFICATION .....	85

<b>5. DATA ANALYSIS .....</b>	<b>88</b>
5.1 SUMMARY STATISTICS .....	88
5.2 NORMALITY ASSESSMENT AND TRANSFORMATION OF VARIABLES .....	89
5.3 CORRELATION MATRIX.....	91
5.4 STATIONARITY PROPERTIES OF VARIABLES .....	91
5.5 ECONOMETRIC ANALYSIS: ANNUAL DATA USA.....	93
5.6 ECONOMETRIC ANALYSIS: QUARTERLY PANEL DATA.....	105
5.7 PANEL ARDL MODELS: REAL STOCK INDEX RETURNS .....	119
5.8 PANEL ARDL MODELS: EXCESS STOCK INDEX RETURNS.....	122
<b>6. SUMMARY AND DISCUSSION.....</b>	<b>125</b>
6.1 STUDY RESULTS .....	125
6.2 SUMMARY OF RESULTS AND DISCUSSIONS .....	129
6.3 CONCLUSION .....	131
6.4 FUTURE RESEARCH DIRECTIONS .....	132
<b>REFERENCES.....</b>	<b>133</b>
ANNEX I: DATA SOURCES, CORRELATION MATRIX, AND DIAGNOSTICS .....	155
ANNEX-II: ARDL MODELS, ANNUAL DATA USA.....	165
ANNEX-III: QUARTERLY PANEL DATA ANALYSIS .....	175
ANNEX-IV: ARDL MODELS ADDITIONAL LAGS, PANEL DATA .....	181

## List of Tables

Table 1: List of variables and their derivation formulae .....	74
Table 2: Summary Statistics.....	88
Table 3: ADF tests at Levels, Ho: The Series is non-stationary, $a=1$ .....	92
Table 4: ADF tests at First Difference, Ho: The Series is non-stationary, $a=1$ .....	92
Table 5: OLS Regressions with R-G (10-Y Bond Rate-GDP Growth).....	94
Table 6: OLS Regressions with R-G (Fed Policy Rate-GDP Growth) .....	95
Table 7: OLS Regressions, considering Debt to GDP is Stationary at Levels.....	96
Table 8: Optimal Lag Order Selection .....	98
Table 9: ARDL Error Correction Model, Excess Real Returns .....	99
Table 10: ARDL Error Correction Model, Real Returns .....	101
Table 11: ARDL Error Correction Model, GDP Growth Rate .....	103
Table 12: Linear Panel Models, Real Stock Index Returns .....	107
Table 13: Linear Panel Models, Real Stock Index Returns (PCSE) .....	111
Table 14: Fixed Effects, Real Returns on Equity (Cluster Robust Standard Errors).....	112
Table 15: Linear Panel Models, Excess Stock Index Returns .....	114
Table 16: Linear Panel Models, Excess Real Return (PCSE).....	117
Table 17: Fixed Effects, Excess Real Returns (Cluster Robust Standard Errors).....	118
Table 18: Panel ARDL models, Real Stock Index Returns.....	120
Table 19: Panel ARDL models, Excess Real Returns.....	123

## Table of Figures

Figure 1: Govt. Debt to GDP (%) .....	6
Figure 2: Indirect Effects of Public Debt on Financial Markets .....	12
Figure 3: Public Debt Effects, Transmission Channels .....	70
Figure 4: Research Model .....	71
Figure 5: Histograms and Density Distributions of Govt Debt to GDP .....	89
Figure 6: Histograms by Transformations and Density Distributions of R-G .....	90
Figure 7: Histograms and Density Distributions of Excess Real Returns .....	90

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## Summary

Motivated by the rising trend in public debt and its growing relevance for fiscal and financial policies across advanced and emerging economies, this research examines the impact of the interest rate–growth rate differential ( $r-g$ ) and the debt-to-GDP ratio on equity market performance. While public debt has become a pressing policy concern, previous research has primarily focused on the debt-to-GDP ratio, often neglecting the evolving significance of the  $r-g$ . This research addresses this gap by analysing the short- and long-term effects of both public debt and  $r-g$  on equity market performance.

The findings show that rising public debt negatively affects equity market returns in the short term but has positive and statistically significant effects in the long term. Concurrently, rising interest rate–growth rate differential ( $r-g$ ) exerts a negative influence on both excess and real returns on equity across short- and long-term horizons. Results from both standard linear panel models and panel ARDL models indicate that the relationship between public debt and equity returns is country- and time-specific. Moreover, the findings suggest that the effects of debt-to-GDP ratio and  $r-g$  on equity market returns cannot be fully explained by important macroeconomic variables such as economic growth, inflation, interest rates, and exchange rates. Finally, contrary to the Ricardian equivalence hypothesis, the short-run effects of public debt align with the debt overhang hypothesis, while the positive long-run effects are consistent with Keynesian economic theory.

The policy implications are twofold. First, public investment should rise to stimulate economic growth, which in turn supports financial markets. Second, analysing the impact of the debt-to-GDP ratio in isolation provides only a partial view of the implications of public debt for an economy and financial markets. Instead, the analysis should also incorporate the interest rate–growth rate differential ( $r-g$ ), as public debt remains sustainable and potentially beneficial so long as economic growth ( $g$ ) exceeds the cost of debt ( $r$ ).

Keywords: Public Debt; Equity Market Returns;  $r-g$ ; Fixed Effects; Random Effects; ARDL.

# 1. Introduction

## 1.1 Overview

Financial asset prices react sensitively to key macroeconomic variables, including news about economic growth, inflation rate, interest rates, money supply, and currency exchange rates, among others. The adjustments in asset prices in response to the economic forces support the notion that a wide array of anticipated and unanticipated factors influence security prices with varying intensity and direction. The co-movement between financial asset prices and macroeconomic forces suggests the presence of relationships between macroeconomic factors and financial asset returns.

Both firm-specific factors and macroeconomic forces influence stock market performance. Economists have explored and identified a range of variables to predict the influence of these factors on investment risk and return on equity and debt securities. Among firm-level factors, commonly investigated business indicators include price-earnings ratio, dividend-price ratio, dividend-payout ratio, book-to-market price ratio, and cash flow to price, among others. By contrast, extensively explored macroeconomic factors include economic growth, short-term and long-term interest rates, inflation rates, oil prices, unemployment rates, money supplies, government taxes, deficits, and government spending, among other macroeconomic indicators.

Considering firm-specific and macroeconomic variables, two major research avenues explore the causes of variations in financial asset prices. The first examines firm-specific characteristics that significantly impact the cross-sectional dispersion of security returns. These studies examine how variations in firm fundamentals and idiosyncratic factors affect equity returns (see, e.g., Campbell and Shiller, 1988; Griffin and Lemmon, 2002; Aharoni, 2013; Fama and French, 2015). In comparison, the second avenue of research focuses on the time-series prediction of real and excess market returns based on macroeconomic and financial variables, including GDP growth, industrial production, inflation, interest rates, exchange rates, oil prices, and other related indicators (see, e.g., Chen, Roll and Ross, 1986; Fama and French, 1989; Auerbach and Gorodnichenko, 2012; Huy, Loan and Anh, 2020; Baker *et al.*, 2021).

On the macroeconomic policy front, most studies address the impacts of macroeconomic policy actions on financial asset prices within the context of monetary policy variables. For example, a leading research study by Chen, Roll & Ross (1986) investigated the effects of macroeconomic forces on equity market returns. By modelling equity portfolio returns as a function of macroeconomic variables and bond returns, they found that equity prices respond sensitively to innovations in expected and unexpected key macroeconomic factors, including interest rates, inflation, industrial production, and oil prices. Building on this foundation, numerous subsequent studies have identified several macroeconomic variables as critical risk factors due to their significant influence on financial asset prices. In comparison, the effects of fiscal policy variables on financial asset prices remain less explored. Particularly, the research literature examining the combined impacts of increasing public debt and r-g is scarce.

Understanding the combined effects of public debt and the evolving r-g on financial asset prices is particularly important, given the substantial increase in debt accumulation in recent years. A recent IMF report (December 2024) indicates that global debt stock increased by over \$12 trillion in the first three quarters of 2024, reaching nearly \$323 trillion. In addition, debt levels in emerging markets have reached 245% of GDP, marking one of the largest growths in public debt. Alongside this, Rogoff & Schmelzing (2024) observe strong evidence of trend stationarity in r-g, coupled with high volatility and a clear upwards trend. The authors argue that, although interest rates appear low, economic growth rates are moving downwards in advanced economies, creating pressure on r-g and thus on debt sustainability. Similarly, Weicheng Lian et al. (2020) argue that high public debt can amplify the adverse effects of unexpected shocks on the economic and financial conditions of a country, causing r-g to rise.

From the public debt perspective, several studies have examined the role of credit rating agencies in influencing bond and equity market returns, considering the sovereign credit ratings they assign based on a country's debt level and perceived credit risk. However, only a limited number of studies have explored the direct relationship between rising government debt and equity market performance, often overlooking the significance of the evolving interest rate-growth differential (e.g., Angeloni and Wolff, 2012; Demirci, Huang and Sialm, 2019; Lim, 2020; Wisniewski and Jackson, 2021). As a result, the finance literature has essentially neglected how increasing public debt and r-g may independently or jointly influence financial market returns as distinct macroeconomic risk factors. Thus far, only a few theoretical macroeconomic models have examined the relationship between rising government debt and financial market performance (e.g., Davig, Leeper and Walker, 2011; Polito and Wickens, 2015). Similarly, until recently, empirical work examining the impact of public debt and r-g on capital markets has remained limited due to the unavailability of comprehensive debt datasets.

Therefore, considering the rising trend in public debt and r-g and their growing relevance for fiscal and financial policies across advanced and emerging economies, this study seeks to address this research gap. Specifically, the first objective of this study is to highlight the significance of evolving r-g and integrate it into the empirical framework alongside the debt-to-GDP ratio to assess the implications of public debt for financial markets. Unlike previous studies that focus only on the debt-to-GDP ratio (e.g., Angeloni and Wolff, 2012; Demirci, Huang and Sialm, 2019; Lim, 2020; Wisniewski and Jackson, 2021; Brunnermeier, Merkel and Sannikov, 2022; Liu, 2023), this research examines the short- and long-term effects of rising public debt and the interest rate-growth rate differential (r-g) on equity market returns.

While the importance of r-g in assessing public debt sustainability has only recently been emphasized in macroeconomic literature by scholars such as Blanchard (2019), Reinhart and Rogoff (2020), and Rogoff & Schmelzing (2024), this study extends its application to financial markets. Having integrated r-g into the analytical framework, the second key objective is to assess how the empirical findings correspond to competing economic theories, such as the Classical, Ricardian, and Keynesian views, in light of the mixed theoretical perspectives and inconclusive empirical evidence on the relationship between public debt, economic growth, and financial markets.

The findings of this research indicate that while increased public investment financed by government debt may not undermine financial markets—particularly when economic growth exceeds the cost of debt finance ( $g > r$ )—rising  $r-g$  has consistently negative effects on equity market returns across short and long-term horizons. Furthermore, contrary to the Ricardian equivalence hypothesis—which posits no effect of public debt—the empirical findings of this research show that the negative effects of public debt in the short run align with the debt overhang hypothesis, while the long-run positive effects on equity markets are consistent with the Keynesian economic theory.

## 1.2 Growth in Public Debt

During the recent worldwide economic downturn triggered by the pandemic in 2020 and the Russia-Ukraine war in 2022, there has been a substantial increase in debt accumulation, marking one of the largest growths in public sector debt after World War II. This trend has been observed across all types of debt, including both government and private debt. It extended to the advanced and emerging markets as well as developing economies (EMDE), involving both external and domestic debt. Moreover, as a result of the Coronavirus, the global government debt expanded significantly, surpassing 100% of world GDP, its highest point in half a century (Kose *et al.*, 2021).

The International Institute of Finance (2023) estimates that global debt increased by \$45 trillion compared to its pre-pandemic level and is likely to continue in the future. The pre-pandemic debt-to-GDP ratio of 335% peaked at 360% in 2021. The report also indicates that in the first quarter of 2023, there has been a significant increase in debt levels across 75% of the emerging markets (EM). Increasing from \$75 trillion in 2019, the overall debt figure surpassed \$100 trillion for the first time, reaching 250% of GDP of the emerging markets. Statistics show that China, India, Mexico, Brazil, and Türkiye faced the biggest increases in public debt levels.

According to the 2023 statistics issued by the IMF, total global debt has risen from \$200 trillion at the start of the 2010s to \$300 trillion at present. By the end of this decade, it is likely to reach \$400 trillion and continue to rise. Within that, there have been huge jumps in state debt. Japan's debt-to-GDP ratio has hit a staggering 225%. Italy's ratio has reached 140%, and France's 111%. The public debt of the UK, with no restraints on debt limits over the last few years, has just passed 100% of GDP, a level that investors and economists regard as the upper limit possible without triggering a collapse of confidence. Additionally, a recent report by the IMF (December 2024) shows that the global debt stock increased by over \$12 trillion in the first three quarters of 2024, reaching nearly \$323 trillion. In addition, debt levels in emerging markets have reached 245% of GDP, reaching a fresh high of \$105 trillion (Tiftik, Mahmood and Aycock, 2024).

Heightened geopolitical risks, rising trade tensions, and supply-chain disruptions are further driving national defense spending. Growing health care costs and aging populations are also causing spending pressures on government budget deficits. Consequently, these factors not only threaten global economic growth but also indicate that the public debt levels are likely to continue rising in the future (IIF, 2023, 2024).

Governments alone are not the ones facing growing debt levels. Corporations have also been involved in extensive borrowing of a significant amount of debt. Globally, companies owe a staggering total of \$87 trillion, which accounts for about 97% of the world's Gross Domestic Product (GDP). Similarly, consumers have also been accumulating substantial debt levels. These growing debt levels have caused inflation to rise again, reaching 10% in the US, the UK, and most parts of Europe in 2022. With so much borrowed money chasing a limited level of goods and services, it is no great surprise that prices started to accelerate. Additionally, it has fueled financial market asset prices, creating mini bubbles in the prices of tech stocks, cryptocurrencies, real estate properties, and bonds. Therefore, reducing government debt, deficits, and controlling the rate of growth in public debt are necessary for price stability, economic development, and debt sustainability (Woodford, 1996).

In the past, high debt episodes resulted in financial crises with wide-ranging spillover effects, for example, the Latin American debt crisis in the 1980s, the East Asian financial crisis in the late 1990s, and the recent financial crisis in 2008-09. Likewise, the recent increase in debt is a major concern for governments and corporations alike, as higher debt levels are associated with higher risks. This implies that high government debt can cause uncertainty in financial markets, and investors perceive it as a risk factor, incorporating it into the prices of financial assets. Intuitively, uncertainty is expected to increase volatility and risk premiums, thereby negatively affecting the economy and financial market returns (Arouri *et al.*, 2016; Sun, 2020; Wisniewski and Jackson, 2021; Addey and Nganje, 2023).

Blanchard (2019) argues that expansionary fiscal policy can effectively counter negative economic impacts of recessions during negative long-run  $r-g$  environments (when the interest rate is lower than the economic growth rate). Therefore, despite growing public debt levels, monetary authorities in many advanced countries maintained low-interest rate policies after the 2008-09 global financial crisis, maintaining the interest rate–growth rate differential ( $r-g$ ) negative. These two conditions offer suitable settings for the governments to pursue fiscal expansion to stimulate economic growth because a low-interest rate environment implies lower interest costs on public debt (Miyamoto, Nguyen and Sergeyev, 2018; Ramey and Zubairy, 2018).

However, persistent public spending financed by public debt may increase risks for debt sustainability, as there is a possibility that  $r-g$  may turn positive—the interest rate will exceed growth rates, endangering debt sustainability. This condition has been observed due to recent rate hikes in major economies of the world and lower economic growth as a result of the present political disorder and trade tensions among major economies (Rogoff, 2020; Mehrotra and Sergeyev, 2021). It is worth emphasizing that even before the COVID pandemic, debt levels were already at a historically high point, and economic growth rates had been struggling in many parts of the world (Yared, 2019).

### 1.3 Rising Public Debt and R-G

The state of rising interest rates on government debt in comparison to economic growth ( $r-g$ ) is a serious concern, as it may further increase debt distress for high-debt countries (Mauro and Zhou, 2020). This may result in large economic and financial costs for the countries in the

event of unexpected economic and geopolitical shocks (Born *et al.*, 2020). Weicheng Lian et al (2020) argue that high public debt, by causing  $r-g$  to rise, may amplify the adverse effects of unexpected shocks. Based on the analysis of data from a large sample of 56 developed and developing market economies, the study documents that higher current government debt levels are likely to cause a large increase in interest rates, a decline in economic growth, and volatility shocks in inflation, increasing the likelihood of rising  $r-g$  in the future.

Likewise, Rogoff (2020) highlights that interest rates may rise during periods of heightened uncertainty—such as natural disasters (e.g., the COVID-19 pandemic), geopolitical tensions, or trade disruptions—which can place additional upward pressure on interest rates. The elevated debt levels, combined with increased interest costs on debt, can pose risks to future debt sustainability. Given that governments can maintain low policy interest rates under an accommodative monetary policy framework, slow economic growth, heightened political and economic uncertainty, and sustained fiscal expansion may cause the  $r-g$  differential to rise, which can adversely affect public debt sustainability.

As higher public debts accompany higher borrowing costs, this can reduce economic growth due to debt overhang, lower private investment, and crowding out effects. In addition, high-debt countries are more likely to face higher  $r-g$  (Bohn, 1998; Aguiar, Amador and Gopinath, 2009; Laubach, 2009; Mauro *et al.*, 2015; Fatás, Ghosh and Panizza, 2019). This happened during the COVID-19 pandemic. Additionally, rising government debt can amplify the effects of adverse economic shocks due to increased borrowing costs, potentially leading to insolvency, especially when a large portion of the debt is denominated in foreign currency (Aguiar, Amador and Gopinath, 2009; Lorenzoni and Werning, 2020).

Based on empirical evidence, Lian et al (2020) argue that the negative  $r-g$  state cannot persist longer. Data for the past seventy years show that the higher the initial level of government debt, the shorter the duration of the negative  $r-g$  state. Therefore, countries with high government debt-to-GDP ratios are at greater risk of shifting from a negative  $r-g$  state to a positive  $r-g$  state at any time in the future. Lian et al (2020) further show that the estimate of the probability of  $r-g$  reversal is 25% for countries with a debt-to-GDP ratio below the median debt level. The probabilities of reversal rise to over 75% for countries in the top quarter of the debt-to-GDP ratio distribution. In addition, findings show that the conditional mean value of  $r-g$  in the next two to five years increases significantly with the increase in current government debt. Finally, countries with a high proportion of foreign currency debt exhibit a higher mean value of  $r-g$  due to low economic growth and increasing interest rates, especially in uncertain and unfavorable economic conditions.

Building on this foundation, it is essential to empirically examine how the evolving  $r-g$  alongside the debt-to-GDP ratio may affect economic growth and financial markets.

## 1.4 Effects of COVID-19 on Public Debt and Financial Markets

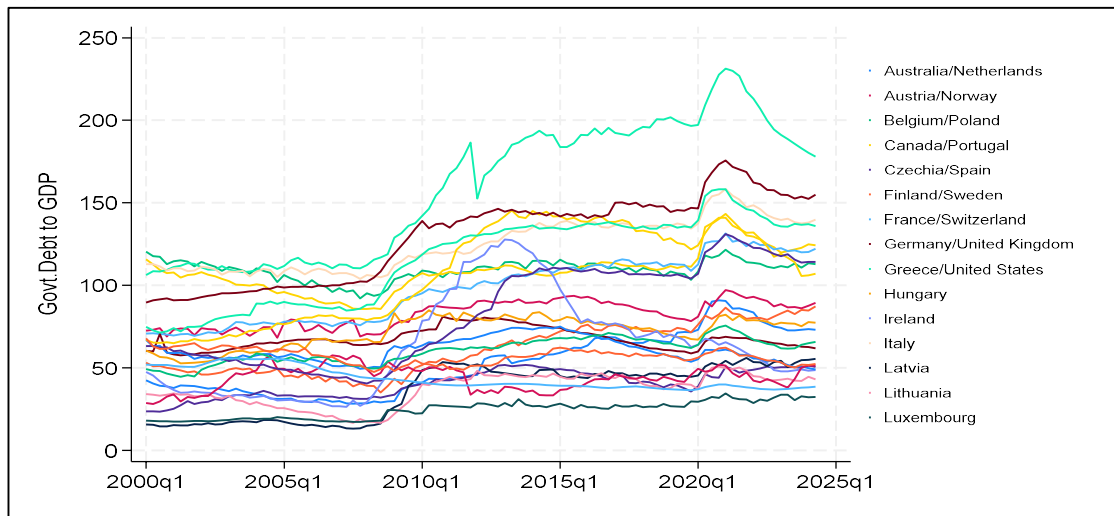
The pandemic caused macroeconomic uncertainty and raised financial market volatility (Baek, Mohanty and Glambsky, 2020). Stock prices significantly declined. As oil prices fell sharply, due to a decline in oil demand resulting from COVID-19 lockdowns, the stock markets of major

oil-exporting countries were also negatively affected. Furthermore, falling oil prices also led to currency depreciation in many of these economies.

To overcome the negative effects of the pandemic, authorities implemented physical and social distancing measures, including travel restrictions and bans on local and international flights, to limit the spread of the highly contagious COVID-19 pandemic. These measures significantly affected non-essential business activities, negatively impacting the operations of the tourism and aviation industries, which eventually significantly reduced oil demand all over the world, including the United States, China, the European Union, and Japan (Taghizadeh-Hesary *et al.*, 2023). The net result was an excess oil supply, which further plummeted oil prices and the economic growth of many countries during the COVID-19 crisis.

To support struggling economies and mitigate the impact of the pandemic, governments and central banks responded by implementing expansionary fiscal policies, cutting interest rates, and injecting liquidity into the financial system (Rostagno *et al.*, 2021; Grasselli, 2022). During the COVID-19 pandemic, governments significantly increased borrowing to address the negative economic impacts. However, interest costs remained relatively stable because of prevailing low interest rates. Nevertheless, as inflation began to rise and peaked in 2022, governments had to increase interest rates several times to control rising prices due to supply shortages and excessive consumer demand. These rate hikes resulted in higher interest payments on debt securities. As expected, Figure 1 shows a clear spike in the government debt-to-GDP ratios across all countries included in the sample selected for this study.

Figure 1: Govt. Debt to GDP (%)



Data source: World Bank Group, Quarterly Public Sector Debt Database.

In addition to increasing debt levels, interest payments on public debt also reached a record high in the fiscal year 2019, reaching \$575 billion for the USA alone. Annual interest payments on the U.S. treasury securities and other forms of government borrowing rose to about 1.7 percent of GDP. These interest costs are estimated to reach 3.3% of GDP by the year 2030. By then, the total interest payments on debt are estimated to surpass federal spending on basic services such as medical care and defence. Moreover, the growing interest payments also

contributed to a 6% increase in total public debt in 2023. Consequently, as debt grows, creditors become alarmed about the increasing default probabilities of governments and demand even higher interest rates, putting pressure on r-g to move higher and into positive territory.

## 1.5 Preliminary Literature Review

The strong form market efficiency hypothesis states that equity market prices are forward-looking and reflect all available relevant information about the economy and other micro and macroeconomic factors into asset prices. Given the premise that all readily available information is instantly reflected in the financial asset prices, changing expectations about monetary and fiscal policy innovations and their effects on the economy may significantly influence financial market asset prices (Bjørnland and Leitemo, 2009; Castelnovo and Nisticò, 2010; Kurov, 2010a). These studies reveal that the volatile nature of asset prices in financial markets is the result of innovations in the monetary and fiscal policies instituted by authorities operating in the economies. In contrast, Rigobon and Sack (2003) and Laopodis (2010) point out the presence of reverse causality, running from equity market to monetary policy, fiscal policy, and other macroeconomic variables. This reverse causality serves as the feedback mechanism for central banks and government authorities, signalling the future course of key macroeconomic variables and helping authorities take corrective actions.

Numerous past and present studies have examined how monetary policy variables influence equity and bond market returns (e.g., Fama and French, 1989; Patelis, 1997; Bjørnland and Leitemo, 2009; Galí and Gambetti, 2015; Drechsler, Savov and Schnabl, 2018; Kaplan, Moll and Violante, 2018; Cieslak, Morse and Vissing-Jorgensen, 2019; Chiang and Chen, 2023). However, there is a scarcity of research that examines the impact of fiscal policy variables—particularly rising public debt and the associated r-g differential—on equity and bond market returns. Several authors, including Agnello and Sousa (2013, 2014) and Wisniewski and Jackson (2021) state the existence of this research gap in the literature.

Monetary and fiscal policy actions (policy variables) play important roles, individually and in combination, by interacting with each other, in affecting not only the economic conditions of a country but also the financial markets. Empirical literature in this sphere of research does not provide any insights into the complex associations between monetary and fiscal policies and their effects on financial markets when they interact with each other (Darrat, 1990; Afonso and Sousa, 2012; Agnello and Sousa, 2013; Lim, 2020; Wisniewski and Jackson, 2021).

### 1.5.1 Fiscal Policy and Equity Markets

Generally, governments can finance spending expenditures by increasing taxes, issuing debt securities, or monetizing the debt to fill the deficit gap. A government may expand the money supply in the economy by implementing expansionary fiscal policy, either by increasing spending on welfare programs, offering subsidies, or cutting income tax rates. Each of these measures helps consumers and businesses to spend more money, leading to increased demand, production, and consumption. The primary objective of expansionary fiscal policy is to prevent the downfall of an economy by stimulating economic activity during a recession or contractionary phase of the business cycle. Specifically, governments follow expansionary

fiscal policy to prevent economies from recession by increasing employment, business activity, and consumer demand. Another important objective of expansionary fiscal policy is to restore consumer, investor, and business confidence in the government's ability to take necessary measures to end the economic recession in the country. However, persistent expansionary fiscal policy may lead to debt expansion and high-interest payments on that debt, which can subsequently cause higher prices, leading to inflationary pressures in the economy, lower demand and consumption, and lower economic growth.

There are three main theoretical arguments regarding how fiscal policy can influence an economy, which in turn may affect debt and equity markets. According to the Ricardian framework, fiscal policy has no impact on the economy and thus on financial markets, regardless of how public expenditure is financed by a government—by increasing taxes or issuing debt securities. On the other hand, Keynesian theory argues that public debt, as part of fiscal policy, stimulates the economy and supports aggregate demand and consumption, leading to higher economic growth and stock prices. On the contrary, the classical economic framework suggests that the crowding-out effects of public debt reduce private investment and business activity in the economy. Thus, the crowding out effects of a fiscal policy can potentially have negative effects on stock prices.

The central argument concerning the effects of fiscal policy is that it can influence the level of economic activity, which in turn affects asset prices and financial market returns. Three major schools of thought—Keynesian, Classical, and Ricardian—offer theoretical perspectives on the economic impacts of fiscal policy.

The Keynesian school advocates a pivotal role of fiscal policy in stabilising economic fluctuations, particularly during recessions and depressions. It views flexible fiscal measures as countercyclical tools—similar to automatic stabilisers—that can support an economy in recovering from downturns. Keynesian economic theory states that government spending can stimulate economic activity, at least in the short term. However, persistent fiscal deficits financed by public debt securities can lead to adverse economic consequences and financial instability in the long term (Adrian, Gaspar and Gourinchas, 2024). Persistent deficits may also escalate government debt levels, potentially crowding out private investment, leading to a decline in economic growth. The sustainability of public finances is threatened without corresponding economic growth, leading to fiscal instability, reduced savings, and inflationary concerns. According to the macroeconomic equilibrium principle, a decrease in domestic savings may result in reduced capital formation within the country, leading to increased reliance on foreign investment or foreign debt. The problem of diminished savings can discourage investment, borrowing, and capital accumulation, which are vital for sustained economic growth.

In contrast to the Keynesian perspective, the Ricardian theory states that fiscal spending has no impact on aggregate demand and consumption and consequently has no effect on economic growth. According to the theory, this occurs because the government borrowing reduces the private savings of rational households by an equal amount. Additionally, classical economists argue that government spending financed by debt crowds out private sector activity and investment in the economy, and therefore, the effects will be weak and small in an economy

with no unemployed resources. While fiscal deficits may provide short-term economic stimulus, their long-term effects such as reduced savings, increased interest rates, and limited capital accumulation, pose challenges to sustained economic progress. In addition to these theoretical arguments, some empirical research studies also show a negative impact of an increase in the supply of government debt securities on the private sector debt financing. For example, Graham et al. (2014, 2015) and Demirci et al. (2019) provide evidence of the negative effect of rising debt-to-GDP ratio on corporate leverage, indicating the negative crowding-out impacts for the economy.

In summary, the Keynesian, Classical, and Ricardian theoretical frameworks provide differing explanations of the economic effects of fiscal policy variables on financial markets, suggesting that these effects may be positive, negative, or neutral, respectively. Therefore, a better understanding of how fiscal policy, in particular public debt and related r-g, may impact financial markets requires empirical investigation. But empirical evidence is rather incomplete.

Existing literature indicates that fiscal deficits may exert a negative influence on current stock market prices. For example, Agnello and Sousa (2013) show negative temporary impacts of fiscal policy innovations on equity prices. Afonso and Sousa (2011, 2012) decompose the government budget deficits into separate components of revenues and expenditures to see the impacts of fiscal deficits on financial market returns. Results show that government expenditure shocks are negatively associated with stock prices, while changes in government revenues have weak positive effects. Moreover, positive fiscal adjustments involving expenditure reduction policies have a positive impact on stock market prices (Alesina and Ardagna, 2009). Consequently, these studies suggest that financial markets tend to respond more positively when fiscal expenditure is restrained, as opposed to during periods of loose expansionary fiscal policy. Finally, although both fiscal and monetary policies have significant individual impacts on financial markets and the economy, studying their combined influence is essential for a better understanding of the real-world dynamics and improving economic models to represent their relationships with economies and financial market returns.

Given that these theoretical frameworks and empirical research present conflicting perspectives, finance literature has mostly stressed the effects of macroeconomic policy actions on financial asset prices within the context of monetary policy variables. However, how fiscal policy actions, particularly public debt and related r-g, may influence financial asset prices has received little attention, except for a few studies ( see e.g., Darrat, 1988; Jansen *et al.*, 2008; Agnello and Sousa, 2013; Simo-Kengne *et al.*, 2016; Wisniewski and Jackson, 2021).

Darrat (1988, p. 353) was among the first to note that the impact of fiscal policy actions on financial market returns had been virtually ignored in academic research. After two decades, Agnello and Sousa (2013, p. 2) and after 30 years, Wisniewski TP, Jackson PM, (2021, p. 2) reconfirmed the view of Darrat (1988), stating that there is still an important research gap in the finance and economics literature requiring exploration of the empirical significance of fiscal policy actions for financial market asset prices.

During the recent economic challenges posed by the COVID-19 pandemic, the Russia-Ukraine war, rising energy costs, and supply shocks, authorities recognised that fiscal policy actions

serve as an effective tool for economic stability as well as a potential source of instability when governments persistently run deficits. Therefore, from the perspective of growing public debt, it is also essential to understand the impacts of fiscal policy actions on financial markets in addition to the effects of monetary policy actions on an economy. However, empirical literature examining the public debt implications for financial markets remains scant, given that theoretical literature has explored the impacts of fiscal policy on financial markets. For example, Tobin (1969) proposed a theoretical model that highlighted the role of both monetary and fiscal policies for the financial markets in an economy. Only recently have a few studies empirically examined the influence of public debt, often overlooking the effects of r-g, on financial markets. One of the main reasons for paying less attention to this area of research has been the unavailability of debt databases until the last decade.

### 1.5.2 Monetary Policy and Financial Markets

The interest rate is a monetary policy instrument that has a significant influence on consumer demand, business activity, production, and consumption in an economy. Movements in interest rates may affect a firm's cost of capital, as well as cash flows. An increase in interest rates negatively influences the market value of the firm due to a higher discount rate. Because higher discount rates reduce the present value of a firm's expected cash flows, resulting in lower equity market value. In contrast, a decline in interest rates may have positive impacts on consumer spending, economic productivity, and stock values of firms. This positive impact is consistent with the traditional Keynesian view on the impacts of interest rates on the economy. Furthermore, lower interest rates provide individuals and businesses with easy access to credit, supporting consumer demand, consumption, investment, business productivity, and the overall economy. Businesses generate more cash flows from increased consumer demand and consumption, resulting in higher revenues and profits. In anticipation of future economic growth, capital investment flows into financial markets, leading to improved market performance. In addition, low interest rates, when applied to discount the cash flows of firms, also result in a higher market value of firms.

Finally, portfolio investment theory suggests that increasing interest rates cause investors to allocate investment funds from equity securities to debt securities, leading to a decline in stock prices because rising interest rates signal inflationary risk and lower demand and consumption. This portfolio balancing act is in line with Tobin's theory of investment, which assumes investors adjust their investment allocations based on profit/value maximization or the risk-return principle (Tobin, 1969).

### 1.5.3 Fiscal Policy and Monetary Policy Interaction

Recent theoretical literature highlights the importance of exploring the combined effects of monetary and fiscal policies on the economy and financial markets. This may help better understand the direct and indirect impacts of these policies. In addition, understanding their individual and interactive roles in influencing the economy and financial markets may help policymakers to control, if not completely prevent, the negative effects of these policies.

Considering the indirect effects, fiscal policy variables may influence financial markets through their intermediary impacts on monetary policy variables and macroeconomic

variables. For example, growing public debt can initially affect monetary variables such as interest rates, money supply, or exchange rates (Muscatelli and Tirelli, 2005). Similarly, public debt may initially influence macroeconomic variables such as economic growth, inflation, exports, and industrial production, among others. In turn, these monetary and macroeconomic intermediate variables may affect financial markets.

Generally, monetary and fiscal policy actions tend to have opposite effects on the economy and financial markets when implemented at the same time (Melitz, 2000). For example, when monetary authorities attempt to control inflation by raising interest rates, this can increase interest payments on future public debt finance, making it difficult for the government to improve debt sustainability. Furthermore, persistent deficits combined with rising interest rates and low economic growth may render fiscal policy unsustainable, leading to increased default probability. In such conditions, investors demand a higher risk premium and pull investment out of the country, leading to currency depreciation. Currency depreciation may increase foreign debt liabilities and interest payments on the debt, particularly when most of the debt is in foreign currency. In addition, currency depreciation may also cause inflation in the economy, which in turn may require an increase in interest rates to control the inflationary pressures, resulting in a cycle of these events (Zoli, 2005). For effective implementation of both policies, it is important that both policies work in harmony in achieving a common goal, and the goals of the two policies should not conflict with each other (Dixit and Lambertini, 2000).

Similarly, a contractionary monetary policy aimed at controlling inflation may render the expansionary fiscal policy, aiming to stimulate economic activity, ineffective (Wallace and Sargent, 1981; Buti, Larch and Balboni, 2009). This way, counter-policy actions may render each other less effective in attaining their respective economic effects (Wyplosz, 1999, p. 7). Given that both fiscal and monetary policy actions have their respective targets for the economy and financial markets, understanding their individual and overlapping effects on the economy and financial markets may provide additional insights (Aarle, Garretsen and Gobbin, 2003; Van Aarle and Garretsen, 2003; Afonso and Sousa, 2012).

#### 1.5.4 Direct and Indirect Impacts of Public Debt on Financial Markets

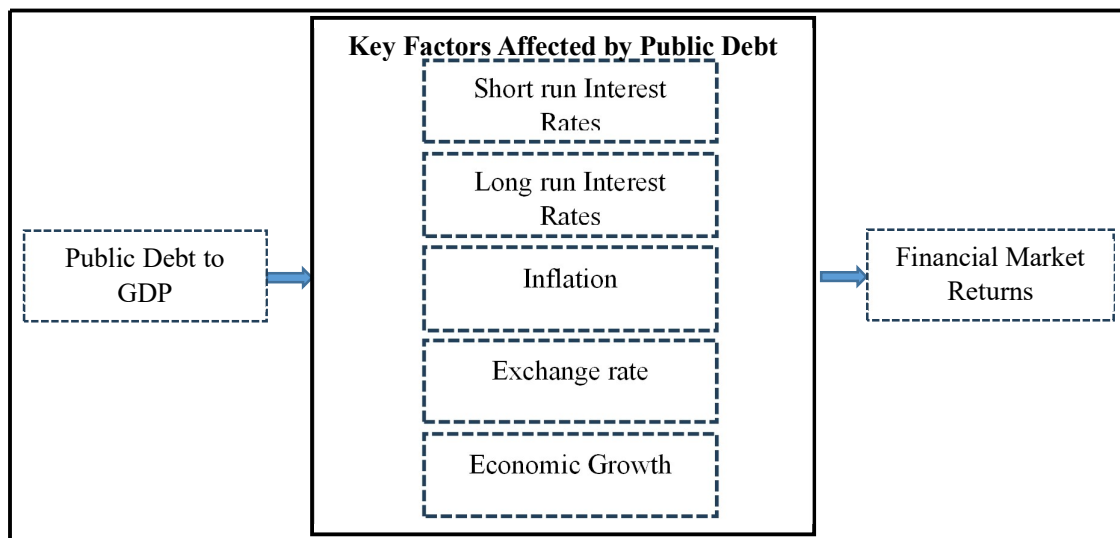
Fiscal policy variables may affect financial market returns through direct and indirect channels. The direct effects of public debt on financial markets emerge when investors perceive a growing debt level as unsustainable, resulting in higher credit risk and default probability, exerting negative pressure on asset prices in the financial markets. The role of rating agencies is paramount in transmitting the direct impact of public debt on financial markets. When increasing public debt raises default risk, investors demand a higher risk premium on their investments, which can result in lower equity market prices.

On the other hand, the indirect effects of public debt emerge when debt is invested in capital projects, leading to an increase in GDP, real economic activity, exports, and lower inflation, which in turn can positively affect equity market performance. However, growing debt may also negatively impact an economy when interest cost on debt exceeds the economic growth rate (the case of  $r > g$ ), resulting in even higher interest rates, inflation, and lower economic growth (Blanchard, 2019).

For example, rising public debt may increase inflation, interest rates, and decrease currency value (Benigno and Missale, 2004). To mitigate inflationary pressures within the economy, governments employ monetary policy instruments such as increasing interest rates. Higher interest rates, when used as a discount factor to determine the value of equity securities, reduce firms' cash flows and thus decrease the value of stocks. Given the negative correlation between stocks and bond returns, investors adjust their investment portfolios from equity to debt securities. In addition, a greater uncertainty and risk resulting from unsustainable public finances, coupled with increased interest rates, negatively affect consumers, businesses, and the government's ability to service and refinance debt.

The indirect influence of public debt (fiscal policy) on financial markets via monetary policy variables and macroeconomic variables reveals the presence of intermediary channels between public debt and financial market returns, as shown in Figure 2 below.

*Figure 2: Indirect Effects of Public Debt on Financial Markets*



While monetary policy authorities aim to maintain low inflation, fiscal policy aims to stimulate the economy and prevent recessions. Public spending financed by public debt may initially impact monetary variables (such as interest rates, money supply, currency exchange rates), as well as macroeconomic variables (such as GDP growth, inflation, and exports, among others), which in turn may influence financial market returns either positively or negatively.

## 1.6 Research Objectives

Against this background, the primary objective of this research is to highlight the significance of evolving r-g and integrate it into the analytical framework alongside the debt-to-GDP ratio for assessing public debt implications for financial markets. Unlike previous studies that focus only on the debt-to-GDP ratio (e.g., Angeloni and Wolff, 2012; Demirci, Huang, and Sialm, 2019; Lim, 2020; Wisniewski and Jackson, 2021; Brunnermeier, Merkel, and Sannikov, 2022; Liu, 2023), this research examines the short- and long-term effects of rising public debt and the interest rate–growth rate differential (r-g) on equity market returns. A second key objective is to assess how the empirical findings correspond to competing economic theories, such as the Classical, Ricardian, and Keynesian views, in light of the

mixed theoretical perspectives on the relationship between public debt, economic growth, and financial markets.

Considering these research objectives, the primary research questions answered in this dissertation are as follows:

The first research question is: how do rising public debt levels impact financial market returns in the short run and long run, and are the relationships statistically and economically significant? Specifically, are the directions of the short and long-run relationships positive, negative, or no relation, given that the theoretical literature points to all of these possibilities?

Second, given that governments can keep policy interest rates low under the framework of accommodative monetary policy, slow economic growth rates, increased economic and political disorders, and sustained fiscal expansions are causing r-g to rise and can make public debt unsustainable. Therefore, the second research question addressed involves understanding how rising r-g may affect equity market returns. To the best of my knowledge, this research question has not been addressed thus far.

Specifically, the primary research questions addressed include:

- (1) How do the present, past (lags), and future (leads) values of public debt and r-g can affect financial market returns on equities?
- (2) How do changes in public debt and r-g affect equity market returns in the short term and long term?
- (3) What is the economic and statistical significance of the changes in equity market returns attributable to the changes in public debt and r-g?
- (4) Are the empirical relations between public debt and financial market returns consistent with theoretical intuition?
- (5) Is the relationship between government debt and equity market returns linear or non-linear, and how does the strength of the relationship change when the Debt to GDP ratio is above 90%?

The key study variables in this research are public debt, the r-g, and stock market index returns. The macroeconomic literature indicates that interest rates, inflation, economic growth, and exchange rates have significant direct and indirect impacts on equity returns. Therefore, to isolate the influence of these variables from the effects of public debt on equity market performance, these variables are incorporated as control variables in the regression models. The selection of these variables is motivated by mainstream research literature in economics and finance. Having integrated r-g into the analytical framework, this research examines the short-run and long-run relationships by employing the time series ARDL framework for annual frequency data for the USA and panel ARDL for panel data of 24 countries included in the sample.

## 1.7 Research Contributions

This research closely relates to the expanding body of literature examining the underlying forces that affect financial markets, economic activity, and macroeconomic policy responses in rising public debt conditions. Some of the notable current research contributions related to

these fields of research include studies on rising public debt and r-g, debt sustainability, and implications of expansionary fiscal policies for an economy (see e.g., Patelis, 1997; Bohn, 1998; Blanchard, 2019; Lian, Presbitero and Wiriadinata, 2020; Lorenzoni and Werning, 2020; Mauro and Zhou, 2020; Law *et al.*, 2021; Wisniewski and Jackson, 2021; Brunnermeier, Merkel and Sannikov, 2022; Liu, 2023; Rogoff and Schmelzing, 2024).

In line with the literature focusing on the impacts of macroeconomic factors on financial market returns, this research contributes in several ways:

This study is the first to integrate r-g with the public debt-to-GDP ratio within a single analytical framework, making the findings both novel and original. The results are influential, as both variables demonstrate a statistically significant impact on equity market returns not only in the short run, but also in the long run. These insights may assist investors, as well as economic and financial policymakers, in making more informed assessments of evolving debt dynamics and their implications for the broader economy and financial markets. By documenting empirical findings on the effects of public debt and r-g on equity market returns, this research finds that, contrary to the Ricardian equivalence hypothesis, the short-run effects of public debt align with the debt overhang hypothesis, while the positive long-run effects are consistent with Keynesian economic theory.

Second, to investigate the short and long-run impacts of public debt and r-g on equity market returns, this research employs annual data for the USA from 1928 to 2023 and quarterly frequency panel data of 24 countries for the period 2000-q1 to 2024-q2. The analysis of two distinct data sets provides a better understanding of the public debt-equity return relationship. Using high-frequency (quarterly) panel data instead of relying solely on annual data of a single country may help better understand the impacts of public debt and r-g on equity market performance. Furthermore, Bernheim (1989) argues that Neoclassicism and Keynesianism present different perspectives of public debt implications for an economy, in the sense that the Keynesian perspective relates to the short-run economic effects, while the Neoclassical perspective relates to the long-run economic impacts. In this respect, the permanent part of deficits is identified as the long-run average of deficits over a period. In contrast, the temporary parts are identified as deviations from the long-run average. Therefore, to analyse the short and long-run effects of public debt on equity index returns, this research applies recently developed econometric approaches: time series ARDL for annual data and the panel ARDL for quarterly panel data.

Finally, this research examines how the current (contemporaneous), past (lags), and future (leads) values of public debt influence equity market returns. It also examines whether countries with a higher public debt-to-GDP ratio (greater than 90% of GDP) face more volatility and risk in the equity markets than those with lower levels of government debt.

In summary, this research contributes to the existing body of knowledge by empirically investigating the impact of the interest rate–growth rate differential (r-g)—a factor that remains largely unexplored in the finance literature—alongside the debt-to-GDP ratio and finds that these are important determinants of equity market returns. Although the recent rise in public

debt has become a critical policy concern, most empirical studies have focused narrowly on the debt-to-GDP ratio, often neglecting the evolving significance of the r-g. Building on this foundation, the present study investigates the short- and long-term effects of r-g alongside debt-to-GDP on equity markets, offering new empirical insights by expanding the analytical framework.

## 2. Literature Review

### 2.1 Overview

This literature review reveals that most research studies focus on examining the relationships between monetary policy variables and financial market returns (see e.g., Fama and French, 1989; Galí and Gambetti, 2015; Drechsler, Savov and Schnabl, 2018; Kaplan, Moll & Violante, 2018; Cieslak, Morse & Vissing-Jorgensen, 2019; Baker *et al.*, 2021; Beckers and Bernoth, 2024; Lyu and Hu, 2024). However, there is a scarcity of research literature that examines how fiscal policy, in particular public debt, can affect financial market returns (Darrat, 1988, 1990; Jansen *et al.*, 2008; Afonso and Sousa, 2011, 2012; Agnello and Sousa, 2013; Simo-Kengne *et al.*, 2016; Sun, 2020; Wisniewski and Jackson, 2021). Monetary and fiscal policies may play a significant role, individually and in combination, by interacting with each other, in affecting not only the overall economy of a country but also financial markets.

Monetary and fiscal policies play critical roles in influencing financial markets. While monetary policy authorities aim to maintain low inflation by controlling interest rates in an economy, fiscal policy seeks to stimulate economic growth and prevent recessions. Monetary policy actions affect financial markets primarily through interest rate adjustments, quantitative easing (QE), and changes in the money supply. For example, cutting the interest rates reduces the cost of borrowing and encourages investment and consumption, which may boost corporate earnings and equity prices. Similarly, an expansion in the money supply can elevate asset prices due to increased liquidity in financial markets. In contrast, fiscal policy may impact financial markets both directly and indirectly. Direct effects arise from changes in public spending, taxation, and levels of public debt, all of which can influence investor expectations and firm profitability. Indirectly, fiscal policy actions can influence key macroeconomic variables such as economic growth, inflation, unemployment, and exchange rates, which in turn affect financial market returns.

Public debt, as a key fiscal policy variable, may also directly and indirectly influence financial markets. Public debt can directly affect financial markets because rising levels of public debt are perceived by investors as unsustainable, which increases the perceived risk of default. This heightened risk of default negatively affects investor confidence, exerting downward pressure on asset prices across financial markets. Indirectly, public debt may influence financial markets through its impact on monetary policy and broader macroeconomic variables. For instance, high public debt levels can affect interest rates and the money supply, or contribute to shifts in macroeconomic indicators such as unemployment, exchange rates, export performance, GDP growth, and inflation. These monetary and macroeconomic factors act as transmission channels through which the effects of public debt influence financial market returns. Therefore, the implications of public debt extend beyond the economy's fiscal position, with clear consequences for financial markets.

There are three main theories regarding how public debt may affect economic growth, which in turn may affect debt and equity markets. Governments can finance spending expenditure by

increasing taxes, issuing debt securities, or monetizing the deficits. According to the Ricardian framework, public debt may have no effects on the economy—and thus does not affect financial markets—regardless of whether public expenditure is financed through increased taxation or the issuance of debt securities by the government. On the other hand, Keynesian theory argues that fiscal spending, financed by issuing public debt securities as part of fiscal policy, can stimulate the economy and support aggregate demand and consumption needed for economic growth in times of distress, potentially driving stock prices higher. On the contrary, the classical economic framework proposes crowding-out effects of government debt, reducing private capital investments, and business activity in the economy. In line with these theoretical frameworks, fiscal policy actions can have no effect, negative effects, or positive effects on financial markets, depending on the specific economic conditions of a country.

While much of the research literature in this sphere of knowledge examines the individual effects of monetary policy on financial markets, research literature on the impact of fiscal policy on financial markets is scarce. Consequently, a gap in the existing literature remains regarding the relationship between monetary and fiscal policy factors and their combined impact on financial markets. Further scholarly investigation may yield deeper insights into how these policy domains interact and influence financial market behaviour (Darrat, 1988; Agnello and Sousa, 2013; Lim, 2020).

Financial markets play a multidimensional role in response to fiscal and monetary policy decisions. Financial markets not only sensitively respond to fiscal and monetary policy actions, affecting the economy, but also serve as a feedback mechanism, providing signals to central banks and government authorities for taking corrective actions (Mishkin, 2001).

## 2.2 Government Debt Definitions

Public debt is defined as government borrowing used to finance public spending for purposes such as health, defence, education, among others. The treasury department of a government borrows money from individuals, firms, or banks, either from internal or external sources, by issuing treasury securities in the form of bills and bonds. The total public debt of a nation is defined as the combined debts of local, state, and national governments (IMF, 2014). In public finance literature, terms like "public debt or credit", "public borrowing", and "state borrowing" have similar meanings and refer to financial obligations incurred by governmental bodies or other public institutions.

According to the OECD, public debt represents the total outstanding government debt (in the form of bonds, papers, and government employee pension obligations) of a country's federal and local governments. Public debt is often expressed as a percentage of a country's gross domestic product (GDP). It is also referred to as general government debt. In public finance, it is commonly known as national debt or sovereign debt. Public debt can be sourced from both domestic and external creditors. Internal debt represents the government's liabilities to domestic lenders such as the central bank, commercial banks, business firms, or individuals. Whereas, external debt is a debt owed to foreign entities, e.g., international financial

institutions such as the World Bank, the IMF, the Asian Development Bank, or foreign private lenders.

Public debt is an important source of funds; a government can use it to finance public expenditures. The primary purpose of debt financing is to fund a country's essential development programs, which support economic growth and stability. The public debt-to-GDP ratio is a widely used economic indicator that represents a country's debt burden in comparison to other countries of different sizes. In addition, according to the OECD, the government debt-to-GDP ratio is considered a key indicator of debt sustainability and macro-financial stability of a country. The IMF defines public debt as the gross general government debt and reports it as a percent of GDP for comparison across countries. Generally, governments issue debt securities (bonds and treasuries) in the domestic and international financial markets to borrow money from individuals, corporations, institutions, and other foreign governments (Dippelsman, Dziobek and Mangas, 2012).

Government expenditures have been rising rapidly during the recent decade. Governments borrow when they cannot fully fund increased public spending from tax revenues, resulting in budget deficits. Borrowing provides the necessary funds to cover current budget deficits. These funds may be sourced from internal (domestic) borrowing, external borrowing, or a combination of both. Debt financing can be for a shorter time duration, less than a year, or a longer time duration of more than ten years. Public debt financing is an important and widely used fiscal policy measure when taxes cannot provide the necessary funding. The primary objective of debt financing is to positively influence aggregate demand, consumption, and investment activity for economic growth and stability. However, in the present time, wars and growing expenditures on defense are also forcing governments towards debt financing.

When government expenditures exceed government revenue, budget deficits emerge. Each year's deficit accumulates to total sovereign debt. Deficit spending as a tool of expansionary fiscal policy aims at ending recessions. The treasury department of a government raises money to fill the deficit gap by issuing treasury bonds, bills, and notes. Investors perceive treasury securities as the safest among other investment options because the government of a country backs these securities with guarantees.

Recent financial unrest, caused by the coronavirus pandemic, the Russia-Ukraine war and supply shortages, brought growing debt, rising interest rates, and inflation to the forefront of economic policy and research. The rapid impacts of these shocks on the global economy highlighted the need for swift and targeted responses from monetary authorities and governments in the form of robust fiscal packages aimed at stabilizing productivity and growth.

From a contemporary standpoint, the demands placed on a state continually expand, necessitating increased spending to address these needs. Typically, governments finance public expenditures from regular sources of public income, including taxes, levies, charges, non-tax revenues, property, other revenues, and fines. Nevertheless, the state encounters situations of a public sector deficit, arising from factors like extensive infrastructure projects, warfare,

development funding, natural calamities, economic downturns, budget shortfalls, and the persistent growth of ordinary public expenses. To address these needs, borrowing becomes a forced choice. Over the years, the process of borrowing has evolved beyond national borders through the establishment of international financial institutions such as the International Monetary Fund (IMF), International Finance Corporation (IFC), World Bank (WB), Islamic Development Bank (IDB), International Development Association (IDA), and European Investment Bank (EIB), that adds a new dimension to debt dynamics.

## 2.3 Statistics on Debt and Borrowing Costs

During the recent worldwide economic downturn triggered by the pandemic in 2020, there was a substantial increase in debt accumulation, marking one of the largest growths in debt levels after World War II. Governments observed this trend across all types of debt, including both public and private debt. It extended to advanced, emerging markets and developing economies (EMDE), involving both foreign and domestic debt. During and after the Coronavirus, total global debt expanded significantly, approaching 263 percent of world GDP, whereas worldwide government debt reached 99% of world GDP, the highest in the last five decades (Kose *et al.*, 2021).

Governments are not alone in facing the growing debt burden. Corporations have also been involved in extensive borrowing of a significant amount. Globally, companies owe a staggering total of \$87 trillion, which accounts for about 97% of the world's gross domestic product (GDP). Furthermore, individual consumers have also accumulated similar substantial debt levels.

