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THE SUFFICIENCY OF DEBT RELIEF AS A PANACEA TO SOVEREIGN DEBT CRISIS IN SUB-SAHARAN AFRICA: A CASE STUDY OF GHANA, NIGERIA, AND ZAMBIA

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I have written this master's thesis independently. All viewpoints of other authors, literary sources, and data from elsewhere used for writing this paper have been referenced.

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Abstract

There has been growing concern about the emergence of an impending sovereign debt crisis across sub-Saharan Africa (SSA), as previously experienced in the 1980s. In November 2020, Zambia defaulted on its sovereign debt, and several other SSA countries have sought assistance from IMF and the World Bank. Consequently, there have been recent calls for debt relief and even outright debt cancellation. This paper studies the long-run (2021-2050) projected impact of stylized debt relief packages on the macroeconomy through a case-by-case country analysis by utilizing deterministic and stochastic approaches to debt sustainability. Using SVAR methodology in the research, we noticed a convergence in the case of debt relief (for the study, we considered a 25% and 80% partial debt reduction, full debt cancellation, and debt standstill scenarios) to the original path of debt. The results imply that debt relief has little impact on the long-run debt projection. Further analysis on the structural impulse responses of the debt level to a shock (increase) in the endogenous variables shows that the GDP growth rate has the most significant impact on the debt level. Therefore, growth reforms are vital for macro-economic reforms targeting debt.

Keywords: Sovereign Debt Crisis, Debt Relief, Debt Sustainability, SVAR, Sub-Saharan Africa, Ghana, Nigeria, Zambia.

JEL classification: C53, F34, F37, H63, H68

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1. Introduction

Sovereign debt indicates the total amount of money owed by a country's general government at a given point in time. Sovereign debt amongst emerging economies has varied dramatically over time. For example, sovereign debt as a phenomenon is more critical in African nations because a significant portion of the debt is denominated in dollars. In this context, the African countries have witnessed the rising and falling of debt, primarily because of the enormous debt accumulation and the need for subsequent restructuring. Worthy of note is that 317 restructuring events occurred in Africa between the 1980s and 2014 that warranted debt relief and forgiveness (Brooks et al., 2014).

Sub-Saharan Africa (SSA) has long been identified as the region with the world's poorest nations. For a region plagued with poverty and dismal governance, rising debt accumulation has been a critical challenge. As of 2019, many of these states were already at moderate to high risk of debt distress, according to the International Monetary fund (IMF). Furthermore, the Coronavirus pandemic disrupted the global economy by creating policy-determined supply and demand restrictions (lockdowns, etc.). It further wreaked havoc by plummeting global demand, increasing health costs, decreasing government revenues coupled with increasing government spending to support the economy. As such, these economies have been most vulnerable due to their lack of economic diversification, overreliance on a single or limited commodity as the primary source of government revenue, and depreciating currency (Calderon et al., 2020). Hence, it has further exacerbated the distress risk and increased their likelihood of default, thus increasing the topicality of debt crisis, debt restructuring, and relief in the past two years.

Given its relevance, several studies have been conducted to examine the effect of previous debt relief on a country's debt level and, ultimately, its impact on the economy (Cassimon et al., 2008, 2015**;** Brooks et al., 2014**;** Prizzon and Mustapha, 2014). However, there is a sparse amount of literature on the expected effects of debt relief on future debt paths and projections. Moreover, other studies where debt is projected (without considering debt relief) focus on the short to medium-term trajectory (Garcia and Rigobon, 2008, di Giovanni and Gardner, 2008; Berti, 2013). This paper looks into the projected effect of stylized debt relief packages that reflect past and current debt relief scenarios (partial external debt reduction, full external debt cancellation,

and external debt standstill), which hasn't been covered to the best of our knowledge before. In addition, our forecast spans for the long horizon (2021-2050), making it a valuable contribution to the body of literature on this subject.

For this research, we conduct a deterministic debt projection using the debt equation model presented by Berti (2013) and a stochastic debt projection using the structural auto-regressive (SVAR) model proposed by Kilian (2011) and Garcia and Rigobon (2004). The forecasts are on a case-by-case analysis of three selected countries, Ghana, Nigeria, and Zambia (the motivation for each country selection is explained in Section 4), which helps narrow the focus of the studies and avoids blanket effects by allowing for individual country responses. Our findings show that debt relief only provides temporary alleviation to the benefitting country. In addition, we delve further by deriving the structural impulse responses, which provide valuable insights on the impact of one standard deviation innovation (shocks) in an endogenous variable on another endogenous variable or on itself. Here, we discovered that positive shocks to the real GDP growth rate have the most significant impact on the debt level. Thus it has a permanently positive effect on the economy. These results are quite informative and have policy implications for the government. As such, macro-economic policies that hinge on growth reforms might prove to be more beneficial to tackling debt in the long term than debt relief.

The rest of the study is outlined as follows: Section 2 brings to our attention some pertinent facts about sub-Saharan sovereign debt and its dynamics. In Section 3, we provide background into the causes and impacts of the debt crisis and the effects of debt relief. Section 4 and section 5 provide the data and methodology, and the analysis with results, respectively. Finally, section 6 summarizes the research findings and policy implications, highlights its limitations and possible recommendations for further studies.

2. Current Sub-Saharan Africa Sovereign Debt Facts

Due to the Covid-19 pandemic, the average fiscal deficits in SSA have risen from 4.3% in 2019 to 5.8% of GDP as of the end of 2020 (IFS[1], 2021). These states, particularly those with a limited export mix, have been forced to rely heavily on debt to finance their budget. For instance, in 2020, Moody's report shows that 19 SSA sovereigns received IMF loans, including South Africa ($4.3bn). South Africa's debt to Gross Domestic Product (GDP) ratio reached 82% by the end of 2020 compared to 62% observed in 2019, and economic forecasts indicate that it will exceed 100% by 2025. Zambia's debt reached 119.97% in 2020 from the previous year's figures of 91.9% and 60.57% in 2016. Mozambique's debt levels spiked by 30pp (percentage points) between 2018 and mid-2020 from 100% to 130%. Likewise, Ghana's debt-to-GDP ratio increased by 14pp to 76.7% in 2020 from 62.8% in 2019, from which external debt is 35.8% of GDP. Besides high debt levels and rising fiscal deficits, high borrowing costs have increased debt burdens over time. According to the United Nations (UN) estimates, the interest rate on Sub-Saharan African 10-year sovereign bonds ranges from 5% to 16%, much higher than the near-zero to negative interest rates observed in developed economies.

Several African states, including Angola and Congo (with a debt-to-GDP ratio above 100%), have lacked the fiscal space needed to respond to the pandemic and simultaneously service their debts. The UN noted that debt servicing constitutes the highest expenditure for SSA. For example, despite Nigeria's low debt levels (35% as of the end of 2020), the debt service ratio to revenue averages 40%. It reached a record high of 99% in Q1 2020 due to crashing oil prices from $61 in December 2019 to $22 per barrel in March 2020 (there's been a recent rebound in oil prices) and exchange rate depreciation. Based on Fitch rating agency figures, emerging economies and SSA states are in a precarious situation, spending a significant share of their revenue on debt servicing (10.4% in 2020 from 8% in 2019) and interest payments alone. On the other hand, advanced economies will spend, on average, 3.3% of their revenues on debt service in 2021 compared to 3.1% in 2019.

As an aftermath of the crisis, major African currencies went through massive depreciation in 2020, hampering their ability to repay foreign-denominated debt. Zambia's currency was the

[1] IFS here refers to the Institute for Fiscal Studies.

worst hit (-33.7%) due to its default. The Nigerian naira depreciated twice (25%), Angola (25.9%), and the South African rand depreciated by 25% as of April 2020 but rebounded to -4.7% of its initial value. Kenya and Mauritius currencies also fell by 7.2% and 8.4%, respectively, according to Proshare. Oil exporters, on average, were affected the most due to oil price shocks. Although local currency bond issuance mitigates the effect of dollar shortage and currency devaluation on public debt, the usage of local currency bonds remains widely untapped in SSA (Essers et al., 2016; Dafe et al., 2018). However, the share of domestic debt has been rising in recent times.

Based on the figures from credit rating agencies like Fitch and Moody's, average SSA public debt will stabilize at 64% of GDP in 2021, up from 57% in 2019 and 26% in 2012. These levels far exceed the 40% threshold[2] of debt-GDP-ratio that the IMF and the UN recommend for developing countries (Chowdhury, 2013). Growth recovery will occur at a languid pace, much slower for energy-exporting SSA economies than non-energy exporting. According to Moody's, debt to GDP growth in South Africa will not return to pre-pandemic levels until 2023. Its interest rate growth differential is as high as 2.5%, complicating its debt problem because of the fiscal adjustment required. UN reports that a decade of progress made towards achieving the Millennium Development Goals (MDGs) of eradicating poverty in the SSA region has reversed.

In light of the growing debt crisis, multilateral organizations such as the International Monetary Fund and World Bank, alongside the G20 countries, approved the Debt Service Suspension Initiative (DSSI) on bilateral and multilateral debt in April 2020 to assist low-income countries in coping with the pandemic till December 2021. Out of about 73 eligible DSSI countries, 40 are sub-Saharan African countries, of which one country (Zambia) defaulted in November 2020.

Unlike previous large scale debt relief programs like the Multilateral Debt Relief Initiative (MDRI) and its predecessor, the Heavily Indebted Poor Countries (HIPCs) initiative, which sprung up after the debt crisis of the 1980s to achieve and maintain debt sustainability of eligible countries (Cassimon, Essers, and Verbeke, 2015), the DSSI program is only aimed at providing temporary relief. Moreover, this relief is given based on the assumption that the current debt crisis is due to liquidity problems rather than solvency and fails to consider the plethora of

[2] For developed economies the recommended threshold on debt-GDP-ratio has been 60%. See also (Chowdhury, 2010; 2013).

Africa's external creditors, which now include commercial lenders and private bondholders to a great extent (about two-thirds). Besides, the degree to which China, sub-Saharan Africa's single largest creditor (accounting for 17% of total external debt), will participate in the debt relief program remains unclear.

This defeats the initiative's aim as it creates a free-riding problem, where non-participating[3] lenders capitalize on the sacrifices of other lenders by demanding full repayment and continuous debt servicing with freed-up funds. Recently there have been persistent requests for a deeper and broader scope of debt relief (i.e., debt reduction and cancellation) by campaign groups and public figures like Ghana's finance minister, Ethiopia's prime minister, and the director-general of the World Trade Organization, Ngozi Okonjo-Iweala. Still, even this comes at the cost of downgrading African sovereign bonds by rating agencies, thus, increasing the cost of future borrowings and making debt relief a double-edged sword that some countries would rather not wield. All things considered, the availability of debt relief and debt relief itself might be insufficient in solving this debt problem without major structural debt reforms.

3. Sub-Saharan Africa Debt Overview and Literature Review

To fully comprehend this study, an insight into the origin of Africa's debt crisis (In the 1980's and now), the resulting debt relief programs that ensued afterward, and their corresponding effect on the receiving country's debt position, debt sustainability, and its economy is essential. This section is dedicated towards achieving that purpose.

3.1 Causes and Impact of Debt Crises in Sub-Saharan Africa

The debt crisis of the 1980s had devastating effects on developing countries' economies (Latin America and Africa). Existing literature on the debt crisis (Green and Khan 1990; Ezenwe, 1993; Fole 2003) attributed the cause to many factors. First was overborrowing caused by the rise in government expenditure following the oil and commodity boom (such as cocoa, coffee, sisal, tea, and uranium) in the 1970s. These expenditures were not commensurately cut despite the crash in

[3] Such as private creditors. Even the extent of China's participation remains unclear.

commodity prices shortly after. Instead, these sovereigns resorted to more borrowing, which increased their debt burden. Secondly, the Eurodollar market expansion into the African continent – as an alternative source of external financing for capital projects – increased their propensity to borrow. Sadly, most of the projects financed out of sovereign debt turned out to be ill-conceived or unproductive (Ezenwe, 1993).