The debt estimates by the International Institute of Finance (2023) indicate that global debt, compared to the pre-pandemic level, is now higher by \$45 trillion and is likely to further increase in the future. The pre-pandemic debt-to-GDP ratio of 335% peaked at 360% in 2021, 25% above pre-pandemic levels. Heightened geopolitical tensions are further driving national defense spending over the medium term. Rising health care costs, climate change, and an aging population are also causing spending pressures on government budget deficits. Consequently, this trend in growing debt levels is expected to continue in the foreseeable future (IIF, 2023, 2024).

The reports also indicate that there has been a significant increase in the debt of 75% of the emerging markets (EM) in the first quarter of 2023. Increasing from \$75 trillion in 2019, the overall debt figure crossed \$100 trillion for the first time, reaching around 250% of GDP. Figures show that China, India, Mexico, Brazil, and Turkey faced the biggest increases in public debt levels (IIF, 2023).

The IMF has also reported similar debt statistics. According to figures from the IMF, total global debt has risen from \$200 trillion at the start of the 2010s to \$300 trillion in the present time. At the end of the decade, it is likely to reach \$400 trillion and continue to rise. Within that, there have been huge rises in state debt. Japan's debt-to-GDP ratio has hit a staggering 225%. Italy's ratio has hit 140%, France 111%. The UK government debt, with no restraints

on debt limits, has reached 100% over the last few years, a level that economists perceive as the upper limit possible without triggering a collapse of confidence.

To sum up, the debt forecasts by World Economic Outlook 2023 and the IMF indicate that global public debt is projected to rise further from 2024 onwards, though global public debt decreased from around 100% of GDP in 2020 to 92% of GDP in 2022. This temporary fall in public debt was seen because of increased inflation, discontinuation of the government's support measures instituted to overcome the negative impacts of the COVID-19 pandemic, and real GDP growth—achieved by government support measures for individuals, vulnerable firms, and other support initiatives to stabilize falling economic growth in the face of the COVID-19 pandemic (IIF, 2023, 2024).

### 2.3.1 Interest Payment Costs on Debt

Recent high debt levels have revitalized the motivation to study the impacts of growing government debt on interest rates, inflation, and economic growth. In addition, how rising debt levels can influence financial markets also requires understanding about how public debt may have important implications for the asset prices in stock and bond markets. Debt or borrowing involves acquiring funds or assets with the promise of repaying them at specific dates in the future. Public borrowing specifically refers to the official commitment of a government to reimburse both the principal amount and the interest cost payable to individuals or entities who provide the funds, following a pre-determined schedule.

During the COVID-19 pandemic, governments' borrowing significantly rose to address the negative economic impacts of the pandemic. However, interest costs remained stable because of low interest rates. But, as inflation started to rise and peaked in the year 2022, the governments had to increase interest rates a number of times to control rising prices due to supply shortages and excessive consumer demand. These rate hikes put upward pressure on interest costs, leading to higher debt service payments on public debt securities.

According to the Congressional Budget Office (CBO) projections, interest payments on the USA public debt hit a record high in the fiscal year 2024, reaching \$881 billion. Annual interest payments on the U.S. treasury securities and other forms of government borrowing are likely to reach 3.2% of gross domestic product (GDP) in 2026 and would climb to 4.1% of GDP by 2035. The total interest payments on debt have already surpassed federal spending on basic services such as medical care and defense. In addition, these higher interest payments on debt also contributed to an increase of 6% in the total public debt in 2023 (Peterson Foundation, 2025). The borrowing costs of a government are closely related to the interest rates. As interest rates go higher, so do the borrowing costs. According to the Congressional Budget Office (CBO), the US government's net interest costs on public debt will be around \$66 trillion over the next 30 years, nearly 40% of the total revenues by 2052. American Enterprise Institute (AEI) warns that those costs could be even higher if interest rates continue to rise to 6 percent by 2052 (Peterson Foundation, 2022) . Therefore, an increase in debt can further increase the deficits in the coming years. As debt keeps growing, creditors become alarmed about the increasing default probability of the government.

By using fiscal policy tools, governments plan spending, financed by public debt or by adjusting tax rates, to drive the economy in a positive direction. By carefully calibrating public expenditures and taxes, policymakers can influence aggregate demand, employment levels, inflation, and overall economic growth. Typically, governments use fiscal policy in recessions or economic downturns to redirect the economy to a strong and sustainable path. The role of fiscal policy and its objectives became more significant when global economies faced the recent crisis, and governments introduced fiscal packages to mitigate the negative impacts of COVID-19 on productivity and economic growth.

For high public debt levels to be sustainable, the GDP growth rate ( $g$ ) of a country needs to be greater than the rate of interest ( $r$ ). Real interest rates remained historically low for a long time in many advanced economies. Until 2022, economically advanced countries with elevated levels of sovereign debt have been able to service their debt easily with low respective interest rates compared to their GDP growth rates. However, before the COVID-19 pandemic, nominal interest rates had already started rising from close to zero levels. In many advanced economies, the authorities held the interest rates low to maintain economic growth and keep the cost of debt servicing manageable. But it is important to recognise that interest rates do not (and cannot) remain low forever.

High public debts become risky as interest rates rise relative to growth, making debt servicing more difficult, requiring a big part of GDP in interest payments on debt. Persistent accumulation of debt entails increased risk of debt defaults, leading to financial crises that are costly and damaging for economies with higher debts and weak financial institutions (Kose *et al.*, 2021). High debt levels make an economy prone to a crisis emerging from a sudden shock and spreading rapidly. High public debt may impose limits on fiscal policy to address new challenges. Therefore, a vulnerable strategy of continuously rolling over the debt can make financial debt unsustainable and risky in the event of supply shortages, economic shocks, or crises.

On the other hand, public debt, a financial resource for a government generated by issuing minimal risk debt securities, may help governments affect economic growth positively by employing debt finance for productive purposes. For example, governments can increase spending on infrastructure, health, and education, which can assist in reducing costs, increasing productivity and income of individuals and organizations, resulting in overall increased productivity and economic growth in a country.

## 2.4 Government Debt Implications for Financial Markets

Public debt can affect financial markets via two main channels: First, growing public debt can increase country risk premiums because of the increased probability of default. Second, growing public debt can affect real economic activity (GDP growth rate) and other important economic and financial variables such as money supply, interest rates, inflation, exchange rates, unemployment, exports, etc. These variables, in turn, influence the financial markets (both debt and equity).

Growing public debt levels may increase the default risk of a country, forcing investors to expect a higher risk premium on their investments, which can result in lower equity market prices. A greater uncertainty and risk resulting from unsustainable public finances can cause interest rates to rise, which in turn can negatively affect a government's ability to service and refinance debt. Rising public debt can push inflation and interest rates upwards or depreciate currency value. To overcome inflationary pressures on the economy, governments use monetary policy and increase interest rates. Given the negative correlation between stocks and bond returns, investors shift their investments from equity to debt securities in rising interest rate environments. In addition, higher interest rates, when used as a discount factor to determine the value of equity securities, reduce the value of stocks.

According to classical economists, rising government debt may cause a fall in national savings, investment, and exports due to the crowding out of private capital. Expansionary fiscal policy increases consumption in the short term, but national savings, investment, and exports fall in the medium to long term. Smith and Ricardo, two prominent economists, argued that borrowing could lead to ineffective spending as it is an easily accessible source of finance. This, in turn, could result in a decline in the effectiveness of economic activities. According to these classical economists, such practices could lead to wasteful use of capital and create a burden of debt for future generations. They believe that public expenditure using public debt could be inefficient, which leads to passing on the debt obligations to future generations.

In the past, high debt episodes resulted in financial crises with wide-ranging spillover effects. For example, the Latin American debt crisis in the 1980s, the East Asian financial crisis in the late 1990s, and the recent financial crisis in 2008-09. Likewise, the recent increase in debt is a major concern for governments and corporations alike, as higher debt levels are associated with higher risk. This implies that high government debt can cause uncertainty in financial markets and is perceived as a risk factor, which is reflected in financial market asset prices. Intuitively, uncertainty is expected to increase volatility and risk premiums, thereby negatively affecting the economy and financial market returns (Arouri *et al.*, 2016; Kaminska and Roberts-Sklar, 2018; Sun, 2020; Wisniewski and Jackson, 2021; Addey and Nganje, 2023; Paule-Vianez *et al.*, 2023).

In recent high-debt environments, following the economic shocks caused by the pandemic and supply shortages, inflation has taken off, racing passed 10% at its peak in the US, the UK, and in most of Europe, during the year 2022 till the present time. With so much borrowed money chasing the same level of goods, it is no great surprise that prices started to accelerate. Though rising interest rates will start to bring that under control again, the government authorities also need to control debt levels for the smooth functioning of the economy and corporations. Additionally, it has fuelled up financial market asset prices, creating mini bubbles in internet stocks, cryptocurrencies, property, stocks, and bonds. Therefore, reducing government debt, deficits, and controlling the rate of growth in public debt is vital for price and growth stability (Checherita-Westphal *et al.*, 2024).

Public debt sustainability is one of the prime objectives of the International Monetary Fund (IMF). This objective holds significant importance for the IMF when making rigorous lending decisions that are economically and politically sustainable for an economy, keeping in view the potential shocks that can make public debt unsafe for the country.

The objective of debt sustainability significantly contributes to shaping IMF programs. For example, appraising the amount and timing of financial assistance, evaluating the member's ability to repay IMF debt payments, and deciding on appropriate policies and policy implementation directions. All these forward-looking evaluations can effectively be performed by having a broad understanding of the short and long-term relationships existing between growing government debt and GDP, inflation, interest rates, and financial asset prices (De Soyres, Kawai Eskimez and Wang, 2022). Furthermore, it is also important to understand how rising levels of government debt are associated with financial market returns in the short run and long run, because financial markets are central to economic growth. Without strong and stable financial markets and institutions, achieving the goal of economic growth becomes difficult if not impossible.

The global pandemic had negative effects on the world economy. Governments initiated various policy initiatives in response to falling economic conditions. Many countries implemented expansionary fiscal policies, which caused a remarkable growth in public debt levels. These policies funded through public debt proved effective in the short run and helped swift economic recovery. However, economists are of the view that increased debt levels may have adverse implications for economic growth in the medium to long term due to rising inflation, interest rates, and supply shortages.

## 2.5 Theoretical Perspectives: Keynesian and Ricardian Views

Keynesian economic theory states that government spending can stimulate economic activity in the short term. However, persistent fiscal deficits financed by issuing public debt securities can lead to adverse economic consequences in the long term. According to macroeconomic equilibrium principles, a decrease in domestic savings may result in reduced capital formation within the country, leading to increased reliance on foreign investment or foreign debt. The problem of reduced savings means higher interest rates, which can discourage investment and borrowing, thus hindering capital accumulation, essential for sustained economic growth.

Persistent deficits may also escalate interest rates alongside government debt levels, potentially crowding out private investment, leading to a decline in economic growth. Increased interest rates and increased debt levels threaten the debt sustainability of public finances. Additionally, lower economic growth and higher interest rates lead to inflationary concerns. While fiscal deficits may provide short-term economic stimulus, their long-term effects, such as reduced savings, increased interest rates, and limited capital accumulation, pose challenges to sustained economic progress. In line with this idea, empirical research shows that an increased supply of government debt securities harms the private sector debt financing. Graham et al. (2014) and Demirci et al. (2019) Provide evidence of the negative effect of rising debt-to-GDP ratio on corporate leverage, indicating negative crowding-out effects for an economy.

Similarly, Zhang et al. (2022) empirically examined the effects of state and regional government debt on corporate debt financing in the national financial markets of China during the period 2008–2019. In line with the neoclassical perspective, findings indicate a negative effect of both central government debt and local government debt on corporate debt financing. The issuance of government debt securities crowds out corporate bonds and corporate loans, providing evidence of crowding-out effects in debt market of China. These crowding out effects took place via a change in commercial banks' asset portfolio—increased investment in government bonds and reduced credit availability to nonfinancial firms and large corporations—because the debt securities issued (accompanied by federal government guarantees) by local government bodies are absorbed by local banks operating in China, leaving less access to finance for corporations (Zhang, Brookins and Huang, 2022).

In contrast to the Keynesian perspective of fiscal policy, the Ricardian theory states that fiscal policy may have no impact on aggregate demand and consumption and thus no impact on economic growth, as the government borrowing will reduce an equal amount of private savings of rational individuals and households. On the other hand, classical economists argue that government spending financed by public debt crowds out private sector activity and capital investment in the economy, and therefore, the effects will be weak and small in an economy with no unemployed resources.

By implication, the economic impacts of fiscal policy variables on the financial markets may be positive, negative, or have no effects according to the theoretical frameworks of Keynesian, Classical, or Ricardian, respectively. Therefore, how fiscal policy, in particular public debt, can impact financial markets needs empirical investigation. But the empirical evidence on the link between public debt and financial market returns is incomplete.

Research in the recent past has indicated the negative economic impacts of fiscal deficits on current stock market prices. For example, by using quarterly data of ten industrialized countries, Agnello and Sousa (2013) show negative impacts of innovations in fiscal deficits on stock prices and an increased sensitivity of equity and housing asset prices to fiscal policy shocks. Afonso and Sousa (2011) decompose the government budget deficits into separate components of revenues and expenditures to see the effects of fiscal deficits on financial market returns. Results show that government expenditure shocks are negatively associated with stock prices, while changes in government revenues are associated with small but positive impacts. Moreover, positive fiscal adjustments involving expenditure reduction policies have positive impacts on stock market prices (Alesina and Ardagna, 2013). Consequently, these studies show that financial markets tend to perform better when governments have a well-planned fiscal policy for economic and financial stability.

Intuitively, it seems reasonable to expect different effects of deficit financing (fiscal policy) depending on how authorities fund public expenditure, i.e., financed with taxes, public debt, or by monetizing the deficits. This means deficit spending financed by taxes is supposed to have different effects on the economy and financial markets in comparison to being financed by issuing debt securities, or monetizing the debt (by increasing the money supply).

According to the conventional fiscal dominance argument, domestic government debt may attract funds from foreign investors if the interest rate in the local financial market is higher than the interest rate in the international markets, leading to real currency appreciation due to increased demand for the currency. However, increased interest rates and growing government debt may increase the probability of default. In this case, public debt may lead to currency depreciation (Blanchard, Giavazzi and Sa, 2005). In turn, currency depreciation and rising interest rates put pressure on public debt, resulting in increased debt service payments. Gale and Orszag (2003) show that an increase in the deficits by 3% of GDP leads to a rise in interest rates by 60 to 180 basis points, with an average of 120 bps, which in turn affects financial asset prices because changes in interest rates are significantly associated with equity prices.

## 2.6 Monetary Policy, Fiscal Policy, and Financial Markets

The interest rate is an important monetary policy instrument that affects demand, production, and consumption in an economy because of monetary policy actions. Movements in interest rates may affect the firms' cost of capital, as well as cash flows, affecting market values of firms by changing the present value of their future cash flows due to a higher discount rate. This implies, higher interest rates or discount rates reduce the present value of future cash flows, leading to lower equity values in the market. On the other hand, a decline in interest rates may have positive impacts on consumer spending, economic productivity, and stock values of firms. This positive impact is in line with the traditional Keynesian view about public spending and interest rate impacts on the economy. Lower interest rates provide individuals and businesses with easy credit or access to money, boosting consumer demand & consumption, and higher investment & business productivity, helping the economy to grow. Businesses generate more cash flows from increased consumer demand and consumption, resulting in higher revenues and profits. In anticipation of future economic growth, more investment in the financial markets results in improved performance. In addition, low interest rates, when applied to discount the future cash flows of firms, also result in a higher market value of firms.

Finally, portfolio investment theory suggests that increased interest rates cause investors to re-allocate investment funds from equity securities to debt security markets—causing stock prices to fall. This portfolio balancing act is in line with Tobin's theory of investment, which assumes that investors adjust their investment allocations based on the profit/value maximization principle (Tobin, 1969).

### 2.6.1 Fiscal Policy and Financial Markets

One of the arguments for the fiscal policy effects is that fiscal expenditures, particularly during recessions, can impact the level of economic activity, which in turn affects financial markets. Three schools of thought (Keynesian, Classical, and Ricardian) offer theoretical explanations regarding the economic impacts of fiscal policy. The Keynesian school of thought argues for the essential role of fiscal policy for stabilizing unwanted economic fluctuations. For example, during the stages of economic recessions and depressions. Specifically, like automatic stabilizers, flexible fiscal policy works as a countercyclical approach, which may stimulate the economy and help it recover from recession.

In weak economic conditions, governments increase the money supply in the economy by implementing expansionary fiscal policy, either by increasing government spending on welfare programs, subsidies, or by income tax cuts. Each of these measures helps consumers and businesses to spend more money, leading to increased demand and consumption. The primary objective of expansionary fiscal policy is to prevent the downfall of the economy by stimulating economic growth during a recession or contractionary phase of the business cycle. Specifically, governments follow expansionary fiscal policy to prevent economic recession by stimulating demand and consumption and reducing unemployment. Finally, another important objective of expansionary fiscal policy is to restore consumer, investor, and business confidence in the government's ability to take necessary measures to end the economic recession in the country. However, expansionary fiscal policy can cause higher prices, leading to inflationary pressures on the economy and asset price bubbles.

In response to the 2008 financial crisis, monetary authorities around the world significantly reduced interest rates to near-zero to provide easy financing for spending programs to boost economic recovery. In addition to quantitative easing, U.S. policymakers injected hundreds of billions of dollars into the U.S. economy to boost domestic aggregate demand for the economic recovery and financial stability. Governments across countries implemented a similar expansionary fiscal policy during the recent COVID-19 pandemic. In addition to fiscal stimulus programs, governments across Europe and in the U.S. reduced the interest rates from 1.5%–1.75% to 0%–0.25% around March 2020 to prevent business closures and to support the halted economies. In this way, governments facilitated access to low-cost debt for both consumers and businesses.

### 2.6.2 Fiscal and Monetary Policy Interactions

Theoretical and empirical literature both emphasize the importance of exploring the combined impacts of monetary and fiscal policies on macroeconomic and financial variables. Exploring the combined effects of fiscal and monetary policy variables in a framework may help better understand the channels that transmit impacts on financial markets and the economy.

Fiscal policy variables may affect financial markets through their effects on monetary policy variables. For example, growing public debt can affect interest rates, inflation, money supply, or exchange rate (Muscatelli and Tirelli, 2005), or through the effects of fiscal policy variables on the macroeconomic variables, for example, exports, economic growth, or industrial production.

Generally, monetary and fiscal policy variables tend to move in opposite directions in their effects on the economy and financial markets (Melitz, 2000). For example, when both policies attempt to target an increasing rate of inflation in the economy by conducting countercyclical policies, each may become less effective in attaining its respective economic effects. In cases where the interest rate is already higher than the economic growth rate, a further increase in public debt may eventually lead to higher inflation due to persistent deficits and unsustainable fiscal policy. In this context, contractionary monetary policy or an increase in interest rates will have limited influence over inflation control. Accordingly, a government with a weak financial

position would make monetary policy less effective for controlling future inflation in the economy (Wallace and Sargent, 1981, p. 2; Buti, Larch and Balboni, 2009).

Given that both fiscal and monetary policies have their respective targets for the economy and the financial markets, for a broad understanding, it is essential to integrate both monetary and fiscal policy analysis into one framework that can capture both their individual effects and their combined effects (Afonso and Sousa, 2011). In addition, for the effective implementation of both policies, it is important to note that both policies should work in harmony in achieving a common goal, and the goals of the two policies should not conflict with each other (Dixit and Lambertini, 2000).

## 2.7 Studies on Public Debt and Stock Returns

High-debt countries pay a risk premium on debt financing as investors are risk-averse. This creates the possibility for a cycle of higher debt, leading to higher default probability and higher risk premia (Alcidi and Gros, 2019). The interest cost of debt goes higher at higher debt levels because there is more debt to service at a higher interest rate—the cost of each additional unit of debt (the marginal rate of interest) will increase. This interdependence between public debt and the debt servicing cost can have adverse implications, especially for high-debt countries. Therefore, high-debt countries pay a significant risk premium due to growing default probability.

Alcidi and Gros (2019) argue that it is straightforward to understand that a government pays more interest cost on additional debt because the marginal interest cost of public debt is much higher than the average interest rate on existing government debt. Therefore, incurring additional debt implies a higher risk premium because additional debt may increase the cost of refinancing the entire stock of public debt, leading to increased default probability.

Olivier Blanchard presented the concept that deficits and higher public debt can have positive effects for an economy if the rate of economic growth is higher than the rate of interest (Blanchard, 2019). Blanchard's idea is in line with the economic theory that infers that an increase in government debt, if used for development purposes, can be beneficial if the growth rate of the economy exceeds the interest rate (Diamond, 1965). The magnitude of the impact may significantly depend on several factors, including the main factor of the economic growth—interest rate differential.

However, as Blanchard also states, higher levels of debt entail higher risks. Recent research studies have found that after a certain threshold of debt, the growth effects of debt disappear as the marginal interest rate goes higher. Additionally, the debt servicing cost and default probability increase with the mounting levels of debt relative to GDP. Many earlier empirical studies, e.g. (Engen and Hubbard, 2005; Laubach, 2009; Alesina and Ardagna, 2013), as well as recent studies, e.g. (Jacobs *et al.*, 2020; Carnazza and Liberati, 2021; Nguyen and Luong, 2021; Liu, 2023; Olaoye and Olomola, 2023) reinforce that interest rate dynamics have profound implications for debt sustainability.

By using a simple definition of risk premium (the difference between the average interest rate on government debt and the risk-free rate) proposed by IMF (2017), the European Commission debt projections show that a 1% increase in the debt to GDP ratio above 60%, is associated with a 3 to 4 basis points increase in the risk premium. In addition, the direct negative effect of increased public debt can also cause an increase in the short and long-term real interest rate, leading to a decrease in interest-sensitive demand and consumption (Jacobs *et al.*, 2020). Another recent study supports the findings that countries with already high debt-to-GDP ratios before the COVID pandemic faced a greater perceived risk of default due to a significant increase in interest rates and hence increased risk premium in those countries (Carnazza and Liberati, 2021).

In the aftermath of the 2008-09 financial and economic crisis, volatility in financial markets has noticeably increased, particularly in equity markets and the debt markets of European Union (EU) countries. Rating agencies are one source of increased volatility in financial markets. However, other sources stem from financial variables that can cause variance or spread (second moments) in volatility and market returns. The important financial variables are part of the monetary and fiscal policy variables. Volatility in financial markets may ignite financial instability and uncertainty, as high volatility implies a higher risk perception of market participants. Moreover, increased volatility and market risk can have adverse effects on investment, output, and macroeconomic growth and stability.

However, as public debt levels increased during and after the financial crisis, creditors began re-evaluating default risks, expecting an increased risk of default and, as a result, demanding higher yields on government bonds according to the level of risk involved. Consequently, countries with high levels of debt struggled with debt restructuring and faced problems in reducing the debt servicing costs and the public debt burden. This asymmetric increase in sovereign risk premium initially affected Greece and had spillover effects on other countries, resulting in higher public borrowing costs for other crisis-hit countries. At the same time, countries such as Germany and Finland, with stable financial positions, were able to access finance at reduced borrowing costs, representing a flight to quality (Badarau, Huart and Sangaré, 2021).

Both past and recent research have empirically examined and measured risk premia on government debt securities, as well as the extent to which these premia can be significant. For example, Alesina *et al.* (1992) and Poterba and Rueben (1997) find that the interest yield on government debt depends on the levels of debt. Lemmen and Goodhart (1999) examined the yield data of government bonds in Australia, Germany, and Canada. Their estimations indicate that yield spreads show a positive association with the government debt-to-GDP ratio. Further studies by Alexander and Anker (1997), Lonning (2000), Copeland and Jones (2001) and Faini (2004) also, report a positive association between interest rates and government debt. Blanchard (2019) points out that when a government authority raises interest rates to target inflation in a country with enormous public debt, this may increase the cost of debt service along with the level of debt, resulting in increased default probability and country risk premium.

Afonso, Jalles, and Kazemi (2020) studied, by applying country-fixed effects OLS regressions, the impacts of different monetary and fiscal policy announcements on 10-year government bond yield spreads of 10 European member countries during the period from 1999 to 2016. The findings indicate a statistically significant association. Specifically, the European Commission's (EC) announcements of higher debt contribute to the rise, whereas better budget balance forecasts contribute to the decline of spreads.

The financial markets reflect fiscal policy risk in the asset prices. An increase in government expenditures (expansionary fiscal policy) can move stock prices upward, while shocks in government revenues do not significantly affect stock prices (Afonso and Sousa, 2011). Furthermore, unexpected changes in the government's fiscal policy may cause increased volatility in asset prices. In contrast, Tavares and Valkanov (2001) argue that fiscal policy significantly affects asset price volatility in the US. Findings further show that an increase in tax revenues significantly reduces expected returns on stocks, whereas movements in government expenditures have no significant effects on expected stock returns.

The default risk component of a bond premium in a country is highly dependent on the level of debt a country holds. There is ample evidence that fiscal risk is priced in the cross-section of bond returns (Bretscher, Hsu, and Tamoni, 2020). Fiscal policy risk is an important element of stock returns, bond returns, the term structure of interest rates, and currency exchange returns (Jiang, Richmond, and Zhang, 2022). Overall, literature suggests that fiscal policy risk has important implications for the returns on debt and equity securities. This supports the view that financial markets price fiscal policy risk, considering the rising public debt levels. For example, for assessing the impacts of fiscal policy (taxes) on equity markets, Arin et al. (2009) examined the effects of tax changes on stock market returns. Findings show that compared to labour taxes, indirect taxes have a stronger influence on equity market returns. Furthermore, since firms can easily switch from debt financing to equity financing, movements in direct corporate taxes have a small effect on stock market returns.

Empirical research has demonstrated a strong relationship between economic growth and stock market index returns. Building on these findings, if an increase in public debt leads to a decline in economic development, the reduced economic growth is likely to be associated with lower equity returns. Conversely, if public debt, through capital investments in infrastructure, contributes positively to economic growth, then its impact on equity prices is likely to be positive. Furthermore, if government debt does not contribute positively to economic development, yet stock market indices continue to rise despite increasing levels of public debt, this suggests the presence of other influential factors driving stock market performance.

### 2.7.1 Government Debt, Default Risk, and Risk Premium

Country default risk is an additional risk that investors face when investing in a foreign country rather than investing in the domestic financial markets. Therefore, investors require a country risk premium for the additional risk associated with foreign investment. The country risk premium tends to be higher for developing economies characterised by weaker economic and

financial conditions, heightened political risk, and greater uncertainty, compared to developed nations.

The risk premium is an important concept in finance and investment. It has important and varied applications in modern finance theory. Risk premium is a core factor in the Capital Asset Pricing Model (CAPM) for determining the cost of capital, forecasting the value and growth of portfolio investments, and deciding asset allocation between stocks and bonds. In principle, it is compensation for investing in an asset with uncertain cash flows and returns. The risk premium in equity securities implies that investors expect higher compensation for assuming extra risk involved in an asset and, therefore, are willing to pay lower prices for the same set of risky assets. When equity risk premium increases, the cost of equity capital moves upwards, attracting less investment in the economy, resulting in lower economic growth.

Investment opportunities in foreign countries accompany higher risk because of geopolitical and macroeconomic factors that must be considered in international investment decisions. In recent times, growing government debt levels have emerged as one of these risk factors. A higher level of public debt implies higher country risk due to an increase in the probability of default or higher future taxes on the income of individuals and businesses, as governments seek to generate sufficient revenue to meet debt obligations, including principal and interest repayments.

Investors assess the financial market risk of a country by comparing the volatility indices of the stock and sovereign bond markets. For this purpose, commonly used measures include the standard deviation of price movements over a period and a volatility index. The primary rationale behind comparison is that investors demand a high risk premium if a market exhibits more risk. Thus, if the country equity index market exhibits more volatility than the credit market, the country risk premium of the equity market would be higher, signifying that investors are likely to require a higher risk premium to invest in the country's stock market relative to the bond market, in line with a risk avoidance attitude.

The recent surge in fiscal deficits and public debt, resulting from expansionary fiscal policies during the COVID-19 crisis, has increased governments' and creditors' concern about fiscal sustainability. Past studies indicate that market participants perceive fiscal discipline as an important risk factor, affecting both debt and equity financial markets. Additionally, rising public debt can increase the country risk premium if additional debt accompanies increased default probability. Recent studies suggest that debt-to-GDP ratios are positively associated with equity returns in the short and long run (one quarter to five years horizons) across advanced economies (Liu, 2023; Ben-Nasr and Boubaker, 2024; Jiang *et al.*, 2024). Higher debt also positively predicts higher risk premiums on bonds, whereas it is negatively associated with risk-free rates. For example, Yang Liu (2023) argues that the debt-to-GDP ratio–asset returns relationship is statistically and economically significant. The risk premium on equity can range from 2.3% in periods of low debt and can reach up to 13.3% in periods of high debt. This implies that higher debt ratios lead to higher subsequent equity market returns. In addition, debt ratios are also positively associated with higher risk premiums on government and corporate bonds, but negatively affect 3-month treasury risk-free rates (Liu, 2023). This

association is evident in a century of economic data from the United States and five decades of data from various advanced economies.

Furthermore, high government debt levels can increase market crash risk. The premise behind this is that higher public debt levels as a percentage of GDP can increase market interest rates, leading to liquidity risk and lower stock prices (Ben-Nasr and Boubaker, 2024). Therefore, a country's growing debt level is likely to render the fiscal policy less productive, riskier, and ineffective. As fiscal policy can influence both the economy and the financial markets, investors perceive it as an important risk factor and reflect it in asset prices in the financial markets. However, the magnitude of fiscal risk may depend on the debt level of the government and its ability to service the debt. In the case of unsustainable fiscal policy, the fiscal risk can spread through the capital markets and the real economy by influencing interest rates, exchange rates, inflation, or other macroeconomic variables.

There are several channels through which risks can spill over from sovereign debt markets to the broader economy and capital markets. First, a weakening fiscal condition—driven by rising interest costs on public debt and low economic growth—signals increased government financing needs, which raises the risk of crowding out private investment from households and firms. Second, growing fiscal deficits may increase inflation expectations and inflation risk, thereby increasing country risk premia and long-term interest rates. The resulting increased interest rates lead to higher funding costs and increased risk premiums due to wider credit spreads.

Furthermore, consistent with the findings of Chernov et al. (2020), the U.S. credit default swap (CDS) spread increased from zero to approximately forty basis points following the 2008–09 financial crisis, reflecting a growing probability of default. This increase in sovereign credit risk can also affect the financial markets, as investors demand a greater risk premium amid heightened concerns about the possibility of a stock market crash in the event of a sovereign default.<sup>1</sup> In addition, a debt crisis may trigger broader fiscal stress, such as debt restructuring at higher marginal interest rates, increased taxation, inflationary pressures, and reductions in government expenditure—all of which may have adverse effects on consumers, businesses, the real economy, and financial markets.

An expected consequence of persistent deficits and an unsustainable fiscal policy is the potential increase in default probability and currency depreciation, leading investors to demand a higher sovereign risk premium. This can lead to capital outflows. Furthermore, currency depreciation not only amplifies the real value of foreign currency-denominated debt but also elevates interest payments on foreign debt. Moreover, depreciation may also fuel domestic

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<sup>1</sup> There are numerous sources of country risk, e.g. geopolitical and economic instability, economic risks such as recession risk, inflation risk, debt burden and probability of default risk, and currency exchange rate risk. In addition, changes in government regulations related to property, profit repatriation etc.

inflation, thereby necessitating further increases in interest rates to curb inflationary pressures, potentially setting off a self-reinforcing cycle of macro–financial instability (Egilsson, 2020).

Finally, the initial level of public debt plays a significant role in determining the effectiveness of additional debt as a fiscal multiplier, uniquely shaping its impact on consumers, businesses, and the broader economy. During periods of low debt, both GDP and consumption multipliers tend to be positive; however, they become negative once debt surpasses a certain threshold. As public debt rises, government spending may shift from being growth–enhancing to growth–impeding, contributing to higher risk premiums in financial markets.

The arguments presented above indicate that increased fiscal risk is associated with a higher risk premium demanded by investors as compensation for greater fiscal uncertainty. During periods of excessive public debt, the heightened probability of default or debt crises can render fiscal policy less effective and more unpredictable. This ineffectiveness stems from elevated interest payments on government debt and adverse fluctuations in exchange rates. These implications align with established debt theories, including those related to liquidity preference, the demand for safe assets, the crowding-out effect, and the debt overhang hypothesis. Consequently, such conditions have significant ramifications for capital markets.

Duan and Zhang (2014) investigated how changes in risk premiums can affect current stock prices. By using forward-looking risk premiums, the results confirmed that an increase in risk premiums increases the discount rate, which negatively affects current stock valuations. Empirical findings align with theoretical relationships, suggesting risk premiums go higher when markets become uncertain. The findings are also consistent with asset pricing theories and the widely accepted idea of risk aversion, suggesting investors demand more compensation for taking additional risks.

Likewise, several studies surveyed economists and investors to assess the magnitude of the forward-looking risk premium in an economy based on the volatility index and real interest rates. Graham and Harvey (2007) conducted a survey on chief financial officers of companies, the analysis of the responses indicated a positive link between market volatility and CFOs' risk premium expectations. In another survey, university professors suggested an average long-term risk premium of 6.3% in the USA market (Fernandez, 2009). During the euro area (EA) sovereign debt crisis, Greece, Ireland, and Portugal faced an unexpected and sharp rise in long-term interest rates as a result of an upward movement in sovereign risk premia for the increasing probability of default (Badarau, Huart and Sangaré, 2014). Sovereign default risk premium increased because of already high and further rising government debt, strong prospects of economic slowdown, and increasingly weak financial positions of banks (Mody and Sandri, 2011). Furthermore, the overreaction of lenders in financial markets increased volatility risk, making conditions even worse.

In the past decade, advanced countries in Europe were able to pay exceptionally low long-term interest rates and extremely low yield spreads on government bonds for years, despite varied levels of public debts and weak macroeconomic performance across member countries.

However, recently, European countries have been paying different interest rates depending on the degree of the public debt level—countries with higher default risks paid high-risk premiums due to high debt. The strong correlation between the degree of public debt and the spread between public and private rates of return on debt securities suggests that the market participants sensitively incorporate debt default risks in the prices of securities.

## 2.8 Public Debt, Economic Growth, and Stock Returns

This section presents an overview of the research studies examining the impact of government debt on economic growth. The next subsection presents a summary of the theoretical and empirical relationship between economic growth and financial market returns. While insights about the impact of rising country debt levels on economic growth rates are essential for understanding debt sustainability implications, studies have found inconsistent results on the direction and strength of the relationships with no uniform threshold level of debt. Recent research has shown that public debt effects on economic growth are country and time-specific, affected by unique country and time-specific (business cycle) factors.

A nation's economic policy framework is aimed at keeping the economy on a positive and stable economic growth (GDP), which is the most monitored economic indicator. Economists use several indicators to measure economic activity reported in the empirical literature. The widely used measures are GDP, industrial production, gross national income, real consumption and investment, employment level, and real wages. Gross domestic product (GDP) is a standard monetary measure of economic activity and growth because it incorporates the nation's entire economic output in each period. GDP consists of the monetary value of all the products and services that individuals, organizations, or businesses in a country produce for sale either domestically or overseas. Real GDP, after subtracting inflationary effects or by applying the GDP deflator, is a reliable indicator of economic growth. Normally, the GDP growth rate refers to the real GDP.

### 2.8.1 Public Debt and Economic Growth: Theoretical Insights

Theoretical research highlights that when a country is already burdened with a high level of debt, the existence of this debt overhang hampers the country's ability to smoothly issue additional debt due to concerns about potential default, which subsequently hurts economic growth prospects (Myers, 1977; Woo and Kumar, 2015). Models that focus on the idea of overlapping generations illustrate that elevated debt levels have negative outcomes on growth (Miller and Modigliani, 1961; Diamond, 1965; Blanchard, 1985). Elevated debt levels can alter expectations about growth, inflation, or currency valuation. Furthermore, they can introduce uncertainty in the economic outlook, financial markets (Cochrane, 2011), influence sovereign yield spreads (Codogno, Favero and Missale, 2003), and manipulate real interest rates, leading to decreased private investment in trade and business (Laubach, 2009).

The conventional wisdom about the effects of public debt assumes short- and long-term implications. In the short run, public debt has positive aggregate demand effects, whereas in the long run, government debt may create crowding-out effects, causing reduced economic activity (Heimberger, 2023). During economic downturns, increased government budget

deficits and spending stimulate the economy by raising the disposable income of households. This increase in consumer income and wealth helps grow aggregate demand in the economy. This short-run effect of public debt and deficits is consistent with the Keynesian school of economics. However, in the medium to long run, fiscal deficits and persistent public debts may increase interest rates, crowd out private capital, and reduce investment, resulting in reduced output and economic growth. In addition, persistent public deficits may lead to currency depreciation, which can negatively affect a country's trade balance by reducing the value of exports. Growing public debt may also cause higher inflation, further dampening economic activity and growth (Ash, Basu and Dube, 2017; Onofrei *et al.*, 2022).

Considering the initial level of public debt, growing debt levels may have positive or negative impacts on economies. Rising government debt can have significant negative effects on economic growth, particularly if it raises uncertainty, risk, and expectations of inflationary pressures (Cochrane, 2011). However, rising government debt at an initial stage, where the debt-to-GDP ratio is significantly lower than a certain threshold level, such as 50% of GDP, may initially achieve long-run economic growth by investing debt finance in productive means (DeLong and Summers, 2012; Fazzari, Ferri and González, 2023). Endogenous growth models also suggest similar implications, in line with Keynesian view of positive effects of government debt on economic growth during the growth phase of the business cycle, provided the debt is used for productive capital projects (Aizenman, Kletzer and Pinto, 2007).

Theory suggests that nonlinearities could arise in the relationship between debt and economic growth, because rapidly increasing government debt starts exerting negative impacts on growth due to declining marginal growth rates (Krugman, 1988). To assess non-linearities, Ghosh *et al.* (2013) formally formulated a theoretical model to incorporate non-linearities in the public debt–economic growth relationship, after a certain threshold point where public debt starts exerting negative impacts on growth. Empirical research studies investigated the presence of a threshold level in the public debt–economic growth relationship. However, the findings fail to identify a uniform threshold for countries with distinct economic and financial conditions. If certain countries exhibit a nonlinear relationship between government debt and economic growth with a certain tipping point beyond which economic growth starts declining, it would be interesting to note if a threshold level also holds for financial markets. In other words, after a certain level of debt-to-GDP ratio, if economic growth declines, do the financial market returns decline too?

Several factors may underlie the nonlinear relationship between public debt and productivity growth, potentially flattening or reversing the impact of government debt. For example, non-linearities may arise when a high level of public indebtedness is associated with a higher marginal cost of interest on debt, requiring a big part of the GDP on debt servicing. In addition, a decline in growth due to crowding out of private capital or use of debt finance in less productive sectors of the economy can also cause nonlinearities (Alesina, De Broeck and Prati, 1992). Furthermore, the government's inability to generate additional debt at normal interest rate conditions can introduce non-linearities because if the government can generate additional public debt at a marginal interest cost that is higher than it has been paying in the past. In this

case, higher debt levels may change the growth trajectory of economic growth in times of financial distress. Therefore, higher marginal interest costs on rising debt levels can limit a government's ability to effectively use expansionary fiscal policy for the most productive projects. Finally, growing debt levels can have a non-linear impact on economic productivity and growth when the government is already in financial distress and is unable to pay back existing debt and interest costs. In such cases, a higher debt-to-GDP ratio can dampen economic growth because the economy is already in financial distress (Proaño, Schoder and Semmler, 2014).

Checherita & Westphal et al., (2014) argue that, to prevent the negative impacts of growing debt on economic growth, governments should only use public debt for spending on capital investments capable of generating returns greater than the interest cost of debt. In addition, private investors should be involved in these capital investment projects, and the optimal level of debt-to-GDP ratio should be determined based on the public and private capital ratios. The model suggests that the optimal level of debt-to-GDP will maximise economic growth depending on the productivity of the capital stock. However, this theoretical result hinges on the assumption that all or most of the public debt goes to productive capital projects. When this is not the case, for example, if governments use debt for purposes such as wars or to pay interest costs on debt, public debt may have adverse impacts on the economy.

### 2.8.2 Public Debt and Economic Growth: Empirical Findings

The debate surrounding rising government debt and economic growth remains a dynamic field of study. Studies have explored the impact of fiscal debt on economic growth; however, the findings are varied and inconclusive. Some studies report a positive association, others report negative impacts of government debt on GDP growth, whereas some show no association.

Growing debt levels and the resulting financial crisis of 2008-09 attracted extensive research attention on the subject of rising debt and economic growth (Reinhart and Rogoff, 2013; Panizza and Presbitero, 2014; Amann and Middleditch, 2020; Law *et al.*, 2021; Asteriou, Spanos and Trachanas, 2024). The significance of rising debt for the GDP growth rate and other macroeconomic factors has further increased as continuously rising public debt levels become a financial burden for the governments of both emerging and advanced economies.

An unexpected increase in public debt implies reduced future savings as governments increase future taxes to repay the debt from the income of future generations. This reduction in future savings may drive up the interest rate, subsequently reducing the incentive for investments. This lower level of investment leads to a decline in capital accumulation, thereby exerting downward pressure on overall economic growth. Consequently, based on endogenous growth models, it's generally observed that excessive public debt may have long-term adverse impacts on future economic growth (Barro, 2020; Yimer and Geda, 2024).

From an empirical perspective, Barro (1996) finds that an unexpected increase in public debt can influence both output and unemployment. However, the extent of this impact tends to be less pronounced compared to shocks emanating from monetary policy. Lo & Rogoff (2015)

report that in response to mounting debt levels, governments strive to increase primary surpluses or run smaller deficits as corrective measures to sustain financial stability and GDP growth. The influential study by Reinhart & Rogoff (2010) asserts that high levels of government debt hinder growth, particularly when the debt limit surpasses roughly 90% of GDP. They pointed out that the economic growth rate falls by 2.3% when the debt level surpasses 90% of a country's GDP.

Alesina et al., (1992) argued that expanding government debts may trigger fiscal risks after a certain point. Mounting government debt may not only affect a government's credit standing, but it can also increase default probability, leading to macroeconomic risks such as currency depreciation, inflation, high interest rates, and higher capital flow out of the country. Based on these findings, a debt level exceeding 90% of GDP can trigger fiscal risks and reduce economic growth, which in turn can negatively affect stock market returns.

Based on macroeconomic data, empirical research offers two major observations about the link between government debt and growth. First, the literature indicates that the linear association between public debt and economic growth can be positive, negative, or no association. In addition, the causal relation may run from debt levels to growth or vice versa. Second, there is a certain threshold point of debt ratio beyond which government debt has significant negative effects on growth prospects. However, in this respect, too, the empirical evidence is inconclusive in finding a uniform threshold level.

Several earlier studies report a negative cause-and-effect relation between debt and growth (Cecchetti, Mohanty and Zampolli, 2011; Afonso and Jalles, 2013; Afonso and Alves, 2015). However, due to the endogenous nature of both variables, there may be other factors jointly affecting the relationship. In addition, though economic theory assumes a causal relation running from debt to growth, the reverse causality also exists in empirical data, when weak economic conditions may be responsible for the rising public debt.

Kumar and Woo (2015), addressed the problem of reverse causality by incorporating the lags of the debt variable and endogeneity issues by applying the GMM estimation approach with suitable instrumental variables. By using large panel data of over 40 years, they examined the association of high debt with long-run growth for the panel of advanced and emerging market economies. Findings indicate that high initial public debt levels are significantly associated with slower growth, largely because of a slowdown in labour productivity and slower capital accumulation.

Similarly, to control for the endogeneity problem, Panizza and Presbitero (2014) employed exchange rate as an instrumental variable in place of the lags of public debt or lags of economic growth, because a big part of the debt is denominated in foreign currency, and changes in the exchange rate can change the total nominal value of government debt. In this way, after controlling for the endogeneity problem of debt and economic growth, the findings report no causal effect of public debt on economic growth.

However, by using panel data analyses, several studies found a significant negative relationship between debt and growth, particularly for countries with debt ratios above a certain threshold (Reinhart and Rogoff, 2010; Cecchetti, Mohanty and Zampolli, 2011; Baum, Checherita-Westphal and Rother, 2013).

Panizza and Presbitero (2013) surveyed the literature on empirical studies examining the relationship between debt and growth. The review highlights the point that cross-country variations significantly affect the public debt–growth relation and are subject to changes over time for the same group of countries. The review reports a diverse set of results with positive, negative, and no association as well as linear and nonlinear relations between fiscal debt and economic growth.

Finally, a meta-analysis study by Philipp Heimberger (2023) reports that, while there is ample literature examining the effects of growing public debt levels on GDP growth, the literature points to conflicting results. By using meta-regression analysis on 826 regression estimates, the overall results suggest the unweighted mean of a 10% increase in debt-to-GDP ratio leads to a 0.14% decline in annual growth rates, at a 95% level of confidence. The meta-analysis further highlights that after removing the effects of endogeneity of public debt and growth, the estimations lean towards the positive side. Finally, the study does not find a universal debt-to-GDP threshold ratio partly because of data sensitivity and econometric choices. These findings imply a further exploration into the growth effect of higher government debt on the economy and financial markets.

There is also a difference in the way anticipated and unanticipated macroeconomic factors affect certain target variables. If financial markets are efficient, investors immediately incorporate anticipated movements in macroeconomic variables into the security prices. Therefore, only the unanticipated movement is the relevant part of a variable to observe the relational effects. A recent study estimated the impact of an unanticipated increase in government debt—using government debt forecast errors as a proxy representing exogenous changes in debt—on the real GDP growth rate and found a negative impact on growth. The sample data consisted of gross public debt for 178 countries over the period 1995-2020. Findings indicate that positive shocks in government debt significantly reduce real GDP growth at the 3-year horizon. Specifically, countries observe negative growth in response to shocks in the debt-to-GDP ratio when the initial debt level is already higher, with rising debt trends over the past 5 years. In contrast, the negative effect fades out or becomes positive if countries are in the initial growth stage (De Soyres, Kawai Eskimez and Wang, 2022).

Similarly, Cecchetti et al. (2011) report that a 10% increase in the debt-to-GDP ratio is negatively associated with a 0.10% decline in the economic growth rate. The economic significance of estimates increases after the debt threshold level of 85% of GDP. Checherita-Westphal & Rother (2014) estimate that after the debt level goes beyond 90 to 100% of GDP, the negative effects of growing public debt emerge, and the non-linearity appears in the relationship. Similarly, Baum et al. (2013) report significantly positive effects of public debt on growth only in the short run or at lower debt levels, but no growth effects and statistically insignificant results emerge as the debt level approaches 67% of GDP and goes higher.

Specifically, countries with greater than 95% of debt-to-GDP ratios observe slow or no growth with additional debt. Beyond 95%, a 1% additional increase in the debt ratio negatively affects the economic growth rate by 0.06%.

Notably, different research studies report different threshold levels, for example, Afonso & Jalles (2013) estimate the debt threshold level at 58% of GDP for the Euro area countries, but a higher threshold level at 79% of GDP for emerging economies. Similarly, Egert (2015) shows that the nonlinear impact of growing debt levels on economic growth is very sensitive to the econometric modelling approach selected. Study reports that nonlinearity in the relationship between debt and growth emerges at a much lower threshold level of debt-to-GDP ratio of 20% to 60%. Furthermore, the study highlights that the sample period, data frequency, the number of observations available to estimate the nonlinear relationship, and country characteristics significantly affect study findings.

Finally, Pescatori et al. (2014) examine the impact of debt levels on future real GDP growth and report that there does not exist any single threshold point of debt to GDP beyond which growth prospects are negatively affected. However, most studies contend that increasing government debt does restrain GDP growth beyond a certain point, depending on the country-specific characteristics. Heterogeneity of the countries, the sample period selected, and the econometric methodology applied also significantly affect the estimated parameters representing the debt-growth relationships. For example, higher government debt has negative economic growth effects, mainly for nations with low democratic government structures (Kourtellos, Stengos and Tan, 2013). In addition, negative growth effects of public debt appear only in some euro area regions and in unsustainable debt periods (Dreger and Reimers, 2013), whereas in industrialized countries, public debt has positive growth effects until sustainable debt levels.

Another research study, based on panel data, investigated the long-run relationships between public debt and economic growth. Findings show supporting evidence of a negative link between growing government debt and GDP growth in the long run, but results show the nonexistence of a uniform debt-to-GDP threshold across countries because of heterogeneous country conditions (Eberhardt and Presbitero, 2015). In a different study, Liaqat (2019) employs a Vector Autoregression (VAR) approach to examine the link between national debt and output growth across 39 developed economies with high per capita income during the period spanning 1980 to 2017. The findings indicate a nonlinear negative relationship between the variables. Additionally, estimates show systematic differences in the significance of cause-and-effect relations across countries. Similar findings emerged from several other studies (Bell, Johnston and Jones, 2015; Bentour, 2021; Gómez-Puig, Sosvilla-Rivero and Martínez-Zarzoso, 2022).

Reinhart, Reinhart & Rogoff (2012) also examined the impact of government debt on economic growth via the interest channel. Study results indicate that countries with significant debt buildup do not always face an increase in market interest rates. Authors argue that if an increase in public debt is positively associated with interest rates, it implies that growing government

debt negatively affects economic growth via the interest rates channel. However, a rigorous econometric approach is needed to establish a cause-and-effect relationship.

Jacobs J. et al., (2020) examine the direction of causality in the debt-growth relationship by using a panel VAR model for 31 EU and OECD countries. Results indicate that, irrespective of the size of the government debt to GDP ratio, the study reports no evidence of causality running from government debt to output growth. Instead, findings show a reverse causality link from growth to government debt. Results indicate that high-debt countries need to acquire more debt due to declining growth. Furthermore, the negative impact becomes significantly stronger because of an increase in the long-term real interest rate, resulting in high debt servicing costs. This, in turn, negatively affects demand and interest-sensitive consumption, leading to reduced productivity and economic growth, forcing governments to increase taxes or acquire additional debt to meet the budget deficits.

Another recent research study shows that government debt accelerates output growth if the cost of investment funded by debt is less than the productivity generated from this investment. This lower cost than the productivity level is achievable when governments make a unique optimal share of investment in technology, human, and physical capital that can generate more output than the cost of investment. Moreover, if the productivity gain starts declining after reaching a tipping point, then there exists a certain threshold level beyond which the interest cost of debt exceeds the productivity gains, where additional government debt may exert negative impacts on growth (Tran, 2021).

Theoretical arguments state that the debt repayment ability of a country becomes weak, as sufficiently high public debt levels require a large part of government revenues for principal repayment and interest cost on the debt. This situation occurs when interest rates increase along with increasing debt levels. High interest rates further increase the marginal cost of additional debt, leading to lower economic growth by negatively affecting capital investment, consumer demand, and consumption. Though theoretical arguments strongly support the idea that higher interest rates negatively affect growth rates, empirical findings are still inconsistent.

### 2.8.3 Economic Growth and Stock Returns

The following paragraphs explore the economic growth and financial market return relationships. Many research studies have investigated how economic growth may impact the financial markets of an economy.

Fiscal changes can affect not only stock market performance but also have significant implications for price volatility. Tavares and Valkanov (2001) show that fiscal policy measures in the US significantly affect asset prices and volatility. Findings indicate that an increase in tax rates significantly reduces expected returns on stocks, whereas movements in government expenditures have no significant effects on expected stock returns. In addition to expected movements in fiscal policy measures, unexpected changes in the government's fiscal policy cause increased volatility in asset prices (Afonso and Sousa, 2011).

In a recent study, Ma et al., (2022) investigated the stock market returns' predictability performance based on macroeconomic attention indices. Out of eight macroeconomic variables, the four factors consisting of GDP, inflation, oil price, and unemployment appeared significantly better predictors. Given that government debt has significant implications for GDP growth, inflation, and unemployment, it is reasonable to assume that growing government debt is likely to have significant effects on financial markets.

Wasserfallen (1989) investigated the effects of economic activity and growth on stock price indices for major advanced economies. Results indicate that stock returns are positively associated with real economic activity, output, and growth. Higher economic productivity and growth increase the profitability of firms, boosting stock prices. Similar findings have been reported by many other research studies, e.g. (Smajlbegovic, 2019; He *et al.*, 2020; Baker *et al.*, 2021; Ozili and Arun, 2022).

Governments attempt to stimulate growth either by spending more (fiscal expansion) or by cutting taxes, or by both. When government spendings exceed tax revenues, the governments face deficit spending. Persistent deficit spendings eventually lead to higher public debt. Much of the empirical research evidence indicates that as debt levels reach 90 to 100% of GDP, economic growth slows down. In line with a risk avoidance attitude, international investors perceive higher debt levels as unsafe and stop investing funds in a country with an increased risk of default due to an alarming debt ratio, increased inflation expectation, or currency depreciation.

Economic growth reflects an increase in the real value of an economy's products and services, which helps businesses grow their output, sales, and profits. That incentivises companies to invest more capital and hire more employees. As more jobs are available, unemployment levels fall, and aggregate consumers' incomes rise. Consumers have more money to buy additional products and services. Thus, consumer demand for products and services rises as well.

Overall, assuming government debt is positively associated with growth, a growing economic activity helps boost the productivity and profitability of firms, thereby causing positive stock price movements. The stock market efficiency hypothesis assumes that security prices reflect all available public information. By implication, if public debt and deficits help grow economic activity, which in turn, positively affects stock prices, this implies any expected and unexpected information related to public debt is supposed to affect equity market prices either directly or indirectly. This would also imply that government debt, by affecting economic growth (as an intermediary channel), is indirectly related to equity market prices, in addition to its direct effects on financial markets.

## 2.9 Government Debt, Inflation, and Stock Returns

This section reviews research studies examining the association between government debt and inflation and between inflation and equity market returns. The insights on these relationships helps explain how public debt may be associated with equity market returns through the inflation channel.

Despite the existence of a vast body of earlier and recent research literature on the relation between debt and inflation, it is difficult to find a clear answer from theoretical or empirical studies exploring the economic effects of government debt and deficits on inflation and inflation expectations (Darrat, 2000). Sargent and Wallace (1981) point out that inflation behaviour is highly dependent on the way budget deficits are financed and used—that is, financed by public debt or monetized and used for capital projects or spending only.

The deficit financing sources raise two related but divergent questions: first, if governments fund the deficits by monetizing, do monetary expansions cause inflation? Second, if governments fund the deficits by public debt, is public debt the cause of inflation? Researchers have been investigating both questions to understand the public debt–inflation processes (Wallace and Sargent, 1981).

The widespread financial and economic crises, such as in 2008-09 and the COVID-19 pandemic in 2020, have driven global debt levels higher. For many advanced and emerging countries, both public and private debt have risen to the highest levels as a result of the large fiscal packages introduced by the governments to counter negative economic effects and support economic recovery. However, high and growing public debt levels pose serious questions about their macroeconomic effects on the economic and financial health of countries. For example, an important concern is that high public debt levels may limit government spending capacity in times of economic recessions due to unexpected economic shocks (Leeper and Leith, 2016; Cochrane, 2021).

Following the coronavirus pandemic, the economic recovery brought a sharp increase in inflation in many parts of the world. This sharp increase in inflation has initiated renewed interest in understanding the behaviour and determinants of inflation expectations during the times of natural calamities, and a growing public debt environment, resulting in a rapidly growing body of academic research in this field (Weber *et al.*, 2022). This post-pandemic rise in inflation, interest rates, and public debt has important implications for understanding the broad-based economic effects of public debt in the event of unexpected shocks (Lian, Presbitero and Wiriadinata, 2020; Rogoff, 2021; Weber *et al.*, 2022).

Rising interest rates, inflation, and extensive government borrowing may harm macroeconomic and financial stability, especially in the case of underdeveloped economies with fragile economic and financial positions. In order to diminish the negative impacts of the pandemic, though such borrowing was inevitable in supporting the world economy and a robust recovery, it is important to evaluate how increased borrowing may affect other key macroeconomic variables such as stock market prices, inflation, interest rates, exchange rates, and future economic growth. In particular, understanding economic mechanisms linking growing public debt to inflation and to asset prices is important for assessing the equity market risks emanating from public debt–induced inflation.

### 2.9.1 Theoretical Relationship between Public Debt and Inflation

Academic research reports different reasons for inflation. According to the proponents of monetary economics, a change in the money supply can cause inflation to change. The quantity

theory of money supply maintains that monetary expansion can increase actual output and prices in the short run due to multiplier effects, but only increase prices in the long run (Friedman, 1995). However, recent research provides evidence that not only can money supply cause inflation, but fiscal deficits and public debt can also cause inflation (Lin and Chu, 2013; Nastansky, Mehnert and Strohe, 2014).

Similarly, Kwon et al. (2006) assert that, in addition to monetary aggregates, the fiscal theory of price level (FTPL) posits that the wealth effect of public debt is the main cause that drives inflation. As opposed to the quantity theory of money supply, FTPL states that the fiscal policy variables, consisting of public debt and taxes, are the only main variables that directly determine inflation in an economy. Therefore, the quantity of money supply is an indirect cause of inflation (Bassetto and Cui, 2018). By implication, FTPL strongly advocates the use of fiscal policy to control inflation in place of monetary policy. This theory proposes that the government is not likely to default on its debts, because the debt can be inflated away when a government cannot pay its debt from tax revenues (Cochrane, 2021). In addition, the argument that fiscal policy is the primary cause of inflation seems reasonable because the interest payments on government debt are inflationary (Cochrane, 2021).

In line with FTPL and recent persistence in inflation after the current fiscal packages in response to the pandemic, contemporary research studies highlight the significance of fiscal expansion in driving inflation (Jacobson, Leeper and Preston, 2019). However, some scientific findings maintain the idea that fiscal debt can have a neutral effect on inflation, especially in cases where the debt levels are low and interest rates are near the zero bound. This latter argument is in line with the Ricardian equivalence hypothesis (Barro, 1996; Aimola and Odhiambo, 2021). Studies that support the view of a positive association between growing debt levels and inflation argue that debt and deficits increase interest rates, which require high interest payments on debt, resulting in an increased quantity of money supply. Thus, deficits cause inflation by necessitating a higher monetary growth rate (Afonso and Ibraimo, 2018). Saleh and Harvie (2005) argue that deficits cause inflation through the channel of increased money supply when central banks purchase government debt securities to fund government spending on public expenditures, thereby increasing money supply and thus the price level. Similarly, modern empirical research indicates that both monetary factors and fiscal policy variables may cause inflation. Accordingly, changes in the government debt may cause movement in inflation, even after controlling for the effects of monetary policy interventions (Assadi, 2015).

According to the Ricardian equivalence viewpoint, rational consumers do not increase their spending as a result of current tax cuts because they expect future tax hikes in anticipation of the repayment of deficit financing. Therefore, tax cuts may not change the purchasing power or wealth of economic agents, and their consumption expenditures on goods and services do not increase. Thus, fiscal deficits may not affect aggregate consumer demand, the level of interest rates, and inflation in an economy because current tax cuts are offset by future tax hikes. In line with the above argument, Barro (1996) supports the Ricardian hypothesis and points out that the total wealth of households is not affected by changes in taxes or debt

financing. Therefore, increased government deficits do not increase inflation, with no effects on the economy. Instead, inflation in the economy may cause government deficits to grow.

As opposed to the Ricardian hypothesis, Vamvoukas (1998) posits in line with Keynesian theory, that economic agents perceive an increase in their private wealth due to the additional income from interest rates they receive by holding government bonds, giving them increased purchasing power for additional consumption. The resulting increased consumption requires more supply and production, which leads to higher profitability of firms and higher employment in the economy, resulting in higher national income derived from interest earnings, increased profitability of firms, and employment in the economy. In turn, higher national income can cause inflation in the economy due to increased demand for money.

Bianchi, Faccini, and Melosi (2023) propose a new class of general-equilibrium model to explain the implications of fiscal policy for persistent inflation. The estimated quantitative model shows that large parts of inflation dynamics come from fiscal expansion. The authors point to the evidence that in the aftermath of the recent pandemic, although fiscal spending sustained economic recoveries, it also caused a persistent increase in inflation.

The relationship between public debt and inflation can be characterised as either direct or indirect. When the central bank of a country purchases government bonds, the public debt may have a direct effect on inflation because the debt–money provided by the central bank to the government will chase the same amount of goods and services available, driving prices higher. In contrast, public debt may indirectly affect inflation when the private sector is the buyer of government bonds or when inflation expectations increase due to growing levels of public debt. These direct and indirect channels are akin to the main channels of monetization and the wealth effect channel identified by Kwon, McFarlane & Robinson (2006). This implies that, in certain conditions, evidence of a statistical association between government debt and inflation cannot be precisely determined, i.e., whether the monetization of public debt or the wealth effects of public debt is the cause of inflation. The wealth effect presents an additional channel that may affect inflation because of fiscal stimulus, and this effect is in line with the views of classical and Keynesian perspectives.

In addition, when debt finance chases a certain quantity of products and services available in the economy, this additional debt finance may increase the quantity demanded than the available supply of products and services, creating the output gap and a higher price level in the economy. However, public debt may negatively affect inflation in the long term if governments use debt financing for infrastructure development and invest in capital projects to improve productivity and reduce production costs.

### 2.9.2 Empirical Studies on Public Debt and Inflation

Empirical evidence, like theoretical arguments, lacks consensus on the direction (positive, negative, or no effect) and causality (running from public deficits to inflation or from inflation to deficits) of the relationship between government debt, deficits, and inflation. Empirical research examining the association between fiscal debt and inflation offers inconclusive findings. The possible reasons could be the use of different data sets, estimation techniques,

and different sample countries with distinct economic conditions. A highly referenced seminal empirical work on government debt and inflation was the research by T.J. Sargent and N. Wallace (1981). Following the line of research, many other researchers conducted empirical studies to explore how monetary and fiscal policies can affect inflation.

For example, Davig, Leeper, and Walker (2011), Ferrara et al.,(2021), Klein & Linnemann (2023) and Caldara & Kamps (2017) find that fiscal spending shocks have an inflationary impact on the prices, while Ricco et al., (2016), Jorgensen and Ravn (2018), and Alessandro et al.,(2019) find that public spending produces deflationary pressures in the economy. However, the main theoretical frameworks, including Real Business Cycle and Keynesian theories, argue that government spending shocks have inflationary effects on the economy.

Overall, empirical literature shows conflicting views on the effects of fiscal debt on inflation. Karakaplan (2009) empirically examined how external fiscal debt affects inflation in countries with open and advanced financial markets. The study indicates that the inflation determinants are different across different countries due to heterogeneous characteristics. Empirical findings show no significant impacts of external debt on inflation for economies with advanced markets and financial institutions. In addition, results also suggest that fiscal debt–inflation relationships are not homogeneous and cannot be generalized across countries (Karakaplan, 2009, p. 215).

In contrast, in a seminal study, Sargent and Wallace (1981, pp. 6–7) point out that an economy where government taxes and spending are exogenously determined, debt–financed deficits are unsustainable because the deficit is expected to be monetized by the government—increasing the money supply and leading to inflation in the long run.

For example, M. Taghavi (2000) examined how fiscal debt may affect inflation in the four large and developed European economies—Germany, the UK, France, and Italy using the Vector Auto Regression framework. Study findings indicate that growing public debt increased price levels in the long term, with a three to five-year lag of public debt, positively affecting inflation over the period from 1970 to 1997. However, in the short term, public debt reflected no inflationary pressure in the case of these economies. Overall, all four economies observed inflationary pressures after government debt shocks in the long run.

Kwon et al. (2009) investigated the relation between debt and inflation, by splitting a panel of countries into advanced and developing economies based on the World Economic Country Classification, and further categorizing them into net debtor and net creditor countries. Findings show that the government debt has significant positive effects on inflation in the case of already highly indebted weak economies, but no significant effects in the case of advanced economies. The findings are coherent with the findings of many recent research studies and are in line with the fiscal theory of the price level, e.g. (Romero and Marín, 2017).

Similarly, the analysis of the panel data of 52 net debtor countries for the period 1961–2015 indicates that a further increase in fiscal debt increases inflationary pressures for the countries with already high government debt (Romero and Marín, 2017). To examine whether the

monetary factor (quantity of money supply) is the only cause of inflation or whether government debt also plays a role in influencing inflation, the authors used a panel VAR model involving public debt, money supply, inflation, and economic growth variables in the analysis. The estimated results confirmed that, in addition to the significant impact of money supply on inflation, an increase in the debt ratio is also strongly associated with high inflation. This relationship is particularly economically significant in the case of highly indebted developing economies. On the contrary, findings show that fiscal debt is not inflationary for developed economies.

A similar study by Janssen, Nolan & Thomas (1999) examined how fiscal policy factors may influence inflation movements in the context of the United Kingdom. The results of the Vector Auto Regression (VAR) model indicated an insignificant role of public debt and budget deficits on inflation in the case of the United Kingdom. Kwon, McFarlane, and Robinson (2006) also report comparable findings. By using VAR and OLS framework data analysis covering the data period from 1963 to 2004 for advanced, developing, Asian and European countries, findings shows no evidence of significant impact of debt on inflation in the case of developed economies, a strong and statistically significant impact on inflation in the case of highly indebted countries, and persistent positive relationship in the case of developing economies with high debt levels.

Bordo and Levy (2021) show that government fiscal expansion is a major factor that can significantly affect inflation in an economy due to the macroeconomic effects of government debt on real income growth and debt monetization. Empirical evidence shows that debt and deficits are positively associated with inflation through the growth rate of money supply, when government debt and deficits are monetized (Anoruo, 2003). Additionally, the significance of growing fiscal debt for inflation is more noticeable in underdeveloped countries with already high inflation in comparison to developed countries with low inflation state (Catao and Terrones, 2005). Empirical evidence also shows a long-run cointegrating relationship among budget deficits, inflation, and money supply (Wolde-Rufael, 2008). In contrast, it is also argued that the government debt-inflation link may not exist because larger deficits aimed at capital project investments, infrastructure, and economic development do not increase inflation (Taghavi, 2000). Additionally, these studies suggest that public debt plays a negligible to insignificant role in shaping the price level in developed countries.

Blanchard (2004) points out that when a government authority raises interest rates to target inflation in the country with already high public debt, this may increase the cost of debt servicing on government debt, increasing default probability and country risk premium. This may also cause a flow of capital out of the country to safe havens, leading to currency depreciation. This, in turn, may affect inflation expectations, pushing the inflation rate upward. Macroeconomic data from 2002 to 2019 of 86 developing economies, including Asian, African, and Latin American, show that public debt and inflation are positively associated (Ho, Nguyen and Nguyen, 2023).

In addition to the empirical evidence based on secondary data, the survey results of primary data collected from households also provide similar conclusions. Growing fiscal debt levels

have a causal effect on inflation through the channel of household inflation expectations. The estimated quantitative effects of growing government debt on inflation expectations are positive and significant. A 10% increase in the debt-to-GDP ratio positively affects one-year forward-looking inflation expectations by around 0.6% (Grigoli and Sandri, 2023). In addition, people across all countries understated the volume of government debt but increased inflation expectations upwards as they received updated information about the size of public debt values. Additionally, the sensitivity of inflation expectations is directly dependent on the information about the size of public debt. However, if people have confidence in the government's ability to fight against inflation, they adjust inflation expectations accordingly. Notably, household inflation expectations may not be consistent with the actual rise in inflation in the economy because the causal effects of public debt on household inflation expectations depend on a vast array of factors.

Along the same line, Coibion et al., (2021) examine the influence of different macroeconomic and fiscal variables on household inflation expectations by using survey information from the US households. Findings indicate that announcements about rising future debt levels not only increase households' expectations about rising inflation, but also about rising public expenditure and interest rates.

Similarly, Andre et al. (2023) study the relationships between changes in fiscal policy variables (government debt, spending, or a rise in taxation) on people's expectations about inflation and unemployment. Though the survey responses vary significantly, study findings indicate that higher inflation expectations of households are associated with increasing government spending.

Aimola and Odhiambo (2020), surveyed literature involving theoretical and empirical studies exploring the link between government debt and inflation. The main findings of the literature review indicate the existence of a relationship between government debt and inflation. However, the sensitivity of the debt-inflation relationship varies across countries in magnitude, ranging from weak to strong and to no relation. However, most of the survey literature provides evidence in favour of the positive impact of rising debt on inflation. The evidence is stronger in high-debt countries with weak financial institutions. Finally, although there is no agreement among researchers on the debt-inflation relationship, the review found that the existence of a positive relationship mostly dominates among the research studies surveyed.

Overall, in line with FTPL, past and present research studies indicate a positive association between growing government debt and inflation and between fiscal spending and inflation, particularly in the case of underdeveloped countries with bad governance, weak financial institutions, and already weak financial conditions.

There is also some empirical evidence that shows no or negative effects of rising debt on inflation. Afonso & Ibraimo (2018) studied the macroeconomic implications of rising government debt on inflation using the structural VAR estimation method on quarterly data for the period 2000 to 2016. The study examined public debt effects on inflation by decomposing total debt into domestic debt, external debt, external debt servicing costs, and domestic debt

servicing costs. The results indicate no effect of external debt as well as total debt on inflation, whereas only domestic debt had a positive effect on inflation in the short term. However, the results indicate that debt service costs (on external, domestic, and total debt) positively affect general price levels, confirming inflationary pressure in response to rising public debt (Afonso and Ibraimo, 2018).

M. Wheeler (1999) analysed how government debt may influence interest rates, economic productivity, and inflation during the sample period from the 1980s to the 1990s for the United States. By applying the autoregressive (VAR) model involving macroeconomic variables of government debt, interest rates, productivity growth, and inflation, the study findings show decreases in interest rates and inflation in response to an increase in government debt. Findings suggest no inflationary pressure in the US economy; instead, the study results show a significant negative effect of rising fiscal debt on inflation as a result of productivity growth.

Similarly, Alessandro et al. (2019) observe the negative effect of fiscal spending shock on inflation. By using a quarterly frequency panel data for the period 1954Q3–2007Q4 and incorporating fiscal debt and inflation in a Bayesian VAR framework, they found that inflation reduced significantly following a positive fiscal spending shock. Additionally, Jorgensen & Ravn (2022) document that inflation falls if government spending actions help increase domestic productivity by boosting the supply side more than the aggregate demand side.

In summary, this review of the studies shows a diverse set of findings with inconclusive results. No evidence of a significant relationship exists between debt and inflation in the case of developed economies, a strong and statistically significant correlation is found for highly indebted countries, and a persistent and positive relationship for underdeveloped economies with high debt levels and weak financial institutions. While fiscal deficits and public debt are important parts of fiscal policy to achieve growth and other macroeconomic targets, price stability and low inflation are essential elements for sustained economic growth and stable financial markets.

### 2.9.3 Inflation and Financial Market Returns

Economies, financial markets, businesses, and households perform poorly when inflation is high, out of control, and unpredictable. The recent resurgence of inflation has forced governments and central banks to address the problem of price instability. Monetary policy decisions involving interest rates or monetary aggregates M1 and M2 increasingly focus on low and stable inflation. Governments and central banks consider price stability an important objective as inflation is costly, exerting negative impacts on economic growth and financial stability.

Historical and present research evidence shows that real stock prices decline when an economy experiences inflation, particularly in developed countries. Equity shares, which represent claims on a firm's future profitability, are not effective against hedging inflation risk because, in inflationary times, stock prices fall due to a lack of consumer demand and increasing business costs. Furthermore, to control inflation in an economy, if a government tightens the interest rate, this further negatively impacts firm value because of high discount rates.

Public debt–dependent expansionary fiscal policy (deficits monetized) increases the quantity of the money supply. In line with the quantity theory of money, increased money supply leads to expected and unexpected inflation. Rising public debt can drive an economy into inflation due to an increased quantity of money supply in the economy or by exerting negative growth pressure on economic growth, among other factors. In the past, high inflation episodes in the 1970s proved detrimental to economies, imposed heavy costs on living standards, and economic stability. In turn, low economic growth adversely affected stock returns during these periods. Though the primary purpose of fiscal spending programs is to stimulate an economy, there may also be a related problem of inflation as a result of expansionary policy. Inflation can surface if the growth rate of the money supply exceeds the economic growth rate. As a result, wages and production costs increase, giving rise to inflation in the economy.

There is ample finance literature that investigates the determinants of stock price movements. One of the earlier studies, conducted by Chen et al., (1986) identified three important common risk factors for equity prices—interest rates, inflation, and industrial production or GDP growth as a proxy for economic growth. These common risk factors have been systematically predicting stock market returns, which shows that industrial production, interest rate, and inflation are systematically correlated with stock market returns. The main reason for this is that the deficit financing primarily aims at stimulating the economy to achieve stable economic growth, financial conditions, and employment levels. This implies that public debt, through economic growth, the level of interest rates, and inflation, may play a vital role in affecting the stock market returns.

Fama (1981) presented well-documented findings on the relationships between economic activity, inflation, money supply, and stock returns. He argued that the positive impact of economic growth on stock returns and the negative effect of inflation on stocks are two interpretations of the same consequence. In other words, increased economic growth resulting in increased productivity and national income is inversely related to inflation, driving stock prices up. Studies show significant negative effects of rising inflation and interest rates on the economy and financial markets. Additionally, inflation-related measures, e.g., expected and unexpected inflation, all negatively affect stock returns. Many earlier and recent research studies report these findings. For example, Aspren (1989) reports that increasing unemployment, imports, inflation, and rising interest rates are negatively associated with equity market prices in European countries. Whereas growing economic activity, national income level, industrial production, and exports are positively correlated with stock prices.

Bulmash and Trivoli (1991) explored the link between fundamental economic factors of economic growth and monetary policy on stock prices. The aggregate variables studied were economic growth & output, inflation, money supply, both M1 and M2, unemployment, and interest rates. Findings indicated that both inflation and rising interest rates negatively influence stock prices because, in a rising interest rate environment, government bonds offer an additional investment alternative, causing stock prices to fall.

Abdullah and Hayworth (1993) examined how monetary policy variables (short-term and long-term interest rates, money growth), fiscal policy variables (budget deficits, trade deficits,

taxes), and macroeconomic variables (industrial production growth, unemployment, inflation) can affect stock price fluctuations. Research results indicate that equity market returns are negatively associated with budget and trade deficits, and with rising interest rates (short and long-run interest rates). Falling interest rates have positive effects on equity prices as investors adjust portfolio allocation, shifting funds from debt securities to equity securities. The equity market is a major source of direct financing for firms. Fluctuations in stock prices have important ramifications for economic and financial stability, corporate borrowing, and investment decisions. Monetary economists have been examining how inflation and monetary policy variables affect stock returns. However, it is essential to include the fiscal policy variables in the analysis to understand the implications that rising public debt can have for the economy, financial markets, and financial stability.

To sum up, empirical literature examining the impacts of fiscal policy actions on inflation shows inconclusive findings. Some studies indicate that an increase in government expenditure has inflationary effects on the economy. On the contrary, studies also report no significant impact of government debt on inflation. Additionally, a sizable number of research studies also report deflationary effects of government spending on inflation (Ricco, Callegari and Cimadomo, 2016; D'Alessandro, Fella and Melosi, 2019; Jørgensen and Ravn, 2022).

## 2.10 Public Debt, Interest Rates, and Equity Returns

The impact of government debt on interest rates has been the subject of theoretical and empirical research for over two decades. However, there is little consensus about the relationship between debt and interest rates in terms of direction and strength of the relationships. Both theoretical and empirical studies report strong differences in opinions among researchers. Following the Keynesian perspective, some economists contend that government debt is strongly correlated with interest rates, while the Ricardian perspective asserts that there exists no significant association between rising government debt and interest rates.

The earlier surveys of the economics and finance literature on government debt, deficits, and interest rates show that existing research evidence is quite mixed and varied. In addition, studies that report positive effects of government debt and deficits on interest rates show significant variation in the magnitude of the effect (Engen and Hubbard, 2005). Possible reasons for different research findings may be tracked to the use of different definitions to measure debt or deficits, different measures of the interest rate (e.g. short or long interest rates, market interest rate or interest rate on government debt securities), different economic conditions of countries, business cycle stage and the econometric methodologies applied in the analysis.

While government debt can influence an economy through various intermediary channels, numerous recent studies on rising public borrowing have examined its potential effects on interest rates and, consequently, on broader economic outcomes. An increase in interest rate due to expanding government debt can decrease the value of financial and real assets, suppress interest rate-sensitive consumption expenditures, and reduce investment. Thus, indirectly

inhibiting consumption expenditures because of reduced consumer income and wealth. The significance of these negative outcomes depends on the size of interest rate hikes set by the monetary authorities or by supply and demand in the market.

High interest rates and their dynamics are also important factors for debt sustainability (Swamy, 2015, 2020). The interest cost of existing debt and the cost of future debt financing are highly dependent on the interest rate level. Interest rate movements can significantly influence the interest cost on existing debt, and raising new finance at favourable interest rates may not be possible, leading to added debt problems for the economy.

Government debt growth has important implications for the macroeconomic and financial stability of an economy. Numerous research studies in the field of macroeconomics focused on how government debt accumulation relates to short-term interest rates and long-term interest rates. The empirical research finds that persistent debt accumulation over a period increases the long-term interest rate. This effect on interest rate also has spillover effects emanating from major world economies to small countries (Strauch, Kremer and Paesani, 2006). This shows that fiscal developments in one major economy can play a significant role in determining the interest rate in other parts of the world. Furthermore, the effects of persistent debt accumulation are not homogeneous across countries due to their distinct economic and financial conditions.

According to the conventional fiscal dominance argument, domestic government debt may attract funds from foreign investors if the local interest rate is higher than the foreign interest rate, leading to real currency appreciation due to an increase in demand for the currency. However, increasing public debt may also increase the probability of default; in this case, public debt may lead to currency depreciation (Blanchard, 2005). In turn, currency depreciation and rising interest rates put pressure on public debt, resulting in increased debt service payments.

### 2.10.1 Theoretical relationships

The neo-classical and Keynesian views present the idea that debt financing to support government spending can stimulate the economy and have positive effects on aggregate demand and consumption (Miller and Modigliani, 1961; Blinder and Solow, 1973). The argument assumes that government debt generates positive wealth effects for the private sector, which in turn increase the buying power of consumers, giving rise to aggregate demand, consumption, and output.

Similarly, an expansionary policy financed through public debt can have far-reaching effects on an economy in several ways. For example, when monetary authorities reduce interest rates to increase easy access to credit for firms and consumers, this action results in increased firm output and consumer spending, with positive effects on economic growth. The expansionary fiscal policy encourages people to acquire more money and increase consumption. In addition, fiscal policy can also stimulate business activity because of easy access to money for capital projects, leading to increased investment, job creation, and economic growth.

The aggregate production function, a common theoretical framework in economics, explains how government debt can affect interest rates in an economy and crowd out private capital investment. Based on the idea of the marginal product of capital, this model determines the level of interest rates if government debt crowds out private productive capital (Engen and Hubbard, 2005). In short, an exogenous increase in government debt, holding other factors constant, may increase the interest rate.

Another basic model that advocates the effects of debt and deficits on interest rates is the Keynesian model of the IS-LM framework. This model explains that deficits increase the interest rate because deficits stimulate aggregate demand for real goods and financial assets. This necessitates increased output of goods and services to match the demand and increased interest rates to match the supply of loanable funds with the demand for money (Hansen, 1953).

In contrast, the neoclassical model supports Ricardian equivalence of no effect. This model assumes that an increase in government debt offsets private savings by an equal amount. Therefore, total capital stock remains unchanged, leaving the interest rate unaffected. This is because rational consumers expect that in the future, the government will need to raise taxes to repay the debt and interest costs, giving them reason to save for the future. In addition, if the central bank purchases the government debt securities, fiscal debt cannot crowd out private capital, and interest rates may not change in response to an increase in government debt. However, empirical studies examining the debt–interest rates relation fail to incorporate central bank purchases of government debt.

In comparison to the above theoretical frameworks, Ricardo's theory explains the public debt–interest rate relation by highlighting the productive or unproductive use of public finances rather than based on the sources of funds, i.e., funds raised by taxes or by debt. The primary burden of public debt to the community depends on its use—the wasteful use of public finance can have negative impacts on the economy and interest rates. Other factors, in addition to government debt, can cause movements in interest rates. For example, the monetary authority may adjust interest rates exogenously to control inflation and price stability in an economy. Econometric problems also arise if other theoretically important factors are confounding the public debt–interest rates relationship.

Studies that report a positive relation between debt and interest rate usually do not incorporate private sector saving in empirical analyses for examining the public debt–interest rate relationship. Furthermore, as the international financial capital market system is integrated with the world economies, foreign sector funds can flow into the country to meet the increased level of government debt, which may also prevent the crowding-out effects. Many research studies failed to incorporate the effects of foreign sector funds in the empirical analysis of government debt because of limited data availability on foreign and locally sourced government debt.

Finally, different research studies use different specifications of these variables for examining the government debt–interest rate relationships in their analysis. For example, using the total stock of government debt for each period instead of each year's deficit, representing only yearly government debt, subsumes more relevant information for explaining the movements in

interest rate as a response to growing levels of public debt (Bernheim, 1989). In addition, while studying the behaviour of interest rates due to movements in public debt, it is also important to consider how econometric models specify these variables for the analysis. For example, measurement of the variables, such as expected or unexpected measures and forward-looking or current measures, can significantly affect econometric estimations.

Laubach argues that the econometric specification based on the expected measure of total government debt instead of yearly deficits can generate markedly different results in terms of the magnitude and significance of the associated interest rate effects. After controlling for the effects of the business cycle, the estimates indicate that a 1% increase in expected debt ratio is positively associated with a 3 to 5 basis points increase in the forward-looking long-term interest rates based on the ten-year treasury rate. Historical data indicate that the US federal budget deficits are serially correlated, leading financial market participants to expect the increase in the government deficit to remain persistent. Therefore, in comparison to these results, when the expected government deficit is used in place of total public debt, results show that a 1% increase in expected deficit ratio is positively associated with a 25 basis points increase in the same forward-looking long-term interest rates measured on ten-year treasury bonds (Laubach, 2009).

In the context of the direction of causality, the seminal work of Abba Lerner (1943) presented the idea that, in times when monetary authorities adjust interest rates as part of a monetary policy tool, interest rate is determined exogenously, and monetary aggregates are affected endogenously. In such a situation, public deficits increase because of increased interest rates. Similarly, Domar (1944) suggests that the causality between the interest rate and fiscal deficit runs from interest rates to public debt when the interest rate is used as a monetary policy tool. Accordingly, a higher interest rate becomes a cause of an increase in the payment of interest cost on public debt, further raising the nominal deficit. The evidence of reverse causality particularly exists in the case of developing countries. However, recent research indicates that such monetary policy interventions have a modest role in affecting debt dynamics for advanced economies such as Germany, France, and Switzerland (Guex and Guex, 2018).

### 2.10.2 Empirical Relations: Debt to GDP and Interest Rates

Theoretical reasoning in economics literature is inconclusive in establishing whether public debt has a positive or negative impact on interest rates. Several literature surveys over the past two decades have analysed the empirical research studies investigating the relationship between debt and interest rates to understand the dynamics of the public debt-interest rate relationship. Despite a large volume of research, the findings report a diverse set of conclusions. Analysis of these studies indicates no clear answer on whether there exists a statistically and economically significant relationship. Additionally, there is also ambiguity about the magnitude of debt and deficit effects on interest rates, as it is possible to find several research studies supporting any plausible position (Bernheim, 1989). Gale and Orszag (2003), surveyed literature to understand the economic effects of government debt on interest rates, and acknowledged that the evidence from the literature is quite varied and mixed.

However, historical reviews find more support for the Ricardian perspective of equivalence. This implies government spendings have no effects on interest rates regardless of whether the governments fund these expenditures by government debt or by raising taxes. In contrast, the literature survey by Bernheim (1989) found support in favour of the Keynesian perspective that argues a positive relationship between federal government debt and interest rates.

In line with Keynesian perspective, deficit spending as a stimulus for the economy may increase output and consumption, but may cause crowding out effects on private investment, leaving interest rates unaffected (Mountford and Uhlig, 2009). But in a recent study, Ferrara et al., (2021) report that government spending shocks not only increased inflationary pressures in the US economy but also increased interest rates. The findings show that the positive effects of fiscal spending on aggregate demand and interest rates remained consistently significant for the first few quarters following the pandemic.

Real interest rates increased relative to the growth rates in most of the industrialized countries in the late 1970s till the 1990s. Specifically, during the period of 1978–1997, the net debt to GDP ratio rose from 19% to around 43% in OECD countries, resulting in an increased debt burden of 24% of GDP. Against this background, Robert Ford and Douglas Laxton (1995) empirically examined the effects of these debt developments on real interest rates in nine advanced industrial economies. By examining the impact of growing ‘world’ debt levels on ‘world’ interest rates as opposed to the impact of national public debt levels on national interest rates, they confirmed that the interest rates increased significantly in response to the increase in OECD-wide public debt during 1970 to 1990. The crowding out of private activity and increasing international capital market integration played a role in the association between these economic variables. Furthermore, these findings suggest that fiscal developments at the international level can affect interest rates in any country.

Blanchard et al. (2019) reports two primary channels that transmit the influence of public debt and deficits on real interest rates. The first channel presents crowding out of private capital investment that can affect interest rates in any economy. The second effect stems from the increased supply of treasury bonds issued by a certain country competing with the total supply of sovereign bonds of other countries. Given the difference in liquidity, price, and default risk in these competing bonds, sovereign bonds of different countries are not perfect substitutes. This additional supply of bonds leads to increased interest rates in the market. Empirical studies indicate that a 1% increase in the US government debt-to-GDP ratio increases the real interest rate on government debt by 2 to 5 basis points. Given the dominance of the US deficits and debt levels in international financial markets, the study in the context of OECD countries also reports comparable results. Findings based on panel data of OECD countries indicate that a 1% increase in the debt ratio is associated with a 3 to 10 basis points increase in the interest rates on government debt (Jiang, Richmond and Zhang, 2022).

Furthermore, a recent report by the American Enterprise Institute (AEI) indicates that mounting government debt levels affect interest rates significantly. Reported estimates show that a 1% increase in debt ratio is associated with a 4.5 bps increase in the long-term interest yields on 10-year treasury bonds (Peterson Foundation, 2022).

Gale and Orszag (2003) show that an increase in deficits by 3% of GDP leads to a rise in interest rates by 60 to 180 basis points, with an average of 120 bps. This increase in interest rates significantly affects the cost of debt servicing.

Jan Jacobs et al., (2020) estimate, using data from 31 EU and OECD countries in a panel VAR framework, the impact of public debt-to-GDP ratios on economic growth, treating long interest rates on government bonds as an intermediary channel. Findings show no causal link in the direction of public debt to growth, as most other studies report. However, they find that in high-debt countries, low economic growth leads to a greater government debt burden. In addition, this reverse causality becomes stronger due to an increase in the long-term interest rates as the debt levels go higher. Increased interest rates, in turn, decrease interest-sensitive consumption and reduce productivity and growth, leading to a further increase in the public debt.

Quantitatively, estimation results indicate that, for a high-debt country, a one standard deviation decrease in GDP growth rate increases public debt by 2.10 % of GDP, and for low-debt countries, the increase in public debt is only 0.79% of GDP. The authors argue that the main reason for the negative effects of low economic growth on public debt is the increase in interest rates due to growing public debt. A rise in the long-term interest rate not only negatively affects the demand, consumption, and investments in the economy but also increases debt servicing costs. Furthermore, negative shocks to economic activity reduce tax revenues, forcing governments to raise more debt to support government expenditures needed to stimulate the economy.

A similar study by Reinhart & Rogoff (2012) examined the effects of growing debt on economic growth via the interest rate channel. Study results indicate that growing debt levels do not always result in increased interest rates. Authors argue that, if elevated debt levels do positively affect interest rates in an economy, it is difficult to conclude that government debt reduces economic growth via the interest rate channel, unless a rigorous econometric approach establishes a cause-and-effect relationship. Baum et al. (2013) find that countries with a public debt to GDP ratio beyond 73.8% experience an increase in long-term interest rate as a result of additional public debt. However, Checherita-Westphal and Rother (2012) test the linear and nonlinear (quadratic form) relationship and provide evidence that long-term interest rates are not affected because of the increasing debt-to-GDP ratio.

### 2.10.3 Empirical Relations: Interest Rates and Equity Returns

According to the asset portfolio allocation theory, as interest rates increase, fixed income debt securities, as an alternative investment option, attract investors to allocate their investments from equity to debt securities. Conversely, when interest rates fall, investors shift their investment from debt securities to equity securities. Therefore, declining interest rates increase stock prices, holding other factors constant.

The business cycle theoretical framework also explains the link between key economic factors and equity prices. Business cycle theory suggests that major economic factors are related to equity prices depending on the stage of the economic cycle. Hyman Minsky, a post-Keynesian economist, explained economic cycle stages by relating them to fluctuations in credit and

interest rates. In an expansion stage with low interest rates, firms and households have easy access to credit from banks. Production and profitability of companies increase because expanding economic activity allows businesses to generate higher cash flows, resulting in increased stock prices. In contrast, in recessions, interest rates are higher, demand declines, prices of goods and services drop, and output and profitability of firms decline. This leads to a decline in stock prices, resulting in a negative association between interest rates and stock prices.

Fluctuations in long-term market interest rates are a key factor in determining long-term saving and investment decisions. The influence of interest rates on household savings, investments, demand, and consumption of durable products plays a notable role in shaping the state of the business cycle and transforming macroeconomic policies into real effects. Craine and Martin (2003) examined how the equity market reacts to the shocks in the interest rate and found statistically significant negative impacts of rising interest rates on equity market returns. Similarly, Bernanke and Kuttner (2005) find that a 25 basis point rate cut by the Fed positively affects broad equity indices by 1%. In addition, Kontonikas et al., (2013) find that stocks exhibit a larger increase in response to interest rate cuts during the periods of recessions, bear markets, and tough credit conditions. In the case of the eurozone equity market response to monetary policy actions (Petraakis *et al.*, (2022) found that conventional (rate cuts) and non-standard monetary policy interventions positively affected equity market returns with lags. Specifically, interest rate cuts have positive and statistically significant effects on equity prices with a lag period of two months in the eurozone.

On the contrary and surprisingly, the stock market in China is positively associated with interest rate hikes and negatively related to rate cuts, providing evidence against the theoretical expectations and findings of most empirical studies. The Shanghai Composite Index returns increased by 1.07% in reaction to interest rate increases and returns decreased by 1.85% in response to falling interest rates during the years from 1996-2016. This implies that short-term movements in interest rates are transitory and have no permanent effects on the equity markets in China (Hu, Jiang and Pan, 2020). Similarly, Sun and Yuan (2021) report that in emergencies, the interest rate cut policy may not be as effective as expected.

## 2.11 Public Debt and Exchange Rate Relation

Numerous theoretical and empirical studies have supported the relations among government debt, exchange rates, and stock prices, covering both advanced and emerging economies.

Existing research shows that growing public debt levels and resulting exchange rate risk can adversely affect the market economies, and recessions can last longer than normal (Jordà, Schularick and Taylor, 2013). Since a debt crisis is often the cause of currency crises, investors critically monitor currency vulnerabilities arising from growing public debt levels, leading to withdrawal of their investments out of the country—further exerting negative pressure on currency valuation. This is true especially in the case of developing countries with weak financial conditions and a higher proportion of foreign currency debt.

The exchange rate has complex relations with both monetary and fiscal policy variables. Both interest rate and public debt, and other important macroeconomic variables, for example, economic growth, inflation, can affect exchange rates. The exchange rate may respond positively to rising interest rates. Specifically, domestic currency may appreciate in response to rising interest rates, given that the interest rate in the international markets is lower. Currency appreciation may have negative effects on the competitiveness of a country, raising export prices of products and services of the country, thereby reducing sales and production, resulting in lower revenues, profits, and lower asset prices in financial markets.

In addition to the interest rates, growing government debt can also affect the exchange rate. As the debt level exceeds a certain threshold, it may exert negative growth effects on the economy and may also raise the probability of defaults when debt servicing costs require a sizeable portion of the country's GDP. Increased default probability raises country risk premiums for investors, demanding additional compensation for taking excessive risk by investing in a country with higher debt. Alternatively, investors can withdraw their investment from the country in response to rising default probability due to growing country debt. Investment outflows from the country may reduce currency demand, depreciating the currency value.

The public debt-exchange rate relationship has important implications for debt sustainability. As a result of currency devaluation, the government has to pay higher interest payments in terms of local currency on the debt obtained in foreign currency. This rising public debt changes investors' perception of higher default risk, inducing investors to pull capital out of the country, causing further devaluation of the currency. The movement of the exchange rate has a significant impact on the value of public and private debt of a country that has a substantial portion of debt denominated in US currency or in any other foreign currency.

Strong form market efficiency holds that equity prices are forward-looking and reflect all available relevant information about the economy and other micro and macroeconomic factors into asset prices. The premise that all readily available information is instantly reflected in the financial market asset prices, changing expectations about exchange rates, monetary and fiscal policy innovations, and their effects on the economy, can significantly influence financial market asset prices (Bjørnland and Leitemo, 2009; Kurov, 2010b). These studies point out that the volatile nature of asset prices in financial markets is the result of innovation in the monetary and fiscal policies instituted by authorities operating in the economies. In addition, Rigobon and Sack (2003) and Laopodis (2010) point to the presence of reverse causality that runs from the stock market to monetary, fiscal policy, and other macroeconomic variables, for example exchange rate and economic growth. This reverse causality serves as the feedback mechanism for policymakers. For example, a rise in the stock market index indicates the potential future economic growth, productivity, and low unemployment.

In short, for economic expansion, larger fiscal spending can expand infrastructure and reduce unemployment levels. However, it is important to note that in later stages, primary budget surpluses are necessary for financial stability and consistent reduction in government debt.

### 2.11.1 Theories of Exchange Rates

Theory offers two primary channels of link among public debt, exchange rate, and financial markets. The first, goods market channel, also called the Flow Oriented Model (Dornbusch and Fischer, 1980), asserts that changes in currency exchange rates affect the competitive position of firms, influencing their revenues, earnings, and stock prices. The currency depreciation of a country makes the products and services more attractive for foreign buyers, increasing demand for the products. This results in a favourable international trade balance and trade competitiveness of the country, positively affecting the real output of firms and stock prices (Ülkü, Kurupparachchi and Kuzmicheva, 2017; Demirci, Huang and Sialm, 2019; Rai and Garg, 2022).

In contrast, currency appreciation makes the products and services expensive for foreign buyers, and the demand for the products and services shrinks, leading to reduced exports, profits, and stock prices. Currency fluctuations also affect the firm's value if a firm has foreign currency-denominated assets and liabilities. How significantly and in which direction exchange rate fluctuations can affect stock prices largely depends on the size of international trade in terms of foreign exchange earned and the ratio of exports to imports (Pan, Fok and Liu, 2007). Based on this theory, a cause-and-effect relation from exchange rates to stock prices seems plausible.

The second, asset market channel, also called the portfolio approach and the Stock Oriented Model (Branson and Henderson, 1985), claims a cause-and-effect relation from stock prices to exchange rates. This theory argues that the performance of the domestic stock market attracts international investment. A rising trend in stock prices can influence currency exchange rates by signalling the improved health of a national economy. Based on this channel, the market mechanism of supply and demand influences the exchange rates of a currency, bringing the supply and demand forces into equilibrium. Strong economic growth expectations can have a positive effect on stock prices because growth potential would attract foreign capital from international investors and hence can cause an increase in the demand for the country's currency, leading to currency appreciation. The opposite effects can happen in the case of declining economic growth. Accordingly, the rise (decline) in stock market prices is likely to be associated with appreciation (depreciation) in the value of local currency. Empirical research studies indicate that increasing stock market prices attract foreign investors' attention and investments. This leads to an increase in demand for companies' stocks operating in the country, and hence, the prices increase in the domestic stock market. The foreign capital inflows and increasing demand for the currency lead to an increase in the value of the local currency (Branson and Henderson, 1985; Wong, 2017; Rai and Garg, 2022).

Mundell-Fleming model argues that the exchange rate system operating in a country—floating or fixed exchange rate—profoundly affects the behavior of macroeconomic variables and thus the economy. Mundell-Fleming model, assuming open economy and perfect capital mobility conditions, argues that the domestic interest rate adjusts itself in line with the world interest rate due to market forces. Thus, movements in the interest rates do not affect the value of financial and non-financial assets but are determined by the fluctuation in the exchange rate.

Specifically, under a floating exchange rate system, market factors drive the exchange rate movements with no intervention by the central bank in the foreign exchange market. In such market conditions, if the domestic interest rate is higher than the world interest rate, international investors prefer investing in a high-interest-rate-paying country, boosting demand for the currency, and increasing the supply of loans due to increased foreign capital inflow. The excess demand appreciates the currency value, and the excess supply of loans brings the interest rate to the point where the country's interest rate becomes equal to the world interest rate. On the contrary, if the country's interest rate falls below the world interest rate, the capital flows out of the country, creating a shortage of loanable funds that raises the country's interest rate to the level of the world interest rate. Therefore, a country's interest rate adjusts in line with the world interest rate due to perfect capital mobility conditions (Mundell, 1960).

In addition, the Mundell-Fleming model also implies that domestic currency depreciation may have adverse effects on their default probability, specifically for emerging economies. This is particularly true when a country holds more foreign currency debt than it has foreign currency assets. In this case, a depreciation of the currency value may cause negative wealth effects for the economy. In addition, the weak currency value negatively affects the balance sheet positions of the domestic borrowers due to an increase in the value of foreign liabilities and an increase in borrowing costs, negatively affecting their credit position. However, depreciation or devaluation of the local currency may positively affect the trade competitive position of the country, as this can increase net exports of the country due to lower prices of exports in the international markets. This creates a positive effect on the aggregate output of the country and reduces the probability of sovereign risk because of a favourable trade balance.

This free flow of capital implies that the rate of interest may not be a policy variable for a small country because the international interest rates may affect local interest rates. That also implies that macroeconomic adjustments occur through exchange rate movements when central banks allow the exchange rate to adjust according to market conditions. Thus, the Mundell-Fleming paradigm explains that the effects of macroeconomic policies on an economy, i.e., the impacts of monetary, fiscal, or trade policy, are highly dependent on the exchange rate system operating in the country.

A similar explanation is offered by Keynesian theory (1923) of interest rate parity, which explains the relationship between interest rates and currency exchange rates (Lavoie, 2000). This theory argues that the difference in the interest rates prevailing in two countries is parallel to the difference between the spot and forward exchange rates. A currency with higher interest rates is likely to trade at a higher forward exchange rate (the forward rate will be greater than the spot market rate) because the investors will shift the capital towards this currency, raising market demand for the currency and its currency value in terms of exchange rate. Thus, the difference in market interest rates on two currencies will be according to the difference between spot and forward exchange rates.

In contrast to the conventional perception of sound finance, the functional finance approach contends that deficits and debt themselves should not be regarded as useful or harmful but

should be evaluated on the positive or negative effects they have on the economy (Lerner, 1943). In simple terms, if deficits and debt stimulate economic growth, reduce unemployment, and improve equitable income distribution, authorities should view debt and deficits positively. Alternatively, when the effects are opposite and exert negative effects in terms of increasing default risk, the authorities should avoid debt and deficits, because a drag on economic growth can cause price and financial instability.

The effects of monetary policy intervention can confound the complex relationships among public debt, interest rates, and exchange rates. For example, when monetary authorities raise the interest rates, this may directly increase the debt servicing costs on government debt, raising the nominal value of the domestic deficit and debt. Parallel to this, however, with higher interest rates, the country may attract foreign capital at least for a short time, increasing the demand and value of the local currency. This in turn, reduces the value of public debt in foreign currency. If the increase in interest rate raises the debt problem more than the decrease in debt caused by currency appreciation, the net effect will be a higher debt burden. Consequently, the net effect will depend on the size of the two forces.

However, the fundamental theory of the traditional interest rate parity condition explains how the currency exchange rate will respond to changing interest rates. According to the interest rate parity (IRP) condition, hedged returns on the currencies of two countries should be equal, regardless of the interest rates prevailing in those countries. In simple terms, if the country's interest rate is higher than the foreign interest rate, the exchange rate will appreciate by attracting foreign capital, increasing the demand and value of the local currency. In contrast, if the domestic interest rate is lower than the foreign interest rate, investors pull their investment out of the country, and as a result, the domestic currency will depreciate. Finally, the perception of international risk rating agencies may also have adverse effects on currency value when public debt-to-GDP is persistently moving upwards.

### 2.11.2 Empirical Relations on Government Debt and Exchange Rate

Vernengo (2006), explored how exchange rate fluctuations can shape public debt dynamics. Research studies indicate that exchange rate appreciation or depreciation can alter the debt value. Appreciation in the currency exchange rate leads to a reduction in debt value because the country will pay a smaller amount of local currency for the same unit of foreign currency. But at the same time, currency appreciation can increase the cost of a nation's products and services in the international market, leading to fewer exports and an unfavourable trade balance. The main concern about this policy mix is that exchange rate appreciation reduces competitiveness, which can have important effects on long-term economic growth. On the contrary, currency devaluation, though, can help boost exports, but if a country's large part of debt involves foreign liabilities, the value of these liabilities will be higher when converted into local currency, indicating a rise in the nominal value of debt.

A nation's economic growth, changes in interest rate as part of monetary policy, and international trade balance can significantly drive the currency value of the issuing state. These factors offer clear indicators that help international investors and financial organizations in

reaching an assessment of a country's attractiveness as an investment destination and the prospects for the national currency to rise in value.

According to the conventional fiscal dominance argument, domestic government debt may attract funds from foreign investors if the local interest rate is higher than the international interest rate, leading to real currency appreciation due to an increase in demand for the currency. However, increasing government debt may also increase default probability; in this case, public debt may lead to currency depreciation (Blanchard, Giavazzi and Sa, 2005). In turn, currency depreciation and rising interest rates put pressure on public debt, resulting in increased debt service payments. Gale and Orszag (2003) show that an increase in deficits by 3% of GDP leads to a rise in interest rates by 60 to 180 basis points, with an average of 120 bps. This increase in interest rates significantly affects the cost of debt servicing.

Carrera Vergara et al (2012) argue that foreign currency-denominated debt may negatively affect the debt-sustainability of an economy, especially when the debt ratio exceeds a certain threshold level, e.g., 90% of GDP. Study findings point out that currency devaluation can significantly weaken the sustainability of fiscal policy. Currency devaluations increase the value of foreign currency debt, which can affect the fiscal sustainability position of a country because a higher debt ratio can lead to a higher interest rate in the market that may result in a lower GDP growth rate.

As research studies argue about the existence of a threshold level of debt beyond which GDP growth slows down for some countries and declines for others, so is the threshold level for external debt and real exchange rates. Couharde, Rey & Allegret (2015) employed a threshold panel methodology to analyse the non-linear relationship between external debt and real exchange rate movements, using quarterly data for a sample of European countries over the period 2003–2012. Study results show that beyond a certain threshold level of external debt ratio, real exchange rates swiftly converge to long-run equilibrium. This convergence towards the long-run equilibrium is slow when the government debt level is lower than the threshold. In addition, real exchange rate adjustments become more sensitive to interest rate differentials when the level of the external debt goes beyond the threshold (Couharde, Rey and Allegret-Sallenave, 2015).

Kim and Roubini (2008) examined how innovations in government budget deficit can affect real exchange rate and current account balance in the presence of a flexible exchange rate system operating in the economy. After controlling for the effect of business cycle, results indicate that fiscal expansions depreciate currency value, which in turn implies higher exports of country products and services. Contrary to the expectations of most theoretical models, analysis of the U.S. data shows that the expansionary fiscal policy and government budget deficits improve the current account balance, though the market depreciates the real exchange rate of US currency. Currency depreciation leads to increased exports, a favourable trade balance, and an increase in net income from abroad, contributing to the current account balance.

Similar findings emerged from other studies (e.g., Ravn, Schmitt-Grohé and Uribe, 2012; Ilzetzki, Mendoza and Végh, 2013). However, Forni & Gambetti (2016), Miyamoto, Nguyen

& Sheremirov (2019), & Lambertini and Proebsting (2019) state that the significance of the effects of government spending on currency exchange rate movements highly varies across countries due to their unique characteristics e.g., the stage of economic development in the country, is the government spending for consumption or investment, and if the expenditure is anticipated or unexpected. For example, Auerbach & Gorodnichenko (2016) find that government spending on military development programs in the USA causes an appreciation of the U.S. currency. Born et al. (2013) point out that under a fixed exchange rate system, an increase in public spending appreciates the real exchange rate. Born et al. (2019) provide further empirical evidence based on quarterly time-series data for 38 countries. Findings indicate that an increase in government spending can appreciate currency value but may not affect output, particularly in full employment and weak economic conditions. Whereas a reduction in government spending may negatively affect output and employment, with no impact on currency exchange rates.

On the other hand, public and private debt buildup may cause currency value depreciation. Park, Ramayandi & Tian (2022) investigated how government debt can influence exchange rates, results indicate that both private and public debt have negative effects on currency value. The empirical analysis based on the panel dataset involving fifty-nine advanced and emerging market economies reveals that the evidence of a significant effect of debt (private and public debt) on currency depreciation is stronger and persistent for private debt than for public debt. In addition, findings show that excessive private debt and external financing are more harmful in the context of emerging markets than developed markets.

The debt-export ratio is another common indicator of debt sustainability, which shows the creditworthiness. Countries with excessive public debt burdens need to maintain a positive trade balance to cover interest payments on foreign debt. The favourable debt-export ratio signals the capability of debt servicing (Dornbusch and Fischer, 1980).

### 2.11.3 Empirical Evidence: Exchange Rate and Stock Prices

Earlier studies show that currency exchange rate movements may have no impact on firms' investment or financing decisions, and hence no effect on their value (Bernard and Galati, 2000; Griffin and Stulz, 2001). However, studies also found a significant positive association between exchange rate fluctuations and stock market returns (Doukas, Hall and Lang, 1999; Patro, Wald and Wu, 2002). Whereas, recently, Adeniyi & Kumeka, (2020) found no correlation between movements in exchange rate and the stock prices of firms operating in the Nigerian economy, implying no effect of exchange rate fluctuations on equity prices.

Recent research studies also present similar mixed patterns of response of stock market prices to currency exchange rate fluctuations. For example, Narayan, Devpura & Wang (2020), investigate the relationship between the currency value of Japanese Yen and the Japanese equity market returns. By using alternative econometric model specifications, findings indicate that the depreciation of the Yen against the US dollar increased equity returns in the Japanese stock market. Specifically, during COVID-19, stock market mean returns improved by 71% in response to a 0.58% depreciation in the value of the Yen. This inverse relationship between

currency value and equity market returns became stronger during the pandemic period from January to August 2020, in comparison to that which existed before the crisis period.

Lee, Lee & Wu (2023) examined how hospitality companies' stock returns were impacted during the pandemic in the Chinese equity market. Pertaining to the impacts of currency exchange rate movements, the findings show that a surprise depreciation in currency value negatively affects stock market returns. Similarly, by using daily frequency data, the study results show strong linear causal relations in both directions for most of the countries. The results also show the presence of nonlinear relations and remain robust in the case of nonlinear Granger causality tests (Cakan and Ejara, 2013). In addition, studies report mixed evidence on the direction of causality as well. For example, Sheikh et al. (2020) report unidirectional causality showing the effect of exchange rate on stock prices, and others report the causal direction from stock prices to exchange rates (Adeniyi and Kumeka, 2020; Mohamed and Elmahgop, 2020; Xu, Huang and An, 2022).