Subsequently, these economies encountered other challenges in the early 1980s, including decreased net capital flow and foreign real interest rate hikes from -17.9% in 1973 to 17.4% in 1981(Khan and Knight 1983). Also, inefficient macroeconomic policies such as highly expansionary fiscal policies and decreased domestic interest rates discouraged private savings that could have substituted external funding. Lastly was the changing financing landscape from concessional bilateral debt, which could be restructured, to increased non-concessional multilateral debt. These bunched-up events, coupled with the inability to adjust public spending to changes in macroeconomic conditions, led to the African debt crisis in the 1980s.

Today, unfortunately, we are witnessing similar trends.

- Huge fiscal deficits played a big part in the current high debt levels. This was spurred by a continuous rise in public expenditure, particularly for infrastructure projects, without a similar rise in domestic savings. Coulibaly et al., (2019) showed that between 2005 and 2017, there was a 38-percentage point increase (21% to 59% of GDP) in average debt for oil-exporting SSA countries (including Nigeria, Angola, and Gabon, among others) and a 16pp increase for its non-oil exporting states.
- High cost of borrowing increased debt servicing obligations. SSA countries pay higher interest rates than their European and American counterparts with similar credit ratings[4]. Olabisi and Stein (2015) posit that the African bond premium was around 2.9 percentage (roughly $300m annual interest) higher than justifiable after controlling for credit ratings, timing, and macroeconomic fundamentals. For instance, Ghanaian bonds have higher spreads than Belarus, Ukraine, and El Salvador, with the same lower B- ratings. Similarly, Brazil's spread on a 10-year Eurobond is 305bp (basis points) relative to South Africa's spread of 486bp despite a similar credit rating[5]. Likewise, Senegal pays five times more for

[4] See https://theconversation.com/african-countries-arent-borrowing-too-much-theyre-paying-too-much-for-debt-131053
[5] See https://www.bondvigilantes.com/insights/2020/08/is-market-pricing-of-african-eurobonds-unfair

its 10-year sovereign bond than Greece, a lower credit-rated country[6]. In 2019, the debt service cost had already reached similar percentages as observed in the 90s (Volz et al., 2020).

- Lack of economic diversification: SSA countries have relied on a limited number of commodities for export. Both their oil-exporting and non-oil-exporting states share the same problem (Coulibaly et al., 2019). In Nigeria, for instance, oil exportation accounts for 75 percent of its total export. This has harmful effects as it exposes them to exogenous shocks from declining commodity prices and global demand.
- The changing debt structure is at the heart of today's debt crisis (Brooks et al., 2014; Coulibaly et al., 2019; Berensmann et al., 2020). In these last two decades, the private debt ratio has increased, while those of official bilateral and multilateral debts have declined. This debt is usually associated with a higher interest rate which increases debt servicing costs.

Nonetheless, other factors have played a part in the current rising debt distress. For instance, the Global Financial Crisis (GFC) of 2008 contributed much to the enormous debt levels we see today (Coulibaly et al., 2019). Following the crisis, primary fiscal deficits ensued from previously surplus running SSA governments. Furthermore, they could no longer access funds from the international capital markets, thus increasing their vulnerability. In addition, the Covid-19 crisis facilitated the accumulation of debt to unsustainable levels (Arellano 2020). With increased health costs and negative economic repercussions of lockdowns, average global debt was as high as 368% of GDP (almost 300 trillion US$) in Q2 of 2021, based on the Institute of International Finance (IIF).

In comparison to this, SSA debt levels were relatively lower at less than 100% of GDP. Although the current debt levels of SSAs are less than those of advanced economies, this region remains most vulnerable because it has a much lower borrowing capacity and tax capacity. As a matter of fact, between February and November 2020, no SSA got access to the international capital market (Volz et al., 2020). Moreover, unlike the GFC, both developing countries and emerging markets are simultaneously in dire need of funds to combat the virus and stabilize their economy. By the end of the first quarter in 2020, about 100 nations had sought IMF funds (Bolton et al., 2020). Also, based on economic projections, it is most probable that more borrowing will arise even after the crisis abates IMF (2020).

[6] See https://www.bloombergquint.com/business/borrowing-costs-make-africa-s-stars-victims-of-the-neighborhood

The impacts of debt crises on economic growth are distressing. Some studies revealed that a high debt burden encourages capital flight, a phenomenon referred to as debt-fuelled capital flight (Sachs and Williamson, 1986; Ndikumana and Boyce, 2011). Sub-Saharan Africa, unfortunately, has the highest rate of capital flight, with a considerable chunk of its private assets held abroad. Ironically, this region remains a net creditor to the world despite its sizeable external debt (Coulibaly et al., 2019). Capital flight has repressive effects on the economy and further accentuates its debt burden. The decrease in the standard of living is yet another negative consequence of high debt because a large part of public revenues, which could have been used to alleviate poverty through the provision of better health, social service, educational and infrastructural systems, are expended in debt service obligations (Berensmann et al., 2020).

Furthermore, debt overhang decreases foreign direct investment (Aguiar and Amador 2011). This leads to stunted economic growth and creates foreign exchange scarcity, that fuels currency devaluation. This is evident from events following the crisis, as major African currencies went through massive depreciation in the first half of 2020. Currency devaluation has further compounded their external debt burden, as some of the debt is in foreign currency.

Given the adverse effects of high debt burden in general and debt crisis in particular, the next sub-section gives an overview of debt reduction mechanisms used, including but not limited to debt relief mechanisms.

3.2 Overview on Mechanisms for Reducing Debt Burden and Crisis

According to Fole (2003), debt reduction mechanisms include debt conversion, debt buybacks, and debt relief. For debt conversion, debt is exchanged at a discount for something else, such as equity (debt-equity swap[7]) or development (debt for development). In a debt buyback, the debtor country repurchases her debt from the original creditors at a discount. Debt relief, on the other hand, involves

[7]See https://www.elibrary.imf.org/view/books/071/01505-9781557753069-en/ch006.xml

giving some form of reprieve to the debtor by stopping debt growth (debt standstill[8] and interest rate waiver[9]), by extending the maturity period and debt service payments (debt rescheduling[10]), or by partial or full debt cancellation (debt write-off/haircut or reduction in nominal value). However, apart from the debt reduction mechanisms that incorporate debt relief, the other means are not comprehensively operational in Africa.

To curb Africa's debt problem, various debt relief proposals were initiated. The important ones include the Baker Plan (1985), The Brady plan (1989), The Toronto Plan (1988), The HIPC (1996), The MDRI (2005), and DSSI (2020).

In 1985, the U.S. Secretary of Treasury, James Baker, launched the Baker Plan with IMF's support to resolve the international debt crisis. It was designed to;

- Encourage structural reforms,
- Improve net capital flows,
- Provide debt flow relief through debt rescheduling for highly indebted middle-income countries.

Although this relief plan targeted Latin American countries (like Mexico, Argentina, Brazil, and others), some African countries, including Nigeria and Cote d'Ivoire, participated. However, this relief plan failed to alleviate Third World debt (Cline 1995).

Consequently, the succeeding U.S. Secretary of the Treasury, Nicolas Brady, initiated the Brady Plan to address the shortcomings of the Baker relief by providing 25% external debt stock relief to eligible Third World countries. Under this plan:

- The benefiting government adopted structural adjustment programs (SAP)
- Capital repatriation was highly encouraged
- Debt reduction was given by commercial banks
- Bilateral debt was rescheduled through the Paris Club[11]

[8] In the case of a debt standstill, debt repayment is halted temporarily, based on the agreement between the creditor and debtor.
[9] Interest waiver means interest payment is permanently halted, and only principal repayment is made during the repayment period or at maturity.
[10] Debt rescheduling in this context refers to postponing debt-servicing and extending the debt's maturity according to the new contractual repayment period.
[11] Paris Club – an official high-income group of bilateral creditors.

- International Bank for Reconstruction and Development (IBRD)[12] and IMF provided US$20bn-US$25bn in funding.

About 4 African countries, Morocco (1989), Congo (1990), Cote d'Ivoire (1991), and Nigeria (1991), benefited from this plan (Ezenwe 1993).

The Toronto Plan was designed to reduce the official non-concessional[13] bilateral debt of heavily indebted countries, via partial write-off (1/3 of total debt service due), by the Paris Club and subsequent rescheduling of the balance at the market interest rate (Oteino 2014). About 18 African countries benefited from this relief in 1991, such as Senegal, Togo, Mali, and Tanzania. Yet, its impact was limited to 2% (around $16bn) of Africa's total debt (Ezenwe 1993)

In 1996, IMF and World Bank launched the HIPC initiative to substantially reduce Low-Income Countries' debt. This relief plan encompassed not only bilateral[14] debt but also multilateral[15] debt for the first time. It involved a two-step process – the decision point and the completion point. At the decision point, highly indebted poor countries were granted interim debt service relief upon establishing desired structural and economic reforms and framing their Poverty Reduction Strategy Paper (PRSP). Eligible countries received up to 80% debt write-off at the completion point. This was achieved after the countries exhibited an excellent track record in implementing and maintaining the reforms and strategies designed in phase one for at least a year. Out of 39 eligible countries, 37 have reached the completion point, 31 being African countries (Brooks et al., 2014; Cassimon et al., 2015; IMF 2021). Building on the HIPC initiative, the MDRI initiative was later designed to explicitly address the Multilateral debt of 36 low-income countries, 29 being African. It involved full debt cancellation for the first time and was taken as a step towards achieving the MDGs (Brooks et al., 2014**,** Cassimon et al., 2015).

[12] IBRD is one of the five constituent institutions that formed the World Bank Group. The other four include: International Development Association, (IDA), Multilateral Investment Guarantee Agency (MIGA), International Finance Corporation (IFC), and International Centre for Settlemnet of Investment Disputes (ICSID)

[13] Although there's no specific definition for non-concessional debt, concessional debt is a debt incurred on more favourable terms than market debt. Concessional debt is typically funded by multilateral organisations like the IMF, the World Bank or someother development bank and is given at lower interest rates or with longer grace periods.

[14] Bilateral debt in this context is the debt owed by a country to another country/government. In other words, it is a debt contract between two countries

[15] Multilateral debt is debt owed by a country to international financial institutions like the IMF, the World Bank, inter-governmental agencies etc., which are formed by the collaborative effort of more than two countries

The present DSSI was devised in April 2020 by IMF, World Bank, and the G20 economies in response to Covid-19 Pandemic, which emerged from China in December 2019. It is designed to give cash flow relief to the poorest countries through a temporary debt standstill valid until December 2021. In total, 73 IDA (International Development Association) countries, 40 stemming from the African community, have qualified for this relief (World Bank 2021). Unfortunately, there are some shortcomings to this program. First, it gives only cash flow relief because it assumes that these countries' debt problem stems from insufficient liquidity rather than solvency, which is the fundamental, long-run problem (Volz et al., 2020). Secondly, private creditors' participation is only voluntary. This means that the freed-up resources gotten through relief from participants will service the debt of non-participants – a conduct known as free-riding.

3.3 Effects of Debt Relief

Debt relief remains a controversial topic to date. While supporters of debt relief argue that it reduces debt burdens and improves the welfare of beneficiaries **(**Obstfeld and Rogoff 1996; Arslanalp and Henry 2004), critics claim that it stunts necessary economic reforms and permits lax and inefficient macroeconomic policies (Easterly 2001, 2006; Freytag and Pehnelt 2009). In the case of debt restructuring and renegotiations, it could lead to output losses and damaged reputation **(**Arellano 2008; Pitchford and Wright 2012).