Fluctuations in currency exchange rates are also correlated with volatility in the stock markets (Diebold and Yilmaz, 2012). This correlation between exchange rate volatility and stock market volatility became further pronounced during the Asian Financial Crisis of 1997 and the Global Financial Crisis of 2008-09. In addition, volatility spillovers affect exchange rates and stock markets running from large financial markets to small emerging countries' markets. Studies show that the volatility index in the exchange markets and equity markets rises, indicating the high risk in financial markets. The volatility spills over is faster in economic & financial uncertainty and crisis periods than in normal periods (Fernández-Rodríguez and Sosvilla-Rivero, 2020; Yildirim, Erdoğan and Tari, 2022).

Della Corte *et al.*, (2022) explore the relation between exchange rates and sovereign risk and argue that an increase in a country's sovereign credit default spread (CDS) negatively affects the currency value, causing a significant depreciation of its exchange rate, an increase in its currency volatility, and currency crash risk. The study reports a strong inverse effect of changes in sovereign CDS spreads on concurrent exchange rate changes observed in daily, weekly, and monthly data. The benchmark pooled regression estimates based on monthly data report a significantly negative slope coefficient, with a 3.7% exchange rate depreciation in response to an increase in CDS by 50 basis points (Della Corte *et al.*, 2022).

In a recent study using US data, Ferrara *et al.*(2021) re-examined the associations among government spending shocks, real exchange rate, and inflation. In contrast to the earlier research findings, results indicate that expansionary fiscal spending is positively associated with the currency exchange rate (currency appreciation) and inflation. Additionally, expansionary fiscal spending results in trade deficits and increases the nominal interest rate in the country.

Overall, though theoretical literature supports the argument of correlation between equity market prices and currency exchange rates, evidence from empirical research is inconclusive. Empirical literature examining the reaction of equity market prices to exchange rate movements, mostly, has shown mixed evidence. Yet, the evidence suggests that greater

dependence on external debt financing exacerbates the impact of debt buildup on currency stress (Park, Ramayandi and Tian, 2022).

## 2.12 Summary of the Literature Review

To summarize, this review highlights that finance literature has focused on the effects of macroeconomic policy actions on asset prices within the context of monetary policy variables. However, how fiscal policy actions, in particular public debt, may influence financial asset prices has received limited attention. Only a few studies, e.g., Darrat (1988), Ardagna (2009), Afonso and Sousa (Afonso and Sousa, 2011; 2020), Simo-Kengne et al., (2016), Sun, Yulong, (2019), Wisniewski and Jackson, (2021, p. 2) investigated how debt-to-GDP affects equity market returns, while overlooking the role of  $r-g$ .

For the first time, Darrat (1988, p.354) noted that the impacts of fiscal policy actions may influence financial market returns. Agnello and Sousa (2010, p. 2), after two decades and Wisniewski TP, Jackson PM, (2021, p-2) after 30 years reconfirmed the view of Darrat stating that there is still an important research gap in finance and economics literature requiring exploration about the empirical relationship between government debt, fiscal spending and financial market asset prices.

In light of the current economic challenges posed by mounting debt levels, increasing trade tensions, Russia-Ukraine war, rising energy costs and supply shocks, an increasing emphasis is being placed on the role of fiscal policy both as a tool for economic stability in difficult times and as a potential source of instability when governments persistently run deficits leading to growing debt levels when perusing expansionary fiscal polices. Therefore, it is essential to understand the impact of fiscal policy actions on both the economy and financial markets.

However, empirical literature in the sphere of financial markets remains scant, given that theoretical literature has explored the impacts of fiscal policy on financial markets since 1960 (Tobin, 1969). For example, Tobin (1969) proposed a theoretical model that pointed out the role of both monetary and fiscal policies for capital markets and the real economy.

Finally, while research studies have examined the role of rating agencies in affecting bond and equity markets, finance literature does not seem to have addressed the issue of increasing public debt in the context of financial markets. So far, some theoretical macroeconomic models have explored the relationship between government debt and financial market performance (Polito and Wickens, 2015; Leeper and Leith, 2016). The empirical work on public debt and its impacts on capital markets remained limited due to the lack of availability of debt datasets for a large number of countries. Only recently, a few studies, e.g., Wisniewski and Jackson (2021), Lim (2020), Demirci, Huang, and Sialm (2019), and some in the recent past, e.g., Angeloni and Wolff (2012), investigated the nexus between public debt and financial market performance.

## 3. Theoretical Framework

### 3.1 Theoretical Background

Several macroeconomic theoretical frameworks explain how government debt may negatively or positively affect economic conditions, which in turn influence equity market returns. A negative effect may stem from the crowding out of capital investments (Elmendorf and Gregory Mankiw, 1999). Another adverse effect may result from an increased probability of default, accompanied by heightened macroeconomic uncertainty. On the other hand, a primary positive influence of public debt on equity market returns is rooted in the Keynesian multiplier effect. The multiplier effect stimulates economic growth through increased demand for goods and services. Expansionary fiscal policy plays a central role in this process by reducing the negative impacts of low economic growth during recessions (Delong and Summers, 2012).

The theoretical literature on public debt and its economic implications is generally classified into three main frameworks: Neoclassical, Keynesian, and Ricardian. In addition, the debt overhang hypothesis also presents compelling arguments about the public debt implications for the economy and financial markets. Finally, corporate finance valuation theory provides a framework for determining the value of a security by discounting the expected future cash flows of a firm using an appropriate discount rate. In the following sections, these theoretical frameworks are discussed.

### 3.2 Neoclassical, Keynesian, and Ricardian Framework

The Neoclassical paradigm asserts that persistent budget deficits can cause crowding-out effects in an economy. When governments fund deficits with debt financing instead of raising taxes, the present tax cuts raise total income and consumption of the present generation by transferring taxes onto the income of future generations. Assuming full employment of economic resources, the theory posits that increased government consumption expenditures financed by debt reduce private savings and crowd out private investment in the economy, producing negative long-term effects.

Similarly, Bernheim (1989) argues that, assuming public deficits have positive effects on aggregate demand in the economy due to wealth effects, then it implies that there may arise conditions in which increased demand may be detrimental to the overall economy, as a result of a rise in inflation if the available supply cannot match the growing demand. This may occur particularly at the full employment level when supply cannot be increased and deficits only crowd out private investment. In turn, higher rates of inflation are associated with increased price volatility, which contributes significant risk and uncertainty in the economic environment.

However, assuming fiscal spending stays constant, then temporary deficits imply a reduction in marginal tax rates and revenues. Reduced income tax rates on capital investments increase the after-tax rate of return on investment, which may stimulate savings. Reduced income tax rates on employees' income raise the current income and savings of individuals, leading to intertemporal substitution—increased income is saved for future consumption. In this way, the Neoclassical theory argues that temporary deficits are likely to have a small influence on

demand, consumption, and other macroeconomic variables in the short run due to the saving tendency of individuals.

If the public deficit is financed by issuing bonds and not monetized—the money supply is fixed—the demand for loanable funds will increase, and the interest rates must rise, leading to increased public savings and reduced private sector investment. This, in turn, may reduce productivity and output and diminish the Keynesian multiplier effect.

To empirically test the crowding-out argument, Diamond (1965) examined the impacts of budget deficits on the macroeconomic variables. Diamond's analysis investigated the effects of permanent changes in deficits but did not examine the macroeconomic effects of the temporary changes in deficits. Findings indicated that a persistent increase in the ratio of public debt to national income crowds out private investment by lowering the steady state capital–labour ratio. An increase in government debt levels pushes interest rates upward as consumers demand higher rates because they are unwilling to hold additional government debt. Rising interest rates due to persistent government deficits may further encourage consumer saving and crowd out private investment.

The Keynesian view proposes that individuals increase their consumption from their current disposable income due to wealth effects. Specifically, public debt and corresponding government expenditures have a significant impact on aggregate demand and national income, generating a Keynesian multiplier effect for the economy. Therefore, deficits have positive effects on the overall economy. Keynesian theory posits that expansionary fiscal policy can stimulate aggregate demand, leading to higher output, productivity, and firm revenues, resulting in increased profitability. Thus, deficits may not crowd out private investment in the short run, even in a rising interest rate environment (Gordon, 1990). In turn, high profits may attract more capital investment into the economy, which supports matching increased demand and consumption by employing unutilized resources. Similarly, Bernheim (1989) attributes these effects to the impact of temporary fiscal deficits, as proposed by Keynesian theory.

In contrast, the Ricardian view argues that financing sourced by issuing public debt may only temporarily shift the payment of taxes in the future, which does not affect an individual's wealth. Thus, deficit policy cannot have any positive effects on the economy.

Empirical analyses show that no single theory fully represents the economic reality. However, according to Bernheim (1980) the macroeconomic effects of deficits are better represented by the Neoclassical framework. The fact that the Ricardian paradigm is based on several unrealistic assumptions renders it less relevant on both theoretical and empirical grounds.

Bernheim (1989) argues that Neoclassical and Keynesian theories offer contrasting perspectives on fiscal policy, with Keynesianism emphasising its short-run economic effects, while Neoclassicism focuses on the long-run implications. But many experts view the long-run economic effects as a sequence of short runs; accordingly, they argue that deficits should be assessed based on temporary and permanent components, and therefore, should be evaluated individually in their impacts on macroeconomic variables. The permanent part of deficits can be identified as the long-run average of deficits over the years, and the temporary parts can be identified as deviations from the long-run average. By controlling the temporary component of

the deficits, governments can stabilize fluctuations in economic variables around the long-run trends.

By fiscal spending funded by temporary deficits, governments can target the objective of macroeconomic stabilization. When aggregate demand, consumption, and output fall and the economy is facing recession, governments can increase fiscal spending beyond their normal level to stimulate the economy. In contrast, when aggregate demand exceeds the supply of products and services, deficit spendings are reduced and set below the normal level to avoid inflation and cool the economy. In this way, temporary deficits represented as countercyclical fiscal policy can help governments achieve economic stabilization without incurring significant debt levels.

Therefore, for long-term policy implications, the Neoclassical paradigm emphasizes the importance of the permanent component of the deficits, which is the average of yearly fiscal deficits over years or the cumulative deficits, rather than temporary deficits that represent the year-to-year changes. Thus, the total volume of public debt is likely to be a more informative measure for assessing the effects of fiscal policy actions on macroeconomic variables instead of the current deficit.

Against this background, the Neoclassical perspective can be viewed as the long-run effects of the permanent part of deficits. In contrast, the Keynesian perspective can be viewed as the impact of temporary deficits. To empirically examine the long-run impact of permanent deficits on consumption, as opposed to temporary deficits, Bernheim (1987) used average measure of deficits over six- and twelve-year periods. Study findings show that permanent deficits have significant positive effects on consumption as a ratio of income. Reid (1985) found similar results by using multiple-year averages of deficits in the U.S. context. These results are in line with the Neoclassical perspective. Therefore, the permanent component of deficits should be given more weight while examining the macroeconomic effects of debt and deficits (Bernheim, 1989).

According to the Neoclassical paradigm, fiscal policy is employed by government institutions to minimise unwanted fluctuations in key economic variables—such as interest rates, unemployment, and inflation—around their long-run equilibrium levels. However, some economists argue that the role of fiscal policy for macroeconomic stabilization is rather weak and small in affecting aggregate demand. This view is contrary to the assertion of Keynesian theorists. But at the same time, it is important to bear in mind that deficits do stimulate economic activity during periods of unemployment and generate desired economic effects in recessions (Bernheim, 1989).

Modern Ricardian theory views each family unit as a single, infinitely living entity. This is in line with the central idea of intergenerational wealth transfer (Barro, 1996). In the case of tax cuts, current generations transfer saved income to future generations, extending the consumption planning horizons. In this case, the timing of taxes or shifting taxes to future generations does not increase an individual's lifetime income or wealth, which cannot alter consumption decisions. Therefore, deficits may not have real macroeconomic effects.

However, if fiscal policy does not defer present tax cuts to the next generation of taxpayers, this may increase the disposable wealth of the current generation. This perceived change in wealth can change their consumption decisions.

### 3.3 The Debt Overhang Hypothesis

Debt overhang is a cornerstone theory in corporate finance. Like a corporation, a country's existing excessive debt obligations may cause underinvestment in the most needed growth projects, as the costs of debt liabilities exceed the benefits of investing in such projects (Myers, 1977). Debt overhang is a condition in which the public debt of a country exceeds its debt repayment capacity. The public debt overhang theory asserts that the persistent accumulation of government debt and debt service costs can negatively affect economic growth and private investment. High debt servicing costs are likely to slow down or completely halt economic growth by diverting financial resources to pay high interest payments on debt that would otherwise be available for investment in human capital and building economic infrastructure (Coccia, 2017).

In this way, debt overhang is a major barrier to economic growth for countries with extensive public deficits (Coccia, 2017), because the major proportion of public resources is spent on interest cost payments on the debt (Dombi and Dedák, 2019) leaving the country with insufficient financial resources needed for economic recovery (Brady and Magazzino, 2018). Persistent large amounts of public deficits lead to higher accumulated debt, resulting in a cycle of debt, especially when governments must incur more debt to pay the debt servicing costs. Krugman (1988) pointed out that public debt accumulated over several years acts as an additional tax on future output and income, reducing the incentive for savings and investments, both for internal and external investors. In particular, debt service payments on high debt levels reduce the available funds for investment, further slowing down economic growth.

In addition, a high debt burden may lead investors to anticipate higher future taxation, as governments seek to generate the necessary revenue for debt repayment. In this case, higher debt levels may also be associated with capital flight out of the country, increasing the risk of currency depreciation. Capital outflow exerts negative effects on economic activity, with a decline in domestic savings and investment, productivity, economic growth, and tax revenues needed for debt servicing (Yusuf and Mohd, 2021).

### 3.4 Theory of Crowding out Effects

The crowding-out effect arises from imbalances in the supply and demand for credit money. Particularly when increased government borrowing leads to higher interest rates, this reduces private investment. The large-scale borrowing by the government may absorb the economy's lending capacity and substantially raise interest rates, which can discourage private capital investments.

Governments borrow money to fill the budget deficit gaps. This borrowing by the government sector may cause the interest rates to rise because the government must compete for the limited supply of funds in the market. This increased demand for funds and limited supply of loans not only raise interest rates but also negatively affect private investment, causing crowding out

effects in the economy. The resulting reduced investment by the private sector implies a decline in future potential output and growth in the country.

Public spending is essential during recessions to stimulate the economy, but persistent deficit spending may have negative consequences for the economy in the long run. Government budget deficits require an increase in future taxes or borrowing money by issuing debt securities. Higher taxes reduce the income and spending of individuals and businesses, and government borrowing implies less availability of funds for individuals and firms, both leading to increased interest rates and reduced consumption, investment, productivity, and economic growth (Spilioti and Vamvoukas, 2015).

However, persistent deficits may also escalate interest rates and government debt levels, potentially crowding out private investment, leading to a decline in economic growth. The sustainability of public finances is threatened without corresponding economic growth, leading to fiscal instability and inflationary concerns. While fiscal deficits may provide short-term economic stimulus, their long-term effects, such as reduced savings, increased interest rates, and limited capital accumulation, pose challenges to sustained economic progress. In line with this idea, empirical research studies show a negative impact of an increase in the supply of government debt securities on the private sector debt financing. Graham et al. (2014) and Demirci et al. (2019) provide evidence of the negative effect of increasing the debt-to-GDP ratio on corporate leverage, indicating the presence of a crowding-out effect in the economy.

Similarly, Zhang et al. (2022) empirically examined the effects of state and regional government debt on corporate debt financing in the national financial market of China during the period 2008–2019. In line with the neoclassical perspective, findings indicate a negative effect of both central government debt and local government debt on corporate debt financing by crowding out corporate bonds and corporate loans, respectively—evidence of crowding-out effects in the credit market of China. These crowding out effects take place via a change in commercial banks' asset portfolio—increased investment in government bonds and reduced credit availability to nonfinancial firms and large corporations—because the debt securities issued (accompanied by federal government guarantees) by local government bodies are absorbed by local banks operating in China, leaving less access to finance for corporations (Zhang, Brookins and Huang, 2022).

### 3.5 Theory from a Finance Perspective

In standard corporate finance textbooks, the value of a security is determined by discounting the value of expected future cash flows at an appropriate discount rate, i.e.:

$$P = \frac{E(c)}{k},$$

Where  $p$  is the price of a security,  $E(c)$  is the expected stream of cash flows generated by a security over a period, and  $k$  stands for the discount rate.

The above simple equation indicates that any systematic forces that can affect expected cash flows of firms ( $E(c)$ ) or the discount factor ( $k$ ) will impact the price and security returns (Chen, Roll, and Ross, 1986). Similarly, Campbell and Shiller (1988) state that movements in equity

returns are the result of changes in the discounted cash flows of firms. Therefore, any macroeconomic factors or monetary and fiscal policy variables that can influence firm cash flows and the discount rate can significantly affect equity security returns.

The discount rate ( $k$ ) is the rate of return investors demand on investments in financial markets. If the future cash flow is risk-free, then the discount rate is the interest rate on risk-free securities such as U.S. government treasury bills. If the future cash flow is uncertain, then the discount rate would be adjusted to reflect the level of risk. The discount rate is an average rate over time, and it may change when the interest rates change in the market or when the term structure of interest rate spread changes across different maturities.

Anticipated and unanticipated movements in risk-free interest rates affect the discount rate, which in turn influences asset returns through its influence on the time value of future cash flows. Since the discount rate reflects the level of risk in an investment, unanticipated changes in the risk premium influence asset returns.

Innovations in real and nominal macroeconomic forces may affect the expected cash flows of an investment. For example, a change in inflation may change the nominal interest rate and nominal cash flows, which may impact the valuation of financial assets. Finally, if the expected level of real production increases due to increased demand and consumption in the economy, it will increase firm cash flows. Therefore, increased output and cash flows positively influence equity returns. In short, as the discount model is a forward-looking asset valuation model, the movements in future cash flows, interest rates, or future economic activity are incorporated in the current stock prices.

Therefore, a discounted cash flow model from standard finance can meaningfully incorporate the effects of economic variables that affect equity market returns. These economic factors affect equity returns through their influence on either the expected cash flows of firms and dividends or the discount rate. Specifically, macroeconomic variables such as increased income and aggregate demand & consumption can affect firm revenues and profits, and factors, such as movements in inflation and interest rates, can influence the discount rate used in the valuation models.

In an earlier research study, Chen, Roll and Ross, (1986) used five economic variables that are expected to affect financial asset returns. These include GDP growth or industrial production, anticipated and unanticipated inflation, term premium (premium earned on long-term Government bonds - treasury bill rate), and oil prices. Since then, many researchers have incorporated these macroeconomic variables to model equity returns as a function of the macroeconomic variables.

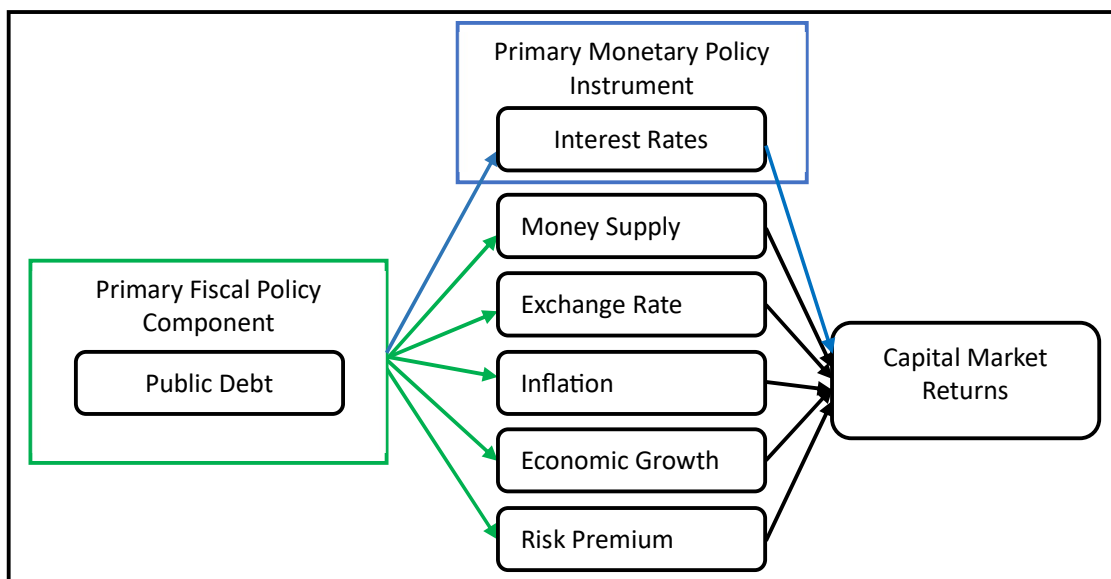
Following the diversification argument, capital market theory—a framework in finance that describes the relationship between risk and expected return for assets in a well-diversified portfolio—suggests that only general state macroeconomic variables affecting the prices of a large set of capital market securities should be considered for constructing efficient portfolios. Any systematic variables that can potentially affect the pricing of securities by affecting the expected cash flow of firms or the discount rate may help construct better investment portfolios (Chen, Roll and Ross, 1986, p. 384).

### 3.6 Public Debt and Equity Returns: Theoretical Framework

The above theoretical reasoning and arguments are summarized in a simple diagram presented in Figure 3. This shows the possible links between interest rate (main monetary policy instrument and public debt (main fiscal policy element) on capital market returns.

The public debt variable can affect financial market returns through direct and indirect channels. Direct effects of public debt (an important fiscal policy variable) on financial markets may surface when investors see a growing debt level as unsustainable, resulting in higher default probability, which can put pressure on asset prices in the financial markets. On the other hand, via indirect effects, public debt may initially impact monetary or macroeconomic variables such as economic growth, unemployment, exports, inflation, money supply, interest rates, currency exchange rates, etc., which in turn, can influence financial market returns.

Figure 3: Public Debt Effects, Transmission Channels



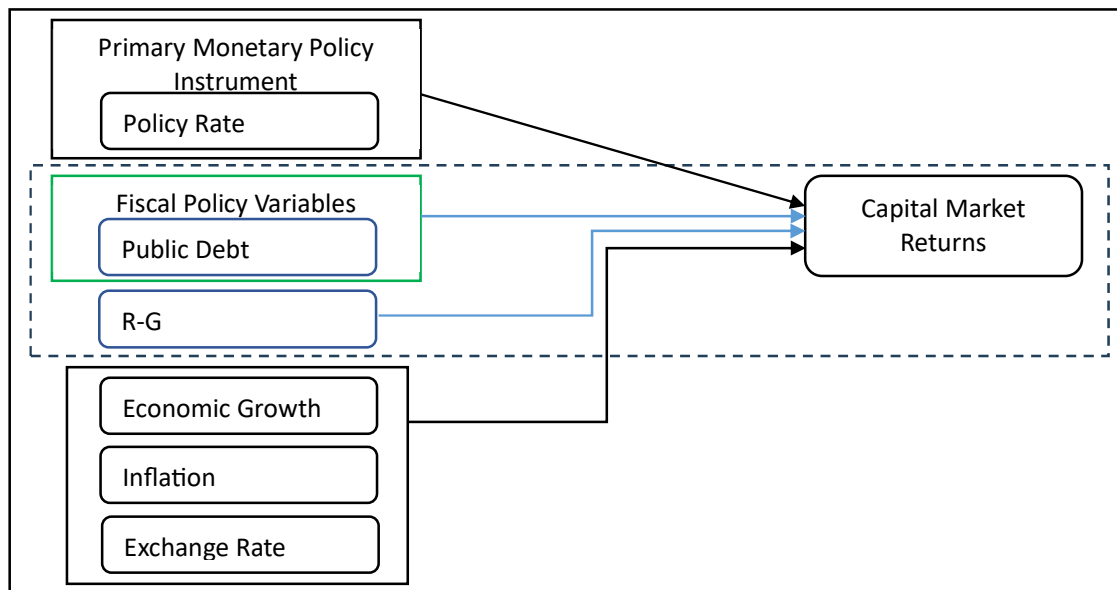
While monetary policy authorities aim at maintaining low inflation mainly by controlling interest rates in the economy, fiscal policy aims at stimulating the economy and preventing recessions. The indirect effects of fiscal policy on financial markets via monetary policy variables and macroeconomic variables indicate the presence of intermediary channels between public debt and financial market returns.

The presence of these intermediary channels has important implications for understanding the role of public debt movements in influencing financial markets. In summary, public debt has both direct effects (excess debt levels and debt servicing costs can affect the credit risk rating of a country) and indirect effects (effects on financial market returns through the intermediary channels) on financial market performance.

### 3.7 Research Model and Hypotheses

Counting on the theoretical base derived from Neoclassical, Keynesian, and Ricardian viewpoints, the following Figure 4 presents the relationships (positive, negative, or no relationships) between public debt, r-g, and capital market returns. The investigation of the relationships in the dashed rectangle is the primary focus of this research. Based on the literature review, economic growth measured as real GDP growth rate, inflation, currency exchange rate, and monetary policy rate have been included as control variables in econometric models. Theoretical and empirical literature show that these control variables are significantly associated with real and excess returns on equity market securities.

Figure 4: Research Model



To empirically assess if public debt and r-g have no impacts (Ricardian theoretical view of no real macroeconomic effects) or positive effects (Keynesian view: public debt and corresponding government expenditures have stimulating impact on aggregate demand and consumption that generate Keynesian multiplier effect for the economy) or have negative impacts (debt overhang or Neoclassical view of crowding out effects), the following set of null hypotheses are formulated and will be tested by two different econometric methodologies; linear OLS models and ARDL models.

In addition, the hypotheses will be tested using two datasets: annual frequency data for the USA and quarterly frequency panel data for 24 countries. Finally, the same set of hypotheses will also be tested for excess real returns on equity.

*H<sub>01</sub>: There is no effect of public debt on real equity returns in the short run.*

*H<sub>02</sub>: There is no effect of public debt on real equity returns in the long run.*

*H<sub>03</sub>: There is no effect of r-g on real equity returns in the short run.*

*H<sub>04</sub>: There is no effect of r-g on real equity returns in the long run.*

*H<sub>05</sub>: There is no difference in the strength of the relationship between debt-to-GDP and real equity returns when debt-to-GDP is greater than 90% of GDP.*

*H<sub>06</sub>: The relationship between government debt and real equity returns is nonlinear.*

In addition to these primary hypotheses, to test the impacts of leads and lags of debt-to-GDP and r-g on equity returns, the following hypotheses will also be tested.

*H<sub>07</sub>: There is no impact of lead values (one period ahead future values) of debt-to-GDP on real equity returns.*

*H<sub>08</sub>: There is no impact of lag values of debt-to-GDP on real equity returns.*

The next chapter provides the details of the data and econometric methodology employed for testing the hypotheses stated above.

## 4. Research Methods

This research examines the effects of the debt-to-GDP ratio and  $r-g$  on equity market returns, using annual frequency data for the USA from 1928 to 2023 as well as quarterly frequency data for a panel of 24 countries from 2000-Q1 to 2024-Q2. Considering two datasets, this study employs both time series and panel Autoregressive Distributed Lag (ARDL) frameworks to estimate the short- and long-term effects of government debt and the interest rate–growth differential ( $r-g$ ) on equity market returns. In addition to these models, standard econometric techniques are applied, including time series ordinary least squares (OLS) for the annual data, as well as pooled OLS, fixed effects, and random effects models for the panel data analysis. Similar econometric approaches have been employed in the existing literature to study the relationship between government debt and GDP growth, as evidenced in the works of Topalova (2016), Li (2017), Furceri, Loungani and Zdzienicka (2018), and Wang (2022).

### 4.1 Study Variables and Sample Data

To examine the short-term and long-term relationships among public debt,  $r-g$ , and equity market returns, this research employs two distinct data sets: annual frequency data for the USA from 1928 to 2023 and quarterly frequency data from the first quarter of 2000 till the 2<sup>nd</sup> quarter of 2024 for a panel of 24 advanced economies. The countries included in the sample are those for which quarterly observations (from 2000 to 2024) for the study variables were available, including data on the control variables incorporated in the estimation models.

The countries included in the sample are Australia, Austria, Belgium, Canada, the Czech Republic, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, the Netherlands, Norway, Poland, Portugal, Spain, Sweden, Switzerland, the United Kingdom, and the United States. Mostly, the countries included in the sample are members of the G-20 and the European Union. The group of G20 countries represents the premier forum for global economic co-operation. G20 members contribute 80% of global GDP, 75% of global exports, and account for 60% of the world's population.

The public debt as a percentage of GDP is employed to investigate the fiscal policy effects on financial markets. The Neoclassical paradigm emphasizes the use of the permanent component of the deficits, which is the average deficit over a certain number of years, rather than temporary deficits, which represent a year-to-year change in deficits. Thus, the total volume of government debt is likely to be a more informative measure while assessing the impact of fiscal policy on macroeconomic variables, instead of current deficits (Bernheim, 1989).

In addition to the main study variables—debt to GDP,  $r-g$ , and equity market returns—the real GDP growth rate as a proxy for economic growth, central bank policy rate, inflation rate, and currency exchange rate have been incorporated in the estimation models to isolate the effects of these confounding factors that may affect equity market returns. The selection of control variables is motivated by the significance of the variables in affecting financial market returns. These variables have been identified in the mainstream finance and economics literature as key economic factors affecting capital market returns.

The stock market index data for the USA stock market ranges from 1928 to 2023. Data for the S&P 500 index starting from 1957—the year the index was formally introduced in its current form—are obtained from the Federal Reserve economic database. The data on the USA stock index before 1957 are based on indices of large market-cap companies that existed before 1957<sup>2</sup> (Damodaran, 2024). The stock indices are adjusted for inflation by deflating the index series by the CPI, and then the continuously compounded returns are calculated. For the panel data, the country stock indices (index 2015=100) were retrieved from the official website of the FRED, Federal Reserve Bank of St. Louis, and the OECD data source.

The list of the variables, along with their derivation formulae, is presented in the following Table 1.

*Table 1: List of variables and their derivation formulae*

<b>Derived Series</b>	<b>Formula</b>
Nominal stock return (Log)	$\text{Ln} [\text{S\&P stock index}_{(t)}] - \text{Ln} [\text{S\&P stock index}_{(t-1)}]$
Real stock market index	$\text{S\&P stock index}_{(t)} / \text{CPI}_{(t)}$
Real stock return (Log)	$\text{Ln} [\text{real stock index}_{(t)}] - \text{Ln} [\text{real stock index}_{(t-1)}]$
Excess Real Returns on Equity/Equity Risk Premium <sup>3</sup>	$\text{Real Return on S\&P index}_{(t)} - \text{Real Risk Free Rate on 3-month T. Bill}_{(t)}$
Govt Debt to GDP (Log)	$\text{Ln} [\text{Govt to Debt to GDP}_{(t)}]$
GDP Growth Rate (Log)	$\text{Ln} [\text{Real GDP}_{(t)}] - \text{Ln} [\text{Real GDP}_{(t-1)}]$
Inflation (Log)	$\text{Ln} [\text{CPI}_{(t)}] - \text{Ln} [\text{CPI}_{(t-1)}]$
Fed Policy Rate (Log)	$\text{Ln} [\text{Fed Policy Rate}_{(t)}]$
Exchange Rate Dollar Per Pound (Log)	$\text{Ln} [\text{Exchange Rate}_{(t)}]$
R-G (10-Y Govt Bond Yield – real GDP Growth)	$\text{Period Average 10-Y Govt Bond Yield}_{(t)} - \text{real GDP Growth Rate}_{(t)}$
R-G (Fed Policy Rate - real GDP Growth)	$\text{Period Average Fed Policy Rate}_{(t)} - \text{real GDP Growth Rate}_{(t)}$

Note: Ln=natural log, t denotes one time period, one year for annual data, one quarter for quarterly data.

<sup>2</sup> [https://pages.stern.nyu.edu/~adamodar/New\\_Home\\_Page/datafile/histretSP.html](https://pages.stern.nyu.edu/~adamodar/New_Home_Page/datafile/histretSP.html)

<sup>3</sup> For quarterly data, the definition for the excess returns is: Market Returns– Risk Free Rate, since inflation is negligible in short horizons.

Data on countries' debt-to-GDP, real GDP growth rates, inflation rates, and central bank policy rates, along with other variables, are collected from national statistical official websites, the World Bank database, the OECD, and the IMF-IFS database. To derive real GDP growth rate and real stock indices, the series of GDP growth rates and stock indices are adjusted for inflation by the CPI.

For robust analysis, the effect of r-g on equity market returns was examined by using two alternative measures of interest cost of debt (r), as presented in the last two rows of the table. The first measure is based on the long-term interest rate (yield) on 10-year government bonds of the respective countries, representing the long-term cost of debt. The second measure is based on the short-term 3-month central bank policy rates, representing the short-term cost of government debt. Both measures are period averages. The table containing the full list of variables, along with their data sources, is given in Annex I.

## 4.2 Econometric Data Analysis

This research employs time series ARDL and panel dynamic autoregressive distributed lag (DARDL) framework to investigate the short and long-term impacts of government debt and r-g on equity market returns. Additionally, traditional econometric approaches, time series OLS for annual time series data, and pooled OLS, Fixed Effects, and Random Effects for quarterly panel data, are also applied for data analysis.

## 4.3 Econometric Model Specification: Annual Time Series

The following baseline regression model will be estimated to evaluate the relationships among public debt, r-g, and equity capital market returns, incorporating real GDP growth rate, inflation rate, central bank policy rate, and currency exchange rate as control variables in the models.

*Equity Market Returns = f (Debt to GDP, R-G, real GDP Growth rate, Inflation rate, Central bank policy rate, Exchange rate)*

The population regression equation in econometric notation is as follows:

$$Y_i = \alpha + \beta_1 X_{1i} + \beta_2 X_{2i} + \beta_3 X_{3i} + \dots + \beta_k X_{ki} + u_i \dots\dots\dots (1)$$

Where:

$Y_i$  = the dependent variable

$\alpha$  = intercept term

$\beta_i$  = coefficient estimate for the  $i^{\text{th}}$  regressor/ control variable

$X_i$  =  $i^{\text{th}}$  explanatory /control variable

$u_i$  = error term

In the above benchmark econometric estimation model,  $X_1$  and  $X_2$  represent the debt-to-GDP and the r-g, respectively, the two main independent variables. The remaining X-explanatory

variables are the standard control variables reported in the mainstream finance literature (Fama, 1981; Chen, Roll and Ross, 1986; Schmeling, 2009; Schmeling and Schrimpf, 2011).

The baseline regression equation, based on equation (1), is derived as follows.

$$\begin{aligned} \ln(Equity\ Returns_t) = & a + b_1 \ln(Debt\ to\ GDP_t) + b_2(R_t - G_t) + \\ & b_3 \ln(real\ GDP\ Growth_t) + b_4 \ln(Inflation_t) + b_5 \ln(Policy\ rate_t) + \\ & b_6 \ln(Exchange\ rate_t) + e_t \dots\dots\dots(2) \end{aligned}$$

The equation (2) will be estimated separately for real stock index returns and excess real stock index returns [Real Stock Index Return (t) - Risk Free Rate on 3-month T. Bill (t)].

The selected control variables include real GDP growth rate as a proxy for economic growth, the inflation rate, the central bank policy rate, and the exchange rate. The estimated regression coefficients  $b_1$  and  $b_2$  will help determine whether there exist positive or negative, and statistically significant relationships between public debt, r-g, and equity returns, holding real GDP growth, inflation, the central bank policy rate, and the currency exchange rate constant.

The efficient market hypothesis (EMH) states that all available public information (past and present information) is immediately reflected in the security prices. The strong form of market efficiency goes one step further and states that share prices reflect all public and non-public, as well as past, present, and future information in stock prices (Fama, 1998). Considering that the market participants forecast and incorporate all pertinent information in share prices, the present and future (forecast) values of public debt and r-g should be examined to determine the extent to which these variables affect equity market returns.

Therefore, the following equations will be estimated to investigate the effect of future (lead) values on real and excess returns:

$$\begin{aligned} \ln(Equity\ Returns_t) = & a + b_1 \Delta \ln(Debt\ to\ GDP_t) + b_2 F. \Delta \ln(Debt\ to\ GDP_t) + \\ & b_2 F. \Delta(R_t - G_t) + b_3 \ln(real\ GDP\ Growth_t) + b_4 \ln(Inflation_t) + \\ & b_5 \ln(Policy\ rate_t) + b_6 \ln(Exchange\ rate_t) + e_t \dots\dots\dots(3) \end{aligned}$$

In equation (3),  $\ln$  stands for natural log transformation,  $\Delta$  is the first difference operator,  $F$  is the one-period-ahead future values (lead value) of the regressor, and  $e$  is the error term.

Before estimating the regression equations, stationarity tests will be applied by using (Dickey and Fuller, 1979, 1981) and the KPSS test proposed by Kwiatkowski et al. (1992). After testing unit root properties of the time series variables, if a variable is not stationary at levels, the first difference of the variable is included in the regression equation to avoid spurious correlation (Granger and Newbold, 1974; Nelson and Plosser, 1982).

#### 4.4 Post Estimation Diagnostic Tests

To evaluate if the basic assumptions of OLS are met, several diagnostic tests were conducted to check model validity and stability (robustness check). Specifically, chi-square ( $\chi^2$ ) tests and  $R^2$  values were obtained with model estimation results for assessing the goodness of model fit

and explanatory power of estimated models. Normality of the residuals was examined based on the graphs (Histogram Plot, Kernel Density Plots, and Standardized normal P-P plots of residuals) and statistical tests of Jarque–Bera (1980) and Shapiro-Wilk W(1965).

Homoskedasticity of residuals was assessed using the Breusch–Pagan/Cook–Weisberg test (1979) for heteroskedasticity and the White IM-test (1980). Independence of the residuals was tested by using the Durbin-Watson (1971) and Breusch–Godfrey LM (1978) test for autocorrelation as well as by graphical evaluation of the residuals plotted against the time variable. The model specification test for omitted variables bias was tested with the Ramsey RESET specification test (Ramsey, 1969).

Multicollinearity among the independent variables was tested by using VIF, tolerance, and condition index values. The linearity of the dependent and independent variables was examined by using an augmented component-plus-residual plot (acpr) and the plots of residuals against the dependent and independent variables (Govt Debt to GDP and R-G).

## 4.5 VAR Specification

In addition to the conventional time series OLS estimations, the VAR analysis is also used to illustrate short- and long-term empirical relationships among these variables. If two or more time series variables are non-stationary, but their linear combination is stationary, then the variables are assumed to be co-integrated. Since most economic and financial variables are non-stationary, the vector autoregression (VAR) econometric model seems more reasonable as it captures both the evolution and the interdependencies between the time series variables over time. A VAR analysis explains the evolution of relationships over time based on the lags of variables of interest and the lags of all the other explanatory variables included in a model. By co-integration analysis and Vector Error Correction Models (VECM), it is possible to analyse simultaneously the short- and long-run dynamics in the modelling process.

Before applying the VAR, the time series properties of public debt, r-g, real GDP growth rate, inflation rate, central bank policy rate, real returns, and excess returns on equity will be examined for stationarity by using the modified Dickey–Fuller (1979) and KPSS tests. The Akaike Information Criterion (AIC), developed by Ng and Perron (2002), is used to determine the lag lengths. The tests will be performed on the levels and first differences of the variables.

In contrast, if two or more time series variables are integrated of order  $I(d)$  (non-stationary) with  $d > 1$ , the variables are said to be co-integrated. In this case, the error correction term is included in the VAR system to estimate the speed of adjustment in the equilibrium, and the model becomes a vector error correction model (VECM). The commonly used methods for testing co-integration of economic variables are: The Engle-Granger three-step method (Engle and Granger, 1987) and the Johansen & Juselius (1990) method of co-integration. However, these methods assume that the variables in a VAR framework are integrated of the same order, i.e.,  $I(1)$  or  $I(2)$ . If this assumption does not hold and the variables are not integrated at the same order, then ARDL is the appropriate choice. The cointegration of non-stationary variables within the ARDL framework is conceptually equivalent to an error-correction (EC) process. The ARDL model achieves this by reparameterising the long-run relationship into an error-correction form to capture both the short-run dynamics and the long-run equilibrium

simultaneously (Engle and Granger, 1987; Hassler and Wolters, 2006). However, the Engle and Granger (1987) approach requires the estimation of a static OLS model at levels, which can cause bias in finite samples while ignoring short-run relationships (Banerjee *et al.*, 1986).

## 4.6 ARDL Specification

The autoregressive distributed lag (ARDL) method, also known as the ARDL bounds test, proposed by Pesaran and Shin in 1999 and improved by Pesaran *et al.* in 2001, is an intuitive and flexible approach for estimating short and long-run dynamics of relationships among variables. The method is intuitive because its implementation and the interpretation of the ARDL results are quite straightforward. Additionally, the ARDL framework is based on a single form equation (Bayer and Hanck, 2013) in comparison to other procedures based on simultaneous equations. Moreover, as in conventional methods, the use of log transformation of the variables in the ARDL model translates the estimated coefficients as elasticities, making the interpretations intuitive and easy.

The ARDL method can incorporate several lags (not necessarily equal for all variables) of dependent and explanatory variables in the estimation models. With an increasing number of explanatory variables, the number of candidate models with all possible lag combinations can be quite large. However, the ARDL command implemented in STATA is computationally so fast and efficient that the optimal model is found efficiently due to its automatic optimal lag selection feature based on the Akaike or Schwarz/Bayesian information criterion specified in the estimation process.

Therefore, this method can be applied irrespective of the order of integration of the time series variables *i.e.*, integrated of order I (0)—stationary at levels or integrated of order I (1) first difference stationary (Pesaran, Shin and Smith, 2001), but not I (2) or higher. Series with I (2) or higher order invalidate the F and t-statistics and all corresponding critical values provided by the ARDL bounds test (Pesaran, Shin and Smith, 2001).

The method is flexible because the ARDL approach provides reliable estimates for small samples. Whereas, Johansen & Juselius (1990) cointegration approach assumes asymptotically large samples (Haug, 2002) for co-integration analysis. In addition, by including the appropriate lag length of the variables in the models, the ARDL method controls for autocorrelation of residuals, which helps overcome the endogeneity problem and thus provides unbiased estimates of coefficients and valid t-statistics (Harris, Sollis and Harris, 2005). Furthermore, since the model specifications distinguish between dependent and independent variables, the short-run adjustments can be integrated into the long-run equilibrium relationship by the error correction mechanism (ECM). In addition, compared to Engle-Granger, the estimation of short- and long-run effects in ARDL models, along with the ability to test hypotheses on the long run coefficients, makes it more flexible in terms of its applications (Halicioglu, 2007).

A recent development in the ARDL bounds testing approach is the replacement of: (i) the near-asymptotic critical values computed by Pesaran, Shin, and Smith (2001), and (ii) replacement of critical values provided by Narayan and Smyth (2005) for finite-samples, with more precise and comprehensive critical values provided by Kripfganz and Schneider (2023) for post

estimation bounds testing. These more precise critical values, along with the approximate p-values, allow easy test decisions at a given level of significance. These values have been obtained from large-scale simulations of the response surface regressions<sup>4</sup>. These critical values and p-values are available for any number of regressors and any sample size.

With the ARDL command in STATA, an ARDL model can be estimated with automatic optimal lag selection, or the lag order can be pre-specified manually. The `ectest` (bounds test) for testing the existence of a long-run relationship is implemented as a postestimation command that provides asymptotic and finite-sample critical lower and upper band values along with approximate lower and upper band p-values.

For this research, the ARDL bounds tests were performed by using the algorithm program written for STATA by Kripfganz, S. and D. C. Schneider (2016) and updated by Kripfganz, S., and D. C. Schneider (Kripfganz and Schneider, 2023). The program is available at (<http://www.kripfganz.de/stata/>).

## 4.7 The ARDL Model Estimation Procedure

The following sequence of econometric approaches was employed for the data analysis.

### 4.7.1 Stationarity Check

Before estimating the ARDL model, the descriptive statistics of the series were calculated along with Jarque–Bera normality tests for the variables and are presented in the data analysis section. In addition, a table of the correlation matrix is also provided in the analysis section to have a preliminary assessment of the relationships among variables. Next, the unit root tests were performed to identify the order of integration for each variable. Unit root tests are needed because the ARDL bounds test models assume stationarity of the variables at level or first difference or a mix of both, i.e., variables must be I (0) or I (1) but not I (2) or higher. The stationarity tests performed are the Augmented Dickey Fuller (ADF) and Kwiatkowski–Phillips–Schmidt–Shin (KPSS) tests. The stationarity tests were conducted on variables in levels and first differences.

### 4.7.2 ARDL Model Specification

An ARDL model has two main components: the autoregressive (AR) component and the distributed lag (DL) component. The AR part includes the lags of the dependent variable, whereas the DL part includes the levels and lags of the independent variables. For example, an ARDL (2, 1, 2) model specifies two lags of the dependent variable as regressors, the level and lag 1 of the first independent variable, and the level, lag 1, and lag 2 of the second independent variable. Following the methodology of Pesaran, Shin, & Smith (2001), the ARDL model with a constant is specified for bounds testing and presented in the following equation.

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<sup>4</sup> Kripfganz, S. and D. C. Schneider (2018). Response surface regressions for critical value bounds and approximate p-values in equilibrium correction models. *Manuscript*, University of Exeter and Max Planck Institute for Demographic Research, [www.kripfganz.de/research/Kripfganz\\_Schneider\\_ec.html](http://www.kripfganz.de/research/Kripfganz_Schneider_ec.html)

$$\begin{aligned} \Delta \ln(\text{Equity Returns}_t) = & \lambda_0 + \sum_{i=1}^m \lambda_{1i} \Delta \ln(\text{Equity Returns}_{t-i}) + \\ & \sum_{i=0}^n \lambda_{2i} \Delta \ln(\text{Debt to GDP}_{t-i}) + \sum_{i=0}^p \lambda_{3i} \Delta \ln((R - G)_{t-i}) + \sum_{i=0}^q \lambda_{4i} \Delta \ln(\text{Inflation}_{t-i}) \\ & + \phi_1 \ln(\text{Equity Returns}_{t-1}) + \phi_2 \ln(\text{Debt to GDP}_{t-1}) + \phi_3 \ln((R - G)_{t-1}) \\ & + \phi_4 \ln(\text{Inflation}_{t-1}) + \mu_t \dots \dots \dots (1) \end{aligned}$$

In the above equation,  $\Delta$  stands for first difference,  $\ln$  stands for natural logarithmic transformation,  $\lambda_0$  is the intercept,  $\lambda_{1i}, \lambda_{2i}, \lambda_{3i}, \lambda_{4i}$  are the short-term coefficient estimates,  $\phi_1, \phi_2, \phi_3, \phi_4$  are the long-term coefficient estimates, and  $\mu_t$  is a white noise error term. The model is estimated with maximum lag lengths of (m, n, p, q) for the respective regressors. The Akaike information criterion is used to automatically select the optimal lag (the lag length at which no autocorrelation is found) length for each variable in the model.

Long Run Levels Equation:

If the bounds test concludes the existence of cointegration or long run relationships, the following long run levels model is estimated to obtain the residuals.

$$\ln(\text{Equity Returns}_t) = a_0 + a_1 \ln(\text{Debt to GDP}_t) + a_2 \ln((R - G)_t) + a_3 \ln(\text{Inflation}_t) + v_t \dots \dots \dots (2)$$

ECT is obtained from residuals of equation (2) for the long-run levels model as follows:

$$\begin{aligned} ECT_{t-1} = & \ln(\text{Equity Returns}_{t-1}) - \hat{\alpha}_0 - \hat{\alpha}_1 \ln(\text{Debt to GDP}_{t-1}) - \hat{\alpha}_2 \ln((R - G)_{t-1}) \\ & - \hat{\alpha}_3 \ln(\text{Inflation}_{t-1}) \dots (3) \end{aligned}$$

After deriving the residuals as in equation (3), the Error Correction Model (ECM) for short-term coefficients and speed of adjustment is estimated as follows:

$$\begin{aligned} \Delta \ln(\text{Equity Returns}_t) = & \delta_0 + \sum_{i=1}^m \delta_{1i} \Delta \ln(\text{Equity Returns}_{t-i}) + \\ & \sum_{i=1}^n \delta_{2i} \Delta \ln(\text{Debt to GDP}_{t-i}) + \sum_{i=1}^p \delta_{3i} \Delta \ln((R - G)_{t-i}) + \sum_{i=1}^q \delta_{4i} \Delta \ln(\text{Inflation}_{t-i}) \\ & + \delta_4 ECT_{t-1} + \omega_t \end{aligned}$$

Where  $\omega_t$  is the error term and  $ECT_{t-1}$  is the error correction or speed of adjustment to the disturbance in equilibrium.

### 4.7.3 Diagnostic Tests after Cointegration Analysis

Several diagnostic tests were conducted to check model validity and stability (robustness check). Specifically, the chi-square ( $\chi^2$ ) tests and  $R^2$  values were obtained with model estimations to assess the goodness of fit and explanatory power of the models. Normality of the residuals was examined by the graphs (Histogram Plot, Kernel Density Plots, and standardized normal P-P plots of residuals) as well as statistical tests of normality proposed by Jarque–Bera and Shapiro-Wilk.

The assumption of homoskedasticity of the residuals was examined using the Breusch–Pagan/Cook–Weisberg test of heteroskedasticity and the IM-test. Independence of the residuals was tested by the Durbin-Watson (DW) and Breusch–Godfrey LM test for autocorrelation, along with the graphical evaluation of the residuals plotted against the time variable. The model specification test for omitted variables bias was tested with the Ramsey RESET test (Ramsey, 1969).

Multicollinearity among the independent variables was tested using the VIF, tolerance, and condition index values. The linearity of the dependent and independent variables was examined using the augmented component-plus-residual plot (acpr) and the plots of residuals against the dependent (excess real returns) and independent variable (debt-to-GDP). Finally, after estimating the ARDL models, the stability of estimated regression coefficients was tested with CUSUM and CUSUM<sup>2</sup> tests (S. Page, 1954).

## 4.8 Quarterly Panel Data

The relationships between public debt,  $r-g$ , and equity market returns are also explored using quarterly frequency data from 2000-Q1 to 2024-Q2 for a panel of 24 countries. Due to the unavailability of quarterly data for many countries, only those countries are included in the sample for which quarterly observations from 2000 to 2024 were available. Stock market indices' quarterly data for a few countries is available before the year 2000. If the time series were extended before the year 2000, only a few countries could be included in the sample, because the quarterly data before the year 2000 is available only for some advanced economies (4 to 5 countries). Therefore, panel data for 24 countries from 2000-Q1 to 2024-Q2 were preferred over the panel data for only 5 countries over a longer period from 1990 to 2024. The data set collected for 24 countries can be characterized as a strongly balanced long (macro) panel because the dataset has no missing observations, and  $N < T$ .

### 4.8.1 Stationarity Tests

Before estimating standard panel data OLS models and panel ARDL models for real returns and excess returns on equity market indices, the panel data series were tested for unit roots with the 1st and 2nd generation panel unit root tests. The standard 1<sup>st</sup> generation stationarity tests performed are: Levin, Lin & Chu (2002), Im, Pesaran & Shin (2003), ADF-Fisher Chi-square and PP-Fisher Chi-square, and the second generation tests performed are: Pesaran's CADF with constant and with constant & trend (Pesaran, 2007).

Since both the Pesaran's test of cross-sectional independence (CD test of Pesaran) and Breusch-Pagan LM test of panel independence (given in diagnostic section) show that the panels are

correlated, therefore, in addition to the first-generation panel unit root tests (PURT), the second-generation PURTs were also conducted with (pescadf) STATA command (Pesaran, 2007). Pesaran's CADF is the t-test for testing stationarity of heterogeneous panels with cross-section dependence, developed by Pesaran (2007). This test is based on individual Dicky Fuller (DF) or Augmented DF t-statistics, like the t-tests of Im, Pesaran & Shin that are determined for each unit in the panel. The standard ADF test regressions are extended with the cross-section averages of lagged levels and lags of first differences of the series (CADF statistics) to overcome cross-sectional dependence in panels. The null hypothesis assumes that all series have unit roots against the alternative hypothesis that only a part of the series are stationary. To conduct 2<sup>nd</sup> generation panel unit root tests, (pescadf) STATA command was used.

## 4.9 Standard Linear Panel Data Models

A general econometric framework for panel data is as follows:

$$Y_{it} = \alpha + \beta_1 X_{1it} + \dots + \beta_k X_{kit} + v_i + \lambda_t + \varepsilon_{it}$$

Where:

$i = 1$  to  $n$ , stands for cross-sectional dimension

$t = 1$  to  $T$  represents the time dimension

$v_i$  captures the individual fixed or random effects,  $v_i$  is an additional error term or constant to model unobserved heterogeneity across entities.

$\lambda_t$  for time fixed or random effects

$\varepsilon_{it}$  is independent and identically distributed (*iid*)

After determining the integration order of variables, the variables were converted into first differences to achieve stationarity if they were non-stationary at levels, to prevent spurious correlations in models (Granger and Newbold, 1974; Nelson and Plosser, 1982). All three panel data models (Pooled OLS, Fixed Effects, and Random Effects) were estimated to select an appropriate model. The Hausman test was conducted to decide between the Random Effect and Fixed Effect model, and to decide between OLS and the Random Effects model, the Breusch and Pagan Lagrangian multiplier test was conducted (Breusch and Pagan, 1979).