Several studies have been devoted to assessing debt relief's fiscal effect (Cassimon et al., 2008, 2015**;** Brooks et al., 2014**;** Prizzon and Mustapha, 2014). Cassimon et al. (2008, 2015) estimated the effect of debt relief, specifically the HIPC and MDRI initiative, on a sample of 24 African countries using a Vector Autoregressive (VAR) model. Their results indicated that debt relief improved the fiscal space of the recipient and positively affected revenues and investment. Yet, the magnitude of debt relief impacts was higher under the HIPC initiative than the MRDI initiative. This was attributed to the fact that the relief received from the latter wasn't tied to reform policies like the former. Irrespective of the results from these panel studies, detailed country case studies were recommended to avoid blindly advocating for more debt relief. In addition to these findings, some claim that the improved fiscal space encouraged new bouts of borrowing (Lewis 2013; Otieno 2014). Shortly after receiving the HIPC and MDRI relief, eight SSA countries – namely,

Mozambique, Senegal, Ghana, Malawi, Niger, São Tomé and Príncipe, Benin, and Uganda – had lost 1/3 of the debt ratio gains realized (Prizzon and Mustapha 2014).

Another study showed that weaker forms of debt relief (like debt standstill, debt rescheduling, and interest rate reduction) have no significant impact in resolving debt crises (Reinhart and Trebesch, 2016). Using Difference-in-Difference (DiD) regression, these authors analyzed the long-term effects of debt relief by evaluating the post-war relief (25% write off of total debt) for advanced economies in the 1930s and the Baker and Brady (25% write off of external debt) relief plans for emerging markets between 1978-2011. By comparing the two eras of debt relief, the authors noticed a significant rebound in sovereign credit ratings for the emerging markets following the debt relief, which was not observed in advanced economies. Also, debt servicing costs decreased by nearly half in developed countries (4.2% to 2.4% of GDP) compared to a slighter decrease for emerging economies (8% to 6% of GDP). Overall, the study showed that debt reduction significantly increased GDP per capita and sovereign bond ratings and decreased the recipients' debt service burdens. In contrast, debt rescheduling did not produce these gains. They found that only deep debt write-off proved effective in resolving the protracted debt crisis in both cases.

In contrast, Sachs (1989); Arslanalp and Henry (2004) deduced that debt reduction does not lead to substantial efficiency gains in economic growth, investment, and overall market response except in the case of debt overhang. Based on this theory, pioneered by Krugman (1988), the government's debt burden can reach a point where further borrowing becomes impossible because creditors doubt their ability to pay back. Thus most, if not all, existing and incoming resources are expended in debt servicing. Of course, the logic here is that debt cancellation, in this case, would go a long way in restoring creditors' confidence and promoting growth.

Even so, when it comes to administering debt relief or reduction, care must be given to avoid the risk of undershooting (providing debt relief below the amount needed for achieving long-term debt sustainability) and overshooting (extracting more relief than is necessary for achieving long debt sustainability). Note that the risk of undershooting is worse than that of overshooting. In the case of overshooting, creditors can regain the excess loss incurred through value recovery instruments[16] –

[16] These instruments require a sovereign to make additional payments if the economic condition improves above a benchmark level. For example oil warrants were included in Brady relief. These required oil-exporting countries to pay more if there is a rebound in oil prices and demand. Also contingent bonds like GDP linked bonds can be applied.

that require additional payments to be made if certain events occur, such as a positive turnaround in the debtor country's economic prospects. On the other hand, undershooting does not restore investors' confidence in the nation's debt sustainability, thereby eliminating any hope of future stability and creating a vicious cycle of default and subsequent debt restructuring (Buchheit and Gulati, 2021).

In the same vein, Berensmann et al. (2020) & Volz et al. (2020) proposed that resolving the current debt crisis requires the participation of all creditors and that debt relief should be administered only to countries that are deemed to be highly indebted. Moreover, they stated that in order to correctly administer debt relief, it should be based on case-by-case analysis using the Debt Sustainability Framework (DSF) – a framework introduced in 2005 by IMF in collaboration with World Bank, to assess both risks of total and external debt distress in debtor countries through debt sustainability analysis. A country's debt is sustainable if it possesses the capacity to meet all its debt obligations – both present and future – without recourse to external assistance or rescheduling.

Against this backdrop, determining the long-run impact of stylized debt relief packages on a case-by-case approach is an essential contribution to the vast amount of literature on this subject matter.

4. Data and Methodology

4.1 Data

For this study, three sub-Saharan countries have been selected for case-by-case analysis: Ghana, Nigeria, and Zambia. The countries used for the case study are chosen based on their DSSI eligibility status and moderate to high risk of debt distress. Asides from their DSSI eligibility, Nigeria and Ghana stand out with annual debt-servicing costs exceeding 50% of GDP, while Zambia has already defaulted on its debt. More motivation has been provided below. The data used cuts across a 31-year period (1990-2020) from reliable databases, including International Financial Statistics (IFS of IMF) and International Debt Statistics (IDS of World Bank).

Case Studies

Nigeria: Lack of Fiscal Space

Nigeria has the highest population (over 200 million inhabitants) and is the largest economy in Africa, accounting for about 18% (US$432.3 billion) of its total nominal GDP based on 2020 Trading Economics data. Its total debt as of Q1 2021 stood at US$87 billion from 79.3 billion observed in Q1 2020 (9.7% increase), out of which US$32.9 billion constitutes external debt. Despite a low debt-GDP ratio (35% in 2020 and projected 36% in 2021, up from 29.17% in 2019), the Nigerian government spent an average of over 40% of its revenues on debt servicing. Nigeria witnessed a record high of 97% debt service to revenue ratio in 2020. These figures, coupled with dwindling revenues from crashed oil prices in 2020, oil quota cuts, and reliance on oil exportation as the primary source of government revenue, make it an interesting and relevant case study.

Ghana: High Risk of Debt Distress

Likewise, Ghana's debt-GDP ratio increased by 14pp to 76.7% in 2020 from 62.8% in 2019, with 35.8% in external debt. Moreover, the expected debt-GDP ratio is estimated to be 83.54% by the end of 2021. Fitch projects its interest expense alone to reach 47% of GDP by 2022, and the country is at risk of being shut out of the international debt market. Conceivably, what makes this country important to this research stems from the fact that she has relatively good governance indicators compared to her sub-Saharan counterparts. In several instances, the Financial Times and similar publications have labeled Ghana's governance as a model of democratic rule to the SSA region, which is in a democratic recession. If the debt situation is this difficult for a country of good governance, imagine how much more difficult it would be for a country with not-so-good governance.

Zambia: In Debt Distress

Of course, the county choice would not be complete without the inclusion of Zambia (a principal copper exporter), which became the first African country to default since the emergence of the pandemic. The default occurred after the expiration of a 30-day grace period in November 2020. Prior to this, Zambia had been at the center of debt renegotiations with major creditors like China. Meanwhile, other struggling African governments keenly watched to see how both parties would handle the case. The country's GDP was about US$20 billion, with debt up to US$13.5 billion at the end of 2020. Zambia's currency lost 1/3 of its value, and debt reached 119.97% of GDP in 2020 from the previous year's figures of 91.9% and 60.57% in 2016.

Table 1 summarizes the variables used in the study, the corresponding data sources, and the definitions. Annual data is used for all the variables, and real values are in constant 2010 US$.

The summary statistics for the various macroeconomic and financial variables used in the methodology (section 4.2) and analysis (section 5) is given in Table 2 above. Ghana's average real GDP growth rate is the highest at 5.31% and has been consistently positive throughout the period under study. Yet, on average, her fiscal deficit is larger than the other SSA countries. At first glance, this might indicate the possibility of a negative correlation between GDP growth rate and primary balance/overall balance. However, the correlation matrix in Appendix B.1.1, B.2.1, and B.3.1 shows a weak positive correlation between growth rate and primary balance. The standard deviation of Nigeria's interest rates and exchange rates signifies greater variability in comparison to her counterparts. Notice that these countries exhibit double-digit inflation rates on average. Zambia's historical inflation rates are alarming, reaching up to 165%. Of course, with inflation rates being so high, it is not surprising that Zambia's real exchange rate is the lowest of the lot. Although the mean and standard deviation of Zambia's gross debt, external debt, and debt service is also relatively large, high inflation could reduce the debt burden over time.

Table 1. Variable Description

Variable Name	Definition	Measurement	Period	Source
Real GDP growth	A country's annual GDP growth rate adjusted for inflation	Annual % Constant 2010 US$	1990-2020	World Bank, World Development Indicators (2020)
Inflation/GDP deflator	The rate of price change in the economy over time	Annual %	1990-2020	World Bank, World Development Indicators (2020)
Real interest rate[17]	Interest paid on the previous year debt outstanding	Annual %	1990-2020	World Bank, International Debt Statistics (2021)
Real effective exchange rate (REER)	The real value of a country's currency relative to a basket of currencies weighted by the relative importance of trading partners (in US$)	Annual % Constant 2010 US$	1990-2020	IMF, International Financial Statistics (2021)
Gross public debt position	Public sector debt of a country's general government	% of GDP	1990-2020	IMF, Historical Public Debt Database (2016) & Fiscal Monitor (2021)
External debt stocks	Debt owed to non-residents	% of GNI	1990-2020	World Bank, International Debt Statistics (2021)
Total debt service	Sum of principal repayments and interest paid on long-term debt and short-term debt	% of GNI	1990-2020	World Bank, International Debt Statistics (2021)
Primary net lending/borrowing (primary balance)	Overall balance excluding net interest payments	% of GDP	1990-2020	IMF, Fiscal Monitor (2021)

[17] The real interest rate is calculated by applying the following formula; $r_t = [(1 + i_t)/(1 + \pi_t)] - 1]$ where i_t is the nominal interest rate, and π_t is the inflation rate (GDP deflator).

Table 2. Descriptive Statistics

Variable Name	N0. of Obs	Mean	SD	Min	Max
Real GDP Growth (Aggregate[18])	93	4.59	3.61	-8.63	15.33
Ghana	31	5.31	2.54	0.41	14.05
Nigeria	31	4.34	4.08	-2.04	15.33
Zambia	31	4.34	3.85	-8.63	10.30
Inflation/GDP Deflator (Aggregate)	93	24.19	27.24	0.69	165.53
Ghana	31	23.53	14.96	9.19	80.75
Nigeria	31	16.99	15.93	0.69	75.40
Zambia	31	32.05	40.99	5.44	165.53
Nominal Interest Rate (Aggregate)	93	2.6	1.88	0.50	15.18
Ghana	31	2.36	0.94	1.01	4.54
Nigeria	31	3.21	2.69	1.06	15.18
Zambia	31	2.23	1.45	0.50	5.20
REER (Aggregate)	93	96.15	37.93	46.98	272.92
Ghana	31	104.56	28.82	64.63	165.99
Nigeria	31	108.04	50.15	49.74	272.92
Zambia	31	75.85	20.52	46.98	112.57
Gross Debt Position (Aggregate)	93	76.73	65.33	7.28	244.52
Ghana	31	59.22	20.31	26.22	111.95
Nigeria	31	55.73	53.37	7.28	193.67
Zambia	31	115.26	86.73	16.72	244.52
External Debt Stocks (Aggregate)	93	72.57	63.27	4.91	233.73
Ghana	31	64.19	36.95	16.58	139.44
Nigeria	31	35.27	32.49	4.91	120.84
Zambia	31	118.24	78.68	17.89	233.73
Total Debt Service (Aggregate)	93	4.92	8.16	0.10	73.28
Ghana	31	4.09	2.59	0.81	9.67
Nigeria	31	2.39	2.13	0.10	6.52
Zambia	31	8.27	13.18	0.79	73.28
Primary Balance (Aggregate)	83	-0.58	4.29	-10.49	18.54
Ghana	31	-2.71	2.36	-10.49	1.23
Nigeria	31	1.51	4.33	-4.71	9.44
Zambia	21	-0.51	5.00	-6.69	18.54

Source: Author's calculations from IMF (2021) and World Bank (2021) data

[18] The aggregate is calculated from compiling the data of all three countries

4.2 Methodology

The primary tool used in assessing a country's debt stance is Debt Sustainability Analysis (DSA). This methodology assesses a country's future debt stance by evaluating its current debt level. DSA is conducted using baseline scenarios and sensitivity tests tailored to the country's circumstances for a thorough assessment of its debt. In order to perform a detailed DSA analysis, the methodology adopted involves the use of both deterministic debt projections and stochastic debt projections. Subsequently, different stylized debt relief packages are introduced into the models and evaluated based on their ability to stabilize debt in the long run. Our debt forecasts are derived through the evolution of the debt equation[19] as follows;

$$d_t = (1 + \gamma_t) d_{t-1} - p_t \tag{1}$$

Where, d_t is the debt-to-GDP ratio in year *t*, p_t is the primary balance in year *t*, and γ_t represents the growth adjusted interest rate in year *t.* Note that:

$$\gamma_t = \frac{r_t - g_t}{1 + g_t}$$

where, g_t refers to the real GDP growth rate in year *t*, and r_t the real interest rate in year *t.* By substituting the components determining the growth adjusted interest rate, we decompose the debt equation as follows:

$$d_t = \frac{1 + r_t}{1 + g_t} d_{t-1} - p_t \tag{2}$$

If we take the share of domestic and external debt into consideration, the debt equation becomes:

$$d_t = \alpha^{dm} \frac{1 + r_t}{1 + g_t} d_{t-1} + \alpha^{ex} \frac{1 + r_t}{1 + g_t} \frac{e_t}{e_{t-1}} d_{t-1} - p_t \tag{3}$$

Where, α^{dm} represents the share of domestic debt, α^{ex} is the share of external debt, and e_t refers to the real effective exchange rate at year *t.*

[19] See Escolano 2010 and Carone and Berti, 2014 for more details.

One might wonder why we include only these variables. Firstly, the debt dynamics equation (1) and (3) are fundamental relations in public finance. Thus, even though some other variables have historically been known to affect debt levels, such as foreign direct investment (FDI), political factors, or corruption index, the variables in our model can capture and reflect these factors. For example, if a country is politically unstable, this would increase the risk premium, thus increasing interest rates. So the interest rates we observed should already reflect this. Also, in the case of FDI, we know that it is an essential source of revenue to the government. As such, the high GDP growth rates we see in most of these developing economies already reflect the effects of FDI.

Moreover, the primary balance and interest rate should already reflect any political-economy effects. The channels through which these indices mentioned above affect the economy can be described in a model explaining primary balance, interest rates, growth rates, and exchange rates, but this is outside the scope of this research. Thus, adding other variables would add unnecessary complexities and invite overfitting to the model. Note that the debt dynamic described above is not limited to any particular approach to debt projections. Thus, the deterministic and stochastic methods rely on these equations for debt forecasts.

4.2.1 Deterministic Approach

In this method, the debt path is dependent on the assumptions made regarding the key macroeconomic variables that determine debt and the evolution of the debt equation. The baseline scenario under the deterministic approach relies on the assumption that the government's fiscal policy remains unchanged and the share of external and domestic debt is fixed at the current values. At the same time, the other non-fiscal variables were calculated based on the historical averages witnessed for each country. In this context, the primary balance remains constant at 2020 figures. The historical averages determine the growth rates, interest rates, and exchange rate values inputted into the debt equation. Sensitivity tests are carried out around the baseline scenario to assess the impact of pre-determined positive or negative shocks on the non-fiscal determinants of public debt. The application of this model is straightforward and has been useful to economists studying debt. However, since it relies on basic assumptions, it intrinsically affects the realism of debt forecasts and is not as useful as the stochastic approach when modeling uncertainty.

4.2.2 Stochastic Approach

Stochastic projections are used to model better the uncertainty in macroeconomic conditions affecting public debt. The common methodological approaches for stochastic debt projection involve the use of the historical variance-covariance matrix (di Giovanni and Gardner, 2008; Berti, 2013) or construction of the VAR model (Garcia and Rigobon, 2004; Medeiros, 2012). This study adopts the SVAR model as it is well adapted to multivariate analysis and forecasting. In addition, it is flexible, and unlike VAR, it can also quickly describe the collective dynamic behavior of the macroeconomic variables under study to structural shocks. In other words, it allows the modeling of the contemporaneous response among these variables through the construction of the structural impulse response function (SIRF).

Our SVAR model comprises a vector of 4 endogenous variables ($y_{1t}, y_{2t,}\, y_{3t,}\, y_{4t}$) representing the key macro-economic determinants of debt, namely, real GDP growth rate, primary balance, real interest rate, and real exchange rate, respectively. Following Sims (1986) and Kilian (2011), the SVAR(p) model takes the following form:

$$A_0 y_t = A_1 y_{t-1} + A_2 y_{t-2} + \cdots + A_p y_{t-p} + \epsilon_t \quad (4)$$

Where y_t is the vector of K variables (in this study K = 4), and $y_{t-1} \ldots y_{t-p}$ are the lagged variables. A_i is the K x K matrix of coefficients for the lags, with i ranging from 0 to p. p represents the number of lags specified in the model. ϵ_t represents K x 1 vector of residuals or innovations which are serially uncorrelated and have zero mean. Therefore, since the number of endogenous variables, K = 4 in this model, the variance-covariance matrix of ϵ_t, also referred to as the sigma matrix Σ_ϵ, can be represented in matrix form as;

$$\mathrm{E}(\epsilon_t \epsilon_t') = \Sigma_\epsilon = \begin{bmatrix} \sigma_1^2 & 0 & 0 & 0 \\ 0 & \sigma_2^2 & 0 & 0 \\ 0 & 0 & \sigma_3^2 & 0 \\ 0 & 0 & 0 & \sigma_4^2 \end{bmatrix}$$

The implication of this is that the number of shocks corresponds to the number of variables in the model. Given that structural shocks are mutually uncorrelated, it also implies that Σ_ϵ is diagonal

Σ_ϵ is then normalized such that its variance-covariance matrix,

$$\Sigma_\epsilon = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} = I_K$$

Equation (4) can be reduced to the form

$$A(L)y_t = \epsilon_t \tag{5}$$

where $A(L)$ represents an autoregressive lag order polynomial given that,

$$A(L) = A_0 - A_1 L - A_2 L^2 - \cdots - A_p L^p$$

By multiplying both sides of equation (4) by the inverse of A_0 (i.e. A_0^{-1}), and defining B_i as $A_0^{-1}A_1$ with i ranging from 1 to p, and u_t as $A_0^{-1}\epsilon_t$. u_t represents the error terms (orthogonalized shocks) of the reduced form VAR,

From here, the structural model can be derived as follows;

$$A_0^{-1}A_0 y_t = A_0^{-1}A_1 y_{t-1} + A_0^{-1}A_2 y_{t-2} + \cdots + A_0^{-1}A_p y_{t-p} + A_0^{-1}\epsilon_t \tag{6}$$

$$y_t = B_1 y_{t-1} + B_2 y_{t-2} + \cdots + B_p y_{t-p} + u_t \tag{7}$$

Again, equation (7) can be reduced to the form

$$B(L)y_t = u_t \tag{8}$$

where $B(L)$ represents an autoregressive lag order polynomial given that,

$$B(L) = I_K - B_1 L - B_2 L^2 - \cdots - B_p L^p$$

Where I_K is an identity matrix, and L is the lag operator. Notice that A_i represents the structural parameters, and their variance-covariance matrix of innovations is Σ_ϵ, while B_i represents the reduced form parameters and their variance-covariance matrix of error terms (orthogonalized shocks), Σ_u.

Since $A_0^{-1}A_1 = B_i$, we can estimate the structural form $A_1 = B_i A_0$. Using the same analogy,

$$A_1(L)y_t = A_0 B_i(L)\, y_t \tag{9}$$

Recall that $B(L)y_t = u_t$ and $u_t = A_0^{-1}\epsilon_t$, we substitute the representative form of $B(L)$ into equation (9), to get the final form of the SVAR model

$$A_1(L)y_t = A_0(I_K - B_1L - B_2L^2 - \cdots - B_pL^p)\, y_t = A_0u_t = B\epsilon_t \tag{10}$$

where ϵ_t is the K x 1 vector of structural innovations with variance-covariance matrix, I_K , u_t is the reduced form shocks with variance-covariance matrix Σ_u, L denotes the lag operator, A_0 represents the structural parameters, and B_i represents the reduced form parameters. The matrix of structural innovations is related to the matrix of error terms such that the orthogonalization matrix $P = B_i^{-1}A_0$ and thus

$$\Sigma_u = PP' \tag{11}$$

Next, we place short-run restrictions on the A_0 structural matrix and on the B_i reduced form matrix. These restrictions, also called "a priori" restrictions," are imposed based on economic theory. The most common type of restriction imposed is the zero restrictions which we use in this study. Other kinds of restrictions include sign restrictions and equality restrictions, amongst others. We impose zero restrictions on matrices such that A_0 is the lower triangular matrix having 1s on the diagonal while B is the diagonal matrix as given below

$$A = \begin{bmatrix} 1 & 0 & 0 & 0 \\ a_{21} & 1 & 0 & 0 \\ a_{31} & a_{32} & 1 & 0 \\ a_{41} & a_{42} & a_{43} & 1 \end{bmatrix} \; and \; B = \begin{bmatrix} b_{11} & 0 & 0 & 0 \\ 0 & b_{22} & 0 & 0 \\ 0 & 0 & b_{33} & 0 \\ 0 & 0 & 0 & b_{44} \end{bmatrix}$$

Given that we have two K x K matrices, $2K^2 - K(K+1)/2$ total constraints are placed on the AB matrix to obtain a precisely identified model. In other words, to avoid an identification problem that is a common issue in SVAR, twenty-two restrictions are necessary to derive a well-identified model. Thus our AB matrix has only *K(K +1)/2,* that is, ten free parameters. For this, $(K^2 - K)/2$, which is six parameters are estimated in the A matrix, and *K(K +1)/2* - $(K^2 - K)/2$, which is four parameters are estimated in the B matrix. Note that the number of AB parameters estimated is the same irrespective of the number of lags used in the model. The $(K^2 - K)/2$, i.e., six zero restrictions placed on the upper triangular side of the A matrix are the "priori restrictions." These restrictions are guided by economic literature. Following Garcia and Rigobon (2004); Neaime et al., (2018), we order the variables as follows; first, real interest rate, then the real GDP growth rate, followed by the primary balance, and lastly, the real exchange rate. The ordering of the variables in this manner implies that the real interest rate can only be contemporaneously affected by its own innovations. Therefore, the growth rates, primary balance, and interest rates do not affect interest rates in the same period. They are, however, able to affect interest after one period lag. Thus $a_{12},\ a_{13},\ a_{14} = 0$. Similarly, The real GDP growth rate is contemporaneously affected by interest rate shocks and shocks to itself but not by shocks in the primary balance or real exchange rate. Thus $a_{23},\ a_{24} = 0$. Likewise, the primary balance is contemporaneously affected by the shocks from the first two variables and itself but not by the real exchange rate, $a_{34} = 0$. In comparison, the real exchange rate is contemporaneously impacted by innovations coming from all four variables. However, before the parameters of the models are estimated, the lag order for each model is selected. The "varsoc" command in Stata is useful for this purpose (see Table B.1.2, B.2.2, and B.3.2 for each of the countries in appendix B).