The Durbin–Wu–Hausman, commonly known as the Hausman specification test, compares the consistency of an estimator with a less efficient estimator already known to be consistent. This statistical hypothesis test was developed by James Durbin, De-Min Wu, and Jerry A. Hausman (Hausman, 1978; Nakamura and Nakamura, 1981). This test evaluates which statistical model better corresponds to the dataset. The test specifies the null hypothesis as: the Random Effects (RE) model is preferred over the Fixed Effects (FE) model.

When it is known that entity-specific characteristics of each unit in the panel are correlated with regressors, fixed effects should be preferred. For example, data collected over time for most countries on macroeconomic variables (regressors) may be influenced by entity-specific attributes or internal characteristics such as the type of government policies, education facilities, industrialization levels, or cultural factors etc. (Greene, 2008, p. 183).

In contrast, the RE model should be preferred over the FE when it is assumed that individual attributes do not influence the predictors (uncorrelated). The Hausman test can examine whether individual attributes are correlated with the explanatory variables (Greene, 2008). The null hypothesis states that individual attributes are not correlated with regressors (random effects).

#### 4.9.1 Pooled OLS

Pooled OLS refers to pooling data collected over different periods ( $t$ ) and across different entities ( $n$ ) and estimating an ordinary least squares regression by assuming the sample data is collected from one large population. Pooling of observations assumes no unobserved heterogeneity among the units in the panel. When heterogeneity is present due to entity-specific attributes that do not change over time (e.g., culture, religion, gender, race, etc.) and are not correlated with the predictor variables, pooled OLS can still be estimated to derive unbiased and consistent estimates of the parameters. But the random effects estimator will be more efficient. Assuming that the unobserved heterogeneous attributes ( $a_i$ ) are uncorrelated with regressors ( $X_{it}$ ), the pooled OLS model is specified as follows:

##### **Pooled Model**

In a pooled model, the intercept terms and regression coefficients are assumed to be the same across all entities in the panel. Errors are not correlated with the regressors (i.e.,  $\varepsilon_{it}$  are independent and identically distributed (iid)).

$$Y_{it} = \beta_0 + \beta_1 X_{1it} + \dots + \beta_k X_{kit} + \varepsilon_{it}$$

Where:

$\beta_0$  = intercept

$Y_{it}$  = the dependent variable

$\beta_{1,\dots,k}$  = regression coefficient for the  $i$ th independent and control variable

$X_{1,\dots,k}$  =  $i$ th independent and control variables

$\varepsilon_{it}$  = error term

#### 4.9.2 Fixed Effects

The Fixed Effects estimator assumes the presence of entity-specific and time constant attributes of individuals. These entity-specific attributes (such as Govt. policies, education level, culture, religion, race, etc) may or may not be correlated with regressors and therefore may or may not impact the dependent variable of individual entities. The estimated slope coefficients of the fixed effects models are free from omitted variable bias because all unobserved time-constant attributes are controlled in FE. In particular, FE models only study the causes of changes (the impact of explanatory variables specified in the model) on the dependent variable of entities, while controlling for the effects of entity-specific unobserved attributes, because an attribute that does not change over time (time-constant characteristic) cannot cause a change in the outcome variable. (Kohler and Kreuter, 2005, pp. 245–250).

For this research study, by incorporating country fixed effects into a model, it is possible to isolate the impact of the debt to GDP and r-g (along with other independent variables) on equity returns (the outcome variable) while holding constant the country-specific factors (for example, type of govt, type of public policies, culture, religion etc.) that could confound the relationship. In short, FE controls the effects of entity-specific attributes that may impact equity market returns but remain unchanged (time invariant) within each country.

The Fixed Effects (FE) and Random Effects (RE) models are based on two assumptions. The RE models assume entity-specific effects are not correlated with the explanatory variables, whereas FE models assume the correlation between entity-specific attributes and the explanatory variables. If the assumption (entity-specific traits correlate with regressor) is valid, the RE estimator is efficient and preferred over FE. If this assumption does not hold, the RE estimator is not consistent, and FE is preferred over RE (Wooldridge, 2010).

### Fixed Effects Model

$$Y_{it} = \beta_1 X_{1,it} + \dots + \beta_k X_{k,it} + \alpha_i + \varepsilon_{it}$$

#### Where:

$i$  = entity (Country) and  $t$  = time (quarters from 2000q1 to 2024q2)

$\alpha_i = \beta_0 + \beta_2 Z_i$  ( $Z_i$  refers to an unobserved time invariant variable but varies from entity to entity; therefore, it is entity-specific intercept)

$Y_{it}$  = the dependent variable (Stock Index Returns)

$\beta_k$  = Regression coefficient of the respective independent and control variables

$X_{k,it}$  =  $ith$  explanatory/control variable

$\varepsilon_{it}$  = error term

### 4.9.3 Random Effects

If entity-specific and time-invariant attributes are present and are not correlated with the predictor variables, the RE will be more efficient than pooled OLS. RE models also control for unobserved heterogeneity when it does not correlate with independent variables. RE model captures the differences and variability between different panel units within a larger group.

In the context of this research, if the effects of debt-to-GDP and r-g (along with other independent variables) on equity returns (the outcome variable) are not constant across countries, instead they vary due to country-specific characteristics, the RE model should be preferred over the FE model, because the random effects model treats  $B_i$  as varying across individuals.

Generally, in the presence of time-invariant attributes, the random effects model is a feasible generalised least squares (FGLS) method, which is asymptotically more efficient than the pooled OLS estimator. In addition, RE model estimations are adjusted for the serial correlation caused by unobserved entity attributes.

### Random Effects Model

The following equation converts to a random effects model assuming the unobserved entity effects ( $a_i$ ) are uncorrelated with regressors [ $\text{Cov}(a_i, X_{k,it}) = 0$ ].

$$Y_{it} = \beta_0 + \beta_1 X_{1,it} + \dots + \beta_k X_{k,it} + \alpha_i + \varepsilon_{it}$$

Where:

$i$  = entity (Country) and  $t$  = time (quarters from 2000q1 to 2024q2)

$\alpha_i$  = ( $i=1 \dots n$ ) is the unknown intercept for each entity

$Y_{it}$  = the dependent variable (Stock Index Returns)

$\beta_k$  = Regression coefficient of the explanatory and control variables

$X_{k,it}$  =  $ith$  regressor

$\varepsilon_{it}$  = error term

## 4.10 Panel ARDL Model Specification

In addition to the traditional econometric models, the data are also analysed with the dynamic panel ARDL models. Panel ARDL models stand out because they provide estimates on the short-term, long-term effects, and the speed of adjustment parameter estimate to equilibrium. In contrast, the traditional static panel data models, such as Fixed Effects, Random Effects, or pooled OLS, fail to provide short and long-term coefficient estimates of the relationships (Loayza and Ranciere, 2006). These traditional models allow intercepts to differ across entities in the panel while all other slope coefficients and error variances are restricted to be homogeneous. Additionally, the estimated parameters can suffer from bias in the presence of endogenous regressors (Campos and Kinoshita, 2010). In contrast, the dynamic panel models, for example, the difference-GMM method proposed by Arellano and Bond (1991) and the GMM-system approach proposed by Arellano and Bover (1995) are applicable if  $N > T$  (short panel)—the number of cross-sectional entities in the panel is greater than the number of periods. Furthermore, the GMM estimator provides only the slope coefficients of short-term relationships (Hendayanti *et al.*, 2025).

Since, the panel data for this study can be characterized as long panel as  $N < T$  ( $N=24$  countries and  $T=98$  quarterly time periods), and variables have mix order of integration, the panel autoregressive distributed lag (ARDL) method seems more appropriate because ARDL can be applied to a data set with variables integrated of order  $I(0)$  or  $I(1)$  or a mix of both. In addition, ARDL can be estimated with MG, PMG, or DFE, which offer different combinations of constrained and unconstrained coefficient models.

Therefore, following Pesaran and Shin (1999, 2001), a dynamic panel ARDL ( $p, q$ ) lags along with an error correction model (ECM) is stated as follows:

### 4.10.1 Panel ARDL Model Specification

A panel ARDL model for  $i=1, 2, 3, \dots, N$  groups and  $t=1, 2, 3, \dots, T$  periods:

ARDL ( $p, q, q, \dots, q$ ):

$$y_{it} = \sum_{k=1}^p \gamma_{ik} Y_{i,t-k} + \sum_{k=0}^q \delta'_{ik} X_{i,t-k} + \omega_i + \varepsilon_{it}$$

Where:

$X_{i,t}$  = (k x 1) vector of regressors for group I, integrated of order I (0), I (1) or mix of both.

$\gamma_{ik}$  = Coefficients of lagged dependent variable.

$\delta'_{ik}$  = (k x 1) vector of coefficients of regressors

$\omega_i$  = entity-specific fixed effects error term

$\varepsilon_{it}$  = error term, iid, i.e., independently and identically distributed

p = lags of the dependent

q = lags of independent variables.

### ARDL Vector Error Correction Model

$$\Delta y_{it} = \sum_{k=1}^{p-1} \gamma_{ik} \Delta Y_{i,t-k} + \sum_{k=0}^{q-1} \delta'_{ik} \Delta X_{i,t-k} + \varphi_i y_{i,t-1} + \beta_i X_{it} \omega_i + \varepsilon_{it}$$

Where

$\gamma_{ik}$ ,  $\delta'_{ik}$  are the estimates of short-run slope coefficients

$\varphi_i$  are group-specific error correction coefficients that measure the speed of adjustment to long-run equilibrium

$\delta'_{ik}$  = (k x 1) vector of coefficients of regressors

$\beta_i$  = vector of long-run coefficients

$\omega_i$  = Group-specific fixed effects error term

$\varepsilon_{it}$  = error term, iid, i.e., independently and identically distributed

A panel ARDL can be estimated by the Mean Group (MG) Pesaran and Smith (1996), the PMG developed by Pesaran et al. (Pesaran, Shin and Smith, 1999), or Dynamic Fixed Effects (DFE) estimator.

The MG estimator proposed by Pesaran and Smith (1999) assumes both short-run and long-run parameter estimates to be heterogeneous. In simple words, MG estimates individual regressions for each entity to determine the unweighted means of the estimated individual regressions, which requires sufficiently large time series for consistent and valid parameter estimates. Alternatively, after pooling the data across time and entities, the estimation process assumes the slope coefficients and error variances are identical. Under the assumption of long-run slope homogeneity, the pooled estimator computes consistent and efficient coefficients.

The long-run equilibrium relationships among the specified variables in the model tend to follow a similar pattern across groups in the panel, because universal or global factors such as common technologies, similar monetary and fiscal policy plans, arbitrage conditions, and budget constraints, etc., impact all groups similarly.

In contrast, the DFE is very restrictive and assumes the short-run, ECT, and the long-run coefficients to be homogeneous across entities. For implementing DFE, the cluster option can be specified when there is evidence of panel dependence (correlated panels). Which can be tested by statistical tests (Blackburne and Frank, 2007).

However, an intermediate approach, the PMG (which involves both pooling and averaging) estimator, is proposed by Pesaran et al. (Pesaran, Shin and Smith, 1999). It assumes the long-term slope parameters to be homogeneous across entities or a subset of entities in the panel; however, the intercept terms, ECT, short-term slope coefficients, and error variances are allowed to be heterogeneous (vary across groups). Furthermore, it allows dynamic specification by allowing the number of lags of the outcome and regressors to differ across groups.

The primary assumptions of the PMG estimator are as follows:

- Error terms  $\varepsilon_{it}$  are serially uncorrelated and independently distributed of the explanatory variables.
- A long-run equilibrium relationship is present between the dependent and explanatory variables.
- Long-run parameter coefficients are assumed to be homogeneous across panels.

Finally, to determine whether MG (short and long-run coefficients are heterogeneous), DFE (short and long-run coefficients are homogeneous), or PMG (short-run heterogeneous and long-run coefficients are homogeneous) is a better estimator, the Hausman test is conducted to test the significance of the differences among the estimated coefficients. Both MG and PMG are consistent; however, PMG is considered more efficient as the long-run slope coefficients (representing the long-run relationships) tend to be homogeneous across entities.

Hausman Test: PMG compared to MG

Ho: PMG is a better estimator; long-run coefficients are homogeneous across groups.

If parameters are homogeneous, the PMG estimator provides more efficient estimates of the coefficients.

The MG estimator is consistent and efficient in terms of the slope estimates of the mean of the long-run coefficients when slope coefficients are not homogeneous across the panels.

The MG, PMG, and DFE computations were carried out using the `xtpmg` STATA command introduced by Blackburne and Frank (2007). The program and data are available on <http://www.econ.cam.ac.uk/faculty/pesaran>.

## 5. Data Analysis

The section presents data analysis and interpretation of results. In the first part, annual data of the USA from 1928 to 2023 are analysed by using standard OLS regression models and the time series ARDL bounds testing approach. In the second part, quarterly panel data of 24 countries from 2000-q1 to 2024-q2 are analysed by using standard linear panel models: pooled OLS, fixed effects, and random effects, as well as panel ARDL models estimated with MG, PMG, and DFE estimators.

### 5.1 Summary Statistics

Table 2 presents the basic summary statistics of the variables. The Jarque-Bera normality tests indicate that the macroeconomic variables included in this study are not normally distributed.

*Table 2: Summary Statistics*

	Nominal Stock Returns	Real Stock Returns	Excess Real Returns: MR-RF	Govt Debt to GDP	Real GDP Growth Rate
Mean	7.85	8.40	8.09	65.30	3.30
Median	11.09	10.49	9.51	60.56	3.11
Maximum	45.02	53.13	51.82	133.50	18.38
Minimum	-47.07	-38.07	-50.89	16.33	-13.05
Std. Dev.	19.07	19.43	19.58	26.25	4.76
Skewness	-0.47	-0.27	-0.38	0.71	-0.03
Kurtosis	2.95	2.83	3.14	2.89	6.02
Jarque-Bera Probability	3.57 0.168	1.28 0.53	2.34 0.31	8.13 0.017	36.48 0.000
Missing Observations	0	0	0	0	0
	Inflation	Fed Policy Rate	Exchange Rate	R-G (10-Y Govt Bond - GDP Growth)	R-G (Policy Rate-GDP Growth)
Mean	3.10	3.61	2.53	1.54	0.30
Median	2.80	2.88	2.28	1.59	0.74
Maximum	14.40	16.14	5.04	16.40	14.10
Minimum	-10.30	0.08	1.23	-15.89	-18.13
Std. Dev.	3.77	3.46	1.14	5.62	6.03
Skewness	-0.01	1.17	0.85	-0.42	-0.40
Kurtosis	5.75	4.19	2.50	4.43	4.41
Jarque-Bera Probability	30.23 0.000	27.54 0.000	12.53 0.002	10.95 0.004	10.52 0.005
Missing Observations	0	0	0	0	0

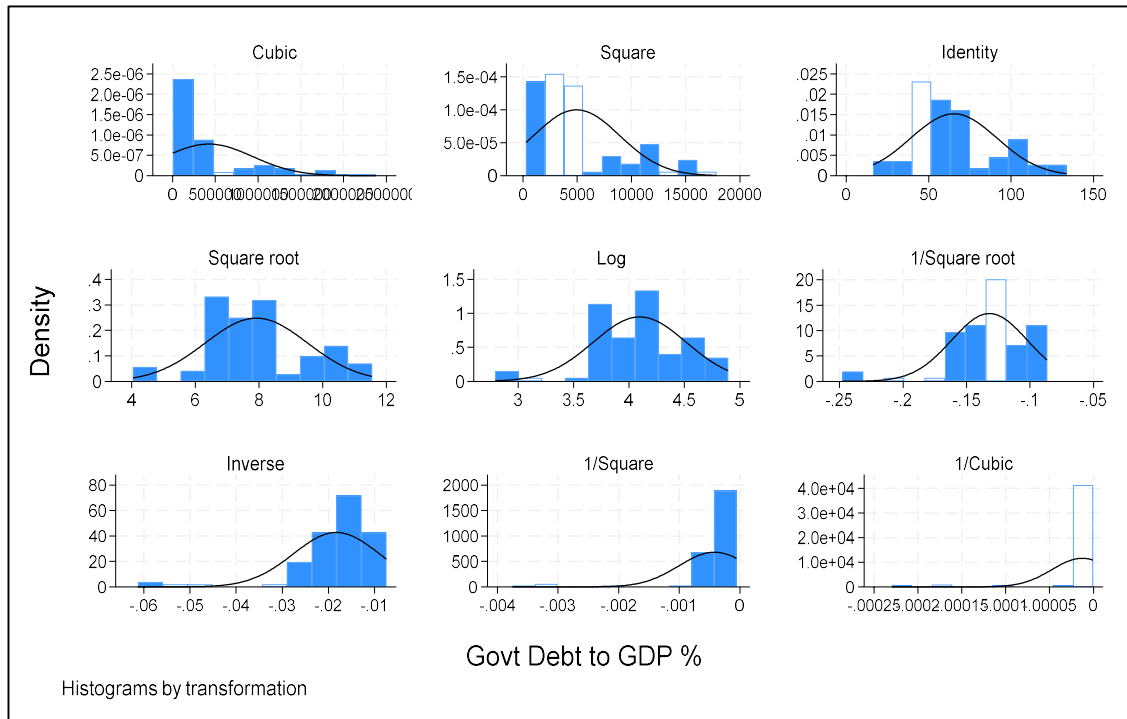
However, the nominal, real, and excess equity returns are normally distributed because the

probability values of the Jarque-Bera test for these index returns are not significant, leading to non-rejection of the null hypothesis that the variable is normally distributed. Furthermore, the statistics indicate that no observations are missing in the data. The remaining statistics in the table are self-evident and require no additional clarification.

## 5.2 Normality Assessment and Transformation of Variables

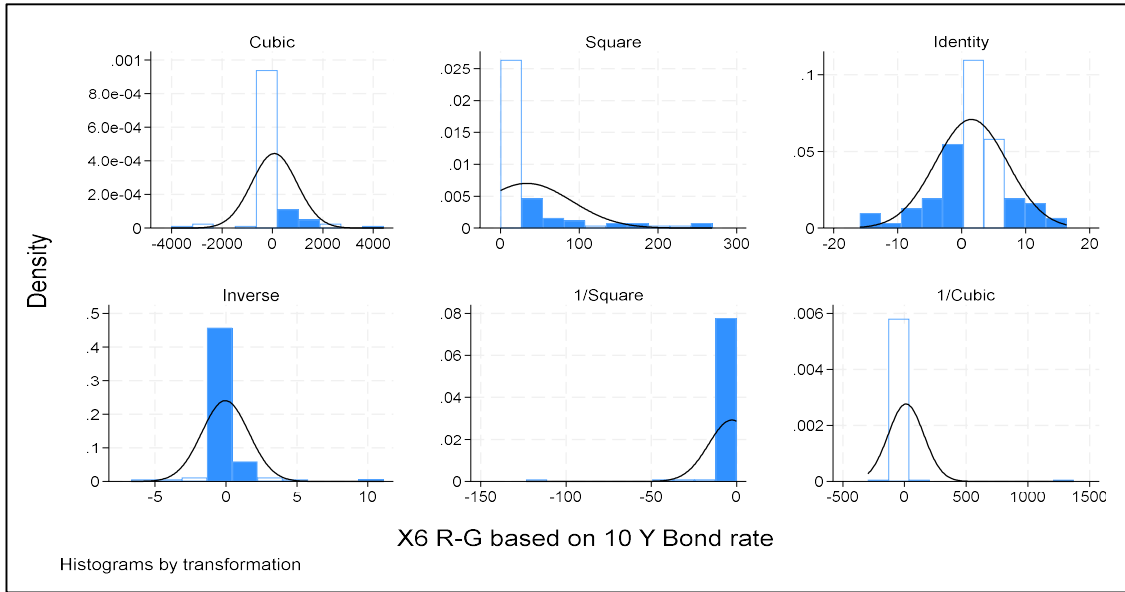
Before estimating econometric models, the normality characteristics of the variables were examined, and an appropriate transformation was applied where necessary. For example, Figure 5 shows that the debt-to-GDP ratio after log transformation appears to be normally distributed compared to any other transformation applied. The cubic, 1/cubic, inverse, squared, and 1/square root transformations often resulted in extreme positive or negative skewness that deviates substantially from normality.

Figure 5: Histograms and Density Distributions of Govt Debt to GDP



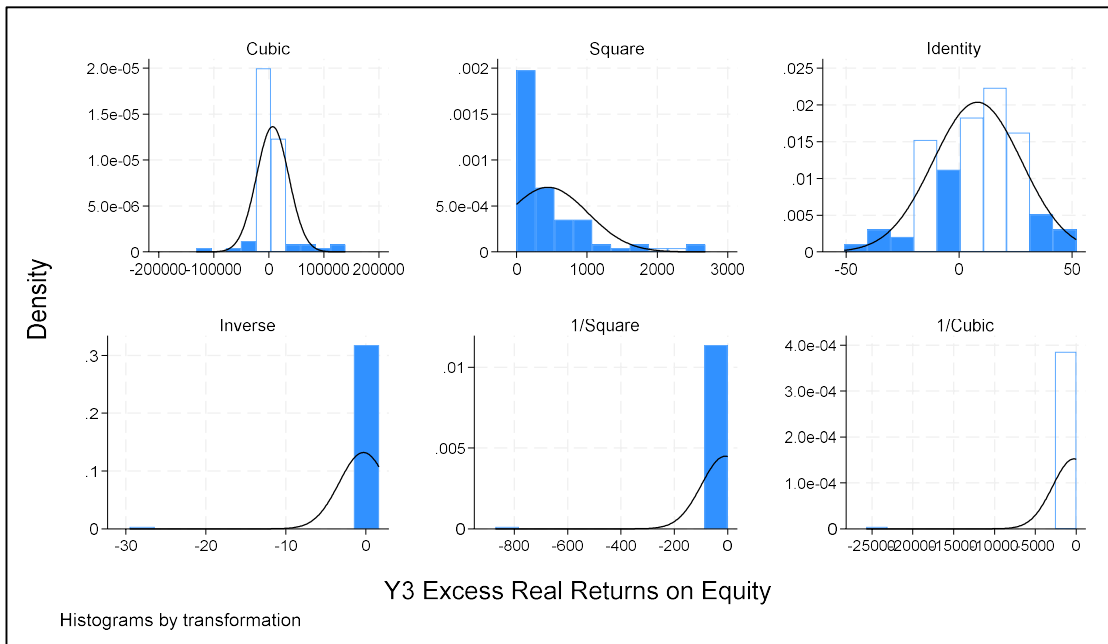
Similarly, Figure 6 presents different transformations applied to r-g (10-Y bond yield – GDP Growth). Transformations of this variable into cubic, 1/cubic, inverse, square, or 1/square resulted in either extremely positive or negative skewed shape and leptokurtic—far from normal distribution. Since the original series includes many negative values, log transformation would generate many missing values, resulting in a loss of information. Thus, the variable in its identity better approximates the normal distribution, as shown in the histogram. Therefore, no transformation is applied to r-g because it approximates the normal distribution better than any other transformation method, including the log of the variable. Using the variable in its identity also simplifies the interpretation, as the unit of measurement of the variable is in percentage. In addition, the post-estimation diagnostic tests of regression models indicate no problem of model misspecification bias, justifying its use in the original form.

Figure 6: Histograms by Transformations and Density Distributions of R-G



The real stock index returns were calculated as continuous compounded returns with log transformation by  $(\ln[\text{real stock index}(t)] - \ln[\text{real stock index}(t-1)])$ . This log transformation resulted in a normal probability distribution of the variable. However, since the excess returns variable included many negative values, applying a log transformation would result in many missing values. To avoid loss of information, a constant could be added, but this would complicate the interpretation of the results. In addition, the excess real return in its identity closely approximates a normal distribution compared to various other transformations, as shown in Figure 7.

Figure 7: Histograms and Density Distributions of Excess Real Returns



The normal approximation of real returns and real excess returns is also confirmed by the Jarque-Bera test of normal distribution given in the table of summary statistics. The histograms in Figure 7 show that the square, 1/square, inverse, and 1/cubic transformations resulted in more skewed distributions, whereas the cubic transformation is leptokurtic. Only the density distribution in the identity shape of the variable better approximates the normal distribution of the excess real stock index returns. Therefore, no transformation is applied to the variable, and it is employed in its original form (identity) in the econometric models.

The graphical evaluation and statistical tests of normality indicated that other economic variables do not exhibit normal distribution. Therefore, GDP growth rate, inflation, federal policy rate, and exchange rate are all log-transformed because the logarithmic transformation provides a closer approximation to a normal distribution compared to other transformation methods. Furthermore, log transformation also simplifies the interpretation of results in percentages as elasticities.

### 5.3 Correlation Matrix

The pairwise correlation matrix, provided in Annex I, shows that the debt-to-GDP ratio is positively correlated to the nominal ( $r = 0.28$ ), real ( $r = 0.24$ ), and excess ( $r = 0.27$ ) stock market returns. The p-values for these coefficients are all statistically significant at 1% level of significance. The correlations between  $r-g$  and nominal, real, and excess real returns on equity are negative but not statistically significant. The notable point is the strong negative relationship between  $r-g$  and GDP growth, with  $r = -0.86$ , and a p-value of 0.0000. This indicates that as the  $r-g$  moves higher or moves from negative to positive territory, it may have a strong negative impact on the real GDP growth rate.

As expected, GDP growth is positively correlated with stock market returns, whereas the federal policy rate and inflation are negatively correlated. Inflation is positively correlated with nominal stock returns. This is because, by definition, inflation is a component of nominal returns—as inflation increases, so do the nominal returns and vice versa. The correlation value between Debt to GDP and real GDP growth rate is ( $r = -0.03$ ), which indicates an extremely weak negative relation, and it is also not statistically significant. This implies a weak negative impact of increasing debt-to-GDP on economic growth.

Finally,  $r-g$  and federal policy rate have a positive ( $r = 0.45$ ) and statistically significant relationship, implying that as the federal policy rate ( $r$ ) goes higher,  $r-g$  also goes higher, and if  $r-g$  is negative, it moves from negative territory to positive territory, which in turn negatively affects the GDP growth rate. The complete table of the correlations with corresponding p-values is provided in Annex I.

### 5.4 Stationarity Properties of Variables

To assess the stochastic properties of the time series variables, Augmented Dickey-Fuller (ADF) unit root tests with constant and constant & trend were conducted, as some data series exhibit trend behaviour over time (time series graphs are provided in Annex I). The tests were performed with the Akaike information criterion for automatic lag length selection. The ADF-tests in Table 3 show that most of the variables are stationary at levels except Fed Policy

Rate (Ln), and r-g (10-Y Govt Bond Yield–GDP Growth), which are stationary at first difference (ADF tests at first difference are presented in Table 4).

The debt-to-GDP ratio appears to be stationary at the level when the test is conducted with constant only, but non-stationary when the test is conducted with constant & trend. However, the time series graph of the variable (see Annex I) shows that the series exhibits an upward trend as the debt-to-GDP ratio has been increasing over the decades. The exchange rate is non-stationary when the test is conducted with an intercept, but stationary when the trend is included. Since the graph indicates a declining trend, the variable is assumed to be stationary at the level.

Table 3: ADF tests at Levels,  $H_0$ : The Series is non-stationary,  $a=1$

Variables	test with constant		with constant and trend	
	test		test	
	statistic	p-value	statistic	p-value
Nominal Stock Returns (Ln Diff S&P Index)	-7.569	0.0000	-7.808	0.0000
Real Stock Returns (Log Diff S&P Real Index)	-7.996	0.0000	-8.146	0.0000
Excess Real Stock Returns: MR-RF	-9.738	0.0000	-9.707	0.0000
Govt Debt to GDP (Ln)	-3.659	0.0063	-3.044	0.1267
Real GDP Growth Rate (Ln)	-3.920	0.0029	-5.774	0.0000
Inflation (Log Diff CPI)	-3.851	0.0035	-3.713	0.0264
Fed Policy Rate (Ln)	-1.960	0.3038	-2.005	0.5906
Dollar Pond Ex Rate (Ln)	-1.046	0.7338	-3.680	0.0286
R-G (10-Y Govt Bond Yield-GDP Growth)	-1.970	0.2991	-2.2286	0.4676
R-G (Fed Policy Rate-GDP Growth)	-4.305	0.0008	-4.416	0.0033

Note. Lag Length Automatic, based on AIC, Mackinnon (1996), one-sided p-values

Table 4: ADF tests at First Difference,  $H_0$ : The Series is non-stationary,  $a=1$

Variables	test with constant		with constant and trend	
	test		test	
	statistic	p-value	statistic	p-value
Govt Debt to GDP (Ln)	-5.655	0.0000	-5.366	0.0000
Fed Policy Rate (Log Diff)	-7.465	0.0000	-7.408	0.0000
Exchange Rate (Log Diff Exchange Rate)	-7.037	0.0000	-6.971	0.0000
R-G (10-Y Govt Bond Yield-GDP Growth)	-3.865	0.0034	-3.844	0.0188
R-G (Fed Policy Rate-GDP Growth)	-6.688	0.0000	-6.630	0.0000

Note. Lag Length Automatic, based on AIC, Mackinnon (1996), one-sided p-values

In the context of ARDL, the variables exhibit different orders of integration, some I (0) and some I (1) during the analysed period, which implies the violation of the precondition for using the cointegration analysis approach based on the Engle-Granger two-step procedure or the Johansen cointegration analysis.

Therefore, this characterization of the time series variables implies the use of the Pesaran/Shin/Smith (PSS) ARDL bounds testing approach (Pesaran et al., 2001). With the ARDL bounds testing, both the short-run and the long-run dynamics of the relationships can be examined irrespective of the order of integration—series may be integrated of order I (0), or I (1), or a mix of both, but not higher. In addition, the error correction term (ECT) of the ARDL model estimates the speed of adjustment parameter that brings the relationship back to equilibrium.

## 5.5 Econometric Analysis: Annual Data USA

This section presents the estimation of standard OLS regression models as baseline regressions. The next section presents the results of ARDL bounds tests for short-run and long-run relationships.

The ADF unit root tests of debt to GDP in Table 3 indicate mixed results—the debt to GDP variable is stationary when the test is conducted with a constant term, but has a unit root when the ADF test includes a trend term. The stationarity results were consistent when assessed using the KPSS test, confirming the robustness of the findings. Since the time series graph of the variable indicates trending behaviour over time (that means trend term needs to be included in the test, the results show first difference stationarity), therefore, first the models are estimated by taking the first difference of Debt to GDP so that the stationarity assumption of the OLS regression can be met to avoid any spurious correlations. In addition, as a robustness check, the models are also estimated using the debt-to-GDP ratio at the level, assuming it is stationary at the level.

### 5.5.1 Time Series OLS Regression Analysis

Table 5 presents the results of the regression models for real and excess stock index returns estimated by taking the first difference of the debt-to-GDP ratio. The objective is to assess how debt-to-GDP and r-g impact real and excess returns on equity. The regression coefficients for the debt-to-GDP ratio are positive and statistically significant at 1% level of significance for both real and excess stock index returns. The economic interpretation indicates that a 1% increase in the debt-to-GDP ratio positively affects the real stock index return by 0.74% or 74 basis points. The response of excess returns is similar to that of real index returns, but slightly higher. A 1% increase in the debt-to-GDP ratio leads to a 76.59 basis points increase in excess stock returns.

However, the interesting point to note is the effect of leads (one-period-ahead future values) of Debt to GDP on stock market index returns. Considering stock market efficiency, market participants anticipate the expected values of the debt-to-GDP ratio for future periods and incorporate that information into the current stock prices. The increase in the one-period future values of the debt-to-GDP ratio negatively affects both the real and excess stock market returns. The coefficient estimates indicate that a 1% expected increase in the future value of Debt to GDP reduces real stock index returns by 0.89% (89 basis points), and excess real stock returns by 86.8 basis points.

Table 5: OLS Regressions with R-G (10-Y Bond Rate-GDP Growth)

VARIABLES	Real Stock Index Ret (Log)	Excess Real Stock Index Ret
D. Debt to GDP (Log)	0.744*** (0.277)	76.593*** (29.069)
F. D. Debt to GDP (Log)	-0.891*** (0.301)	-86.864*** (31.155)
F. D. R-G (10-Y Bond Rate-GDP Growth)	-0.011* (0.006)	-1.171* (0.635)
Real GDP Growth Rate (Log)	1.842*** (0.537)	188.574*** (52.728)
D. Fed Policy Rate (Log)	-0.022 (0.034)	-2.316 (3.099)
Inflation (Log Diff CPI)	-0.901* (0.501)	-19.575 (48.162)
Exchange Rate (Log)	-0.082* (0.048)	-3.048 (4.858)
Constant	0.066 (0.047)	5.134 (4.832)
Observations	94	94
R-squared	0.357	0.322

“Robust standard errors in parentheses, \*\*\* p<0.01, \*\* p<0.05, \* p<0.1”

Note. D refers to the first difference, and F refers to the lead or future value one period ahead. The equation for regression model specification follows:  $\ln(Equity\ Returns_t) = a + b_1\Delta\ln(Debt\ to\ GDP_t) + b_2F.\Delta\ln(Debt\ to\ GDP_t) + b_2F.\Delta(R_t - G_t) + b_3\ln(real\ GDP\ Growth_t) + b_5\ln(Policy\ rate_t) + b_4\ln(Inflation_t) + b_6\ln(Exchange\ rate_t) + e_t$

Finally, the impact of one period ahead values of r-g is also negative on both the real and excess stock market returns and significant at the 10% level; a 1 percentage point increase in r-g is associated with a 1.1% decrease in the real stock index returns and a 1.17% decrease in the excess stock index returns. Inflation, federal policy rate, and exchange rate were included in the model as control variables to avoid omitted variable bias (model misspecification bias). As expected, and as theory and empirical research have shown, the impact of real GDP growth on equity market returns is positive and statistically significant at any level of significance. In contrast, the effect of inflation is negative and statistically significant at the 10% level. Like inflation, the federal policy rate negatively affects equity market returns. However, the impact is not statistically significant in this model.

Finally, the R-squared values imply that a 35.7% change in the dependent variable (real stock index return) and a 32% change in excess returns are explained by the independent variables included in the models.

As an alternative measure of r-g, Table 6 presents the results of the regression models for real and excess stock index returns estimated with r-g based on the federal policy rate.

Table 6: OLS Regressions with R-G (Fed Policy Rate-GDP Growth)

VARIABLES	Real Stock Index Ret (Log)	Excess Real Stock Index Ret
D. Debt to GDP (Log)	0.814*** (0.239)	80.444*** (26.070)
F. D. Debt to GDP (Log)	-1.036*** (0.300)	-96.807*** (29.374)
F. D. R-G (Fed Policy Rate-GDP Growth)	-0.005 (0.004)	-0.787* (0.417)
Real GDP Growth Rate (Log)	1.087** (0.423)	87.304** (43.591)
D. Fed Policy Rate (Log)	-0.025 (0.034)	-2.102 (3.184)
Inflation (Log Diff CPI)	-0.747 (0.535)	7.408 (50.310)
Exchange Rate (Log)	-0.093* (0.049)	-4.997 (4.958)
Constant	0.096* (0.049)	9.450* (5.040)
Observations	94	94
R-squared	0.324	0.307

“Robust standard errors in parentheses, \*\*\* p<0.01, \*\* p<0.05, \* p<0.1”

Note. D refers to the first difference, and F refers to the lead or future value one period ahead. The equation for regression model specification follows:  $\ln(Equity\ Returns_t) = a + b_1\Delta\ln(Debt\ to\ GDP_t) + b_2F.\Delta\ln(Debt\ to\ GDP_t) + b_2F.\Delta(R_t - G_t) + b_3\ln(real\ GDP\ Growth_t) + b_5\ln(Policy\ rate_t) + b_4\ln(Inflation_t) + b_6\ln(Exchange\ rate_t) + e_t$

To evaluate the sensitivity of results to alternative definitions of the interest rate–growth differential (r-g), Table 6 presents the outcomes of Ordinary Least Squares (OLS) regressions in which the original R–G variable (10-year government bond yield – real GDP growth) is replaced with an alternative specification using the r-g (Fed Policy Rate – GDP Growth). This modification allows for a comparison of the explanatory power of different r–g formulations in predicting stock index returns. The objective is to determine which version of r-g serves as a stronger predictor of equity market performance within the context of the model.

Results indicate that r-g based on the federal policy rate shows similar results to those of R-G based on the 10-Year bond yield (both have a negative impact). However, the effect of r-g based on Fed Policy Rate is weaker than R-G based on 10-Y bond yields; a 1 percentage point increase in r-g leads to a decrease of 0.5% in comparison to 1.1% for real stock index returns, whereas 0.78% or 78 basis points in comparison to 117 basis points for excess returns. Moreover, the impact is statistically significant only for excess stock returns but not for real stock index returns. In contrast, when the models are estimated with R-G based on the 10-Year bond yield, the impact is statistically significant for both real and excess returns.

Therefore, R-G, based on the 10-Year bond yields, appears to be a stronger predictor, probably because real GDP growth is a long-term economic outcome that takes time to materialize and

achieve the long-term GDP growth rate. A long-run (R) based on 10-Year government bonds in comparison to a short-run (r) based on the federal policy rate (which is decided for a short time) better corresponds with G, the GDP growth. Finally, the impacts of debt-to-GDP, real GDP growth rate, inflation, and federal policy rate are similar, in terms of economic and statistical significance, in both model specifications.

As shown in Table 3, the Augmented Dickey–Fuller (ADF) unit root tests indicate that the debt-to-GDP ratio appears stationary when the test includes a constant term but is first difference stationary when the test includes both a constant and a trend term. In light of this mixed evidence, the model is re-estimated under the assumption that the variable is stationary in levels as a robustness check. The corresponding results are presented in Table 7 below.

Table 7: OLS Regressions, considering Debt to GDP is Stationary at Levels

VARIABLES	Real Stock Index Ret (Log)	Excess Real Stock Index Ret
Debt to GDP (Log)	0.517** (0.199)	49.719** (19.460)
F. Debt to GDP (Log)	-0.419** (0.206)	-35.416* (20.201)
F. D. R-G (10-Y Bond Rate-GDP Growth)	-0.014** (0.006)	-1.503** (0.617)
Real GDP Growth Rate (Log)	1.641** (0.655)	168.198*** (63.255)
D. Fed Policy Rate (Log)	-0.04 (0.032)	-4.39 (2.825)
Inflation (Log Diff CPI)	-1.337** (0.555)	-67.133 (54.020)
Exchange Rate (Log)	-0.027 (0.055)	4.655 (5.501)
Constant	-0.353 (0.258)	-57.068** (26.325)
Observations	95	95
R-squared	0.324	0.322

“Robust standard errors in parentheses, \*\*\* p<0.01, \*\* p<0.05, \* p<0.1”

Note. D refers to the first difference, and F refers to the lead or future value one period ahead. The equation for regression model specification follows:  $\ln(Equity\ Returns_t) = a + b_1 \ln(Debt\ to\ GDP_t) + b_2 F. \ln(Debt\ to\ GDP_t) + b_2 F. \Delta(R_t - G_t) + b_3 \ln(real\ GDP\ Growth_t) + b_5 \ln(Policy\ rate_t) + b_4 \ln(Inflation_t) + b_6 \ln(Exchange\ rate_t) + e_t$

Similar to the models estimated with the first difference of debt to GDP, the regression coefficients for Debt to GDP are positive and statistically significant at 5% level of significance for both real and excess stock index returns. The economic interpretation indicates that a 1% increase in the debt-to-GDP ratio positively affects real stock index return by 0.51% or 51 basis points compared to 0.74% (74 basis points) obtained in the model estimated with the first difference of debt-to-GDP. The response of excess returns is similar to the response of real

index returns, but slightly weaker; a 1% increase in the debt-to-GDP ratio leads to 49.72 basis points compared to 76.59 basis points estimated in the earlier model<sup>5</sup>.

As earlier, the notable point is the effect of leads (one period future values) of debt-to-GDP on stock market index returns. Market participants anticipate the expected values of the debt-to-GDP ratio for future periods and incorporate that information in current stock prices. The increase in future values (one-period ahead) of debt-to-GDP negatively affects both the real and excess stock market returns. The coefficient estimates show that a 1% expected increase in the future value of debt-to-GDP reduces real stock index returns by 0.42% and excess stock returns decrease by .35%.

Finally, the impact of r-g is negative on both the real and excess stock market returns, but stronger and significant at 5% level compared to the significance level of 10% in earlier models. A 1 percentage point increase in r-g leads to a 1.4% decrease in the real stock index returns and 1.5% or 150 basis points compared to a 117 basis points decrease in the excess stock index returns when models are estimated by taking the first difference of debt-to-GDP. Overall, the results remain robust in both model specifications, with similar results.

### 5.5.2 Time Series ARDL Models (Bounds Test)

Based on the previous work on the ARDL framework of Pesaran and Shin (1999), Pesaran et al (2001) introduced the ARDL bounds test for examining the short-run, long-run relationships and cointegration analysis. The popular bounds test is implemented as a postestimation feature with recently improved critical bound values and approximate p-values (Kripfganz and Schneider, 2020). These critical bounds test values depend on the type of ARDL model specification—no constant, a restricted constant, a constant, a constant and restricted trend, and a constant with trend.

To test the significance of the long run relationships (cointegration) in the ARDL framework, Pesaran et al. (2001) proposed a bounds test (btest) which involves comparing the values of conventional F- and t-statistics to pairs of lower and upper bound critical values. In a recent development, the btest has been replaced with (ectest). The ectest has not only improved bounds test critical values with more precise critical values, but also provides approximate p-values (Kripfganz and Schneider, 2020)<sup>6</sup>.

The ‘bounds test’ involves comparing the values of conventional F- and t-statistics to pairs of lower bound  $I(0)$  and upper bound  $I(1)$  critical values. If critical F or t-values exceed the upper bounds  $I(1)$ , the test conclusively rejects the null hypothesis. In contrast, if critical values are lower than the lower bound values  $I(0)$ , the test does not reject the null hypothesis. Inside the lower and upper bounds, the test remains inconclusive.

An important feature of the ARDL and ECM model command in STATA is the automatic selection of the optimal lag order based on the Akaike or Schwarz/Bayesian information

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<sup>5</sup> Unlike real stock returns, excess stock returns are not in log form.

<sup>6</sup> The (ectest) replaces (btest) for time series ARDL bounds test.

criterion. With an increasing number of explanatory variables, the number of possible models—specified by all possible combinations of lag orders—can be quickly estimated, and an efficient computation can be implemented. This procedure ensures that the optimal model out of all possible model specifications is selected in seconds (Kripfganz and Schneider, 2020).

The ARDL model with bounds testing approach can be implemented with five variations indicated in the following table. Identification of these model variations is important because the critical F and t-values are determined based on the type of model specification. These F and t-values are then used to test the significance of the long run coefficients to infer long-run causal relationships (cointegration) among the study variables.

ARDL Model Specification	
Case 1	no constant
Case 2	[constant] restricted
Case 3	[constant]
Case 4	[constant] and restricted trend
Case 5	[constant] and trend

Before estimating the ARDL model, the optimal lag length was determined by the VAR lag length selection criteria. The table given below presents the lag order selection results.

*Table 8: Optimal Lag Order Selection*

Lag	LL	LR	df	p	FPE	AIC	HQIC	SBIC
0	-206.284				0.4230	4.815	4.905	5.039
1	-189.601	33.366	4	0	0.3182	4.530	4.665*	4.865*
2	-185.328	8.5461	4	0.074	.3164*	4.524*	4.704	4.971
3	-183.293	4.0701	4	0.397	0.3310	4.568	4.793	5.127
4	-180.928	4.7301	4	0.316	0.3439	4.605	4.875	5.276
5	-173.751	14.354*	4	0.006	0.3208	4.533	4.849	5.316
6	-169.547	8.4087	4	0.078	0.3202	4.529	4.889	5.423
7	-167.34	4.4138	4	0.353	0.3345	4.569	4.975	5.576

\* Optimal lag, Sample: 1935 through 2023

Number of obs = 89

Endogenous: Real Index Ret, Excess Real Ret on Equity

Exogenous: Govt Debt to GDP, R-G:10YBond Yield- GDP Growth, Inflation, cons

As shown in Table 8 above, HQIC and SBIC determined the optimal lag order to be 1, whereas according to FPE and AIC, the optimal lag order selected is 2. To retain more lags, ARDL models were estimated by specifying the maximum lag order of 2 in the ARDL specification. In the second step, the ARDL-ECT model is estimated by automatic lag length. The automatic lag selection feature eliminates any non-significant lag (s) of the variables.

To analyse the short and long-run impacts of the debt-to-GDP and r-g on stock index returns, all ARDL models are estimated for each case—case 1 to case 5. The complete results of these models are presented in Annex II. An overview of all the models indicates that the results remain very similar in all the model specification cases. However, the constant & trend terms (both restricted and unrestricted) appear non-significant.

Therefore, the default model for case 3 (only constant term included) is selected for hypotheses testing and interpretation of the results. The estimation results are presented in Table 9 below.

Since the ARDL command in STATA does not report the coefficients of any variable or lags of a variable if the coefficients are insignificant, the coefficient of r-g is omitted from the results of the short run column in Table 9.

Table 9: ARDL Error Correction Model, Excess Real Returns

VARIABLES	Excess Real Stock Index Returns		
	ADJ	LR	SR
$\Delta$ Govt Debt to GDP (log)			-86.389*** (22.388)
L1. $\Delta$ Govt Debt to GDP (log)			62.546*** (23.540)
$\Delta$ Inflation (log)			-141.246** (69.376)
<b>Govt. Debt to GDP (log)</b>		<b>9.281**</b> <b>(4.529)</b>	
<b>R-G: 10 Y bond Yield- GDP Growth</b>		<b>-1.253***</b> <b>(0.328)</b>	
<b>Inflation (log)</b>		<b>61.133</b> <b>(51.263)</b>	
L1. Excess Real Ret on Equity (ECT)	-1.070*** (0.098)		
Constant			-32.175 (20.373)
Observations	93	93	93
R-squared	0.667	0.667	0.667

L1=lag 1 of variable,  $\Delta$ = Difference, "Standard errors in parentheses, \*\*\* p<0.01, \*\* p<0.05, \* p<0.1"

Case 3 Model (with Constant). ADJ=Speed of adjustment, LR=Long-Run, SR=Short-Run.

The bounds test criteria for case 3, including the F- and t-statistics along with their corresponding critical values and approximate p-values, are presented in the table below. The model estimation has been specified by case 3 of the ARDL framework.

Pesaran, Shin, and Smith (2001) bounds test							F= 20.604	
Case 3 (estat ectest)							t= -8.918	
	10%		5%		1%		p-values	
	I(0)	I(1)	I(0)	I(1)	I(0)	I(1)	I(0)	I(1)
F	2.749	3.847	3.287	4.489	4.489	5.895	0.000	0.000
t	-2.542	-3.411	-2.857	-3.758	-3.477	-4.422	0.000	0.000
"Kripfganz and Schneider (2020) critical values and approximate p-values"								

The null hypothesis is  $H_0$ : no level or long-run relationships exist. Since the  $F=20.60$  value is greater than the upper bound  $I(1)$  at 10%, 5%, and 1% level of significance, the null hypothesis is rejected, and it is concluded that long-run causal relationships exist among the study variables: debt-to-GDP, r-g, and inflation. The same decision is determined when using the t-value or the p-value. Since the p-value (0.000) is highly significant, the null hypothesis,  $H_0$ : no long-run relationships exist among the variables, is rejected, and it is concluded that the variables are cointegrated.

The results of (LR) coefficients indicate that the impact of debt-to-GDP on excess real stock index returns is positive and statistically significant in the long run; a 1% increase in the debt-to-GDP ratio increases the excess real returns on equity by 9.28 basis points. However, the short-run effect of the debt-to-GDP ratio on the excess real stock index return is negative and statistically significant at 1% level; a 1% increase in the debt-to-GDP ratio negatively affects excess stock returns by a decline of 86 basis points. In addition, the SR impact of a one-period lag difference of the debt-to-GDP ratio has a significant positive impact, which corresponds to the LR positive impact. This implies that the effect of debt-to-GDP with a one-period lag converts to the long-run impact. That's why the long-run coefficient and short-run coefficient of the one-period lag debt-to-GDP ratio are positive. In short, debt-to-GDP negatively affects excess returns in the short run but positively affects excess stock returns in the long run.

The long run coefficient of r-g (-1.25) is negative and statistically significant at any conventional level of significance. This implies that a 1 unit (percentage point) increase in r-g reduces the excess equity returns by 1.25%. There is no coefficient estimate for r-g reported (in the SR results column) because the ARDL suppresses the result if the coefficient turns out to be insignificant. In the remaining models, to avoid suppression of the results, the lags will be explicitly specified. In summary, r-g has negative effects on excess stock returns only in the long run, but no significant impact in the short run.

Inflation has a statistically significant negative impact on excess returns only in the short run, as the coefficient estimate value (-141.24) is negative and statistically significant at the 5% level; a 1% increase in inflation leads to 141.2 basis points or 1.41% decrease in the excess returns. In the long run, the impact is not significant.

Finally, the coefficient of the error correction term (ECT) or speed of adjustment should be negative to bring the relationship back to equilibrium, and it should also be statistically significant. The coefficient value of ECT (-1.070) is negative and statistically significant at the 1% level, meeting both requirements. This coefficient indicates that any deviation from the equilibrium is corrected by 1.07% each period to maintain the long run cointegrating relationships or equilibrium. Overall, the estimated results show that both the short-run and long-run relationships exist between debt-to-GDP and excess stock index returns, and only the long-run relationship exists between r-g and excess stock index returns. The previous model (model for Excess Real Returns) is estimated by the automatic lag selection option. The estimation results do not show r-g or any lags of this variable in the SR results column because the estimated coefficients are not significant. To avoid suppression of the results, the remaining models (models for Real Index Returns and GDP growth) explicitly specify the lags, so that the insignificant coefficients are reported in the results.

Table 10 presents the ARDL model estimates of the coefficients for the short run (SR), long run (LR), and the speed of adjustment (ADJ) for real returns.

Table 10: ARDL Error Correction Model, Real Returns

VARIABLES	Real Stock Index Returns (Log)		
	ADJ	LR	SR
L1. $\Delta$ Real Index Returns (log)			0.086 (0.131)
$\Delta$ Govt Debt to GDP (log)			-1.008*** (0.291)
L1. $\Delta$ Govt Debt to GDP (log)			0.619** (0.298)
$\Delta$ R-G (10-Y bond yield - GDP Growth)			0.0000 (0.006)
L1. $\Delta$ R-G (10-Y Bond yield - GDP Growth)			-0.004 (0.005)
$\Delta$ Inflation (log)			-1.599** (0.752)
L1. $\Delta$ Inflation (log)			0.559 (0.830)
<b>Govt Debt to GDP (log)</b>		<b>0.084*</b> <b>(0.044)</b>	
<b>R-G (10-Y Bond Yield-GDP Growth)</b>		<b>-0.007*</b> <b>(0.004)</b>	
<b>Inflation (log)</b>		<b>-0.182</b> <b>(0.576)</b>	
L1. Real Index Returns (log)	-1.164*** (0.189)		
Constant			-0.346 (0.214)
Observations	93	93	93
R-squared	0.673	0.673	0.673

L1=lag 1 of variable,  $\Delta$ = Difference, “Standard errors in parentheses, \*\*\* p<0.01, \*\* p<0.05, \* p<0.1”  
Case 3 Model (with Constant). ADJ=Speed of adjustment, LR=Long-Run, SR=Short-Run.

The results of (LR) coefficients indicate that the impact of debt-to-GDP on real stock index returns is positive and statistically significant at 10% in the long run; a 1% increase in the debt-to-GDP ratio increases real stock returns on equity by 0.08%. However, the short-run effect of the debt-to-GDP ratio on the real stock index return is negative and statistically significant; a 1% increase in the debt-to-GDP ratio negatively affects excess stock returns by a decline of 1.008% in real stock returns. As in the case of excess stock returns, the SR impact of the lag of the first difference of the debt-to-GDP ratio has a significant positive impact, which resembles the LR positive impact. This implies that the impact of debt-to-GDP with a one-period lag

converts to the long-run impact. In short, debt-to-GDP negatively affects real stock returns in the short run but has positive effects in the long run.

The long run coefficient of r-g (-0.007) is negative and statistically significant at the 10% level of significance. This implies that a 1 unit (percentage point) increase in r-g reduces the real returns on equity by 0.7% in the long run. As was the case with excess real returns, there is no statistically significant impact of the contemporaneous and one-period lag of r-g on the real stock index return in the short run. In short, r-g seems to have a negative effect on stock returns only in the long run; it has no significant short-run impact on real stock index returns.

The bounds test criteria for the models estimated as case 3, with the reported F and t critical values along with approximate p-values, are given in the table below.

Pesaran, Shin, and Smith (2001) bounds test								
							F=	17.873
Case 3 (estat ectest)							t=	-8.281
	10%		5%		1%		p-values	
	I(0)	I(1)	I(0)	I(1)	I(0)	I(1)	I(0)	I(1)
F	2.749	3.847	3.287	4.489	4.489	5.895	0.000	0.000
t	-2.542	-3.411	-2.857	-3.758	-3.477	-4.422	0.000	0.000
"Kripfganz and Schneider (2020) critical values and approximate p-values"								

The null hypothesis is  $H_0$ : no level or long-run relationships exist. Since the critical  $F=17.87$  value is greater than the upper bound  $I(1)$  at 10%, 5%, and 1% level of significance, the null hypothesis is rejected, and it is concluded that long-run causal relationships exist among the study variables: debt to GDP, r-g, and inflation. The same decision is concluded based on the t-value or the p-value. Since the p-value is highly significant, the null hypothesis of no relationship is rejected, and it is concluded that the variables are cointegrated.