We are particularly interested in forecasting the debt ratio in the long run (spanning 30 years). Thus to improve the forecast precision, the maximum lag is set to 4 since the time series is relatively short (31 observations). We obtain the optimal lag selection by using Akaike's

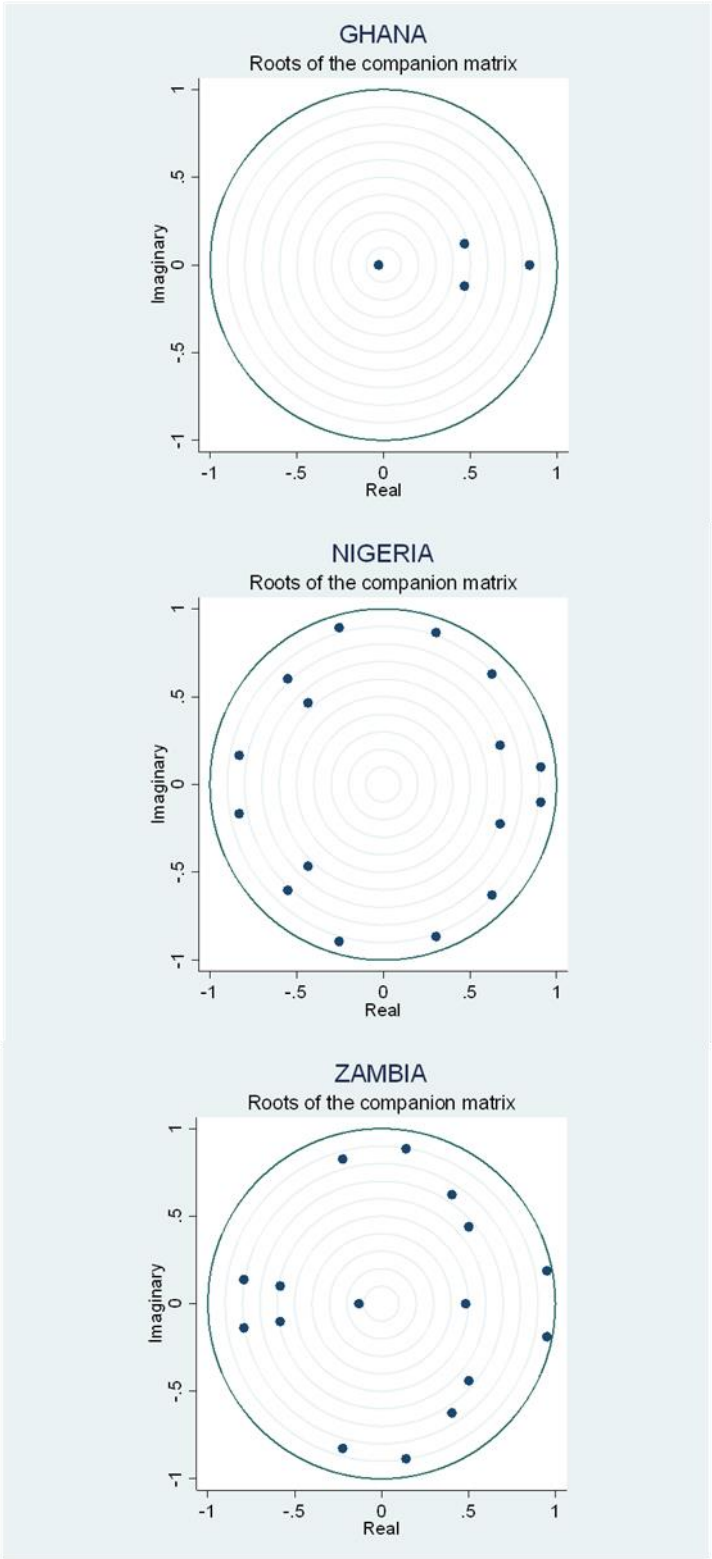
Information Criterion (AIC) and the Final Prediction Error (FPE), as they are well suited for fewer observations. In the case of a contradiction between the two, FPE is used as it outperforms AIC for small sample sizes and reduces the forecast error.

In time series modeling, stationarity is taken into account to avoid spurious results. Thus, we test the stability of the model by using the command "varstable" in Stata. The model is stable if all the unit-roots lie within the modulus of the companion matrix. In other words, the eigenvalues must be less than 1. In Figure 1 below, we see that the optimal SVAR model is stable for all the countries. Further tests such as the Lagrange Multiplier (LM) test for autocorrelation in the residuals[20] and Granger causality[21] tests are carried out after the model parameters estimation.

Using the SVAR estimates, forecasts for the four macroeconomic variables are projected for 2021-2050. Note that we do not need to derive SVAR estimates for domestic and external debt shares as these are kept constant at current figures (see Berti, 2013; 2014; European commission 2021). The projected public debt for the forecast horizon is then determined by introducing the estimates of the four variables, the domestic and external debt shares, and the previous debt level into the debt equation. Modifications are made to the model based on stylized debt relief packages, and new debt projections are drawn and assessed. Finally, we conducted a Structural Impulse Response Function (SIRF) exercise to assess the reaction of the macro-economic variables to one standard deviation of structural shock in each variable. The impulse response function for the debt level is also evaluated by applying the responses to the debt evolution equation (3).

[20] See Table B.1.5, B.2.5, and B.3.5 for the results of the LM test for Ghana, Nigeria, and Zambia respectively.
[21] See Table B.1.4, B.2.4, and B.3.4 for the results of the granger casuality test for Ghana, Nigeria, and Zambia respectively

Figure 1. Unit-roots graph of the companion matrix showing the stationarity of the SVAR model.



Source: Author's calculations from IMF (2021) and World Bank (2021) data.

5. Analysis and Results

We analyze the effect of three types of stylized debt packages reflecting past debt relief scenarios, such as the 25% and 80% partial external debt reduction under the Brady plan and HIPC initiative, full external debt cancellation under the MDRI, and debt standstill under the most recent DSSI. Hence, four specific relief packages are taken into account. The analysis is mainly conducted in two parts. The first part gives the results of debt projection from the deterministic approach. In contrast, the second part incorporates the results of debt projection from the stochastic process and the structural impulse responses.

5.1 Deterministic Debt Projections

The baseline scenario under the deterministic approach relies on the assumption that the government's fiscal policy remains unchanged. In this context, the primary balance remains constant at 2020 figures while the historical average is used for the non-fiscal determinants of the debt-to-GDP ratio. Interest-rate-growth-rate-differential (IRGD) sensitivity tests are carried out to see the effect of shocks on the interest rate or growth rate. A favorable (negative) interest-rate-growth-rate-differential shock occurs when there is a positive growth shock or negative interest rate shock, or a combination of both scenarios. The reverse is true for unfavorable (positive) interest-rate-growth-rate-differential shock. For this analysis, following the work of Turner & Spinelli (2013), a one-period shock of two percentage points is used to test the sensitivity of each country's debt dynamics to upside and downward risks in 2020. In Table 3, the IRGD is calculated by taking the difference between the average historical real GDP growth rate and real interest rate (r-g). Using the IRGD to derive the equivalent of $1 + \gamma_t$, Figure 2 is drawn by applying equation (3).

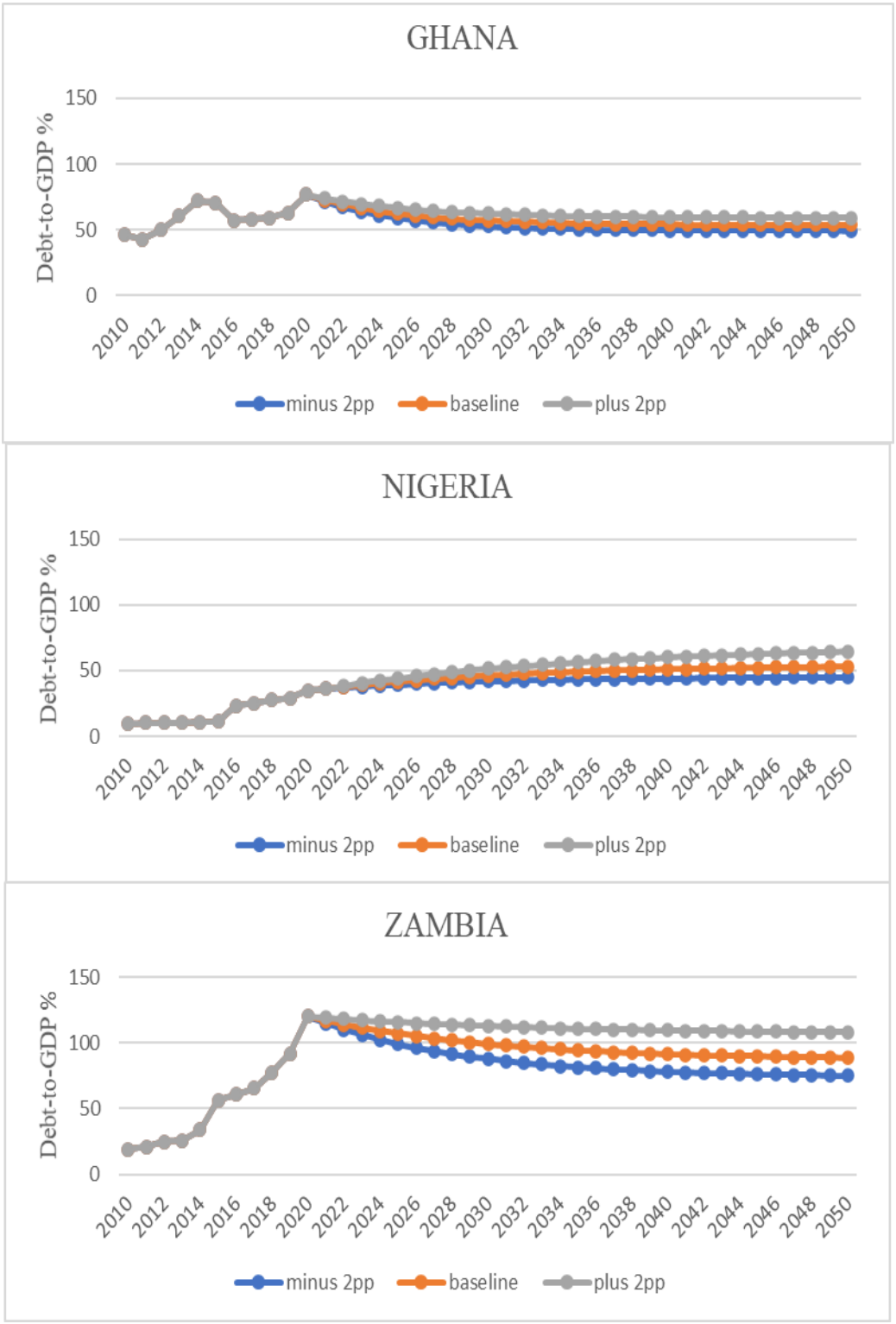
Table 3. Debt dynamics under the deterministic approach

Country	g	i	π	r	r-g	$\frac{1+r}{1+g}$	p	d_{t-1}	α^{dm}	α^{ex}	$\frac{e_t}{e_{t-1}}$
Ghana	6.3	3.2	17.2	-11.9	-18.2	82.8	-9.2	76.7	53	47	97
Nigeria	2.9	2.8	9.4	-6.0	-8.9	91.3	-4.7	35.0	62	38	102
Zambia	4.0	3.3	9.8	-5.9	-9.9	90.5	-8.3	120.0	55	45	97

Notes: The values are expressed in percentages where g stands for real GDP growth rate. i represents the nominal interest rate. Π stands for the inflation rate, r represents the real interest rate. p is the primary balance which is contant at 2020 figures. d_{t-1} is the previous year debt at time t. e_t represents the exchange rate at time t. The shares of domestic and external debt are denoted by α^{dm} and α^{dm} respectively. *Source:* Author's calculations from IMF (2021) and World Bank (2021) data.

From Figure 2, the debt dynamics of Nigeria and Zambia are more sensitive to interest-rate-growth-differential shocks compared with Ghana. The public debt ratio of Nigeria is on an increasing path, exceeding 40% in 2050 for all scenarios. The debt level in 2050 reaches 44% when there is 2pp favorable (negative) IRGD shock, 52% in the baseline case, and 64% when there is 2pp positive IRGD shock. On the other hand, the debt path of Ghana declines and eventually stabilizes in 2043 to approximately 49%, 54%, and 59% across the three scenarios. Similarly, the debt path of Zambia also declines and settles around 75%, 89%, and 108% in 2045. From here, we notice that the percentage change between the baseline scenario and the alternative shock scenarios is larger when there is an increase in r-g (9.25%, 23.08%, and 21.3% for Ghana, Nigeria, and Zambia, respectively) than when there is a decrease (9.25% for Ghana, 15.38% for Nigeria, and 15.75% for Zambia). This implies that debt rises more rapidly than it reduces. Note that other feedback effects might intensify these IRGD effects. For example, rising debt can adversely affect real GDP growth rates.

Figure 2. Deterministic debt projection with IRGD sensitivity tests of +/- 2 percentage points



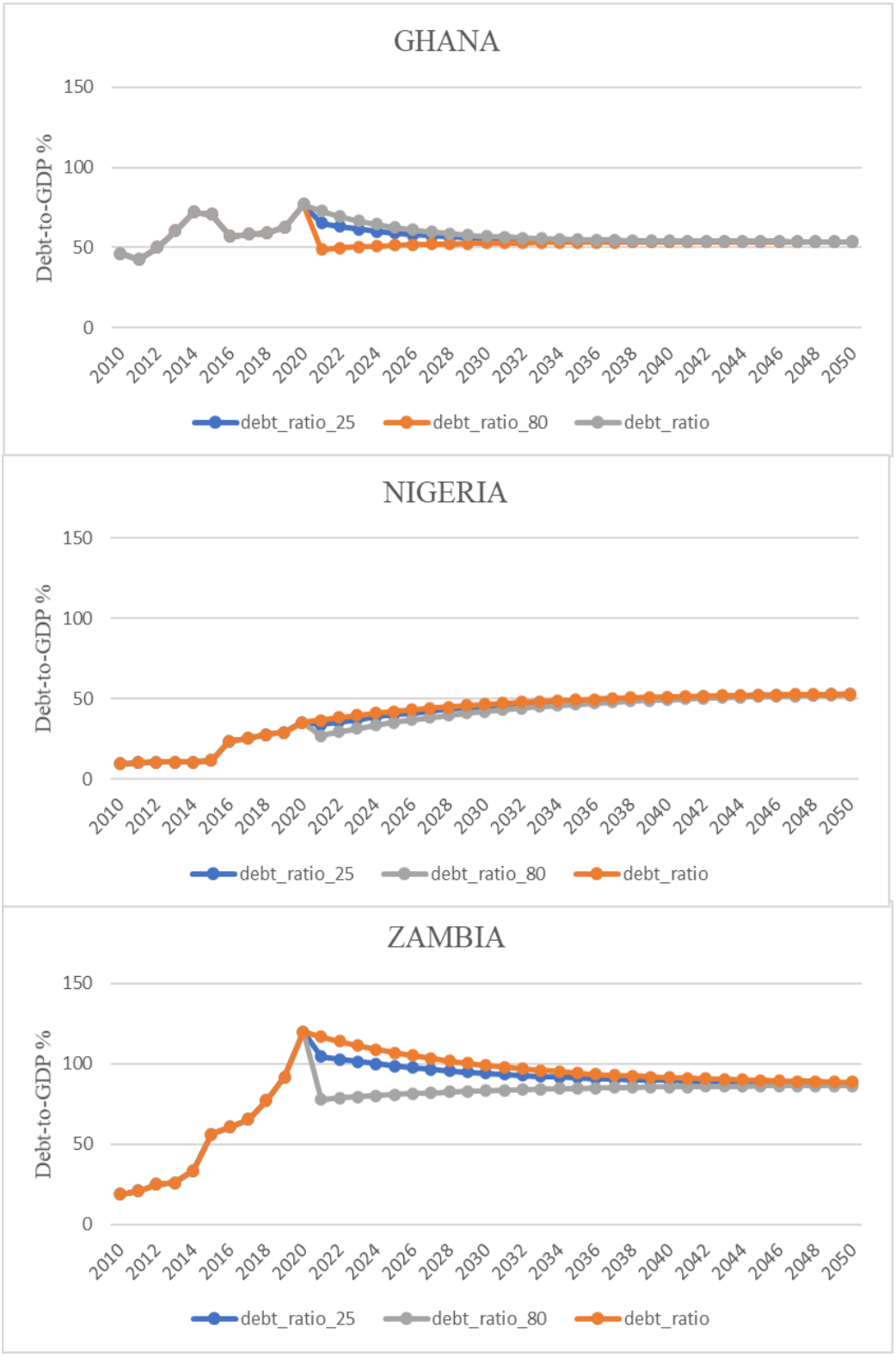
Note: In the baseline scenario, shocks are absent. The IRGD represents the interest rate growth differential (r-g). *Source:* Author's calculations from IMF (2021) and World Bank (2021) data.

Figure 3 shows the effect of 25% and 80% external debt reduction on the debt path. Since we assume that debt reduction occurs in 2021, we compute 2021 debt by considering that the previous year's (2020) external debt outstanding reduces to 75% and 20%, respectively. For Ghana, Nigeria, and Zambia, debt reduction provides only temporary alleviation of the debt burden. As a result, the debt level catches up with its previous path of about 54% by 2038 for Ghana, 53% by 2049 for Nigeria, and differs by only 1pp and 2pp (88% and 87% compared to 89% without debt reduction) in 2050 for Zambia. These results are valid under the assumption of no shocks, and they inform our view of fundamental debt dynamics.

Figure 4 considers the second stylized debt relief package of an outright cancellation in the external debt. In the year of the cancellation (2021), debt reduces to 42.87%, 24.52%, and 85% from 72.73%, 35%, and 120% for the respective countries. Again, we notice a convergence to the initial debt path. These results are not surprising as the debt ratio in the model is determined solely by the determinants of the debt and has no feedback effects. Hence, if there is only a change in debt level but no change in these determinants, then the path of debt remains the same and ultimately converges.

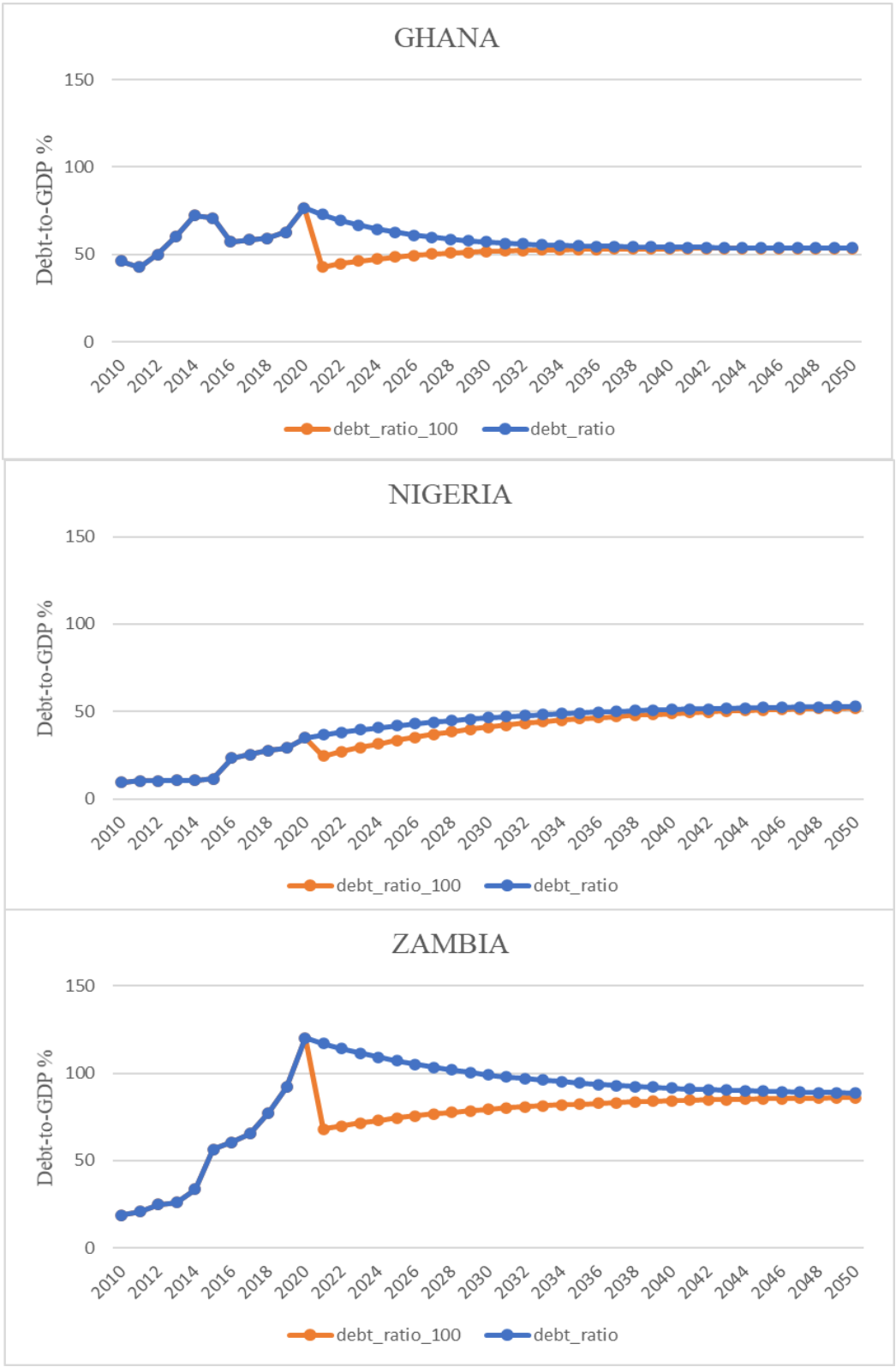
Lastly, Figure 5 shows the effect of a debt standstill. When a country benefits from a debt standstill, debt servicing is halted temporarily. Thus, in the scenario, since the DSSI is currently valid until the end of December 2021, we consider that in 2021, interest is not paid on the 2020 debt outstanding. Therefore, we get the real rate by setting the nominal interest rate to zero. We notice a minute decrease in 2021 debt levels which implies that no significant relief is derived from soft relief. This result is also in line with Reinhart and Trebesch (2016). In the next section, we make the picture richer but turning on many different shocks

Figure 3. Deterministic debt projection with partial external debt reduction of 25% and 80%