Finally, the coefficient of the error correction term (ECT) or speed of adjustment is negative and statistically significant. The coefficient value of ECT (-1.164) is negative and significant at the 1% level, meeting both the requirements for an ARDL model to be valid. This coefficient indicates that the error or disturbance is corrected by 1.16% each period to maintain the long run cointegrating relationship or equilibrium. Overall, the estimated results show that both short-run and long-run relationships exist between debt-to-GDP and real stock index returns, and only a long-run negative statistically significant relationship exists between r-g and real stock index returns.

As expected, and as theory states, inflation has a statistically significant negative impact on real returns. However, the impact is statistically significant only in the short run. The coefficient estimate value (-1.599) is negative and statistically significant at the 5% level. This indicates that a 1% increase in inflation leads to a 1.59% decrease in the real stock returns.

The third ARDL model is estimated to examine the short-run and long-run impact of debt to GDP and r-g on GDP Growth. This analysis, though not the aim of this research, will help

conform to the results obtained in previous models estimated for equity returns. The results are presented in Table 11.

The estimate of the speed-of-adjustment or the coefficient of the error correction term ECT (-0.287) is negative and significant at any conventional level of significance. The adjustment coefficient indicates that the deviation from the equilibrium or disturbance to the long-run relationship is corrected by 0.28% each period.

Table 11 presents the estimates of the long-run (LR) coefficients, which indicate a statistically significant negative impact of both the debt-to-GDP ratio and the r-g on the GDP growth rate. Specifically, a 1% increase in the debt-to-GDP ratio is associated with a 0.03% decline in long-run GDP growth.

Table 11: ARDL Error Correction Model, GDP Growth Rate

VARIABLES	Real GDP Growth (Log)		
	ADJ	LR	SR
L1. $\Delta$ Real GDP Growth Rate (log)			-0.035 (0.034)
$\Delta$ . Govt Debt to GDP (log)			-0.009 (0.018)
L1. $\Delta$ Govt Debt to GDP (log)			-0.002 (0.019)
$\Delta$ R-G (10 Y bond Yield-GDP Growth)			0.002*** (0.001)
L1. $\Delta$ R-G (10 Y bond Yield-GDP Growth)			-0.007*** (0.001)
$\Delta$ Inflation (log)			-0.068 (0.055)
L1. $\Delta$ Inflation (log)			-0.013 (0.060)
<b>Govt. Debt to GDP (log)</b>		<b>-0.033**</b> <b>(0.013)</b>	
<b>R-G (10 Y bond Yield-GDP Growth)</b>		<b>-0.007***</b> <b>(0.001)</b>	
<b>Inflation (log)</b>		<b>0.480***</b> <b>(0.161)</b>	
L1. Real GDP Growth (log)	-0.287*** (0.081)		
Constant			0.047** (0.018)
R-squared	0.94	0.94	0.94

L1=lag 1 of variable,  $\Delta$ = Difference, "Standard errors in parentheses, \*\*\* p<0.01, \*\* p<0.05, \* p<0.1"

Case 3 Model (with Constant). ADJ=Speed of adjustment, LR=Long-Run, SR=Short-Run.

However, the short-run effect of the debt-to-GDP ratio on GDP growth is negative but not statistically significant. In addition, the short-run impact of the lag of the debt-to-GDP ratio is also not statistically significant, though it is negative. This implies that rising debt-to-GDP negatively affects GDP growth only in the long run.

The long run coefficient of  $r-g$  (-0.007) is negative and statistically significant at any conventional level. This implies that a 1% increase in  $r-g$  reduces GDP growth by 0.7%. Similarly, the short-run coefficient of the one-period lag value of  $r-g$  (-0.007) also shows a statistically significant negative impact. In summary, rising  $r-g$  negatively affects GDP growth both in the long run and in the short run.

The bounds test criteria for the default models of case 3 with the F and t critical values and approximate p-values are given in the table below. The estimated model is specified with the constant term included and lags explicitly specified to avoid suppression of insignificant coefficients of variables or lags of the variables.

Pesaran, Shin, and Smith (2001) bounds test							
Case 3 (estat ectest)						F=	4.886
						t=	-4.386
	10%		5%		1%		p-values
	I(0)	I(1)	I(0)	I(1)	I(0)	I(1)	I(0) I(1)
F	2.749	3.847	3.287	4.489	4.489	5.895	0.000 0.000
t	-2.542	-3.411	-2.857	-3.758	-3.477	-4.422	0.000 0.000
"Kripfganz and Schneider (2020) critical values and approximate p-values"							

Since the critical  $F=4.88$  value is greater than the upper bound  $I(1)$  at 10%, 5%, but not at 1% level of significance, the null hypothesis  $H_0$ : no level or long run relationship exists, is rejected at 5% significance level. This suggests that long-run causal negative relationships exist between debt-to-GDP,  $r-g$ , and GDP growth rate. A similar decision is concluded when using the t-value or the p-value. Since the p-value is significant at the 5%, the null hypothesis of no relationship is rejected, and it is concluded that the variables are cointegrated in the long run.

Overall, the estimated results show that both short-run and long-run negative relationships exist between  $r-g$  and GDP growth rate. This implies that when the  $r-g$  starts rising or starts moving from negative to positive territory, it negatively affects the growth of GDP. This also means that until the growth rate ( $g$ ) remains higher than the cost of debt financing ( $r$ ), GDP growth is not adversely affected, but when ( $g < r$ ), rising public debt negatively affects GDP growth.

Overall, the test results indicate that, in the context of the United States, rising public debt (debt-to-GDP ratio) has a negative effect on stock market returns in the short run. This outcome can be attributed to the government's reliance on debt issuance to finance its expenditures. As the government issues more debt securities, it competes with other borrowers for funds, leading to higher interest rates, making fixed-income securities more attractive relative to equities. Findings also indicate that public debt has a positive impact on stock market returns in the long run. This is because the aim of economic growth typically materialises in the long run, as

investments in long-term projects, financed through government borrowing, begin to yield positive returns for the economy over time. The negative impact of r-g on GDP growth extends to equity returns, as equity returns broadly depend on GDP growth. This has been empirically found in many research studies, which support the view that higher GDP growth leads to higher stock market returns, while lower GDP growth leads to lower stock market returns.

### **Post-estimation Diagnostics**

After estimating an ARDL model along with an ECM model using the ARDL STATA algorithm, several post-estimation diagnostic tests were performed to examine the model's robustness and reliability and any potential misspecification bias.

The histogram, Kernel Density plot, P-P plot, and Shapiro-Wilk W test for normal distribution show that the residuals are normally distributed (normality assumption). Breusch–Pagan/Cook–Weisberg test for heteroskedasticity shows that the residuals are homoscedastic (no problem of heteroscedasticity). Durbin-Watson (DW) and Breusch–Godfrey LM test for autocorrelation indicate that the residuals show no pattern of serial correlation and no autocorrelation. The augmented component-plus-residual plot (acpr) and plots of residuals against the dependent variables also show that the relationship among the variables is approximately linear. Finally, the CUSUM and CUSUM2 tests show that the bounds test results remain stable over time.

All the details of the diagnostic tests, along with the interpretation of the test results for both real returns on equity and excess real returns on equity, are presented in Annex II.

## **5.6 Econometric Analysis: Quarterly Panel Data**

### **Descriptive Statistics**

The basic summary statistics of the quarterly panel data are presented in Annex III. As the statistics show, there are no missing observations in the data, forming a strongly balanced long panel ( $N < T$ , i.e.,  $N=24$  countries and  $T=98$ , quarterly frequency data from 2000-q1 to 2024-q2) with a total of 2342 observations for 24 countries. The rest of the information is self-explanatory.

### **Correlation Matrix**

The pair-wise correlations indicate (given in Annex III) that the debt-to-GDP ratio is negatively correlated with the nominal ( $r = -0.014$ ) and real ( $r = -0.007$ ) stock index returns, but the correlations are not statistically significant as indicated by their p-values. However, the debt-to-GDP ratio is positively correlated ( $r = 0.05$ ) with excess stock index returns, and the correlation is statistically significant at 1% level. The correlations between r-g and equity market returns are weakly negative but are statistically significant for nominal, real, and excess stock market returns.

The notable point is the strong negative correlation between r-g and GDP growth ( $r = -0.67$ ) with a p-value of 0.0000. This indicates that as the r-g moves higher or moves from negative to positive territory, it may negatively impact the real GDP growth rate. Another important

correlation is between government debt-to-GDP and r-g. The correlation value is positive ( $r = 0.04$ ) and statistically significant. This implies that as the debt-to-GDP ratio moves higher, so does the r-g, and higher r-g negatively affects the real GDP growth rate. This is confirmed by the direct negative and significant correlation value ( $r = -0.067$ ) between debt-to-GDP and real GDP growth rate.

As expected, GDP growth is positively correlated with all stock market returns, and the correlations are highly significant, as all the p-values are below 0.05%. The federal policy rate and inflation are negatively correlated, except that inflation has a positive relation with nominal stock returns because nominal returns adjust to the level of inflation. Furthermore, the correlation value between debt-to-GDP and real GDP growth rate ( $r = -0.06$ ) indicates an extremely weak negative relation, and it is also not significant. This may imply a weak negative impact of increasing debt-to-GDP on economic growth.

Finally, r-g and federal policy rates have positive ( $r=0.46$ ) and statistically significant relations, implying that as the federal policy rate ( $r$ ) moves higher, r-g also goes higher, and starts moving from negative to positive territory. The complete correlation matrix is provided in Annex III.

### **Unit Root Tests**

To assess the stationarity properties of the time series variables in the panel data set, both the first-generation and second-generation panel unit root tests were applied. Specifically, the first-generation tests applied are: Levin-Lin-Chu (2002), Im-Pesaran-Shin (2003), ADF - Fisher Chi-square and PP - Fisher Chi-square. Whereas, the second-generation tests applied are: Pesaran's CADF (2007) with constant and with constant & Trend.

These tests specify the null hypothesis as: all the panels contain a unit root. First, the tests were conducted with variables in levels. If the variables were not stationary in level, the tests were conducted in first differences. These tests were performed with constant and with constant & trend, as some data series exhibit trending behaviour. The Akaike information criterion was used with automatic lag length selection. The test results are presented in the tables provided in Annex III.

The unit root test results show the corresponding t-values and p-values for each variable under four different tests. If the p-value is less than 0.05, the null hypothesis that panels contain a unit root is rejected, and it is concluded that the variable is stationary at levels. Only government debt-to-GDP (log) and Monetary Policy Rate (log) appear to contain a unit root, as the p-values are greater than the 0.05% level of significance. This leads to the conclusion of non-stationarity at levels—particularly tests conducted with trend fail to reject the null hypotheses, because the variables follow a trending pattern as shown in the time series graphs in Annex III. However, when the same tests were applied on the first difference of these two variables, the p-values rejected the null hypotheses, leading to the conclusion of stationarity at first difference. The first difference test results are presented in Annex III.

The cross-sectional dependence (CD) test of Pesaran and the Breusch-Pagan LM test of independence (diagnostic section, page 110) show that the panels are correlated. Therefore, in addition to the first-generation panel unit root tests (PURTs), the second-generation PURT test

proposed by Pesaran (2007) is also conducted. Pesaran's CADF is the t-test for testing stationarity in heterogeneous panels with cross-section dependence. The null hypothesis assumes that all series are non-stationary, against the alternative hypothesis that some of the series are stationary. To conduct the second-generation panel unit root tests, (pescadf) STATA command was used. The test results are shown in the table in Annex III. The results show that debt-to-GDP (log) is not stationary at levels but attains stationarity at first difference. However, Monetary Policy Rate (log) appears to be stationary at levels in both tests conducted with constant and with constant & trend. As the panels are correlated, as indicated by the CD test of Pesaran, the Monetary Policy Rate (log) will be used at the level for econometric model estimation. Whereas the debt-to-GDP (log) will be used in the first difference.

### 5.6.1 Basic Panel Regression Models-Real Returns on Equity

Table 12 presents the results of models estimated with pooled OLS, fixed effects, and random effects for real returns on equity.

*Table 12: Linear Panel Models, Real Stock Index Returns*

VARIABLES	Real Stock Index Returns (Log)		
	Pooled OLS	Fixed Effects	Random Effects
D. Debt to GDP (Log)	-0.197*** (0.048)	-0.217*** (0.048)	-0.197*** (0.048)
R-G: (10-Y bond Yield-GDP Growth)	-0.002** (0.001)	-0.002** (0.001)	-0.002** (0.001)
GDP Growth (Log)	0.166*** (0.022)	0.157*** (0.023)	0.166*** (0.022)
Inflation (Log Diff CPI)	-0.843*** (0.193)	-0.988*** (0.195)	-0.843*** (0.193)
Real Exchange Rate (Log)	-0.008 (0.019)	0.03 (0.023)	-0.008 (0.019)
Policy Rate (Log)	-0.015*** (0.005)	-0.021*** (0.005)	-0.015*** (0.005)
Constant	-0.447*** (0.110)	-0.582*** (0.126)	-0.447*** (0.110)
Observations	2,322	2,322	2,322
R-squared	0.109	0.118	0.1089
Number of Countries	24	24	24

Note. D= first difference, “Standard errors in parentheses, \*\*\* p<0.01, \*\* p<0.05, \* p<0.1”

To select which model is a better estimator, the Hausman test is conducted between the Random Effects and Fixed Effects models, and the Breusch and Pagan Lagrangian multiplier test for deciding between OLS and the Random Effects model.

The null hypothesis for the Hausman test is  $H_0$ : RE model is preferred, and the alternative hypothesis is  $H_1$ : FE model is preferred. As the p-value is very small and lower than 0.01, the

null hypothesis is rejected, and it is concluded that the Fixed Effect model is appropriate. The complete details of the test are given in the table below.

### Model Diagnostics- Real Returns on Equity

#### Hausman Test for Fixed and Random Effects

	(b) fixed	(B) random	(b-B) Difference	sqrt(diag(V_b- V_B)) Std. err.
D. Debt to GDP (Log)	-0.2170	-0.1970	-0.0200	0.0044
R-G: (10-Y bond Yield-GDP Growth)	-0.0024	-0.0021	-0.0003	0.0004
GDP Growth (Log)	0.1567	0.1656	-0.0089	0.0062
Inflation (Log Diff CPI)	-0.9876	-0.8428	-0.1448	0.0326
Real Exchange Rate (Log)	0.0299	-0.0078	0.0377	0.0142
Policy Rate (Log)	-0.0214	-0.0148	-0.0066	0.0020
b = Consistent under H0 and Ha; obtained from xtreg.				
B = Inconsistent under Ha, efficient under H0; obtained from xtreg.				
chi2(6) = (b-B)'[(V_b-V_B)^(-1)](b-B)				
= 30.45				
Prob > chi2 = 0.0000				

H0: The RE model is preferred, and the alternative is H1: The FE model is preferred.

The test results in the above table show that the p-value is lower than any conventional level of significance. So, the null hypothesis is rejected, and it is concluded that the Fixed Effects model is a better estimator.

In addition, to decide whether Pooled OLS or Random Effect is an appropriate model, the Breusch and Pagan Lagrangian-LM test is conducted, and the results are given in the table below.

#### Breusch and Pagan Lagrangian multiplier test for random effects

Breusch and Pagan Lagrangian multiplier test for random effects		
RSIR (Log) [Country1, t] = Xb + u[Country1] + e [Country1, t]		
Estimated results:	Var	SD = sqrt (Var)
Real Stock Index Returns (Log)	0.0079363	0.0890858
e	0.0070323	0.0838587
u	0	0
Test: Var(u) = 0		
chibar2(01) = 0.00		
Prob > chibar2 = 1.0000		

This test helps decide between the RE and simple OLS model, with the following hypothesis: H<sub>0</sub>: Variances across entities are zero or no panel effects. If the variance across entities is zero, then Pooled OLS is a better choice for model estimation. The test results in the table show that p-value is greater than any conventional level of significance, so the null hypothesis cannot be rejected, and it is concluded that Pooled OLS is a better estimator, which indicates that that random effects are not needed.

### **Comparing FE versus Pooled OLS**

Finally, to compare Pooled OLS with Fixed Effects model, the LSDV regression model is estimated, and the F-test for the following null hypothesis is:

$H_0$ : All country coefficients=0

The F-test statistic with corresponding p-value is given below.

$$F(23, 2292) = 1.83$$

$$\text{Prob} > F = 0.0094$$

Since the probability value of the F-statistic is significant ( $P < 0.05$ ), the null hypothesis is rejected, and it is concluded that the Fixed Effects model is more appropriate than Pooled OLS.

### **Are Time Fixed Effects Needed**

To test for the significance of time fixed effects, a Least Squares Dummy Variable (LSDV) regression model is estimated to test the following hypothesis:

$H_0$ : The coefficients for the time variable (Quarters) are jointly equal to zero.

The F-test statistics with the corresponding p-value is given below.

$$F(96, 2196) = 49.43$$

$$\text{Prob} > F = 0.0000$$

Since the probability value of the F-statistic is significant ( $P < 0.05$ ), the null hypothesis is rejected, and it is concluded that time Fixed Effects are needed in the model.

### **Testing for Serial Correlation**

The serial correlation, or autocorrelation, in the error term of a model is a common problem in panel data analysis. If error terms of a regression model are correlated with each other, the assumption of independence is violated. To test for serial correlation in panel data, the Wooldridge test for autocorrelation with the null hypothesis is:  $H_0$ : no first-order autocorrelation in error terms.

$$F(1, 23) = 308.149$$

$$\text{Prob} > F = 0.0000$$

Since the probability value of the F-statistic is significant ( $P < 0.05$ ), the null hypothesis is rejected, and it is concluded that serial correlation exists. To overcome the problem, the model will be tested with robust standard errors.

### **Testing for Heteroskedasticity**

An important assumption of the regression models is that the residuals have constant variance. This assumption is tested with the Modified Wald test for groupwise heteroskedasticity after estimating the Fixed Effects regression model with the following hypothesis:

The null hypothesis,  $H_0$ : Homoscedasticity or Constant Variance or variance of the residuals is homogeneous/constant.

The Modified Wald test results for groupwise heteroskedasticity are given below.  $H_0$ :  $\sigma(i)^2 = \sigma^2$  for all  $i$

$$\text{Chi2 (24)} = 119.18$$

$$\text{Prob} > \text{chi2} = 0.0000$$

Since the p-value of the test for heteroskedasticity is lower than all conventional levels of significance, the null hypothesis is rejected, and it is concluded that the errors have problems with heteroskedasticity. Therefore, the model will be re-estimated with robust standard errors to overcome the problem of heteroskedasticity and serial correlation.

### **Are the Panels Correlated**

According to Baltagi (2021), a cross-sectional dependence can be present in macro panels with long time series (over 20-30 years). To test for the panel independence, the Breusch-Pagan LM test of independence is conducted. The test results of the Breusch-Pagan LM are given below.

$H_0$ : Panels are not correlated

$$\text{Chi}^2 (276) = 12877.923, \text{ Based on 94 complete observations over 24 panel units}$$
$$\text{P-Value} = 0.0000$$

Since the probability value is significant ( $P < 0.05$ ), the null hypothesis is rejected, and it is concluded that there exists cross-sectional dependence due to correlated panels.

### **Alternative Test for Correlated Panels**

Pesaran's test of cross-sectional independence = 111.655, p-value = 0.0000

Average absolute value of the off-diagonal elements = 0.684

Since the probability value is significant ( $P < 0.05$ ), the null hypothesis is rejected, and it is concluded that there exists cross-sectional dependence due to correlated panels.

The above diagnostic tests indicate that there are problems of serial correlation, heteroskedasticity, and the panels are not independent (correlated panels). In addition, the tests suggest that country fixed effects and time fixed effects are needed in the model estimations. Therefore, the panel regression model is re-estimated with Panel Corrected Standard Errors (PCSE) along with country and time fixed effects to overcome these problems and to estimate unbiased standard errors. The results are presented in Table 13.

In Table 13, the model (1) is estimated to have no country and no time fixed effects, model (2) with country fixed effects only, model (3) with time fixed effects only, and model (4) with both country and time fixed effects.

Table 13: Linear Panel Models, Real Stock Index Returns (PCSE)

VARIABLES	(1) Panel Corrected SE	(2) Panel Corrected SE	(3) Panel Corrected SE	(4) Panel Corrected SE
D. Debt to GDP (Log)	-0.184*** (0.068)	-0.193*** (0.069)	-0.058* (0.034)	-0.059 (0.034)
R-G: (10-Y bond Yield-GDP Growth)	-0.002 (0.002)	-0.002* (0.003)	-0.002* (0.001)	-0.002 (0.001)
Real GDP Growth (Log)	0.110** (0.055)	0.106* (0.058)	0.0000 (0.021)	-0.004 (0.022)
Inflation (Log Diff CPI)	-0.411 (0.475)	-0.49 (0.483)	-1.133*** (0.192)	-1.260*** (0.191)
Real Exchange Rate (Log)	0.003 (0.035)	0.043 (0.051)	-0.055*** (0.015)	-0.059*** (0.021)
Policy Rate (Log)	-0.018 (0.018)	-0.025 (0.021)	0.008 (0.006)	-0.007 (0.008)
Constant	-0.32 (0.257)	-0.469 (0.303)	0.234** (0.092)	0.297*** (0.109)
Observations	2,322	2,322	2,322	2,322
R-squared	0.077	0.087	0.685	0.695
Number of Country1	24	24	24	24
Country FE	NO	YES	NO	YES
Time FE	NO	NO	YES	YES

D= First difference, “Standard errors in parentheses, \*\*\* p<0.01, \*\* p<0.05, \* p<0.1”  
Prais–Winsten regression, correlated panels corrected standard errors (PCSEs), adjusted for  
Heteroskedasticity and Panel Dependence

The results indicate that debt-to-GDP has a negative and statistically significant impact on real stock index returns in all four models. The effect of r-g is negative but statistically significant only in models (2) and (3) at the 10% level of significance. Inflation, GDP growth, real effective exchange rate, and policy rate are included in the models as control variables. Inflation has a significant negative impact on real stock returns, as shown in models (3) and (4), whereas real GDP growth has a significant positive effect on real stock returns in models (1) and (2). Overall, estimated results indicate that debt-to-GDP and r-g negatively affect real returns on equity.

### Extension to the Basic Models (Cluster Robust Standard Errors)

An alternative to overcome the problem of correlated errors or panel dependence is to estimate the model with cluster–robust standard errors. The robust estimator of variance with the option in the STATA command: `vce (cluster country)` can produce “correct” standard errors (in the measurement sense), even if the panel observations are correlated. This feature is not possible in the conventional estimators. In contrast, a model estimated with cluster robust standard errors can relax the assumption of panel independence and provide unbiased measurements of standard errors (Abadie *et al.*, 2022). In addition, estimating models with cluster robust standard errors can save results from false positive inferences (Yixin and Huang, 2019).

Therefore, the FE model with cluster-robust standard errors is estimated, and results are presented in Table 14 below. All models are FE with cluster-robust standard errors with added variables of lead, lag, the square of debt-to-GDP, and a dummy variable with value 1 when debt-to-GDP is greater than 90%, 0 otherwise.

The objective is to assess how debt-to-GDP and r-g affect stock market index returns. The regression coefficients in all models for debt-to-GDP are negative and statistically significant at 1% level of significance. The economic interpretation indicates that a 1% increase in the debt-to-GDP ratio negatively affects real stock index return by 0.21%.

Table 14: Fixed Effects, Real Returns on Equity (Cluster Robust Standard Errors)

Model	FE	FE with Lead Debt/GDP	FE with Lead & Lag Debt/GDP	FE with Lead & Lag & Squared Debt/GDP	FE with Lead & Lag & Squared & Dummy Debt/GDP
D. Debt to GDP (Log)	-0.217*** (0.071)	-0.213*** (0.071)	-0.212*** (0.070)	-0.213*** (0.070)	-0.213*** (0.070)
F. Debt to GDP (Log)		-0.183*** (0.060)	-0.184*** (0.064)	-0.181*** (0.064)	-0.181** (0.065)
L. Debt to GDP (Log)			-0.002 (0.064)	-0.003 (0.065)	-0.003 (0.065)
Sq. Debt to GDP (Log)				0.001 (0.001)	0.0001 (0.001)
Dummy Debt/GDP>90%					0.001 (0.007)
R-G: (10-Y bond Yield-GDP Growth)	-0.002* (0.001)	-0.002* (0.002)	-0.002* (0.002)	-0.002* (0.002)	-0.002* (0.002)
Real GDP Growth (Log)	0.157*** (0.052)	0.160*** (0.052)	0.160*** (0.053)	0.160*** (0.053)	0.160*** (0.053)
Inflation (Log Diff CPI)	-0.988*** (0.346)	-1.081*** (0.337)	-1.068*** (0.344)	-1.068*** (0.341)	-1.068*** (0.342)
Real Exchange Rate (Log)	0.03 (0.028)	0.04 (0.029)	0.039 (0.028)	0.038 (0.029)	0.038 (0.029)
Policy Rate (Log)	-0.021*** (0.005)	-0.025*** (0.005)	-0.025*** (0.006)	-0.023*** (0.006)	-0.023*** (0.006)
Constant	-0.582*** (0.186)	-0.637*** (0.189)	-0.629*** (0.189)	-0.637*** (0.190)	-0.637*** (0.190)
Observations	2,322	2,298	2,276	2,276	2,276
R-squared	0.125	0.133	0.132	0.132	0.132

“Robust standard errors in parentheses, \*\*\* p<0.01, \*\* p<0.05, \* p<0.1”

Note. Std. Errors adjusted for 24 clusters identified as countries in the panel. D refers to the first difference, and F refers to the lead or future value one period ahead.

The interesting point to note is the effect of leads or one-period-ahead future values of debt-to-GDP on stock market index returns. Considering stock market efficiency, market participants anticipate the expected values of debt-to-GDP for future periods and incorporate that

information into the current stock prices. The expected increase in the one-period future values of debt-to-GDP negatively affects real returns on equity. The coefficient estimates show that a 1% expected increase in the one-period future value of debt-to-GDP reduces the real stock index returns by 0.18%.

To examine if the lag values of debt-to-GDP have any impact on the equity returns, the one-period lag of the first difference of debt-to-GDP is included in the models. As the coefficient of the lagged values is not significant, it can be inferred that the lags of debt-to-GDP do not affect stock returns, as the impact of contemporaneous and lead or future values is already incorporated in stock prices.

Furthermore, to examine if there is a nonlinear relationship between debt-to-GDP and stock market returns, a squared term of debt-to-GDP is included as a regressor in the model. The estimated coefficient value of the squared term is not significant, leading to the conclusion that the relationship between debt-to-GDP and stock market returns seems to be linear.

The impact of  $r-g$  is negative on real stock market returns and statistically significant at the 10% level: a 1% increase in  $r-g$  leads to a 0.2% decrease in the real stock index returns.

The GDP growth rate, Inflation, federal policy rate, and exchange rate were included in the models as control variables to overcome the problem of omitted variable bias or model misspecification bias. As expected, and as theory and empirical research have shown, the impact of real GDP growth is positive and statistically significant at any level of significance in all the model specifications. In contrast, the effect of inflation is negative and significant at 1% level. Like inflation, an increase in the fed policy rate negatively affects stock index returns, and the effect is statistically significant at any conventional level.

Finally, the R-squared value implies that a 13.3% change in the dependent variable (real stock index return) is explained by the independent variables included in the model.

### 5.6.2 Basic Panel Regression Models-Excess Real Returns on Equity

Table 15 presents the results of models estimated with pooled OLS, fixed effects, and random effects for excess real returns on equity.

To select a model, the Hausman test is conducted between the Random Effect and Fixed Effect models, and the Breusch and Pagan Lagrangian multiplier test for deciding between OLS and the RE model.

The null hypothesis for the Hausman test is  $H_0$ : RE model is preferred, and the alternative hypothesis is  $H_1$ : FE model is preferred. Since the p-value is very small and lower than 0.01, the null hypothesis is rejected, and it is concluded that the Fixed Effect model is an appropriate model.

The test results in the table below show that the p-value is lower than any conventional level of significance, so the null hypothesis is rejected, and it is concluded that the Fixed Effects model provides better estimation results.

Table 15: Linear Panel Models, Excess Stock Index Returns

Excess Stock Index Returns			
Model	Pooled OLS	Fixed Effects	Random Effects
D. Debt to GDP (Log)	-16.454** (8.02)	-18.024** (6.51)	-16.454** (6.45)
R-G: (10-Y bond Yield-GDP Growth)	-0.320** (0.14)	-0.364*** (0.10)	-0.320*** (0.09)
Real GDP Growth (Log)	14.113*** (4.55)	13.202*** (4.68)	14.113*** (4.58)
Inflation (Log Diff CPI)	-7.669 (22.33)	-18.371 (33.57)	-7.669 (32.11)
Real Exchange Rate (Log)	-0.322 (1.59)	3.696 (2.96)	-0.322 (1.61)
Policy Rate (Log)	-5.355*** (0.60)	-5.845*** (0.45)	-5.355*** (0.39)
Constant	-35.541** (16.14)	-50.281** (18.72)	-35.541** (16.01)
Observations	2,321	2,321	2,321
R-squared (Overall)	0.197	0.198	0.197
Number of Countries	24	24	24

“Standard errors in parentheses, \*\*\* p<0.01, \*\* p<0.05, \* p<0.1”

### Model Diagnostics- Excess Returns on Equity

To select between fixed effects and random effects models, the Hausmann test results are given in the table below.

#### Hausman Test for Fixed and Random Effects

	(b) fixed	(B) random	(b-B) Difference	sqrt(diag(V_b-V_B)) Std. err.
D. Debt to GDP (Log)	-18.024	-16.454	-1.570	0.517
R-G: (10-Y bond Yield-GDP Growth)	-0.364	-0.320	-0.044	0.038
GDP Growth (Log)	13.202	14.113	-0.911	0.616
Inflation (Log Diff CPI)	-18.371	-7.669	-10.702	3.376
Real Exchange Rate (Log)	3.696	-0.322	4.018	1.378
Policy Rate (Log)	-5.845	-5.355	-0.490	0.200

b = Consistent under H0 and Ha; obtained from xtreg.  
 B = Inconsistent under Ha, efficient under H0; obtained from xtreg.

Test of H0: Difference in coefficients not systematic  

$$\text{chi2}(6) = (b-B)'[(V_b-V_B)^{-1}](b-B)$$

$$= 24.33$$

$$\text{Prob} > \text{chi2} = 0.0005$$

H0: RE model is preferred, and the alternative is H1: FE model is preferred.

### Breusch and Pagan Lagrangian multiplier test for random effects

To decide whether Pooled OLS or Random Effect is an appropriate model, the Breusch and Pagan Lagrangian-LM test is conducted, and the results are given in the table below. Since the p-value is greater than all the conventional levels of significance, the null hypothesis cannot be rejected, and it is concluded that the Pooled OLS model is a better estimator.

#### Breusch and Pagan Lagrangian multiplier test for random effects

Breusch and Pagan Lagrangian multiplier test for random effects		
Excess Real Returns [Country1, t] = Xb + u[Country1] + e [Country1, t]		
Estimated results:		
	Var	SD = sqrt (Var)
Excess real returns	82.78533	9.098644
e	66.33181	8.144434
u	0	0
Test: Var(u)=	0.0000	
chibar2(01) =	0.0000	
Prob > chibar2 =	1.0000	

This test helps decide between Random Effects and simple OLS regression, with the following hypothesis:  $H_0$ : Variances across entities are zero or no panel effects. If the variance across entities is zero, then Pooled OLS is a better choice for model estimation. The test result in the table shows that the p-value is greater than any conventional level of significance, so the null hypothesis cannot be rejected, and it is concluded that Pooled OLS is a better estimator. This suggests that random effects are not needed.

### Comparing FE versus Pooled OLS

Finally, to select between Pooled OLS and Fixed Effects model, the LSDV regression model is estimated, and the F-test for the null hypothesis is  $H_0$ : All country coefficients = 0.

The F-test statistic with corresponding p-value is given below.

$$F(23, 2291) = 1.53, \quad \text{Prob} > F = 0.0522$$

Since the probability value of the F-statistic is significant ( $P < 0.10$ ), the null hypothesis is rejected, and it is concluded that the Fixed Effects model is more appropriate than Pooled OLS.

### Are Time Fixed Effects Needed

To test for the significance of time fixed effects, a Least Squares Dummy Variable (LSDV) regression model is estimated to test the following hypothesis:

$H_0$ : The coefficients for the time variable (Quarters) are jointly equal to zero.

The F-test statistic with corresponding p-value is given below.

$$F(96, 2218) = 39.43, \quad \text{Prob} > F = 0.0000$$

Since the probability value of the F-statistic is significant ( $P < 0.05$ ), the null hypothesis is rejected, and it is concluded that time Fixed Effects are needed in the model.

### Testing for Serial Correlation

The problem of serial correlation is common in macro panels with long time series (over 20-30 years). It is not a problem with micro panels ( a few years). If the errors of a regression model are correlated with each other, the assumption of independence is violated. This can cause the standard errors of the coefficients to be smaller and a higher R-squared value. To test for the serial correlation in panel data, the Wooldridge test for autocorrelation specifies the hypothesis as:  $H_0$ : No first-order autocorrelation in error terms.

$$F(1, 23) = 294.007, \quad \text{Prob} > F = 0.000$$

Since the probability value of the F-statistic is significant ( $P < 0.05$ ), the null hypothesis is rejected, and it is concluded that serial correlation exists. To overcome the problem, the model needs to be estimated with robust standard errors.

### Testing for Heteroskedasticity

An important assumption of a regression model is that the residuals of the model have constant variance. After estimating the Fixed Effects regression model, this assumption is tested by the Modified Wald test for groupwise heteroskedasticity with the following hypothesis,  $H_0$ : Homoscedasticity or constant Variance or variance of the residuals is homogeneous.

The test results of the Modified Wald test for groupwise heteroskedasticity are given below.

$$H_0: \sigma(i)^2 = \sigma^2 \text{ for all } i$$

$$\text{Chi}^2(24) = 150.11, \quad \text{Prob} > \text{chi}^2 = 0.000$$

Since the p-value of the test for heteroskedasticity is lower than all conventional levels of significance, the null hypothesis is rejected, and it is concluded that the errors suffer heteroskedasticity. Therefore, the model will be re-estimated with robust standard errors to overcome the problems of heteroskedasticity and serial correlation.

The above diagnostic tests indicate that there are problems of serial correlation, heteroskedasticity, and the panels are not independent (correlated panels). In addition, the tests also indicate that country fixed effects and time fixed effects need to be included in the model estimation. Therefore, the panel regression model is estimated with Panel Corrected Standard Errors along with country and time fixed effects to overcome these problems and to estimate unbiased standard errors.

The following Table 16 presents the results for excess real returns with PCSE. The table below shows that the model (1) is estimated to have no country and no time fixed effects, model (2) with country fixed effects only, model (3) with time fixed effects only, and model (4) with both country and time fixed effects. The results indicate that Debt to GDP has a negative and statistically significant impact on excess stock index returns in the models (1) and (2). The effect of R-G is negative but significant only in models (3) and (4) at 1% level of significance. Inflation, GDP growth, real effective exchange rate, and policy rate are included in the models

as control variables. Only the fed policy has a significant negative impact on excess real stock returns in all four models, whereas inflation and GDP growth are not significant. Models (3) and (4) have higher R-squared, and the constant term is also significant. Therefore, based on these models, estimated results show that Debt to GDP has negative but not significant effects, whereas R-G has negative and significant effects on excess real returns on equity.

Table 16: Linear Panel Models, Excess Return (PCSE)

VARIABLES	(1) Panel Corrected SE	(2) Panel Corrected SE	(3) Panel Corrected SE	(4) Panel Corrected SE
D. Debt to GDP (Log)	-13.895** (6.43)	-14.565** (6.47)	-4.931 (3.42)	-5.114 (3.42)
R-G: (10-Y bond Yield-GDP Growth)	-0.335 (0.23)	-0.365 (0.26)	-0.338*** (0.11)	-0.358*** (0.12)
GDP Growth (Log)	8.384 (5.24)	7.925 (5.59)	-2.725 (2.02)	-3.145 (2.13)
Inflation (Log Diff CPI)	41.71 (45.47)	35.975 (46.22)	-18.633 (19.46)	-27.542 (19.46)
Real Exchange Rate (Log)	0.604 (3.41)	4.802 (4.99)	-5.705*** (1.50)	-5.729** (2.25)
Policy Rate (Log)	-5.628*** (1.74)	-6.166*** (2.02)	-3.561*** (0.64)	-4.657*** (0.86)
Constant	-21.883 (24.80)	-37.668 (29.29)	36.295*** (9.24)	39.994*** (11.16)
Observations	2,321	2,321	2,321	2,321
R-squared	0.132	0.141	0.685	0.693
Number of Country1	24	24	24	24
Panel Corrected SE Country FE	NO	YES	NO	YES
Time FE	NO	NO	YES	YES

D= First difference, “Standard errors in parentheses, \*\*\* p<0.01, \*\* p<0.05, \* p<0.1”  
Prais–Winsten regression, correlated panels corrected standard errors (PCSEs), adjusted for Heteroskedasticity and Panel Dependence

Overall, the main finding of panel data models for real and excess equity returns indicates that the public debt–equity returns and R-G–equity return relationships are country and time-specific, country fixed effects, and time fixed effects are present.

### Extension to the Basic Model (Cluster Robust Standard Errors)

An alternative to overcome the problem of correlated errors, or panel dependence, is to estimate the model with cluster–robust standard errors (Yixin and Huang, 2019). The robust estimator of variance with the option: vce (cluster country) can produce “correct” standard errors (in the measurement sense), even if the panel observations are correlated. Models estimated with cluster robust standard errors can relax the assumption of panel independence and provide unbiased measurements of standard errors (Abadie *et al.*, 2022). In addition, estimating models

with cluster robust standard errors can save results from false positive inferences (Yixin and Huang, 2019).

Therefore, the FE model (decided by the Hausman test) with cluster robust standard errors is estimated, and the results are presented in Table 17 below. All the models are FE with cluster robust standard errors with added variables of lead, lag, the square of Debt to GDP, and a dummy variable when Debt to GDP is greater than 90%.

Table 17: Fixed Effects, Excess Returns (Cluster Robust Standard Errors)

Model	FE	FE with Lead Debt/GDP	FE with Lead & Lag Debt/GDP	FE with Lead & Lag & Squared Debt/GDP	FE with Lead & Lag & Squared & Dummy Debt/GDP
D. Debt to GDP (Log)	-18.024** (6.51)	-17.649** (6.36)	-17.530*** (6.17)	-17.583*** (6.17)	-17.606*** (6.17)
F. Debt to GDP (Log)		-19.356*** (5.42)	-19.246*** (5.68)	-19.058*** (5.85)	-18.984*** (5.89)
L. Debt to GDP (Log)			-2.389 (6.53)	-2.45 (6.55)	-2.469 (6.54)
Sq. Debt to GDP (Log)				0.033 (0.07)	0.061 (0.10)
Dummy Debt/GDP>90%					-0.438 (0.70)
R-G: (10-Y bond Yield-GDP Growth)	-0.364*** (0.10)	-0.283** (0.11)	-0.275** (0.12)	-0.276** (0.12)	-0.274** (0.12)
GDP Growth (Log)	13.202*** (4.68)	13.538*** (4.66)	13.679*** (4.67)	13.686*** (4.68)	13.716*** (4.68)
Inflation (Log Diff CPI)	-18.371 (33.57)	-28.127 (33.23)	-27.116 (34.19)	-27.14 (34.03)	-26.986 (33.93)
Real Exchange Rate (Log)	3.696 (2.96)	4.84 (2.99)	4.599 (2.93)	4.546 (2.99)	4.41 (3.06)
Policy Rate (Log)	-5.845*** (0.45)	-6.214*** (0.45)	-6.210*** (0.45)	-6.126*** (0.51)	-6.131*** (0.51)
Constant	-50.281** (18.72)	-56.243*** (18.62)	-55.592*** (18.25)	-56.064*** (18.25)	-55.902*** (18.14)
Observations	2,321	2,297	2,275	2,275	2,275
R-squared	0.209	0.218	0.215	0.215	0.215

“Robust standard errors in parentheses, \*\*\* p<0.01, \*\* p<0.05, \* p<0.1, Std. Errors adjusted for 24 clusters identified as countries in the panel”.

The objective is to assess how debt-to-GDP and r-g affect excess returns on equity. The regression coefficients in all models for debt-to-GDP are negative and statistically significant. The economic interpretation indicates that a 1% increase in the debt-to-GDP ratio negatively

affects excess real stock index return by 17.65 basis points. As in the case of real stock index returns, the notable point is the effect of leads or future values of debt to GDP on excess returns. Considering stock market efficiency, the market participants anticipate the expected values of debt to GDP for future periods and incorporate that information into the current stock prices. The expected increase in the one-period future values of debt to GDP negatively affects excess returns on equity. The coefficient estimates show that a 1% expected increase in the future value of debt to GDP reduces excess real returns by 19.35 basis points.

The impact of  $r-g$  is negative on excess returns and significant at the 5% level: a 1% increase in  $r-g$  leads to a 0.28% decrease in excess returns on equity.

To examine if the lag values of debt-to-GDP have any impact on the equity returns, one-period lags of the first difference of debt-to-GDP are included in the models. As the coefficient of the lagged values is not significant, it can be inferred that the lags of debt to GDP do not affect stock returns. This is because the impact of lead (-19.24) and contemporaneous (-17.53) values is already incorporated. Furthermore, to examine if there is a nonlinear relationship between debt to GDP and stock market returns, a squared term of debt to GDP is included as a regressor in the model. The estimated coefficient value of the squared term is not significant, leading to the conclusion that the relationship between debt to GDP and excess returns seems to be linear.

GDP growth rate, inflation, federal fund policy rate, and exchange rate were included in the models as control variables to overcome the problem of omitted variable bias or model misspecification bias. As expected, and as theory and empirical research have shown, the impact of real GDP growth is positive and statistically significant at any level of significance in all the model specifications, whereas the impact of fed policy is negative and significant at 1% level. However, the impact of inflation is not statistically significant, though negative. Like inflation, an increase in the fed policy rate negatively affects excess returns, and the effect is statistically significant at any conventional level.

Finally, the R-squared value implies that a 21.8% change in the dependent variable (real stock index return) is explained by the independent variables included in the models.

Overall, the main findings of standard linear panel data models indicate that lead and contemporaneous values of public debt and  $r-g$  have a statistically significant negative impact on both real and excess returns on equity, but no significant effects of lags. In addition, the public debt–equity returns nexus is country (country fixed effects) and time-specific (time fixed effects).

## 5.7 Panel ARDL Models: Real Stock Index Returns

As the stationarity tests indicate that the variables have different orders of integration, some I (0) and some I (1) during the analysed period, this violates the precondition for using the cointegration analysis approach based on the Engle-Granger two-step procedure or the Johansen cointegration test.

Therefore, this characterization of the variables leads to the use of the Pesaran/Shin/Smith (PSS) ARDL testing approach (Pesaran, Shin and Smith, 1999). With the ARDL testing, both

the short run and the long-run relationships can be examined irrespective of whether the series is integrated of order I (0), I (1), or a mix of both.

The DFE model with cluster robust standard errors is estimated because the panels are correlated and exhibit dependence as identified by the Breusch-Pagan LM test of panel independence. If panels are correlated, the standard errors may be biased. Therefore, the DFE model is re-estimated as DFE with the cluster robust option. Furthermore, the cluster robust specification produces heteroscedasticity-robust standard errors (Baltagi, 2021).

In addition, as a robustness check, the models are estimated with a lag order of 1 and then with a lag order of 2. However, the results remain very similar in all variations. These results indicate that the MG, PMG, and DFE seem quite robust to the choice of lag order. This is partly because T is large ( $N < T$ ), and panels are strongly balanced. However, when T is small and panels are unbalanced, the choice of lag order becomes more important in model specifications.

Table 18: Panel ARDL models, Real Stock Index Returns

VARIABLES	Mean Group	Pooled Mean Group	DFE	DFE Cluster Robust
<b>Short Run Coefficients</b>				
ECT	-0.7778*** (0.018)	-0.7523*** (0.018)	-0.7550*** (0.024)	-0.755*** (0.018)
LD. Real Stock Index Returns	0.1257*** (0.015)	0.1244*** (0.015)	0.1498*** (0.020)	0.150*** (0.015)
D. Debt to GDP (Log)	-0.1244 (0.094)	-0.0894 (0.081)	-0.1800*** (0.046)	-0.180*** (0.069)
D. GDP Growth (Log)	0.2744 (0.178)	0.3169** (0.157)	-0.1032*** (0.035)	-0.103** (0.046)
D. CPI (Log)	-0.9955*** (0.270)	-1.0972*** (0.260)	-0.9665*** (0.189)	-0.967*** (0.242)
D. R-G (10-Y bond Yield-GDP Growth)	0.0105 (0.008)	0.0119* (0.007)	-0.0061*** (0.002)	-0.006** (0.003)
Constant	-0.4950*** (0.168)	-0.2723*** (0.006)	-0.4001*** (0.121)	-0.400*** (0.130)
<b>Long Run Coefficients</b>				
Debt to GDP (Log)	0.0866*** (0.020)	0.0169 (0.011)	0.0281** (0.011)	0.028*** (0.007)
GDP Growth (Log)	0.1313** (0.064)	0.1352*** (0.040)	0.1649*** (0.038)	0.165*** (0.042)
CPI (Log)	-0.0176 (0.033)	-0.0225 (0.019)	-0.0175 (0.020)	-0.017 (0.016)
R-G (10-Y bond Yield-GDP Growth)	-0.0059*** (0.001)	-0.0049*** (0.001)	-0.0036*** (0.001)	-0.004*** (0.001)
Observations	2,282	2,282	--	--

Standard errors in parentheses, \*\*\* p<0.01, \*\* p<0.05, \* p<0.1, D=First Difference, and LD=Lag of First Difference

The results of ARDL Error Correction Models for real stock index returns are shown in Table 18. The models are estimated with mean group (MG), pooled mean group (PMG), dynamic fixed effects (DFE), and DFE with cluster robust standard errors. Table 18 presents ECT (speed of adjustment), the short-run coefficients (short-run causal relationships), and the long-run coefficient (long-run causal impacts) on real stock index returns.

Before inferring about the relationships among the variables based on the test results, the first step is to determine which model specification, MG, PMG, or DFE, is a better estimator. For this purpose, the Hausman specification tests were conducted. The test results are given in Annex IV. The first test given in the table compares the MG and PMG models with the null hypothesis  $H_0$ : The PMG is preferred over the MG.

The p-value (0.0007) is significantly below the 1% level, leading to the rejection of the null hypothesis. Therefore, at this stage, MG is preferred over the PMG model. Further, to compare the MG model with the DFE model, the Hausmann test is conducted again with the null hypothesis  $H_0$ : DFE model is preferred over MG. The p-value of the Hausmann test is (0.9998) with a chi-square value (0.04) close to zero. This leads to non-rejection of the null hypothesis. Therefore, the DFE model is selected over the MG model.

Finally, to compare the PMG with the DFE model (this step is optional), the Hausman test is conducted with the null hypothesis  $H_0$ : DFE model specification is preferred over PMG model specification. The test result shows that the p-value (1.000) is very high and does not reject the null hypothesis. Therefore, the DFE model is selected to infer the relationships existing among the variables.

The coefficient estimates of DFE, DFE with cluster-robust standard errors, and those of the PMG estimator are very similar. However, PMG restricts the coefficient of the co-integrating vector to be homogeneous across groups in the long run. The DFE models also restrict the speed of adjustment coefficient and the short-run coefficients to be homogeneous across panels, but the intercepts can vary.

Results of DFE (Cluster robust standard error) indicate that the coefficient of the error correction term (ECT) or speed of adjustment is negative and statistically significant. The coefficient value of ECT (-0.755) is negative and significant at the 1% level. This coefficient indicates that the disturbance to the equilibrium is corrected by 0.75% each period to maintain the long run cointegrating relationship or equilibrium. The MG estimator suggests a slightly faster adjustment ECT (-0.77) than the PMG or DFE.

Results of (SR) coefficients indicate that the impact of debt to GDP on real stock index returns is negative and statistically significant at 1% in the short run; a 1% increase in the debt to GDP ratio decreases real stock returns by 0.18%. However, the long-run effect of the debt-to-GDP ratio on the real stock index return is positive and statistically significant; a 1% increase in debt to GDP ratio positively affects stock returns by an increase of 0.028% in real stock returns.

The long run coefficient of  $r-g$  (-0.004) is negative and statistically significant at 1% level of significance. This implies that a 1% increase in  $r-g$  reduces the real returns on equity by 0.4% in the long run. The short run coefficient of  $r-g$  (-0.006) is also negative and statistically

significant at 5% level of significance. This implies that a 1% increase in r-g reduces the real returns on equity by 0.6% in the short run. Overall, R-G negatively affects the real stock returns both in the short and long run. but the effect in the short run is stronger than that in the long run.

To sum up, the estimated results show that there exist both short-run and long-run causal relationships between public debt and real stock index returns (negative impact in the short run and positive impact in the long run) and r-g and real stock return (negative in both the short and long run). These short and long-run results are similar to the results obtained in the context of the USA annual data in the time series ARDL model specifications. Rising debt-to-GDP negatively affects real stock returns in the short run but positively affects real stock returns in the long run. In contrast, r-g negatively affects real stock returns both in the short and long run. The effects of both public debt and r-g are stronger in the short run than in the long run.

As expected, and as theory states, GDP growth has a statistically significant positive impact on real returns in the long run, with a coefficient value of 0.165. Whereas inflation has a statistically significant negative impact on real stock index returns both in the short run, with a coefficient value of  $-0.96$ , and in the long run, with a coefficient value of  $-0.017$ .

The ARDL model is re-estimated to see if adding additional lags has any significant impacts. The results are presented in Annex IV. As can be seen, the additional lags of the variables of debt to GDP, GDP growth rate, and r-g are not significant. Therefore, no additional lags are included in the models.

## 5.8 Panel ARDL Models: Excess Stock Index Returns

As in the case of real stock index returns, the DFE model with cluster robust standard errors is estimated because the panels are correlated and exhibit dependence (identified by the Breusch-Pagan LM test of panel independence). If panels are correlated, the standard errors may be biased. Therefore, the DFE model is re-estimated as DFE with the cluster robust option. In addition, as a robustness check, the models are estimated with an additional lag; results are presented in Annex III. The results remain very similar in all specifications. The results indicate that the MG, PMG, and DFE seem quite robust to the choice of lag order. This is partly because T is large ( $N < T$ ), and panels are strongly balanced. However, when T is small and panels are unbalanced, the choice of lag order becomes more important in model specifications.

Table 19 below presents panel ARDL model estimation for excess real stock index returns with mean group (MG), pooled mean group (PMG), dynamic fixed effects (DFE), and DFE model with cluster-robust standard errors.

The table shows ECT (speed of adjustment), short-run coefficients (short-run causal relationships), and long-run coefficients (long-run causal impacts) on excess real stock index returns. The Hausman tests were applied for selecting the final model, which determined the DFE model. Results of the DFE (CRSE) model indicate that the coefficient of the error correction term (ECT) or speed of adjustment is negative and statistically significant. The coefficient value of ECT ( $-0.712$ ) is negative and statistically significant at the 1% level. This coefficient indicates that the disturbance to the equilibrium is corrected by 0.71% each period

to maintain the long run cointegrating relationship among the study variables. The MG estimator suggests a slightly faster adjustment ECT (-0.76) than the PMG or DFE.

Table 19: Panel ARDL models, Excess Returns

VARIABLES	Pooled Mean		DFE	DFE Cluster Robust
	Mean Group	Group		
<b>Short Run Coefficients</b>				
ECT	-0.7682*** (0.018)	-0.7209*** (0.017)	-0.7122*** (0.023)	-0.712*** (0.017)
LD. Excess Stock Index Returns	0.1141*** (0.013)	0.1069*** (0.013)	0.1301*** (0.020)	0.130*** (0.013)
D. Debt to GDP (Log)	-4.9484 (9.447)	1.758 (7.246)	-10.2919** (4.472)	-10.292** (6.891)
D. GDP Growth (Log)	28.0579 (17.705)	29.1528** (14.300)	-9.2699*** (3.454)	-9.270* (4.767)
D. CPI (Log)	-12.28 (26.483)	-34.9236 (25.318)	-28.3083 (18.463)	-28.308 (21.241)
D. R-G (10-Y bond Yield-GDP Growth)	1.109 (0.795)	1.1379* (0.645)	-0.5215*** (0.160)	-0.521* (0.293)
Constant	-8.9877 (18.627)	-9.3200*** (0.469)	-29.3331** (11.883)	-29.333 (18.047)
<b>Long Run Coefficients</b>				
Debt to GDP (Log)	13.6501*** (2.226)	4.4357*** (1.109)	5.4209*** (1.187)	5.421*** (1.025)
GDP Growth (Log)	-0.7263 (6.891)	5.6827 (4.098)	9.8739** (3.925)	9.874* (5.112)
CPI (Log)	-8.4361** (3.678)	-4.5043** (1.946)	-2.2972 (2.020)	-2.297 (2.726)
R-G (10-Y bond Yield-GDP Growth)	-1.2954*** (0.177)	-1.0858*** (0.115)	-0.8149*** (0.109)	-0.815*** (0.238)
Observations	2,295	2,295		

Standard errors in parentheses, \*\*\* p<0.01, \*\* p<0.05, \* p<0.1, D=First Difference, and LD=Lag of First Difference

Results of (SR) coefficients indicate that the impact of debt to GDP on excess real stock index returns is negative and statistically significant at 5% level in the short run; a 1% increase in the debt to GDP ratio decreases excess real stock returns by 10.29 basis points. However, the long-run effect of the debt-to-GDP ratio on the excess real stock index return is positive and statistically significant; a 1% increase in the debt-to-GDP ratio positively affects excess stock returns by an increase of 5.42 basis points. These short and long-run results are similar to the results obtained from the ARDL model specifications in the context of the USA annual data. In short, an increase in debt to GDP negatively affects excess real stock returns in the short run but positively affects real stock returns in the long run, possibly because the economic impacts of public investments take time to materialize in terms of GDP growth rate, which in turn leads to positive effects for the equity markets.