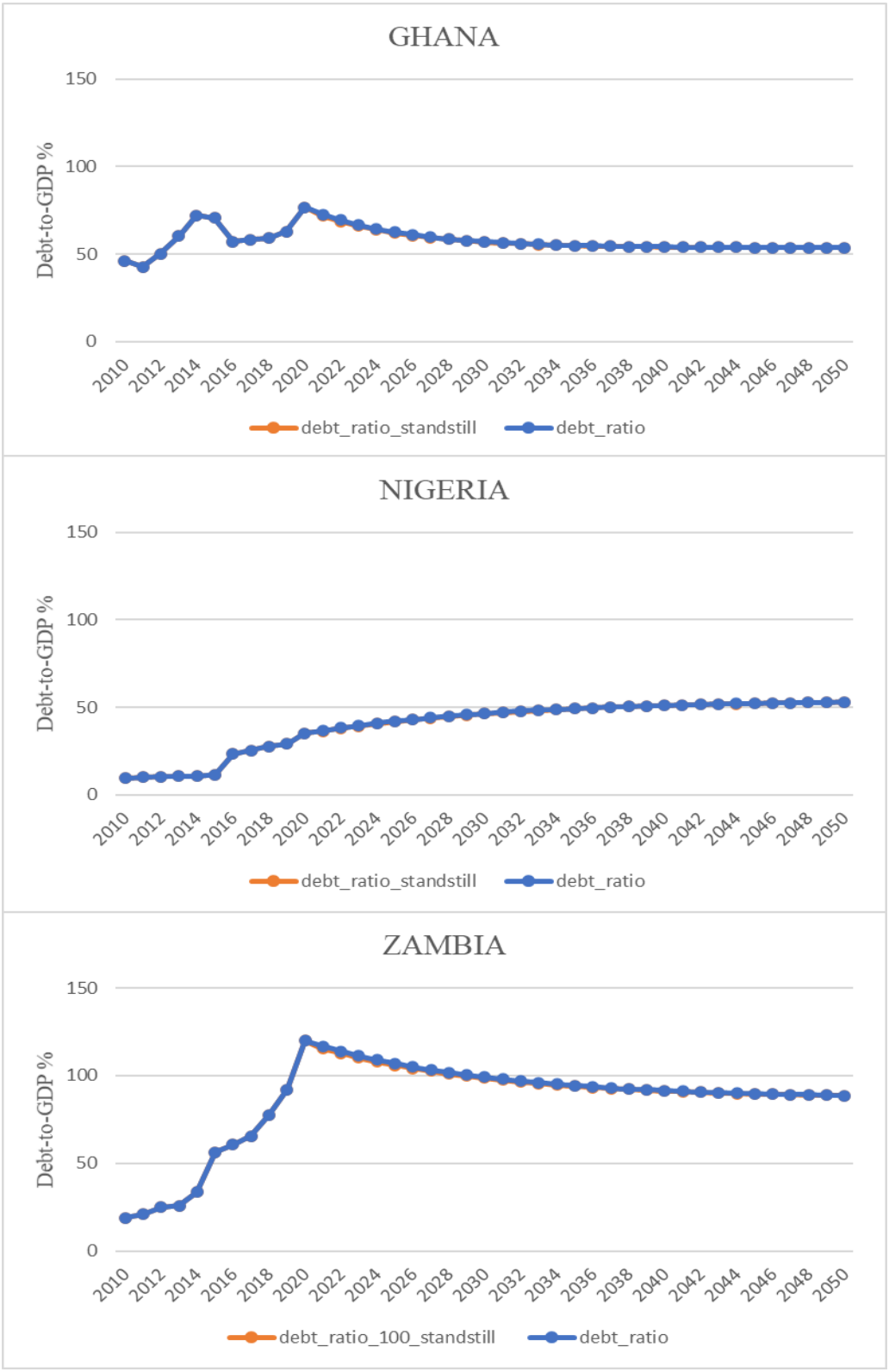
Source: Author's calculations from IMF (2021) and World Bank (2021) data.

Figure 4. Deterministic debt projection with full external debt cancellation



Source: Author's calculations from IMF (2021) and World Bank (2021) data.

Figure 5. Deterministic debt projection with debt standstill



Source: Author's calculations from IMF (2021) and World Bank (2021) data.

5.2 Stochastic Debt Projections and Impulse Responses

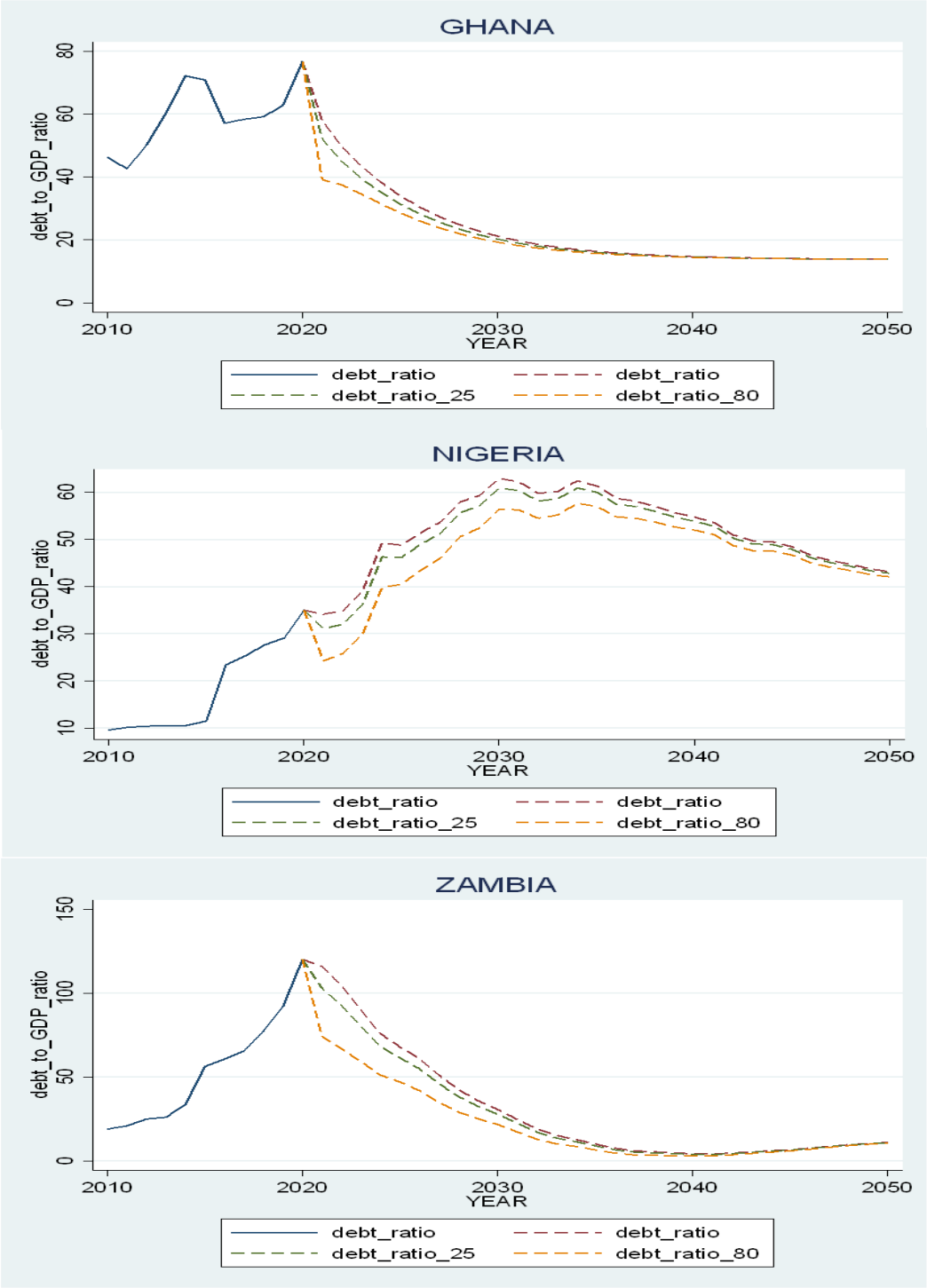
Unlike the deterministic approach, we do not assume a no-policy change scenario (constant primary balance) in the stochastic approach. We compute the forecast of the four determinants of debt through the SVAR model, which allows a dynamic interaction. From there, we project the long-run path of debt for all three stylized debt scenarios using equation (3).

In line with the deterministic projections, the dynamic forecasts show that Ghana's long-run debt path is declining (see Figure 6). Similarly, for Zambia, the debt level is on a declining path up until 2042, where the trend reverses to an increase. In contrast, Nigeria's debt path peaks in 2034 before switching to a downward trend. For Nigeria, the debt level increases from 35% in 2020 and peaks at 62.4% in 2034. We also notice a fall in the debt ratio to 43% in 2050, which is above its pre-pandemic state.

Furthermore, we consider a partial external debt reduction of 25% and 80% (see Figure 6) for all three countries. Similarly to the deterministic approach, we assume that the debt reduction takes place in 2021 and compute 2021 debt by considering that the previous year (2020) external debt outstanding is reduced by 25% or 80% to 75% or 20%. A 25% debt reduction of Nigeria's external debt position in 2021 leads to a 4pp decline in the overall debt burden, while an 80% external debt reduction leads to an 11pp decrease in the debt level. Nonetheless, the debt level almost converges to 42.8% and 42.04%, respectively, which differ by less than 1pp from the previous debt projection of 42.9%. Likewise, Ghana and Zambia's debt forecasts ultimately converge to their prior debt path after the reductions. Notice that there are no significant changes in the debt slope for all countries. This shows that debt relief does not decrease the debt burden in the long term.

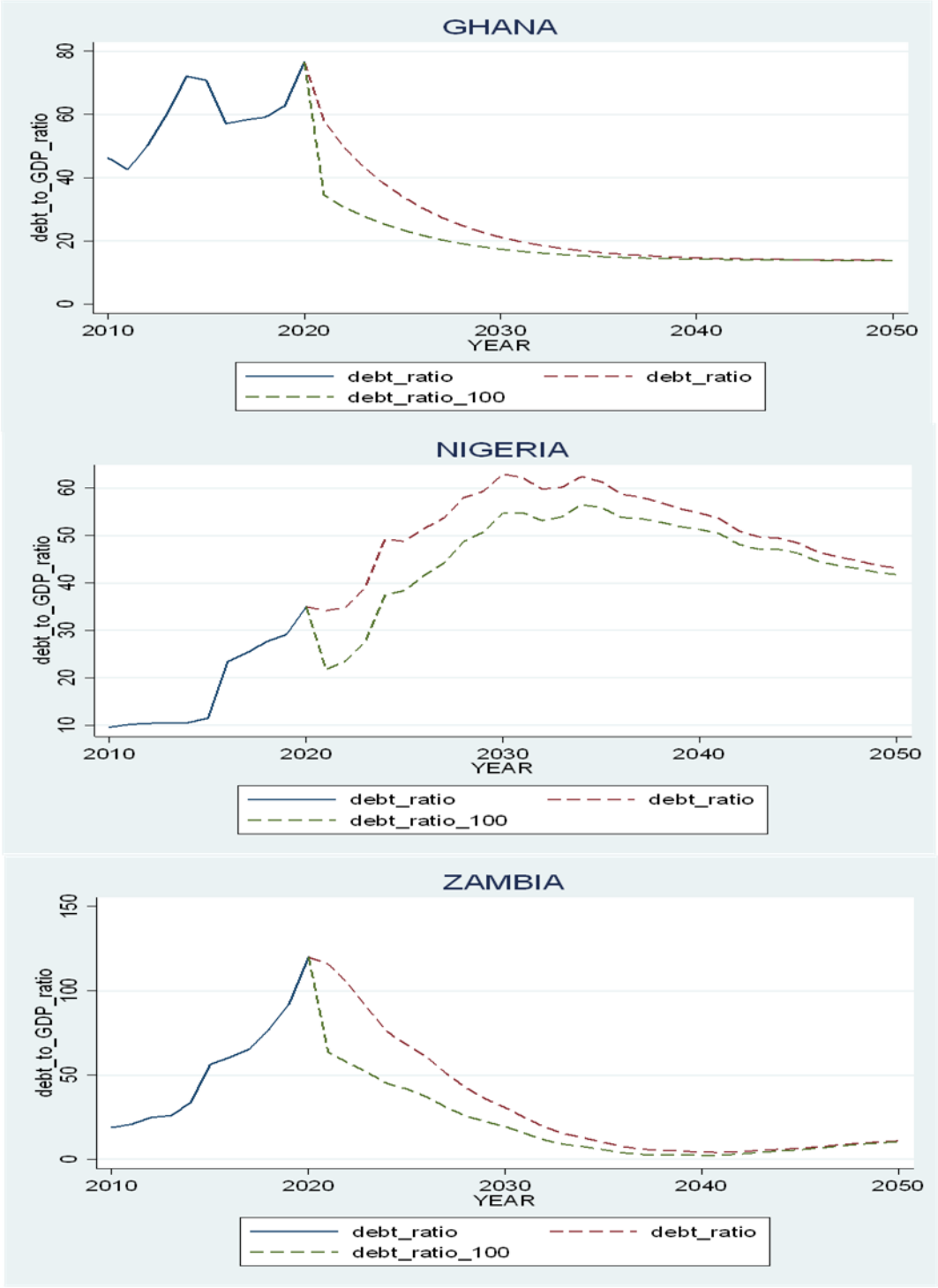
In the case of complete external debt cancellation (see Figure 7), we consider a 100% decrease in 2020 external debt outstanding when forecasting 2021 debt. We observed a significant drop in the first few years after the reduction. However, debt still catches up or almost reaches the initial debt path. Because debt relief alone is not sufficient, growth-friendly reforms are needed. Again, these results arise because we do not model the feedback effects but forecast debt based on the evolution of the debt equation.