The long run coefficient of  $r-g$  (-0.815) is negative and statistically significant at 1% level of significance. This implies that a 1% increase in  $r-g$  reduces the excess real returns on equity by 0.81% (81 basis points) in the long run. The short-run coefficient of  $r-g$  (-0.521) is also negative and statistically significant at the 10 % level of significance. This implies that a 1% increase in  $r-g$  reduces the real excess returns on equity by 0.52% in the short run. Overall, a rising  $r-g$  negatively affects the equity market returns, both in the short and long run, but the effect in the long run is stronger than in the short run (DFE Cluster robust results).

Again, as expected, and as theory states and empirical research has reported, GDP growth has a statistically significant positive impact on excess real returns in the long run, with a coefficient value (9.87), representing a 9.87 basis points increase in excess returns on equity. Whereas inflation has a statistically significant negative impact on excess real stock index returns both in the short run with a coefficient value (-28.308) and in the long run with the coefficient value (-2.297).

The ARDL model for excess real returns on equity with the same specification is re-estimated by adding additional lags, and the results are presented in Annex IV. As can be seen, the additional lags of the variables of debt to GDP,  $r-g$ , and DGP growth rate are not significant. Therefore, no additional lag models were estimated.

Overall, the estimated results show that there exist both short run and long run causal relationships between public debt and excess real stock index returns (negative impact in the short run and positive impact in the long run) and  $r-g$  and excess real stock return, negative both in short and long run but stronger in the long run ( based on final model estimated by DFE Cluster Robust). Examination of the PMG and MG estimations for individual countries shows varying results, ranging from negative, no effects to positive effects of public debt on equity returns. Moreover, results show that the public debt–equity returns relations are country and time-specific, conditional on several factors.

## 6. Summary and Discussion

During and after the global economic downturns triggered by the COVID-19 pandemic in 2020 and the Russia–Ukraine war in 2022, many countries accumulated substantial amounts of debt, marking one of the largest growths in public debt after World War II. This trend has been observed across all types of debt, including both government and private debt. It extended to advanced, emerging markets as well as developing economies (EMDE), involving both external and domestic debt (Kose *et al.*, 2021, IIF, 2023, 2024).

The significance of public debt for economic growth and financial stability can be traced back to the global financial crisis. There is growing concern that the increasing debt burden, which is expected to persist in the foreseeable future, may negatively affect the economic growth prospects of many countries (Reinhart and Rogoff, 2013). Furthermore, given that governments can maintain low policy interest rates under an accommodative monetary policy framework, declining economic growth, heightened trade tensions, economic and political uncertainty, and persistent fiscal expansion may cause  $r-g$  to rise, rendering public debt unsustainable. Rogoff (2020) pointed out that interest rates may increase in response to adverse economic shocks, such as those caused by the COVID-19 pandemic, trade tensions, and supply shortages, causing  $r-g$  to shift from negative to positive territory, as has been observed in the current context. This development poses a significant risk to future debt sustainability.

These two conditions, rising public debt and  $r-g$ , have recently attracted considerable attention from policymakers, governments, and economists. While much of this attention has focused on economic growth and debt sustainability, relatively narrow attention has been directed towards their implications for financial markets. This research aimed to address this gap by examining the effects of public debt and the interest rate–growth differential ( $r-g$ ) on financial market performance, with a particular focus on equity market returns.

Specifically, based on the annual time series data for the USA and quarterly panel data for 24 advanced countries, and by using the autoregressive distributed lag (ARDL) model proposed by Pesaran *et al.* (2001), this study investigated the short- and long-run impacts of public debt and  $r-g$  on equity market returns. To ensure consistency, the models were also estimated using standard OLS regressions for both time series and panel data. The findings remained robust across all model specifications. The summarized results are presented below.

### 6.1 Study Results

#### 6.1.1 Time Series OLS Regression Analysis

The primary objective is to assess how public debt and the interest rate–growth differential ( $r-g$ ) influence real and excess returns on equity. In the case of the USA, model estimations indicate that the regression coefficients for the debt-to-GDP ratio are positive and statistically significant at the 1% level for both real and excess stock index returns. The economic interpretation suggests that a 1% increase in the debt-to-GDP ratio is associated with a 0.74% (74 basis points) increase in the real stock index return. The response of excess returns is similar

but slightly stronger. A 1% increase in the debt-to-GDP ratio leads to a 76.59 basis point increase in excess stock index returns.

However, a notable finding is the effect of the lead (one-period-ahead) values of the debt-to-GDP ratio on equity index returns. The coefficient estimates indicate that a 1% expected increase in the future value of the debt-to-GDP ratio is associated with a decline of 0.89% (89 basis points) in real stock index returns and a drop of 86.8 basis points in excess equity returns. These results suggest that public debt has a negative impact in the short run, but after one year, the coefficients become positive, representing a long-run positive impact.

The impact of lead (one-period-ahead) values of  $r-g$  is negative on both real and excess stock market returns and is statistically significant. A 1% increase in  $r-g$  is associated with a 1.1% decrease in the real stock index returns and a 1.17% decrease in the excess returns. Real GDP growth rate, inflation, federal funds policy rate, and exchange rate were included in the models as control variables. As expected, and as theory and empirical research show, the impact of real GDP growth on equity market returns is positive and statistically significant at any level of significance, whereas the influence of inflation is negative and statistically significant at the 10% level.

Finally, the R-squared values indicate that a 35.7% change in the real stock index return and a 32% change in excess return are explained by the independent variables included in the models.

As a robustness check, the models were also estimated by using an alternative measure of  $r-g$  (Monetary Policy Rate- real GDP Growth) in place of  $r-g$  (10-Y Govt Bond Yield- real GDP Growth) to evaluate if the results remain robust and to assess which  $r-g$  variable strongly explains the relationship between  $r-g$  and stock index returns. As the econometric estimations indicate, the  $r-g$  based on the federal policy rate yields similar results to the  $r-g$  based on the 10-year bond yield, with both showing negative impacts. However, the influence of  $r-g$  based on the federal policy rate is weaker than that of  $r-g$  based on the 10-Y bond yield. Therefore, the  $r-g$  based on the 10-year bond yield appears to be a stronger predictor, primarily because real GDP growth is a long-term economic outcome that takes time to materialise. Thus, a long-run ' $r$ ' based on the 10-year government bond yield corresponds more closely with ' $g$ '—the GDP growth—than does ' $r$ ' based on the federal policy rate, which is determined over a shorter horizon.

### 6.1.2 Time Series ARDL Models (Bounds Test)

The time series ARDL bounds test using annual data for the USA confirms the existence of cointegration (long-run causal relationships) among the study variables: equity market returns, debt-to-GDP ratio,  $r-g$ , and inflation. The coefficients of the error correction terms (ECT) are negative and statistically significant at the 1% level:  $ECT = -1.070$  for excess returns on equity and  $ECT = -1.160$  for real returns. These coefficients indicate that any deviation from the long-run equilibrium is corrected by approximately 1.07% and 1.16% per period, respectively. The adjustment towards equilibrium is thus slightly faster for real returns than for excess returns.

The ARDL long run (LR) coefficients indicate that the impact of debt-to-GDP on excess real stock index returns is positive and statistically significant in the long run; a 1% increase in the

debt-to-GDP ratio is associated with a 9.28 basis points increase in excess returns on equity and 8.4 basis points in real returns. However, the short run (SR) effect of the debt-to-GDP ratio on the excess and real stock index return is negative and statistically significant at 1% level. A 1% increase in the debt-to-GDP ratio leads to a decline of 86 basis points in excess returns and a decline of 108 basis points in real returns. In short, rising public debt levels have a strong negative impact on equity returns in the short run but a positive impact in the long run.

The long-run coefficient of  $r-g$  is  $(-1.25)$  for excess returns and  $(-0.007)$  for real returns, and both are negative and statistically significant. This indicates that a 1% increase in  $r-g$  leads to a 1.25% decline in excess returns and a 0.7% decline in real returns. However,  $r-g$  does not have a statistically significant impact in the short run. Overall, the results suggest that rising  $r-g$  has negative effects on equity returns over the long term.

In summary, the test results suggest that, in the context of the USA, rising public debt (debt-to-GDP ratio) negatively impacts stock market returns in the short run. This is likely because when the government raises financing by issuing debt securities, these securities compete with other issuers, leading to higher interest rates. Consequently, investors may shift their investments from the equity market to the debt market.

The findings also suggest that the effect of public debt on stock market index returns is positive in the long run, primarily because the objective of promoting economic growth takes a long time to materialize. This occurs because long-term projects financed by public debt begin to generate desired economic outcomes over a long period. However, the rising interest rate-growth differential ( $r-g$ ) consistently transmits adverse effects to equity markets directly and through declining GDP growth rate. This finding aligns with a substantial body of empirical research showing that higher GDP growth is associated with higher stock market returns, but lower GDP growth tends to depress equity market performance.

In short, the estimated results show that there exist both short-run and long-run relationships between debt-to-GDP ratio and equity market returns (negative in the short run and positive in the long run), but only a long-run negative relationship between  $r-g$  and equity returns.

### 6.1.3 Results from Linear Panel Models

Standard linear OLS panel data models were estimated with pooled OLS, fixed effects, and random effects. The Hausman and LM tests for model selection preferred the DFE (cluster robust) over other models. The DFE (cluster robust) panel data models were estimated by including the lag, the lead, the square of public debt, and a dummy variable for debt-to-GDP > 90%. The regression coefficients for debt-to-GDP in all models are negative and statistically significant at 1% level of significance. The economic interpretation indicates that a 1% increase in the debt-to-GDP ratio negatively affects real stock index return by 0.21% and excess returns by 0.17%.

As in the case of the USA, an interesting point to note is the effect of lead (one-period-ahead future) values of debt-to-GDP on stock market index returns. The expected increase in one-period future values of debt-to-GDP negatively affects real returns on equity. The coefficient

estimates show that a 1% expected increase in the one-period-ahead future value of debt-to-GDP reduces real stock index returns by 0.18%, and excess returns by 0.19%.

The impact of  $r-g$  is negative on equity market returns and is statistically significant; a 1% increase in  $r-g$  leads to a 0.20% decrease in real returns and a decrease of 0.27% in excess returns. Finally, the two R-squared values suggest that a 13.3% change in real stock index return and a 21.5% change in excess return are explained by the independent variables included in the models.

To examine if the lag of debt-to-GDP has any impact on equity returns, a one-period lag of the first difference of debt-to-GDP is included in the models. As the coefficient of the lagged value is not significant, it can be inferred that the lag of debt-to-GDP does not affect stock returns, as the impact of lead (-19.24) and contemporaneous (-17.53) values is already reflected in equity prices and seems to decay over time.

Furthermore, to examine the nonlinearity of the relationship between debt-to-GDP and stock market returns, a squared term of debt-to-GDP is included as a regressor in the model. As results show, the estimated coefficient value of the squared term is not significant, leading to the conclusion that the relationship between debt-to-GDP and equity returns seems to be linear.

Finally, the GDP growth rate, Inflation, federal policy rate, and exchange rate were included in the models as control variables to overcome omitted variable bias or model misspecification bias. As expected, and as theory and empirical research have shown, the impact of real GDP growth is positive and statistically significant at 1% level of significance in all model specifications. By contrast, the effect of the federal policy rate is negative and significant at 1% level.

Overall, the main findings of standard linear panel data models indicate that lead and contemporaneous values of public debt and  $r-g$  have statistically significant negative impacts on both real and excess returns on equity, but insignificant lag effects. In addition, (PCSE) models estimated with country fixed effects and time fixed effects indicate that the public debt–equity return relations are country and time-specific, being affected by unique country and time-specific factors.

#### 6.1.4 Results from Panel ARDL Models

Panel ARDL mean group (MG), pooled mean group (PMG), dynamic fixed effects (DFE), and DFE (Cluster Robust) models were estimated. The Hausmann test results led to the selection of the DFE models. However, the coefficient estimates of DFE and DFE (cluster robust standard errors) are similar to those of the PMG estimator.

Results of DFE (Cluster robust standard error) indicate that the coefficients of the error correction term (ECT) or speed of adjustment are negative and statistically significant. The speed of adjustment for real returns is ECT (-0.755), and the speed of adjustment for excess returns is ECT (-0.71). These coefficients indicate that the disturbance to the equilibrium is corrected by 0.75% and 0.71% each period to maintain the long run cointegrating relationship or equilibrium, for real and excess returns, respectively.

The results of (SR) coefficients indicate that the impact of debt-to-GDP on equity index returns is negative and statistically significant in the short run; a 1% increase in the debt-to-GDP ratio decreases real stock index returns by 0.18% and excess returns by 0.10%. However, the long run (LR) effect of the debt-to-GDP ratio on the equity index returns is positive and statistically significant at 1% level of significance: a 1% increase in the debt-to-GDP ratio positively affects real stock returns by 0.028% and excess returns by 0.05%.

The long run coefficient of  $r-g$  (-0.004) is negative and statistically significant at 1% level of significance. This implies that a 1% increase in  $r-g$  reduces the real returns on equity by 0.4% and excess returns by -0.82% (82 basis points) in the long run. The short-run coefficients of  $r-g$  (-0.006) for real returns and  $r-g$  (-0.52) for excess returns are also negative and statistically significant. This implies a 1% increase in  $r-g$  leads to a decline of 0.6% in real returns and a decline of 0.52% (52 basis points) in excess returns in the short run. Overall,  $r-g$  has negative effects on equity returns, both in the short and long run, but the effect is stronger for excess returns than for real returns.

To sum up, the estimated results of panel ARDL models show that there exist both short-run and long-run causal relationships between public debt and equity index returns (negative impact in the short run and positive impact in the long run). Whereas,  $r-g$  negatively affects equity returns, both in the short and long run. These short and long-run results obtained from panel ARDL models are similar to the results obtained from time series ARDL model specifications of the USA—increasing debt-to-GDP negatively affects equity returns in the short run but positively affects them in the long run, whereas  $r-g$  negatively affects real and excess stock index returns in the long run.

## 6.2 Summary of Results and Discussions

Econometric results, ARDL models using annual time series data for the USA and panel data for 24 countries, indicate that the public debt-to-GDP ratio has positive effects on equity market returns in the long run. These positive effects align with Keynesian perspective about the positive effects of expansionary fiscal policy and government debt on an economy, which in turn positively affect financial markets, particularly when fiscal policies target a long-run economic growth rate by investing debt finance in productive capital projects (Aizenman, Kletzer and Pinto, 2007; Delong and Summers, 2012; Fazzari, Ferri and González, 2023).

In line with this idea, Aschauer (1989) was the first to realize that public capital for productive government services is essential for economic prosperity. Based on his empirical results, a 1% increase in public capital investments positively affects the total productivity factor by 0.4%. Endogenous growth models also suggest similar implications. For example, a recent study shows that government debt accelerates output growth if the cost of investment funded by debt is less than the productivity generated from this investment. This lower cost on public debt than the productivity level is attainable when a unique optimal share of investment is made in technology, human, and physical capital that can generate more output than the cost of investment (Tran, 2021).

Economists believe that investment in public infrastructure is an important aspect of a competitive economy. According to the World Bank (1994), public capital serves as “wheels”, if not the engine of economic activity. It is claimed that infrastructure development lowers fixed costs, attracts companies and factors of production, resulting in increased production, profits, and employment (Haughwout, 2002; Kadyraliev *et al.*, 2022). In turn, these economic effects positively affect equity market performance.

Finally, a meta-analysis by Philipp Heimberger (2023) reports that although not all studies find a growth-enhancing impact of public capital, it is worth noting that after eliminating the effects of endogeneity from public debt and growth, the estimations lean towards the positive side. In contrast, the negative effects fade out or become positive when countries are in the growth phase (De Soyres, Kawai Eskimez and Wang, 2022).

Similarly, Dreger and Reimers (2013) demonstrate that, in industrialized countries, public debt has positive growth effects until sustainable debt levels. Baum *et al.* (2013) find positive significant effects of public debt, while stating that negative growth effects of public debt appear only in some euro area regions and unsustainable debt periods.

The evidence given above indicates that the positive effects of public debt also extend to financial markets. As empirical evidence, Wasserfallen (1989) investigated the effects of economic activity and growth on stock price indices for major advanced economies. Results indicate that stock returns are positively associated with real economic activity and output. In turn, higher economic productivity and growth increase the profitability of firms, driving equity prices up. Many other studies have reported similar findings (e.g., Smajlbegovic, 2019; He *et al.*, 2020; Baker *et al.*, 2021; Ozili and Arun, 2022).

The second notable point in the study results is the effect of lead (one period ahead) values of debt-to-GDP on equity index returns. Results from annual data for the USA show that a 1% expected increase in the future value of the debt-to-GDP ratio is negatively associated with real stock index returns, by a decline of 0.85% to 0.89%. Similarly, panel data results suggest that equity returns may decline by 0.18% to 0.19%.

In line with the stock market efficiency hypothesis, market participants anticipate the expected values of debt-to-GDP for future periods and incorporate that information into the current stock prices. In anticipation of future government debt financing, investors expect an increasing trend in interest rates (Jiang, Richmond and Zhang, 2022; Peterson Foundation, 2022). This occurs due to a limited supply of funds available to meet the additional funding needs of the government (Blanchard, 2019). Likewise, Bernheim (1989) supports the Keynesian perspective that argues a positive relationship between rising federal government debt and interest rates. Moreover, in a recent study, Ferrara *et al.*, (2021) report that government spending shocks not only increased inflationary pressures in the US economy but also raised interest rates. Increased interest rates in inflationary conditions attract investment in fixed-income debt securities from equity markets. In addition, the expected increase in interest rates reduces the discounted value of firm cash flows, resulting in declining equity prices.

The short-run negative reaction of equity returns can be attributed to the idea of portfolio investment theory, which suggests that in anticipation of increasing interest rates, investors re-allocate investment funds from equity securities to debt securities, causing stock prices to fall. This portfolio balancing act aligns with Tobin's theory of investment, which assumes that investors adjust their investment allocations based on profit/value maximization or the risk-return principle (Tobin, 1969).

Third, rising  $r-g$  negatively affects equity returns, both in the short and long run. The short and long-run results obtained from panel ARDL models are similar to those obtained from time series ARDL model specifications for the USA. This negative impact seemed very obvious from the simple correlation statistics (provided in the annex) between  $r-g$  and GDP growth ( $r = -0.86$ ) in the case of the USA and ( $r = -0.67$ ) in panel data with a p-value of 0.0000. Similarly, the correlation between  $r-g$  and equity returns ( $r = -0.23$ ) with a p-value of 0.000 based on panel data. These findings align with the study results of Dreger and Reimers (2013). Their findings suggest that in the case of industrialized countries, public debt has a positive impact on output growth until sustainable debt levels ( $g > r$ ).

Fourth, the standard panel models suggest the presence of country and time fixed effects. The findings from the PMG and MG estimates of individual countries suggest varying results, ranging from negative to positive effects of public debt on equity market returns. This implies that the public debt–equity return relations are country and time-specific, conditional on several factors. These findings are in line with many research studies that report systematic differences in the cause-and-effect relationship between public debt and economic growth across countries (see, e.g., Bell, Johnston and Jones, 2015; Bentour, 2021; Gómez-Puig, Sosvilla-Rivero and Martínez-Zarzoso, 2022).

Finally, contrary to Ricardian equivalence of no effects, the results of this study indicate that the short-run effects correspond to the debt overhang hypothesis. However, the long-run effects align with Keynesian perspectives. Although most studies report negative effects of public debt on economic growth after a certain threshold, analyses solely based on the debt-to-GDP ratio may not reflect true impacts. This could be the reason that the findings from previous empirical studies show quite mixed evidence till now. This study highlights that the actual effects of public debt ratio on economic growth, financial markets, and other macroeconomic variables, such as inflation, interest rates, and exchange rates, can better be explained when investigated in connection with  $r-g$ .

### 6.3 Conclusion

In conclusion, although rising public debt has negative impacts on equity market returns in the short run, it has positive and statistically significant effects in the long run. In addition, the impact of  $r-g$  is negative, both in the short and long run, for both excess and real returns on equity. Finally, both standard linear panel models and panel ARDL models suggest that the relationship between public debt and equity returns is country and time-specific.

These results indicate that the significance of public debt ratio and  $r-g$  in affecting equity market returns cannot be explained by the widely recognized macroeconomic state variables that

strongly influence financial market returns (economic growth, inflation, interest rates, and exchange rates).

The main message of these findings is: Public investment should support the economy, which in turn can support financial markets. Second, assessing the impact of debt to GDP ratio in isolation for drawing any conclusions about public debt implication for the economy and financial markets presents a partial view, instead the analysis should include  $r-g$  alongside the debt-to-GDP ratio, because until the growth ( $g$ ) is higher than the cost of debt ( $r$ ), public debt may remain sustainable with positive effects on the economy and financial markets.

## 6.4 Future Research Directions

This research examined the effects of public debt on equity market index returns, which are typically constructed using large-cap firms across various industries. However, further insights may emerge if the implications of increasing public debt and rising  $r-g$  are specifically investigated within the context of the banking sector and other financial institutions that are directly involved in purchasing government debt securities. Such an analysis could yield additional insights that may support more informed investment portfolio strategies.

Second, this research uses total public debt as the independent variable to assess how public debt influences equity market returns. However, decomposing the total debt into internal and external public debt or local and foreign currency debt (depending on data availability) may help better understand these relationships.

Third, since both monetary policy and fiscal policy variables have significant impacts on the financial markets, it is necessary to explore how public debt–financial market return relations are affected when the interaction effect between major fiscal and monetary policy factors is considered. Specifically, how do monetary and fiscal policy variables moderate or mediate these relationships?

Finally, this study highlights that the impact of public debt-to-GDP ratio on economic growth, equity markets, and other macroeconomic variables, such as inflation, interest rates, and exchange rates, is better assessed in connection with  $r-g$ . Therefore, future research examining the influence of public debt on economic growth and financial markets should consider  $r-g$  alongside the debt-to-GDP ratio in the analytical framework.

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## Annex I: Data Sources, Correlation Matrix, and Diagnostics

### Variables and Data Sources, Annual Data USA (1928-2023)

Variables	Data Sources
S&P Stock Index	Federal Reserve Economic Data, Federal Reserve Bank of St. Louis/Aswath Damodaran
Govt Debt to GDP %	Public Finances in modern his/World Bank, IMF Global Debt Database
Gross Domestic Product	IMF and World Bank/Federal Reserve Economic Data, Federal Reserve Bank of St. Louis
CPI, Inflation	U.S. Bureau of Labor Statistics (BLS)/Federal Reserve Bank of Minneapolis/Federal Reserve Economic Data, Federal Reserve Bank of St. Louis
Fed Policy Rate	Federal Reserve Economic Data, Federal Reserve Bank of St. Louis
Exchange Rate Dollar Per Pound	Measuring Worth/Federal Reserve Bank of Minneapolis.
10-Y Govt Bond Yield	Federal Reserve Economic Data, Federal Reserve Bank of St. Louis
T-bills 3-month annual average rate %	Federal Reserve Economic Data, Federal Reserve Bank of St. Louis

### Variables and Data Sources, Panel Data of 24 Countries (2000q1-2024q2)

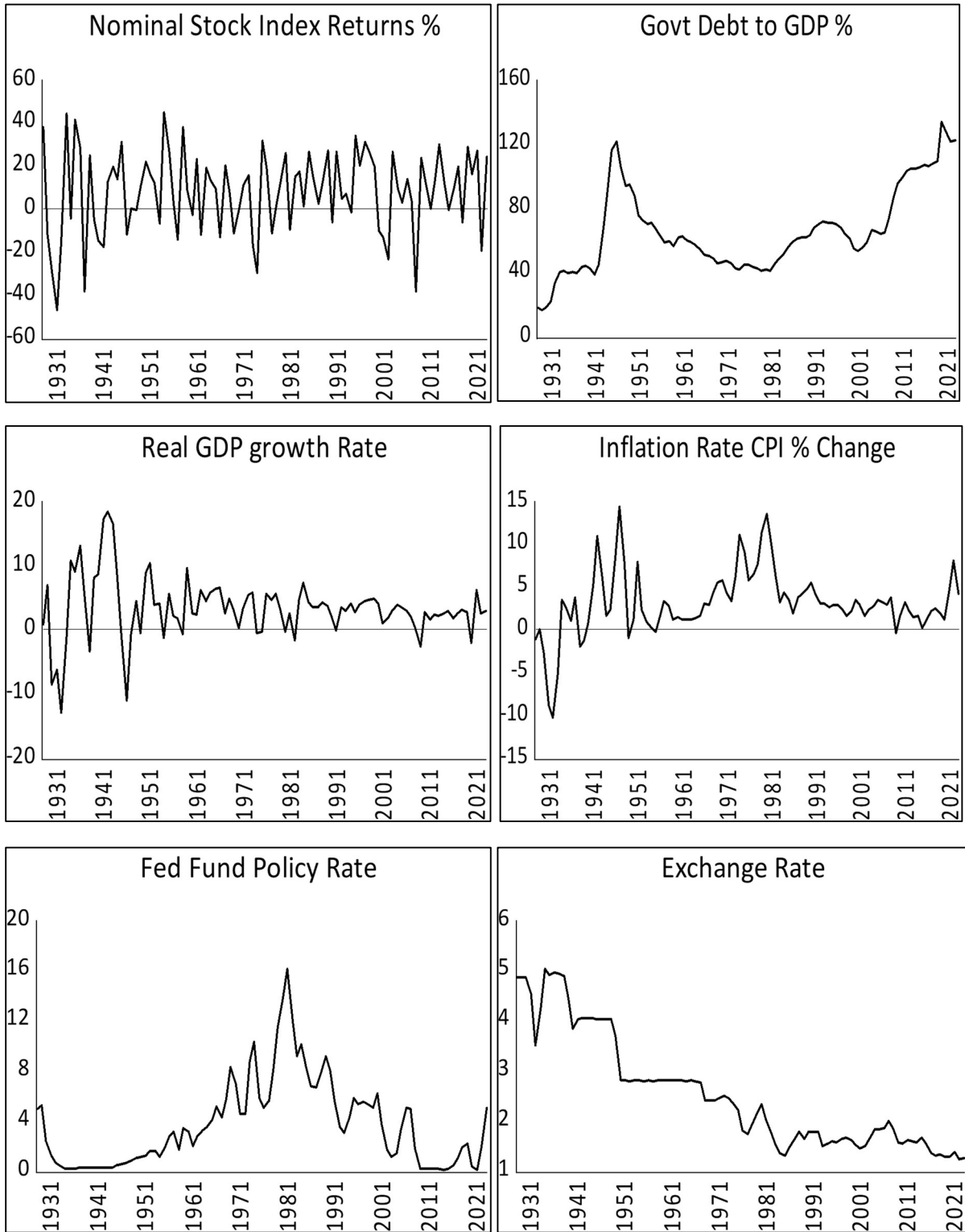
Variables	Data Sources
Share Prices, Stock Indexes	OECD, retrieved from Federal Reserve Economic Data, Federal Reserve Bank of St. Louis
Govt Gross Debt to GDP %	World Bank Group, Quarterly Public Sector Debt,
Gross Domestic Product per quarter	International Financial Statistics (IFS), World Development Indicators
CPI, Inflation quarterly	IMF data portal, IFS
Central bank policy rates %	World Bank, World Development Indicator/Bank for International Settlements
Exchange Rate Index	World Bank, World Development Indicators, /International Financial Statistics (IFS)
10-Y Govt Bond Yield	Federal Reserve Economic Data, Federal Reserve Bank of St. Louis
T-bills 3-month period average rate %	World Bank, World Development Indicators/IMF data portal, IFS

Note. Data for central bank policy rate and three-month treasury bill rate were obtained from the respective country's central banks if not available in the World Bank or the IMF databases.

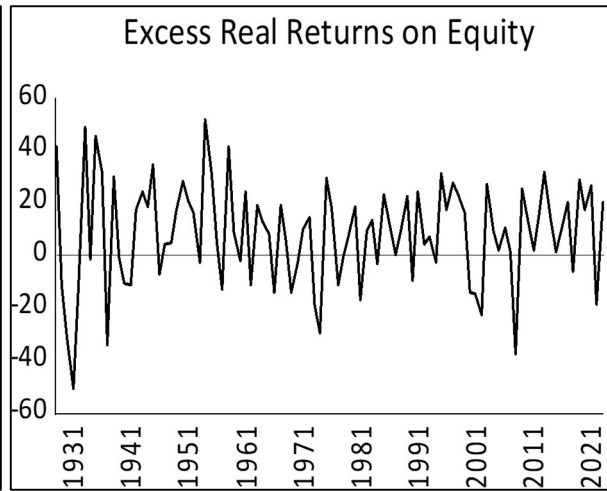
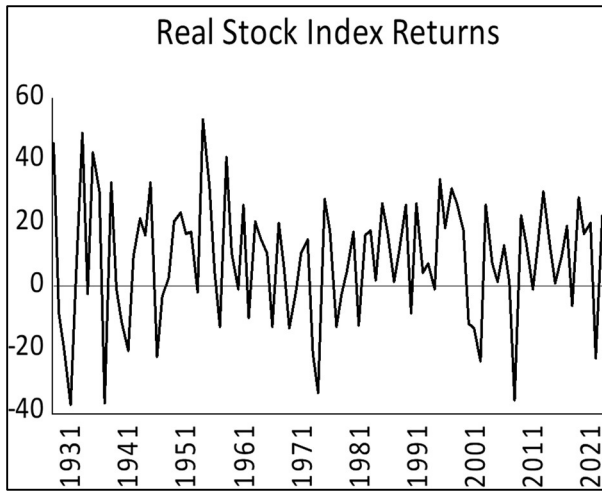
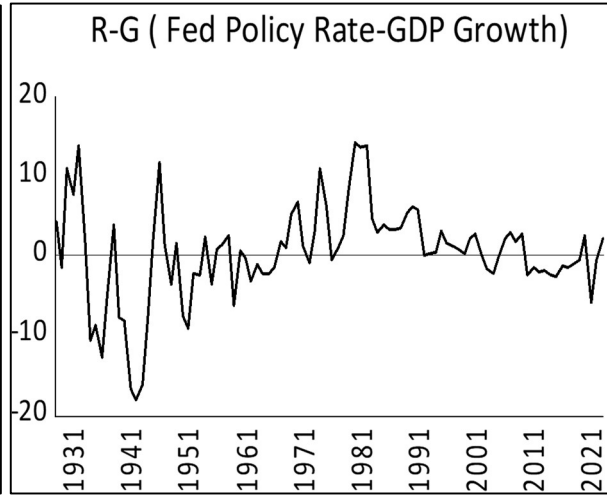
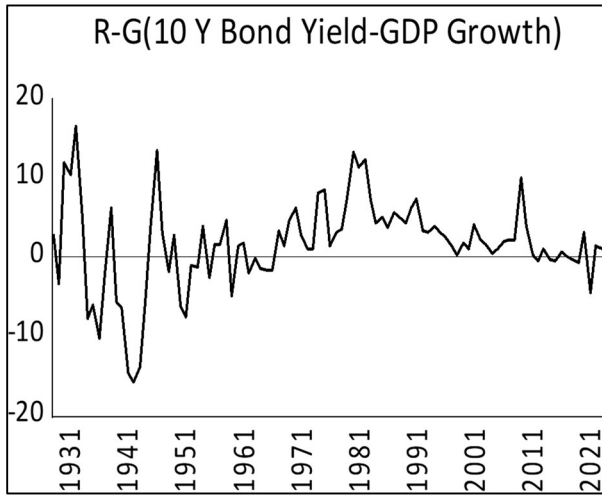
Correlation Matrix Annual Data USA

<b>Correlations and p-values</b>	Nominal Stock Returns (Ln Diff S&P Index)	Real Stock Returns (Log Diff S&P Real Index)	Excess Real Stock Returns: MR-RF	Govt Debt to GDP (Ln)	Real GDP Growth Rate (Ln)	Inflation (Log Diff CPI)	Fed Policy Rate (Log Diff)	Exchange Rate (Log Diff Exchange Rate)	R-G (10-Y Govt Bond Yield-GDP Growth)
Nominal Stock Returns (Ln Diff S&P Index)	1.00 ----								
Real Stock Returns (Log Diff S&P Real Index)	0.98 (0.000)	1.00 ----							
Excess Real Stock Returns: MR-RF	0.98 (0.000)	0.97 (0.000)	1.00 ----						
Govt Debt to GDP (Ln)	0.28 (0.006)	0.24 (0.017)	0.27 (0.007)	1.00 ----					
Real GDP Growth Rate (Ln)	0.15 (0.142)	0.09 (0.360)	0.14 (0.181)	-0.03 (0.772)	1.00 ----				
Inflation (Log Diff CPI)	0.03 (0.768)	-0.16 (0.123)	-0.06 (0.594)	0.17 (0.094)	0.29 (0.004)	1.00 ----			
Fed Policy Rate (Log Diff)	-0.05 (0.611)	-0.11 (0.303)	-0.19 (0.058)	-0.32 (0.001)	-0.10 (0.314)	0.29 (0.004)	1.00 ----		
Exchange Rate (Log Diff Exchange Rate)	0.13 (0.192)	0.10 (0.311)	0.12 (0.227)	-0.01 (0.942)	0.15 (0.155)	0.15 (0.143)	-0.02 (0.831)	1.00 ----	
R-G (10-Y Govt Bond Yield-GDP Growth)	-0.09 (0.379)	-0.08 (0.438)	-0.15 (0.132)	-0.11 (0.265)	-0.86 (0.000)	-0.05 (0.623)	0.45 (0.000)	-0.14 (0.173)	1.00 ----

Time Series Graphs for Unit Root Tests



Time Series Graphs for Unit Root Tests-Continued



## Diagnostic Tests: Real Stock Index Returns (OLS Model)

### Normality of Residuals

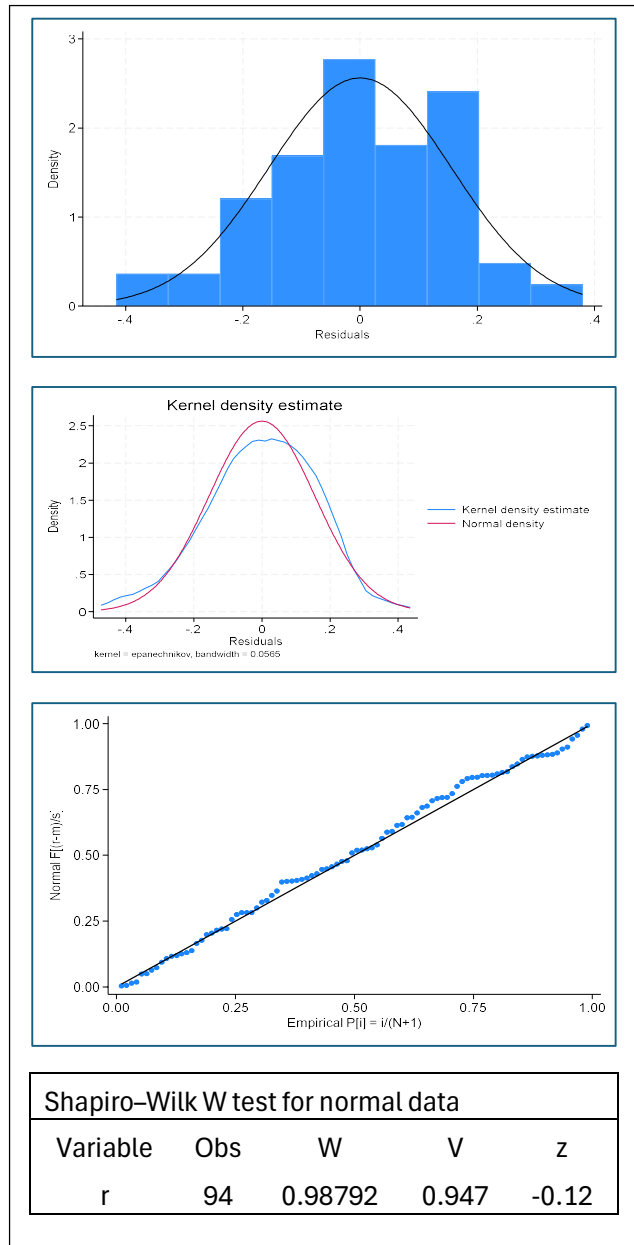
The histogram shows the distribution of residuals of the OLS model. The chart shows an approximate symmetrical bell shape that indicates no skewness in the residuals. Histograms are sensitive to the number of frequency bins used to distribute data points.

An alternative is to use a smooth Kernel Density plot. This plot shows a slight deviation near the peak of the distribution, but still it approximates the normal distribution with small deviation near the right tail. In addition, the P-P plot indicates minor deviations from the normal plot in the middle of the graph, as can also be seen near the peak of the Kernel density plot.

Finally, the Shapiro-Wilk W test for normal distribution conforms with the graphical interpretations as the p-value 0.3445 is well above the 5% and 10% significance level, leading to non-rejection of the null hypothesis of normal distribution. Based on these graphs, it can be inferred that the residuals are close to normal distribution.

### Model Specification Test

The p-value of the Ramsey Reset test is greater than 0.10% level of significance, leading to the non-rejection of the null hypothesis. The test indicates no bias in model specification.

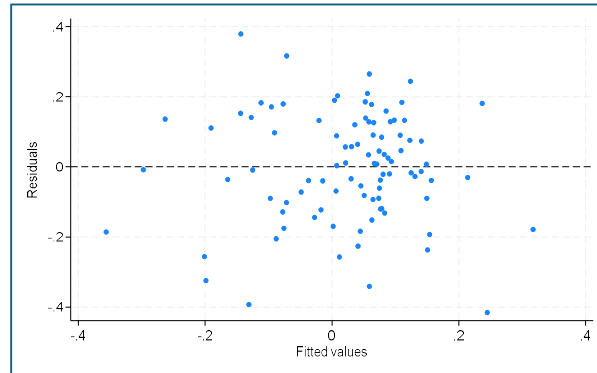


Ramsey RESET test for omitted variables	
Omitted: Powers of fitted values of Real Index Ret	
F (3, 83) =	1.72
Prob > F =	0.1692
H0: Model has no omitted variable bias.	

## Homoskedasticity of Residuals

Another assumption of the OLS models is that the residuals of the models have constant variance. The null hypothesis  $H_0$ : variance of the residuals is constant or homogeneous. Since the p-value of Breusch–Pagan/Cook–Weisberg test for heteroskedasticity is greater than all conventional levels of significance, the null hypothesis is not rejected.

Since these tests are overly sensitive to the normality assumption of the model, the normality diagnostics of the residuals indicate that the residuals are normally distributed. Therefore, both the normality diagnostics and the heteroskedasticity test of the residuals provide evidence that the residuals are homoscedastic.



Breusch–Pagan/Cook–Weisberg test for heteroskedasticity	
Assumption: Normal error terms	
Variable: Fitted values of Real Index Ret	
chi2(1) =	1.67
Prob > chi2 =	0.1956
H0: Constant variance	

## Tests for Multicollinearity

To test if multicollinearity problems exist among the independent variables, VIF and Tolerance values are given in the table.

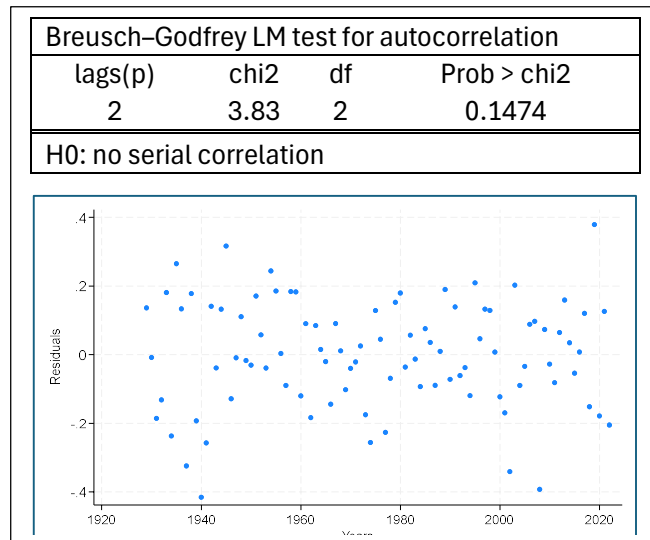
VIF values greater than 10 and tolerance values less than 0.1 are the threshold values and indicate a problem of multicollinearity. In this case, VIF for all the variables is less than 10, and none of the tolerance values is below 0.1, indicating no problem of multicollinearity.

Variable	VIF	1/VIF
D. Govt Debt to GDP (Log)	2.03	0.4923
FD. Govt Debt to GDP (Log)	1.89	0.5300
FD. R-G, 10 Y Bond-GDP Growth	1.61	0.6199
Real GDP Growth Rate (Log)	1.47	0.6820
Inflation (Log Diff CPI)	1.26	0.7957
Fed Policy Rate (Log Diff)	1.21	0.8296
Dol Pond Exchange Rate (Log)	1.07	0.9364
Mean VIF	1.5	

## Independence of Residuals

To test autocorrelation, the Durbin Watson (d-statistic(8,94)=2.26) and Breusch–Godfrey LM test for autocorrelation are conducted. The DW test value is close to 2.00, which indicates that there is no autocorrelation. Similarly, the LM test for no serial correlation does not reject the null hypothesis as the p-value is greater than the 10% level of significance.

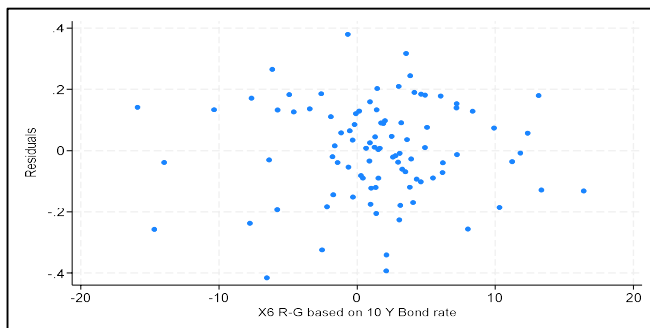
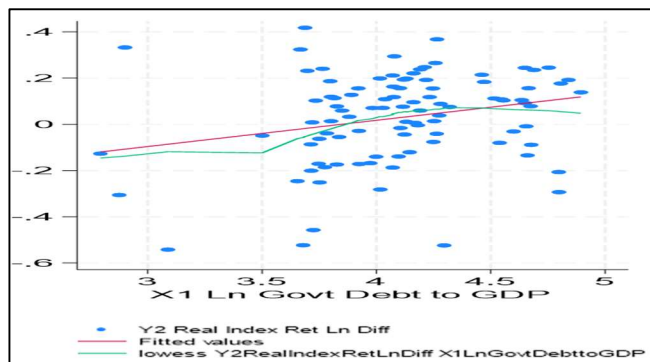
Finally, the graph of residuals against the time variable confirms no serial correlation as it indicates no systematic pattern or correlation in the residuals over all periods.



## Linearity assumption

Linear regression analysis assumes a linear relationship between the dependent variable and the independent variables. If the relationship is not linear, a straight-line regression cannot provide valid estimates of the regression coefficients.

The first graph shows an augmented component-plus-residual plot (acpr) with the lowess smoothing. The lowess helps in detecting nonlinearities by adding a smooth of the plotted points with locally weighted regression on the scatterplot. The graphs show a nonlinearity in the starting data points, but later the line follows an approximate linear pattern.



Finally, the plots of residuals against the excess real returns and debt to GDP show no curvilinear pattern in both scatter plots. Therefore, these plots indicate linear relationships. Similarly, the non-significance of the squared term of debt to GDP in the regression models also confirms the linearity of the relationship.



## Diagnostic Tests: Excess Stock Index Returns (OLS Model)

### Normality of Residuals

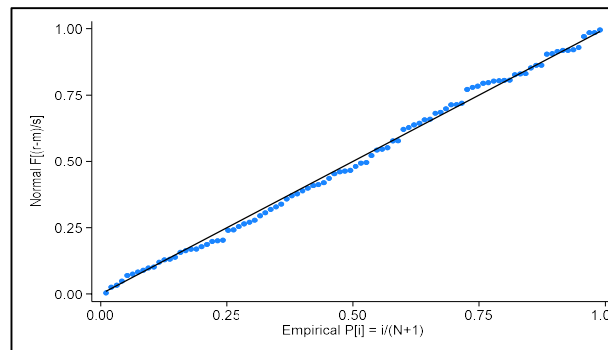
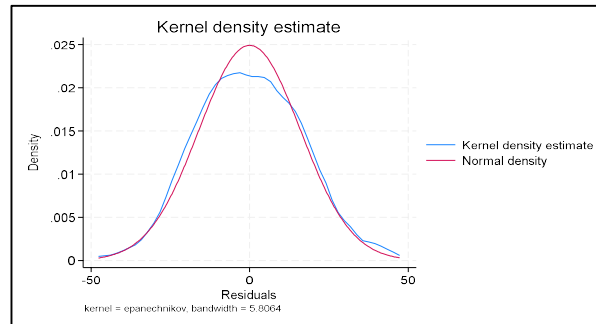
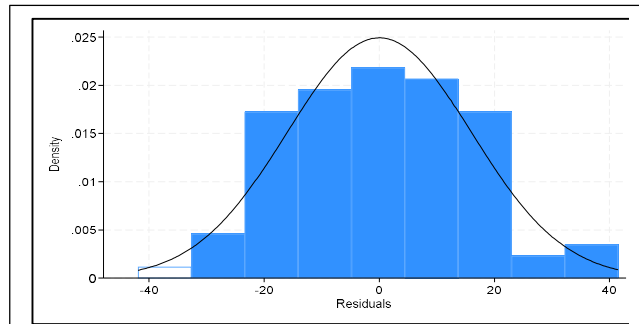
The histogram shows the distribution of residuals of the OLS model. The chart shows an approximate symmetrical bell shape that indicates no skewness in the residuals. Histograms are sensitive to the number of frequency bins used to distribute data points.

An alternative is to use a smooth Kernel Density plot, this plot shows a slight deviation near the peak of the distribution, but still it approximates the normal distribution with small deviation near the right tail. In addition, the P-P plot indicates minor deviations from the normal plot in the middle of the graph as can also be seen near the peak of the Kernel density plot.

Finally, the Shapiro-Wilk W test for normal distribution conforms with the graphical interpretations as the p-value 0.3445 is well above the 5% and 10% significance level, leading to non-rejection of the null hypothesis of normal distribution. Based on these graphs, it can be inferred that the residuals are close to normal distribution.

### Model Specification Test

The p-value of the Ramsey Reset test is greater than 0.05% level of significance, leading to the non-rejection of the null hypothesis. The test indicates no problem of model misspecification.



#### Shapiro-Wilk W test for normal data

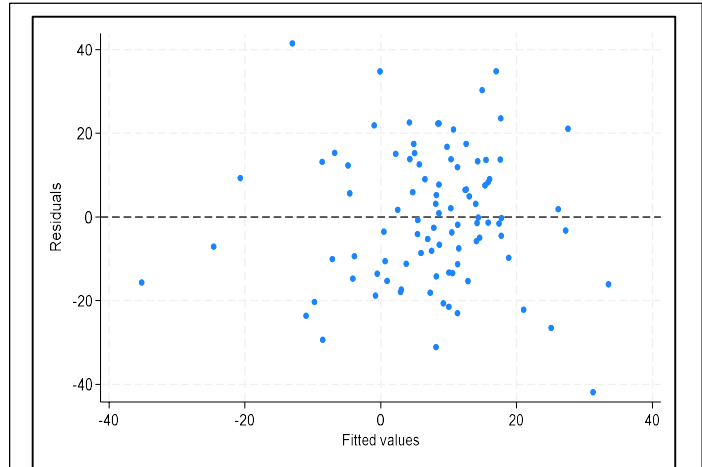
Variable	Obs	W	V	z
r	94	0.9945	0.431	-1.859

Ramsey RESET test for omitted variables	
Omitted: Powers of fitted values of Excess Real Ret on Equity	
F (3, 83) =	2.39
Prob > F =	0.0747
H0: Model has no omitted variables	

### Homoskedasticity of Residuals

Another assumption of the OLS models is that the residuals of the models have constant variance. The null hypothesis  $H_0$ : variance of the residuals is constant or homogeneous. Since the p-values of Breusch–Pagan/Cook–Weisberg test for heteroskedasticity are greater than all conventional levels of significance, the null hypothesis is not rejected.

Since these tests are overly sensitive to the normality assumption of the model, the normality diagnostics of the residuals indicate that the residuals are normally distributed. Thus, both the normality diagnostics and the heteroskedasticity test of the residuals provide evidence that the residuals are homoscedastic.



Breusch–Pagan/Cook–Weisberg test for heteroskedasticity	
Assumption: Normal error terms	
Variable: Fitted values of Excess Real Ret on Equity	
chi2(1) =	0.01
Prob > chi2 =	0.9326
H0: Constant variance	

### Tests for Multicollinearity

To test if multicollinearity problems exist among the independent variables, VIF and Tolerance values are given in the table. VIF values greater than 10 and tolerance values less than 0.1 are the threshold values and indicate a problem of multicollinearity. In this case, VIF for all the variables is less than 10, and none of the tolerance values is below 0.1, indicating no problem of multicollinearity.

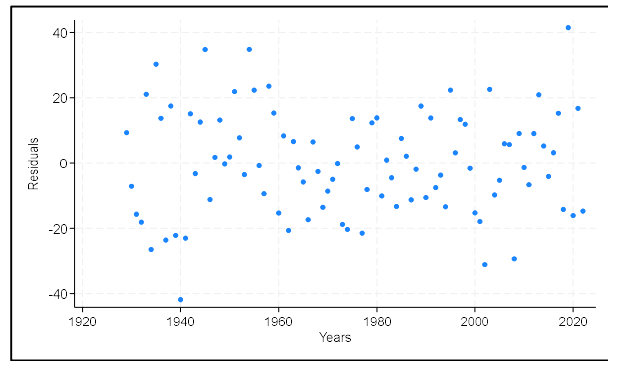
Variable	VIF	1/VIF
D. Govt Debt to GDP (Log)	2.03	0.4923
FD. Govt Debt to GDP (Log)	1.89	0.5300
FD. R-G, 10 Y Bond-GDP Growth	1.61	0.6199
Real GDP Growth Rate (Log)	1.47	0.6820
Inflation (Log Diff CPI)	1.26	0.7957
Fed Policy Rate (Log Diff)	1.21	0.8296
Dol Pond Exchange Rate (Log)	1.07	0.9364
Mean VIF	1.5	

## Independence of Residuals

To test autocorrelation, the Durbin Watson (d-statistic (8, 94)=2.209), and the Breusch–Godfrey LM test for autocorrelation is conducted. The DW test value is close to 2.0, indicating no autocorrelation. Similarly, the LM test for no serial correlation does not reject the null hypothesis as the p-value is greater than the 10% level of significance.

Finally, the graph of residuals against the time variable confirms no serial correlation as it indicates no systematic pattern or correlation in the residuals over periods.

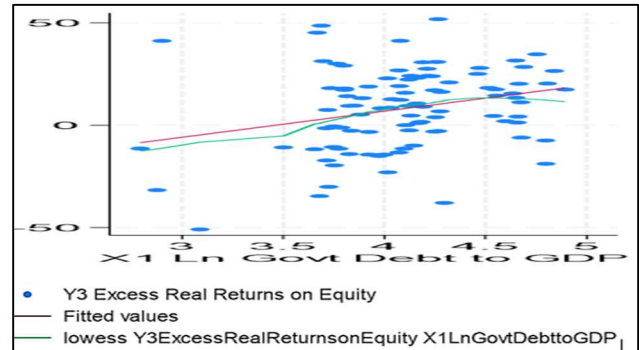
Breusch–Godfrey LM test for autocorrelation			
lags(p)	chi2	df	Prob > chi2
1	1.655	1	0.1983
H0: no serial correlation			



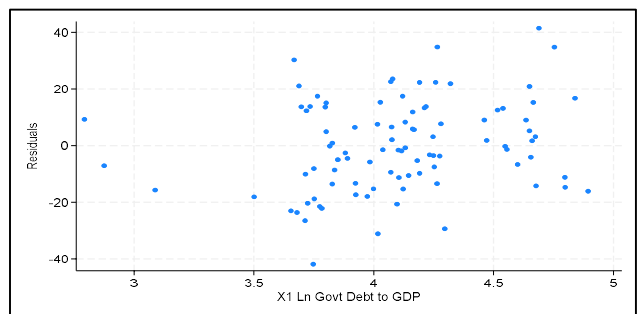
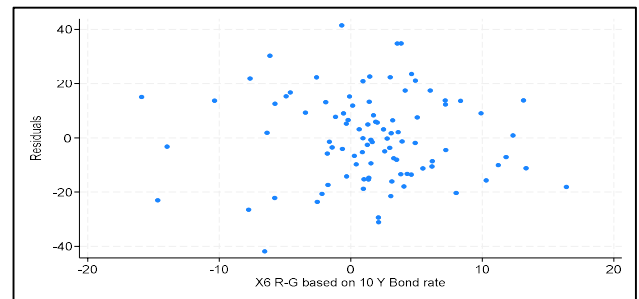
## Testing the linearity assumption

Linear regression analysis assumes a linear relationship between the dependent variable and the independent variables. If the relationship is not linear, a straight-line regression cannot provide valid estimates of the regression coefficients.

The first graph shows an augmented component-plus-residual plot (acpr) with the lowess smoothing. The lowess helps in detecting nonlinearities by adding a smooth of the plotted points with locally weighted regression on the scatterplot. The graphs show a nonlinearity in the starting data points, but later the line follows an approximate linear pattern.



Finally, the plots of residuals against the excess real returns and debt to GDP show no curvilinear pattern in both scatter plots. Therefore, these plots indicate linear relationships. Similarly, the non-significance of the squared term of debt to GDP in the regression models also confirms the linearity of the relationship.



## Annex-II: ARDL Models, Annual Data USA

### ARDL Model Excess Real Stock Index Returns, Detailed Results

Model	No Constant		With Constant		With Restricted Constant		With Constant & Trend		With Constant & Restricted Trend	
	LR	SR	LR	SR	LR	SR	LR	SR	LR	SR
ADJ/L. Excess Real Returns		-1.035*** (0.097)		-1.070*** (0.098)		-1.070*** (0.098)		-1.072*** (0.100)		-1.072*** (0.100)
D. Debt to GDP (Log)		-88.691*** (22.533)		-86.389*** (22.388)		-86.389*** (22.388)		-86.559*** (22.573)		-86.559*** (22.573)
L.D. Debt to GDP (Log)		69.181*** (23.363)		62.546*** (23.540)		62.546*** (23.540)		62.035** (24.137)		62.035** (24.137)
D. Inflation (Log)		-149.978** (69.753)		-141.246** (69.376)		-141.246** (69.376)		-140.943** (69.837)		-140.943** (69.837)
<b>Debt to GDP (Log)</b>	<b>2.011***</b> <b>(0.574)</b>		<b>9.281**</b> <b>(4.529)</b>		<b>9.281**</b> <b>(4.529)</b>		<b>9.652*</b> <b>(5.669)</b>		<b>9.652*</b> <b>(5.669)</b>	
<b>R-G (10 Y Bond-GDP Growth)</b>	<b>-1.364***</b> <b>(0.339)</b>		<b>-1.253***</b> <b>(0.328)</b>		<b>-1.253***</b> <b>(0.328)</b>		<b>-1.238***</b> <b>(0.356)</b>		<b>-1.238***</b> <b>(0.356)</b>	
<b>Inflation (Log)</b>	<b>71.302</b> <b>(53.177)</b>		<b>61.133</b> <b>(51.263)</b>		<b>61.133</b> <b>(51.263)</b>		<b>60.954</b> <b>(51.499)</b>		<b>60.954</b> <b>(51.499)</b>	
Years							-0.009 (0.082)		-0.008 (0.077)	
Constant				-32.175 (20.373)		-30.069 (18.611)		-16.074 (148.771)		-16.074 (148.771)
R-squared	0.657	0.657	0.667	0.667	0.667	0.667	0.667	0.667	0.667	0.667

L=lag 1 of variable, D= Difference, Standard errors in parentheses, \*\*\* p<0.01, \*\* p<0.05, \* p<0.1

Case 3 Model (with Constant). ADJ=Speed of adjustment, LR=Long-Run, SR=Short-Run.

ARDL Model Real Stock Index Returns, Detailed Results

Model	No Constant		With Constant		With Restricted Constant		With Constant & Trend		With Con & Rest. Trend	
	LR	SR	LR	SR	LR	SR	LR	SR	LR	SR
ADJ/ L. Real Index Returns		-1.110*** (0.188)		-1.164*** (0.189)		-1.164*** (0.189)		-1.186*** (0.190)		-1.186*** (0.190)
L. D. Real Index Returns		0.056 (0.131)		0.086 (0.131)		0.086 (0.131)		0.093 (0.131)		0.093 (0.131)
D. Debt to GDP (Log)		-1.059*** (0.292)		-1.008*** (0.291)		-1.008*** (0.291)		-1.043*** (0.292)		-1.043*** (0.292)
L.D. Debt to GDP (Log)		0.729** (0.293)		0.619** (0.298)		0.619** (0.298)		0.679** (0.303)		0.679** (0.303)
D.R-G(10-YBond-GDP Gr)		0.002 (0.006)		0.0000 (0.006)		0.0000 (0.006)		0.002 (0.006)		0.002 (0.006)
L.D.R-G(0YBond-GDP Gr)		-0.004 (0.005)		-0.004 (0.005)		-0.004 (0.005)		-0.003 (0.005)		-0.003 (0.005)
D. Inflation (Log)		-1.730** (0.755)		-1.599** (0.752)		-1.599** (0.752)		-1.582** (0.752)		-1.582** (0.752)
L.D. Inflation (Log)		0.453 (0.835)		0.559 (0.830)		0.559 (0.830)		0.528 (0.829)		0.528 (0.829)
<b>Debt to GDP (Log)</b>		<b>0.012*</b> <b>(0.006)</b>		<b>0.084*</b> <b>(0.044)</b>		<b>0.084*</b> <b>(0.044)</b>		<b>0.046</b> <b>(0.055)</b>		<b>0.046</b> <b>(0.055)</b>
<b>R-G (10 Y Bond-GDP Gr)</b>		<b>-0.009**</b> <b>(0.004)</b>		<b>-0.007*</b> <b>(0.004)</b>		<b>-0.007*</b> <b>(0.004)</b>		<b>-0.009**</b> <b>(0.004)</b>		<b>-0.009**</b> <b>(0.004)</b>
<b>Inflation (Log)</b>		<b>-0.054</b> <b>(0.610)</b>		<b>-0.182</b> <b>(0.576)</b>		<b>-0.182</b> <b>(0.576)</b>		<b>-0.193</b> <b>(0.564)</b>		<b>-0.193</b> <b>(0.564)</b>
Years								0.001 (0.001)		0.001 (0.001)
Constant				-0.346 (0.214)		-0.297 (0.182)		-2.026 (1.570)		-2.026 (1.570)
R-squared		0.663		0.663		0.673		0.673		0.678

L=lag 1 of variable, D= Difference, Standard errors in parentheses, \*\*\* p<0.01, \*\* p<0.05, \* p<0.1  
Case 3 Model (with Constant). ADJ=Speed of adjustment, LR=Long-Run, SR=Short-Run.

ARDL Model GDP Growth, Detailed Results

Model	No Constant		With Constant		With Restricted Const		With Constant & Trend		With Con & Restri Trend	
	LR	SR	LR	SR	LR	SR	LR	SR	LR	SR
ADJ/L.Real GDP Growth (log)		-0.174** (0.071)		-0.287*** (0.081)		-0.287*** (0.081)		-0.358*** (0.088)		-0.358*** (0.088)
L.D.Real GDP Growth (log)		-0.045 (0.035)		-0.035 (0.034)		-0.035 (0.034)		-0.038 (0.033)		-0.038 (0.033)
D. Debt to GDP (Log)		-0.002 (0.019)		-0.009 (0.018)		-0.009 (0.018)		-0.011 (0.018)		-0.011 (0.018)
L.D. Debt to GDP (Log)		-0.013 (0.019)		-0.002 (0.019)		-0.002 (0.019)		0.008 (0.020)		0.008 (0.020)
D.R-G (10 Y Bond-GDP Growth)		0.001** (0.001)		0.002*** (0.001)		0.002*** (0.001)		0.003*** (0.001)		0.003*** (0.001)
L.D.R-G (10YBond-GDP Growth)		-0.008*** (0.001)		-0.007*** (0.001)		-0.007*** (0.001)		-0.006*** (0.001)		-0.006*** (0.001)
D. Inflation (Log)		-0.036 (0.055)		-0.068 (0.055)		-0.068 (0.055)		-0.083 (0.054)		-0.083 (0.054)
L.D. Inflation (Log)		0.019 (0.061)		-0.013 (0.060)		-0.013 (0.060)		-0.033 (0.060)		-0.033 (0.060)
<b>Debt to GDP (Log)</b>		<b>0.007** (0.003)</b>		<b>-0.033** (0.013)</b>		<b>-0.033** (0.013)</b>		<b>-0.049*** (0.014)</b>		<b>-0.049*** (0.014)</b>
<b>R-G (10 Y Bond-GDP Growth)</b>		<b>-0.007*** (0.002)</b>		<b>-0.007*** (0.001)</b>		<b>-0.007*** (0.001)</b>		<b>-0.008*** (0.001)</b>		<b>-0.008*** (0.001)</b>
<b>Inflation (Log)</b>		<b>0.459* (0.274)</b>		<b>0.480*** (0.161)</b>		<b>0.480*** (0.161)</b>		<b>0.472*** (0.127)</b>		<b>0.472*** (0.127)</b>
Years								0.000* 0.000		0.000** 0.000
Constant				0.047** (0.018)		0.164*** (0.054)		-0.179 (0.119)		-0.179 (0.119)
R-squared		0.939		0.939		0.944		0.944		0.946

L=lag 1 of variable, D= Difference, Standard errors in parentheses, \*\*\* p<0.01, \*\* p<0.05, \* p<0.1

Case 3 Model (with Constant). ADJ=Speed of adjustment, LR=Long-Run, SR=Short-Run.

## Diagnostic Tests: Excess Real Stock Index Returns (ARDL Model)

### Normality of Residuals

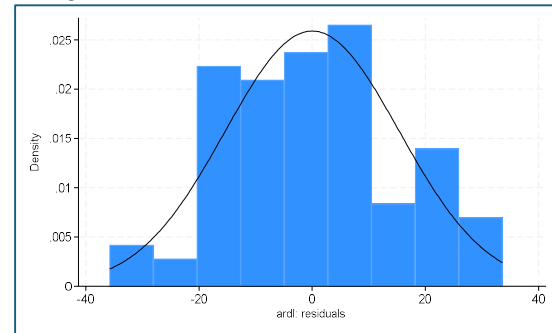
The histogram shows the distribution of residuals of the ARDL model. The chart shows an approximate symmetrical bell shape that indicates no skewness in the residuals. Histograms are sensitive to the number of frequency bins used to distribute data points. ∴

An alternative is to use a smooth Kernel Density plot, this plot shows a slight deviation near the peak of the distribution, but still it approximates the normal distribution with small deviation near the right tail.

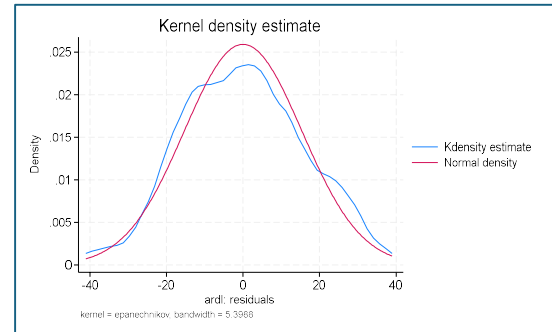
In addition, the P-P plot indicates minor deviations from the normal plot in the middle of the graph, as can also be seen near the peak of the Kernel density plot.

Finally, the Shapiro-Wilk W test for normal distribution conforms with the graphical interpretations as the p-value 0.3445 is well above the 5% and 10% significance level leading to non-rejection of the null hypothesis of normal distribution. Based on these graphs, it can be inferred that the residuals are close to normal distribution.

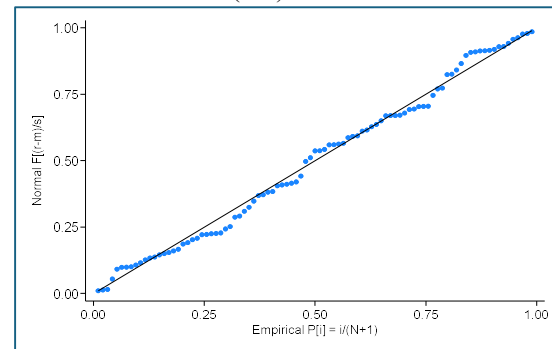
Histogram Plot ARDL-Residuals



Kernal Density Plot ARDL-Residuals



Standardized Normal (P-P) Plot ARDL-Residuals



### Shapiro–Wilk W test for normal data

Variable	Obs	W	V	z	Prob>z
r	93	0.9845	1.199	0.4	0.3445

### Homoskedasticity of Residuals

Another assumption of the OLS models is that the residuals of the models have constant variance. The null hypothesis H0: variance of the residuals is constant or homogeneous. Since the p-values of both Breusch–Pagan/Cook–Weisberg test for heteroskedasticity and the IM-test are greater than all conventional levels of significance, the null hypothesis is not rejected.

Since these tests are overly sensitive to the normality assumption of the model,

the normality diagnostics of the residuals indicate that the residuals are normally distributed. Therefore, both the normality diagnostics and the heteroskedasticity test of the residuals provide evidence that the residuals are homoscedastic.

Breusch–Pagan/Cook–Weisberg test for heteroskedasticity			
Assumption: Normal error terms			
Variable: Fitted values of D. Excess Real Return on Equity			
H0: Constant variance			
	chi2(1) =		1.430
	Prob > chi2 =		0.232
Cameron & Trivedi's decomposition of IM-test			
Source	chi2	df	p
Heteroskedasticity	79.46	65	0.1071
Skewness	2.58	10	0.9896
Kurtosis	2.27	1	0.132
Total	84.31	76	0.2405

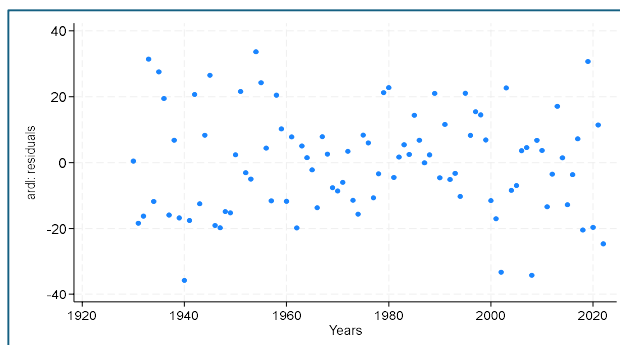
### Independence of Residuals

To test for the autocorrelation, the Durbin Watson (DW) and Breusch–Godfrey LM test for autocorrelation is conducted. The DW test value is close to 2.00, which indicates that there is no autocorrelation. Similarly, the LM test for no serial correlation does not reject the null hypothesis as the p-value is greater than 10% level of significance.

Finally, the graph of residuals against the time variable confirms no serial correlation as it indicates no systematic pattern or correlation in the residuals over all the time periods.

Durbin–Watson d-statistic (11, 93) = 2.0918

Breusch–Godfrey LM test for autocorrelation			
lags(p)	chi2	df	Prob > chi2
2	3.26	2	0.1959
H0: no serial correlation			

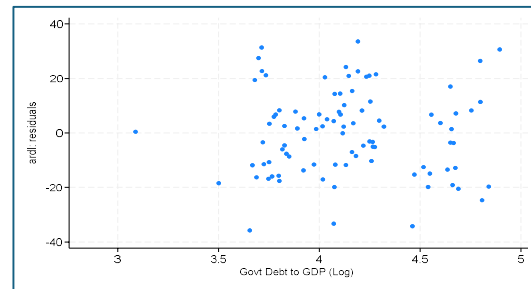
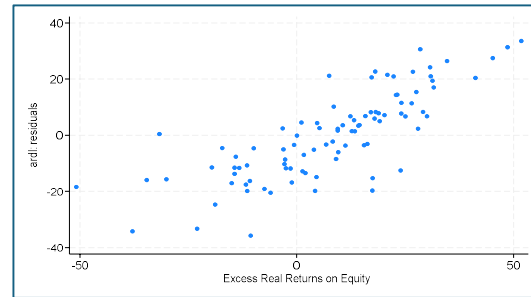
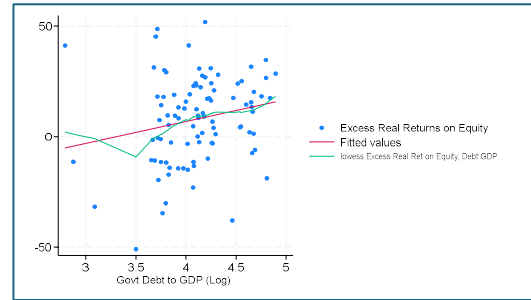


## Linearity Assumption

Linear regression analysis assumes a linear relationship between the dependent variable and the independent variables. If the relationship is not linear, a straight-line regression cannot provide valid estimates of the regression coefficients.

The first graph shows an augmented component-plus-residual plot (acpr) with the lowess smoothing. The lowess helps in detecting nonlinearities by adding a smooth of the plotted points with locally weighted regression on the scatterplot. The graphs show a nonlinearity in the starting data points, but later the line follows an approximate linear pattern.

Finally, the plots of residuals against the excess real returns and Govt Debt to GDP show that there seems to be no curvilinear pattern in both scatter plots. Therefore, it can be inferred that the relationship is approximately linear. This was also confirmed by the non-significance of squared terms in the regression models.

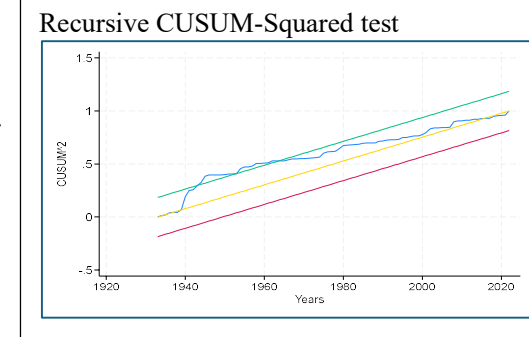
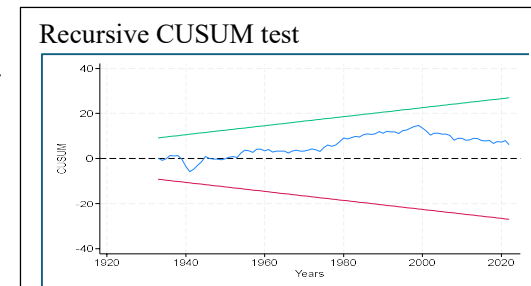


## Model Stability

After estimating ARDL models, the stability of estimated regression coefficients can be tested with CUSUM or CUSUM<sup>2</sup> tests.

These tests assess whether the coefficients estimated in a time-series regression are stable over time. This test statistic is based on the cumulative sum of the recursive residuals or OLS residuals.

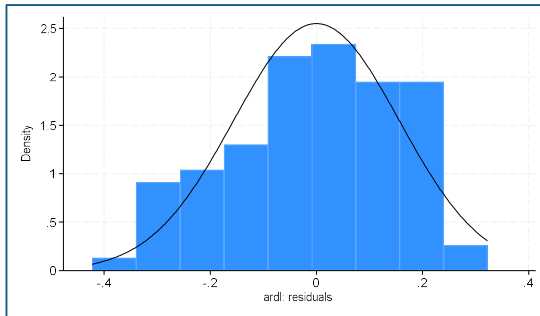
Neither of the CUSUM tests based on recursive residuals triggers a warning flag, as the blue line of the recursive residuals is within the 5% bounds. Therefore, the bounds test results stay reliable over time



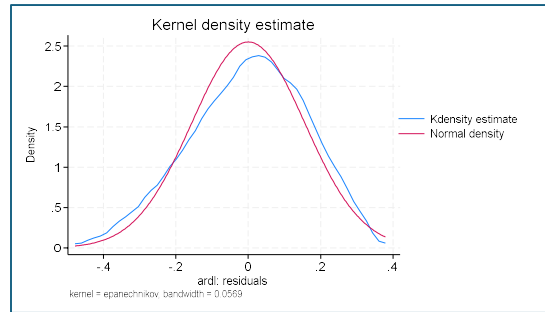
## Diagnostic Tests: Real Stock Index Returns (ARDL Model)

### Normality of Residuals

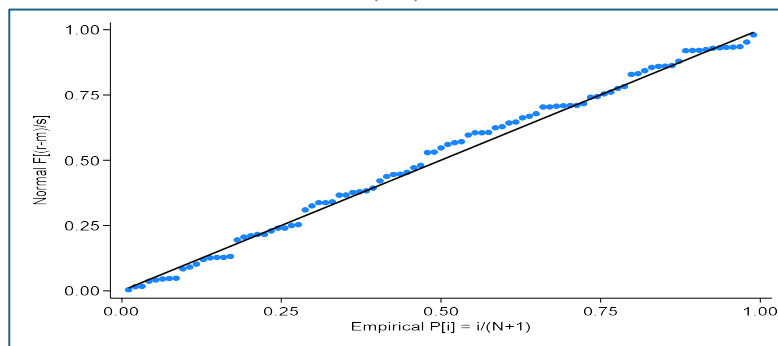
Histogram Plot ARDL-Residuals



Kernel Density Plot ARDL-Residuals



Standardized Normal (P-P) Plot ARDL-Residuals



One of the assumptions of OLS is that the residual or error terms of the regression model are normally distributed to ensure the validity of the F-test of the overall model and t-tests of the individual regression coefficients.

The P-P plot indicates minor deviations from the normal plot in the middle of the graph, as can also be seen near the peak of the Kernel density plot. In addition, the histogram also shows a symmetrical bell shape, showing no skewness or kurtosis in the residuals. Based on these graphs, it can be inferred that the residuals are close to normal distribution.

Shapiro–Wilk W test for normal data

Variable	Obs	W	V	z	Prob>z
r	93	0.9835	1.279	0.544	0.2932

Finally, the Shapiro-Wilk W test for normal distribution conforms with the graphical interpretations as the p-value 0.293 is above the 5% and 10% significance level, leading to non-rejection of the null hypothesis of normal distribution.

### Homoskedasticity of Residuals

Another assumption of the OLS models is that the residuals of the models have constant variance. The null hypothesis H0: variance of the residuals is constant or homogeneous. Since the p-values of both Breusch–Pagan/Cook–Weisberg test for heteroskedasticity and the IM-test are greater than all conventional levels of significance, the null hypothesis is not rejected.

Since these tests are overly sensitive to

the normality assumption of the model, the normality diagnostics of the residuals show that the residuals are normally distributed. Therefore, both the normality diagnostics and the heteroskedasticity test of the residuals provide evidence that the residuals are homoscedastic.

Cameron & Trivedi's decomposition of IM-test			
Source	chi2	df	p
Heteroskedasticity	81.78	65	0.078
Skewness	4.2	10	0.9378
Kurtosis	1.11	1	0.2922
Total	87.09	76	0.1807

Breusch–Pagan/Cook–Weisberg test for heteroskedasticity	
Assumption: Normal error terms	
Variable: Fitted values of D. Real Index Ret	
H0: Constant variance	
chi2(1) =	0.100
Prob > chi2 =	0.748

### Tests for Multicollinearity

To test if multicollinearity problems exist among the independent variables, VIF, Tolerance and condition index values are given in the tables. VIF for all the variables is less than 10 and none of the tolerance value is below 0.1 showing no problem of multicollinearity.

Variable	VIF	SQRT R-VIF	Tolerance	Sq
Real Returns (Log)	1.19	1.09	0.8382	0.1618
Debt to GDP	1.07	1.03	0.9377	0.0623
R-G: (10Y Bond Yield-GDP growth)	1.15	1.07	0.8686	0.1314
Inflation	1.06	1.03	0.9401	0.0599
Mean VIF	1.12			

However, the last eigenvalue is close to zero, and the corresponding condition index is greater than 15 that points to minor collinearity but not severe problem of multicollinearity because the condition index is less than critical threshold of 30.

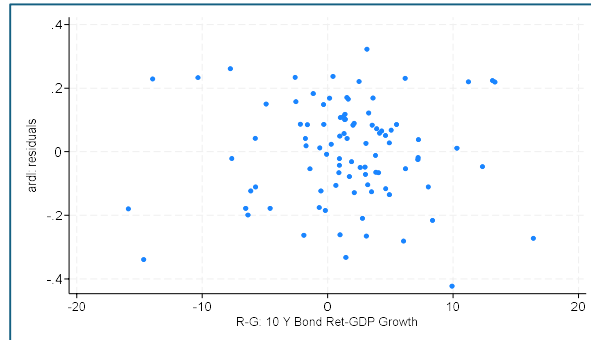
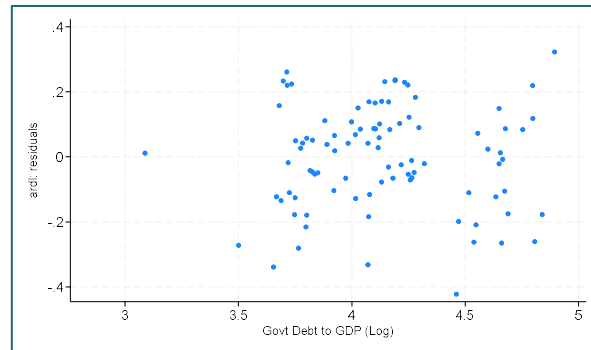
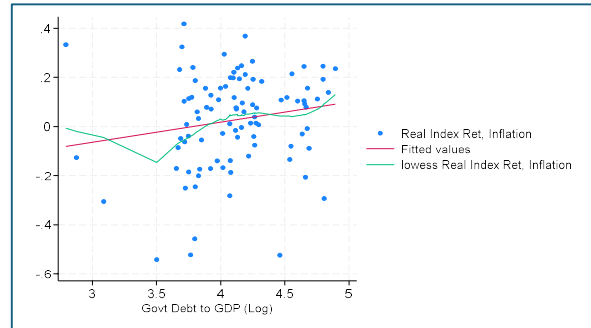
	Eigenvalues	Condition Index
1	2.6416	1
2	1.2941	1.4287
3	0.6283	2.0505
4	0.4315	2.4742
5	0.0045	24.1967
Condition Number		24.1967
Eigenvalues & Cond Index computed from scaled raw SSCP (w/ intercept) Det (correlation matrix) 0.7972		

### Linearity Assumption

Linear regression analysis assumes a linear relationship between the dependent variable and the independent variables. If the relationship is not linear, a straight-line regression cannot provide valid estimates of the regression coefficients.

The first graph shows an augmented component-plus-residual plot (acpr) with the lowess smoothing. The lowess helps in detecting nonlinearities by adding a smooth of the plotted points with locally weighted regression on the scatterplot. The graphs show a nonlinearity in the starting data points, but later the line follows an approximate linear pattern.

Finally, the plots of residuals against the excess real returns and debt to GDP show no curvilinear pattern in both scatter plots. Therefore, these plots indicate linear relationships. Similarly, the non-significance of the squared term of debt to GDP in the regression models also confirms the linearity of the relationship.

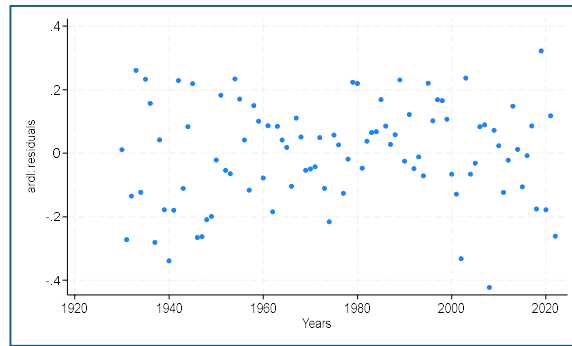


### Independence of Residuals

To test for the autocorrelation, the Durbin-Watson (DW) and Breusch-Godfrey LM test for autocorrelation are conducted. The DW test value is 2.054, which is close to 2.00, which shows that there is no autocorrelation. Similarly, the LM test for no serial correlation does not reject the null hypothesis as the p-value is greater than the 10% level of significance. Finally, the graph of residuals against the time variable

<b>Durbin-Watson Test for Autocorrelation</b>			
Durbin-Watson d-statistic (11, 93) = 2.054			
<b>Breusch-Godfrey LM test for autocorrelation</b>			
lags(p)	chi2	df	Prob > chi2
2	1.765	2	0.4138
H0: no serial correlation			

confirms no serial correlation as it shows no systematic pattern or correlation in the residuals over all time periods.

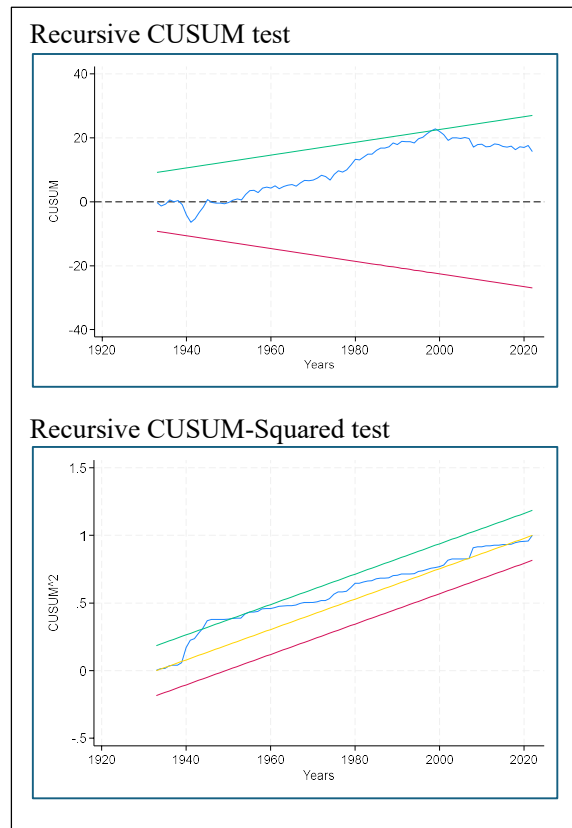


### Model Stability

After estimating ARDL models, the stability of estimated regression coefficients can be tested with CUSUM or CUSUM<sup>2</sup> tests.

These tests assess if the coefficients estimated in a time-series regression are stable over time. This test statistic is based on the cumulative sum of the recursive residuals or OLS residuals.

Neither of the CUSUM tests based on recursive residuals triggers a warning flag as the blue line of the recursive residuals is within the 5% bounds. Therefore, the test results stay reliable over time.



## Annex-III: Quarterly Panel Data Analysis

### Descriptive Statistics

	Mean	Median	Maximum	Minimum	Std. Dev.	Observations
Nominal Stock Index Return	1.246	1.813	51.582	-51.003	8.698	2342
Real Stock Index Return	0.619	1.237	50.608	-50.295	8.739	2342
Excess Return=MR-RF	-0.901	0.049	48.040	-55.218	9.248	2342
Govt. Debt to GDP Ratio	76.633	67.503	231.280	13.124	38.727	2342
Real GDP Growth Rate	0.506	0.547	20.636	-20.332	1.959	2342
Monetary Policy Rate	2.109	1.500	19.000	-0.750	2.288	2342
Inflation rate	0.627	0.508	8.672	-2.988	0.945	2342
Real Effective Exchange Rate	94.084	98.212	132.929	-1.451	21.151	2342
R-G=10 Y Bond Yield-GDP Growth Rate	2.893	2.861	27.263	-19.587	3.253	2342

### Correlation Matrix

	Nominal Stock Index Return	Real Stock Index Return	Excess Return=M R-RF	Govt. Debt to GDP Ratio	Real GDP Growth Rate	Monetary Policy Rate	Inflation rate	Real Effective Exchange Rate	R-G=10 Y Bond Yield-GDP Growth Rate
Nominal Stock Index Return	1.000 -----								
Real Stock Index Return	0.994 0.000	1.000 -----							
Excess Return=MR-RF	0.962 0.000	0.964 0.000	1.000 -----						
Govt. Debt to GDP Ratio	-0.014 0.507	-0.007 0.745	0.052 0.011	1.000 -----					
Real GDP Growth Rate	0.291 0.000	0.285 0.000	0.283 0.000	-0.067 0.001	1.000 -----				
Monetary Policy Rate	-0.071 0.001	-0.097 0.000	-0.320 0.000	-0.221 0.000	-0.003 0.891	1.000 -----			
Inflation rate	0.011 0.591	-0.097 0.000	-0.053 0.011	-0.064 0.002	0.045 0.031	0.244 0.000	1.000 -----		
Real Effective Exchange Rate	-0.054 0.009	-0.046 0.027	-0.052 0.011	0.212 0.000	-0.067 0.001	0.045 0.028	-0.076 0.000	1.000 -----	
R-G=10 Y Bond Yield-GDP Growth Rate	-0.226 0.000	-0.231 0.000	-0.363 0.000	0.042 0.044	-0.666 0.000	0.466 0.000	0.055 0.007	0.021 0.309	1.000 -----

### Summary of Unit Root Tests

Variables	Tests at Level							
	Tests with constant							
	Levin, Lin & Chu t (Common Unit Root Process)		Im, Pesaran and Shin W-stat (individual Unit Root process)		ADF - Fisher Chi- square (individual Unit Root process)		PP - Fisher Chi- square (individual Unit Root process)	
	test statistic	Prob**	test statistic	Prob**	test statistic	Prob**	test statistic	Prob**
Real Stock Index Returns (Log)	-32.4604	0.0000	-30.3438	0.0000	770.8430	0.0000	763.5830	0.0000
Excess Returns on Equity=Market Return–RF	-29.4038	0.0000	-27.4381	0.0000	697.0550	0.0000	695.6750	0.0000
Govt Debt to GDP (Log)	-1.9090	0.0281	0.7980	0.7875	35.2525	0.9144	30.4458	0.9774
Real GDP Growth Rate (Log)	-55.3064	0.0000	-53.2782	0.0000	594.3360	0.0000	566.9420	0.0000
Monetary Policy Rate (Log)	-2.7922	0.0026	-4.8265	0.0000	97.1317	0.0000	46.3699	0.5398
Inflation Rate (log diff CPI)	-11.6543	0.0000	-14.4043	0.0000	305.2110	0.0000	655.0310	0.0000
Real Effective Exchange Rate (Log)	-2.0980	0.0180	-3.9907	0.0000	106.2940	0.0000	106.2940	0.0000
R-G (10 Y Govt Bond rate-GDP growth rate)	-3.7189	0.0001	-8.4141	0.0000	182.1280	0.0000	633.8030	0.0000
R-G (3-month T. bills rate-GDP growth rate)	-4.0284	0.0000	-10.6685	0.0000	228.6340	0.0000	577.5300	0.0000

Tests with Constant and Trend								
Real Stock Index Returns (Log)	-14.5122	0.0000	-29.4728	0.0000	714.3750	0.0000	709.8540	0.0000
Excess Returns on Equity=Market Return–RF	-33.3017	0.0000	-27.6000	0.0000	656.5880	0.0000	651.6780	0.0000
Govt Debt to GDP (Log)	-0.3948	0.3465	0.2212	0.5875	48.3968	0.4568	35.4394	0.9107
Real GDP Growth Rate (Log)	-60.4309	0.0000	-54.9162	0.0000	1388.71	0.0000	1474.03	0.0000
Monetary Policy Rate (Log)	6.4146	1.0000	2.8649	0.9979	31.4116	0.9693	6.4305	1.0000
Inflation Rate (log diff CPI)	-12.7462	0.0000	-12.7665	0.0000	275.7560	0.0000	872.0290	0.0000
Real Effective Exchange Rate (Log)	-3.4805	0.0003	-4.0255	0.0000	106.9470	0.0000	82.0263	0.0016
R-G (10 Y Govt Bond rate-GDP growth rate)	-15.5391	0.0000	-18.8331	0.0000	474.0230	0.0000	868.2860	0.0000
R-G (3-month T.bills rate-GDP growth rate)	-3.6515	0.0001	-9.9089	0.0000	245.6950	0.0000	653.6150	0.0000

\*\* Probabilities for Fisher tests are computed using an asymptotic Chi-square distribution. All other tests assume asymptotic normality.

### Summary of Unit Root Tests

Variables	Tests at First Difference							
	Tests with constant							
	Levin, Lin & Chu t (Common Unit Root Process)		Im, Pesaran and Shin W-stat (individual Unit Root process)		ADF - Fisher Chi- square (individual Unit Root process)		PP - Fisher Chi- square (individual Unit Root process)	
	test statistic	Prob**	test statistic	Prob**	test statistic	Prob**	test statistic	Prob**
Govt Debt to GDP	-30.6534	0.0000	-31.3972	0.0000	562.2820	0.0000	717.6380	0.0000
Monetary Policy Rate	-16.2789	0.0000	-20.4448	0.0000	487.3510	0.0000	426.0820	0.0000
	Tests with constant and trend							
Govt Debt to GDP	-33.7741	0.0000	-31.2471	0.0000	769.8950	0.0000	1031.29	0.0000
Monetary Policy Rate	-18.3070	0.0000	-20.4092	0.0000	445.5840	0.0000	364.1740	0.0000

\*\* Probabilities for Fisher tests are computed using an asymptotic Chi-square distribution. All other tests assume asymptotic normality

**Table : Summary of Unit Root Tests**

Variables	Tests at Level				Tests at First Difference			
	Pesaran's CADF With constant		Pesaran's CADF With constant & Trend		Pesaran's CADF With constant		Pesaran's CADF With constant & Trend	
	test statistic	Prob**	test statistic	Prob**	test statistic	Prob**	test statistic	Prob**
Real Stock Index Returns (Log)	-11.514	0.0000	-11.118	0.0000				
Excess Returns on Equity=Market Return–RF	-10.213	0.0000	-9.277	0.0000				
Govt Debt to GDP (Log)	0.767	0.7780	2.726	0.9970	-9.073	0.0000	-8.405	0.0000
Real GDP Growth Rate (Log)	-8.267	0.0000	-6.064	0.0000				
Monetary Policy Rate (Log)	-7.009	0.0000	-6.594	0.0000				
Inflation Rate (log diff CPI)	-9.963	0.0000	-10.226	0.0000				
Real Effective Exchange Rate (Log)	1.754	0.9600	-1.105	0.0900*				
R-G (10 Y Govt Bond rate-GDP growth rate)	-2.898	0.0020	-0.468	0.3200	-18.810	0.0000	-17.604	0.0000
R-G (3-month T.bills rate-GDP growth rate)	-6.200	0.0000	-3.763	0.0000				

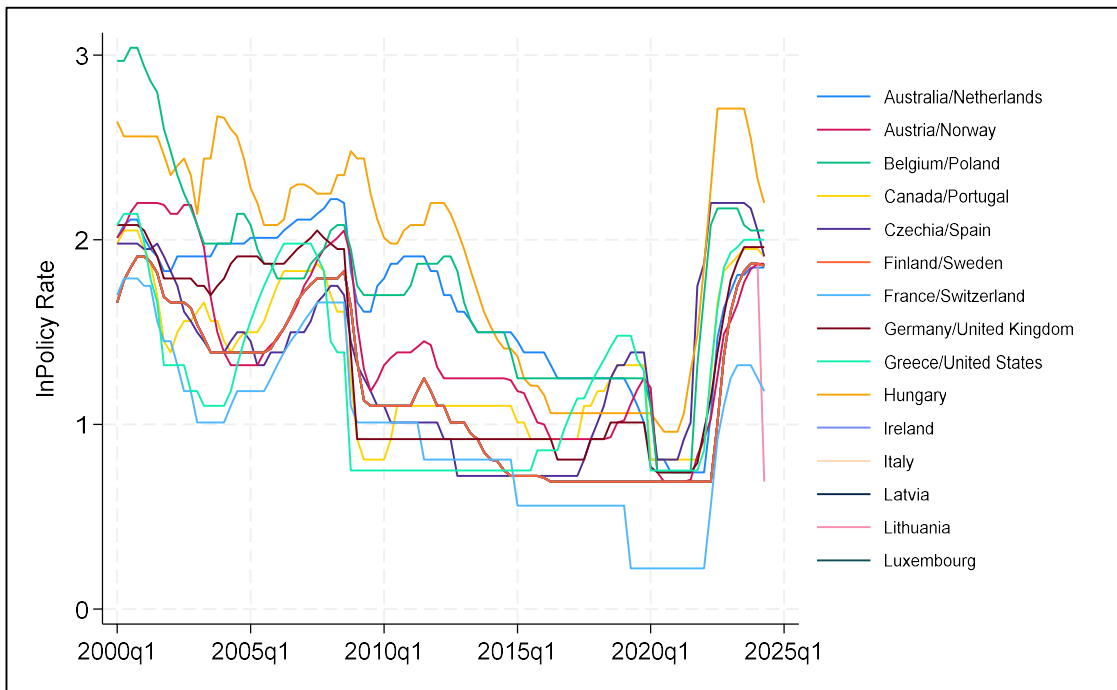
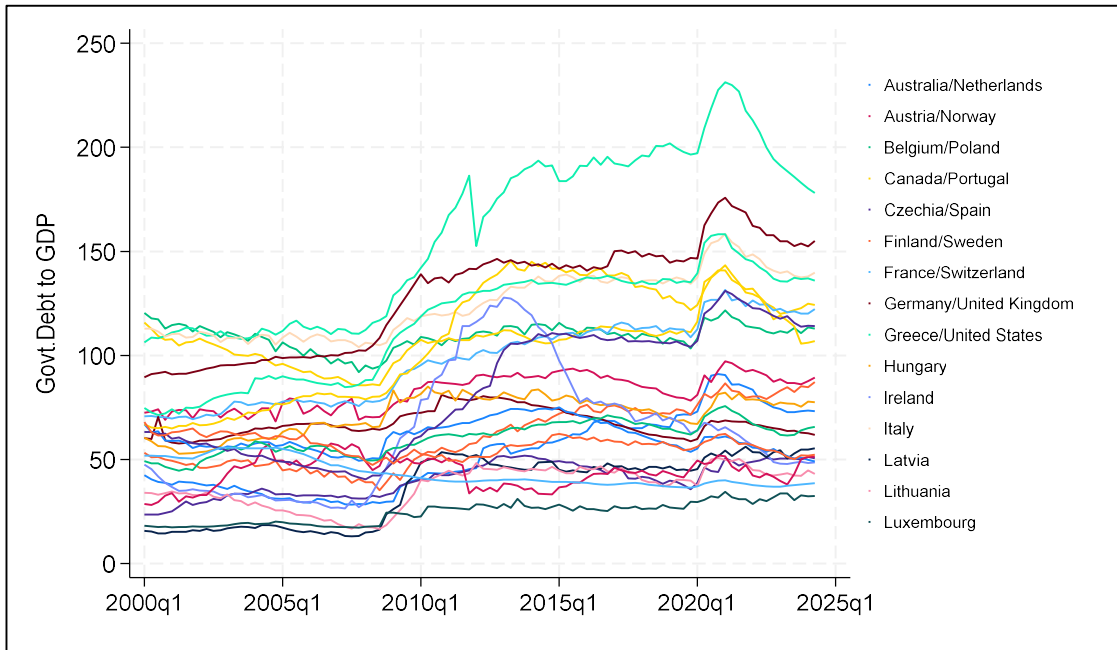
Note: The tests for all the variables were conducted at a maximum lag 4, considering the quarterly frequency data.

\*Test for Real effective exchange rate at lag 3, (test statistic -1.725 and p-value= 0.042).

The exact critical values of the t-bar statistics are given by Pesaran (2003).

Pesaran's CADF is a second-generation panel unit root. It is the t-test for testing stationarity in heterogeneous panels with cross-section dependence, proposed by Pesaran (2003). Parallel to Im, Pesaran, and Shin (IPS, 2003) test, it is based on the individual DF (or ADF) t-statistics of each unit in the panel. The null hypothesis assumes that all series are non-stationary. To eliminate cross dependence, the standard DF (or ADF) regressions are augmented with the cross-section averages of lagged levels and first differences of the individual series (CADF statistics).

**Panel Data, Time Series Graphs for Unit Root Test**



## Annex-IV: ARDL Models Additional Lags, Panel Data

Real Return Model Specification: Hausmann Test for MG vs PMG

```
. hausman mg pmg, sigmamore
```

	— Coefficients —		(b-B) Difference	sqrt(diag(V_b-V_B)) Std. err.
	(b) mg	(B) pmg		
lmgovtdebt~p	.0866095	.016907	.0697025	.017197
lmgdpgrowth~e	.1312998	.1351556	-.0038558	.053504
lncpi	-.0175516	-.0225206	.0049691	.0281594
lrgbasedoni~d	-.0058715	-.0048851	-.0009863	.0010662

b = Consistent under H0 and Ha; obtained from **xtpmg**.  
B = Inconsistent under Ha, efficient under H0; obtained from **xtpmg**.

Test of H0: Difference in coefficients not systematic

$$\text{chi2}(4) = (b-B)'[(V_b-V_B)^{-1}](b-B)$$

= 19.35

Prob > chi2 = 0.0007

Real Return Model Specification: Hausmann Test for MG vs DFE

```
. hausman mg DFE, sigmamore
```

	— Coefficients —		(b-B) Difference	sqrt(diag(V_b-V_B)) Std. err.
	(b) mg	(B) DFE		
lmgovtdebt~p	.0866095	.0281294	.0584801	.2998162
lmgdpgrowth~e	.1312998	.1648693	-.0335696	.985564
lncpi	-.0175516	-.0174811	-.0000704	.4990606
lrgbasedoni~d	-.0058715	-.003613	-.0022585	.0221595

b = Consistent under H0 and Ha; obtained from **xtpmg**.  
B = Inconsistent under Ha, efficient under H0; obtained from **xtpmg**.

Test of H0: Difference in coefficients not systematic

$$\text{chi2}(4) = (b-B)'[(V_b-V_B)^{-1}](b-B)$$

= 0.04

Prob > chi2 = 0.9998

Real Return Model Specification: Hausmann Test for PMG vs DFE

```
. hausman pmg DFE, sigmamore
```

	— Coefficients —		(b-B) Difference	sqrt(diag(V_b-V_B)) Std. err.
	(b) pmg	(B) DFE		
lmgovtdebt~p	.016907	.0281294	-.0112224	.1599982
lmgdpgrowth~e	.1351556	.1648693	-.0297138	.5907761
lncpi	-.0225206	-.0174811	-.0050395	.2769147
rgbasedoni~d	-.0048851	-.003613	-.0012722	.0156172

b = Consistent under H0 and Ha; obtained from `xtpmg`.  
B = Inconsistent under Ha, efficient under H0; obtained from `xtpmg`.

Test of H0: Difference in coefficients not systematic

$$\begin{aligned} \text{chi2}(4) &= (b-B)'[(V_b-V_B)^{-1}](b-B) \\ &= 0.01 \end{aligned}$$

Prob > chi2 = 1.0000

Panel Data ARDL Model, Real Returns and Specification Tests

VARIABLES	Mean Group	Pooled Mean Group	DFE	DFE Cluster Robust
<b>Short Run Coefficients</b>				
ECT	-0.7979*** (0.019)	-0.7403*** (0.016)	-0.7846*** (0.029)	-0.785*** (0.016)
LD. Real Stock Index Returns	0.1338*** (0.013)	0.1122*** (0.015)	0.1636*** (0.024)	0.164*** (0.014)
L2D. Real Stock Index Returns	0.0572*** (0.015)	0.0415** (0.017)	0.0339* (0.020)	0.034** (0.016)
D. Debt to GDP (Log)	-0.2494** (0.104)	-0.2336*** (0.085)	-0.2325*** (0.047)	-0.233*** (0.062)
LD. Debt to GDP (Log)	0.0039 (0.094)	0.0569 (0.071)	0.0758* (0.046)	0.076 (0.059)
D. GDP Growth (Log)	0.2443 (0.169)	0.3405* (0.199)	-0.1124*** (0.040)	-0.112** (0.049)
LD. GDP Growth (Log)	0.0431 (0.134)	0.0922 (0.134)	-0.0133 (0.035)	-0.013 (0.033)
D. CPI (Log)	-0.6300** (0.293)	-0.5209* (0.308)	-0.6376*** (0.195)	-0.638** (0.293)
LD. CPI (Log)	-2.5163*** (0.468)	-2.3908*** (0.432)	-1.1818*** (0.196)	-1.182*** (0.327)
D. R-G (10-Y bond Yield-GDP Growth)	0.0093 (0.009)	0.0109 (0.010)	-0.0062*** (0.002)	-0.006** (0.003)
LD. R-G (10-Y bond Yield-GDP Growth)	0.0022 (0.005)	0.0033 (0.006)	-0.0011 (0.002)	-0.001 (0.001)
Constant	-1.0255*** (0.263)	-0.2941*** (0.007)	-0.4894*** (0.143)	-0.489*** (0.158)
<b>Long Run Coefficients</b>				
Debt to GDP (Log)	0.0719*** (0.025)	0.0039 (0.011)	0.0147 (0.011)	0.015* (0.008)
GDP Growth (Log)	0.2139*** (0.076)	0.1055** (0.045)	0.1822*** (0.045)	0.182*** (0.052)
CPI (Log)	0.0689 (0.049)	0.0186 (0.020)	0.0043 (0.020)	0.004 (0.018)
R-G (10-Y bond Yield-GDP Growth)	-0.0018 (0.002)	-0.0031*** (0.001)	-0.0027** (0.001)	-0.003*** (0.001)
Observations	2,258	2,258	--	--
Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1, D=First Difference, and LD=Lag of First Difference				

Real Return Model Specification: Hausmann Test for MG vs PMG

```
. hausman mg pmg, sigmamore
```

	— Coefficients —		(b-B) Difference	sqrt(diag(V_b-V_B)) Std. err.
	(b) mg	(B) pmg		
Ingovtdebt~p	.0718544	.0038838	.0679706	.0239398
Ingdpgrowth~e	.2138665	.1054772	.1083893	.0659325
Incpi	.0689301	.0185695	.0503607	.0476687
rgbasedoni~d	-.0017866	-.0030627	.0012761	.001492

b = Consistent under H0 and Ha; obtained from **xtpmg**.  
B = Inconsistent under Ha, efficient under H0; obtained from **xtpmg**.

Test of H0: Difference in coefficients not systematic

chi2(4) = (b-B)'[(V\_b-V\_B)^(-1)](b-B)  
= 39.42  
Prob > chi2 = 0.0000

```
.
```

Real Return Model Specification: Hausmann Test for PMG vs DFE.

```
. hausman pmg DFE, sigmamore
```

	— Coefficients —		(b-B) Difference	sqrt(diag(V_b-V_B)) Std. err.
	(b) pmg	(B) DFE		
Ingovtdebt~p	.0038838	.0146643	-.0107805	.1770106
Ingdpgrowth~e	.1054772	.1821671	-.0766899	.7246915
Incpi	.0185695	.0043007	.0142688	.3170129
rgbasedoni~d	-.0030627	-.0026733	-.0003895	.0179432

b = Consistent under H0 and Ha; obtained from **xtpmg**.  
B = Inconsistent under Ha, efficient under H0; obtained from **xtpmg**.

Test of H0: Difference in coefficients not systematic

chi2(4) = (b-B)'[(V\_b-V\_B)^(-1)](b-B)  
= 0.02  
Prob > chi2 = 1.0000

Real Return Model Specification: Hausmann Test for MG vs DFE

```
. hausman mg DFE, sigmamore
```

	Coefficients		(b-B) Difference	sqrt(diag(V_b-V_B)) Std. err.
	(b) mg	(B) DFE		
Ingovtdebt~p	.0718544	.0146643	.0571901	.426647
Ingdpgrowt~e	.2138665	.1821671	.0316994	1.291588
Incpi	.0689301	.0043007	.0646294	.8354504
rgbasedoni~d	-.0017866	-.0026733	.0008866	.0301208

b = Consistent under H0 and Ha; obtained from **xtpmg**.  
 B = Inconsistent under Ha, efficient under H0; obtained from **xtpmg**.

Test of H0: Difference in coefficients not systematic

$\chi^2(4) = (b-B)'[(V_b-V_B)^{-1}](b-B)$   
 = 0.04  
 Prob >  $\chi^2$  = 0.9998

.

Data ARDL Model, Excess Real Returns

VARIABLES	Mean Group	Pooled Mean Group	DFE	DFE Cluster Robust
ECT	-0.7999*** (0.020)	-0.7172*** (0.017)	-0.7469*** (0.028)	-0.747*** (0.017)
LD. Excess Stock Index Returns	0.1424*** (0.012)	0.1087*** (0.014)	0.1494*** (0.024)	0.149*** (0.016)
L2D. Excess Stock Index Returns	0.0833*** (0.016)	0.0638*** (0.017)	0.0517*** (0.020)	0.052*** (0.011)
D. Debt to GDP (Log)	-17.7397* (10.416)	-12.9939 (8.678)	-17.0862*** (4.543)	-17.086*** (6.259)
LD. Debt to GDP (Log)	2.6158 (9.439)	11.3305 (7.714)	5.7453 (4.424)	5.745 (5.914)
D. GDP Growth (Log)	24.2749 (17.209)	28.3614 (18.864)	-7.9717** (3.915)	-7.972* (4.734)
LD. GDP Growth (Log)	5.6847 (12.605)	7.6097 (13.087)	1.3576 (3.433)	1.358 (3.578)
D. CPI (Log)	21.7374 (27.996)	17.2841 (29.123)	7.4282 (18.877)	7.428 (25.627)
LD. CPI (Log)	-271.332*** (43.436)	-275.198*** (40.812)	-173.998*** (18.919)	-173.999*** (30.265)
D. R-G (10-Y bond Yield-GDP Growth)	0.966 (0.923)	0.9837 (0.930)	-0.4750*** (0.168)	-0.475 (0.294)
LD. R-G (10-Y bond Yield-GDP Growth)	0.2831 (0.513)	0.2968 (0.554)	0.0058 (0.161)	0.006 (0.163)
Constant	-59.850** (23.501)	-25.063*** (0.688)	-38.104*** (13.985)	-38.104** (18.170)
<b>Long Run Coefficients</b>				
Debt to GDP (Log)	10.591*** (2.421)	2.0620* (1.083)	3.005*** (1.148)	3.005*** (0.964)
GDP Growth (Log)	7.7211 (6.958)	6.1563 (4.671)	9.8684** (4.630)	9.868* (5.105)
CPI (Log)	2.0733 (4.939)	2.3091 (1.966)	2.2043 (2.010)	2.204 (2.790)
R-G (10-Y bond Yield-GDP Growth)	-0.9282*** (0.180)	-0.8870*** (0.119)	-0.7141*** (0.107)	-0.714*** (0.192)
Observations	2,270	2,270		

Standard errors in parentheses, \*\*\* p<0.01, \*\* p<0.05, \* p<0.1, D=First Difference, and LD=Lag of First Difference