Figure 6. Dynamic debt projections with 25% and 80% partial external debt reduction.



Note: The continuous lines are for actual debt ratio figures from 2010 until 2020, while the broken lines signify the debt ratio forecast for 2021 till 2050. *Source:* Author's calculations from IMF (2021) and World Bank (2021) data.

Figure 7. Dynamic debt projections with full external debt cancellation



Note: The continuous lines are for actual debt ratio figures from 2010 until 2020, while the broken lines signify the debt ratio forecast for 2021 till 2050. *Source:* Author's calculations from IMF (2021) and World Bank (2021) data.

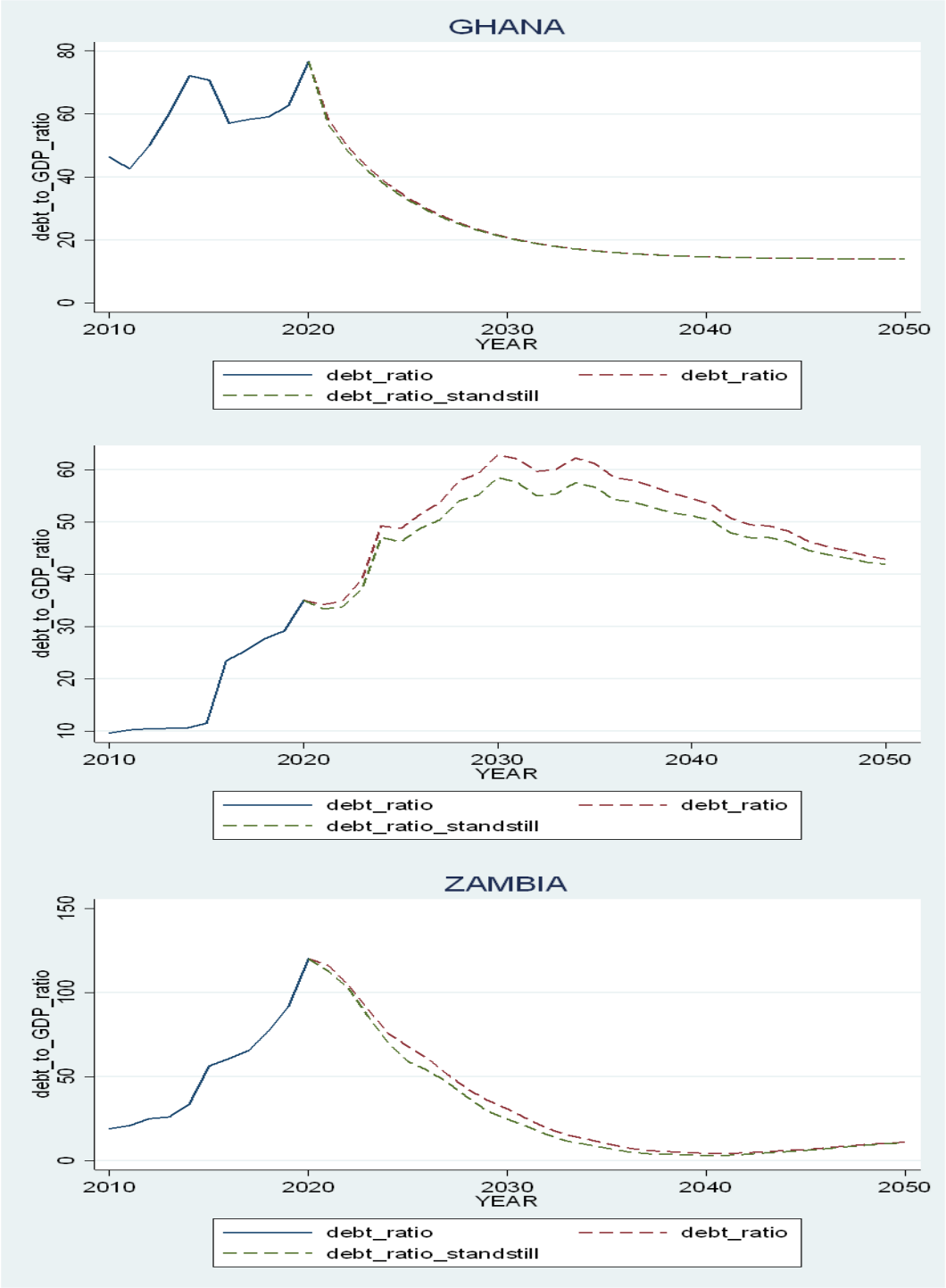
In the case of a debt standstill (see Figure 8), again, we consider that in 2021, interest is not paid on the 2020 debt outstanding. Therefore, we get the real rate by setting the nominal interest rate to zero. The results vary slightly for Nigeria compared to the rest as the long-run path is below the initial path. This may imply that interest rates play a larger role in the debt of Nigeria. Of course, this could be because large economies like Nigeria do not easily gain access to lower than market interest rates. A slight drop in interest rate can significantly affect its debt position. For Zambia and Ghana, the debt standstill has subtle effects in the early periods and no effect later. This shows that debt cancellation alone does not deter future debt accumulation. Since debt remains insufficient in all three stylized debt relief types, other macro-economic reforms such as growth reforms are needed.

Lastly, we measure the structural impulse response functions (SIRFs), which show the impacts of one standard deviation innovation (shocks) to an endogenous variable on another endogenous variable or on itself. Here, we also measure the effects of these shocks on the debt level by applying the debt evolution formula in equation (3) to indirectly assess the structural response of the debt ratio to a combination of responses gotten from the four macroeconomic variables. All five impulse responses are included in each plot. Individual impulse responses can be found in Figures B.1.2, B.2.2, and B.3.2 of appendix B for Ghana, Nigeria, and Zambia, respectively. Four plots for each country are shown to reflect the shocks coming from each of the four macro-economic determinants of debt.

When measuring SIRFs, the ordering of the variables must be guided by economic theory and literature. In line with Garcia and Rigobon (2004), we assume that the sequence is as follows; first, real interest rate, then the real GDP growth rate, followed by the primary balance, and the real exchange rate.

Figures 9 to 11 show the impulse response, where the first variable is hit by a shock (the impulse), which then propagates to the second variable (the response). For instance, “ir-gdpg” refers to the reaction of the GDP growth rate to one standard deviation increase in real interest rate.

Figure 8. Dynamic debt projections with debt standstill



Note: The continuous lines are for actual debt ratio figures from 2010 until 2020, while the broken lines signify the debt ratio forecast for 2021 till 2050. *Source:* Author's calculations from IMF (2021) and World Bank (2021) data.

As shown in Figure 9, an increase in Ghana's real interest rate lasts for around two periods. Also, an increase in the real interest rate decreases the real exchange rate (appreciation), which is in line with economic theory. It also has an increasing effect on the debt level, yet its impact is small and persists for more than ten periods. Other variables react only marginally to an interest rate shock. All variables return to their steady states before the 30^{th} period.

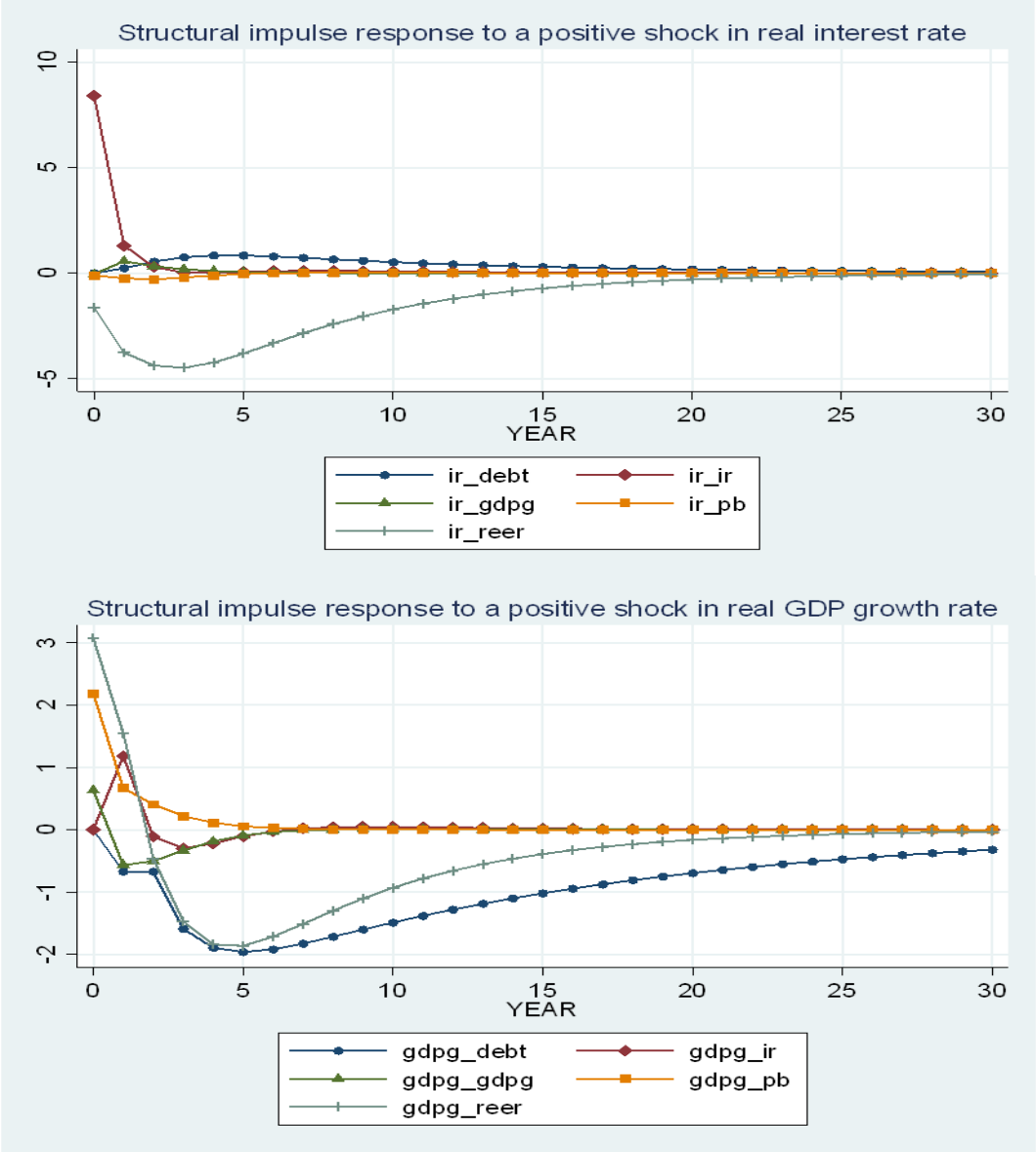
In line with economic theory, a one-time positive shock to Ghana's GDP growth rate permanently improves the debt level. It leads to a persistent appreciation in the real exchange rate after two periods. The primary balance responds positively to this increase while the interest rate increases in the next period and returns to its steady-state afterward.

Compared to the former shocks, one standard deviation shock to primary balance does not have as much effect on the other variables. It causes an appreciation in the real exchange in the same period. Still, later on, it leads to a depreciation in the same variable, and this behavior persists for a more extended period than seen in other variables. Debt level transitions from a decrease to an increase, but this lasts for a brief period. Primary balance and real interest rate react positively to this shock, while real GDP growth rate responds negatively to this shock. However, the real GDP growth rate decrease is slight and does not persist for long.

An increase in the real exchange rate (depreciation) persists for a long time and causes a tiny increase in debt and GDP growth rates. It also leads to an insignificant decrease in the real interest rate and has a near-zero impact on the primary balance. Since there are only minor impacts on the real interest rates and the real GDP growth rate, it is intuitive that the effect on the debt level is also marginal.

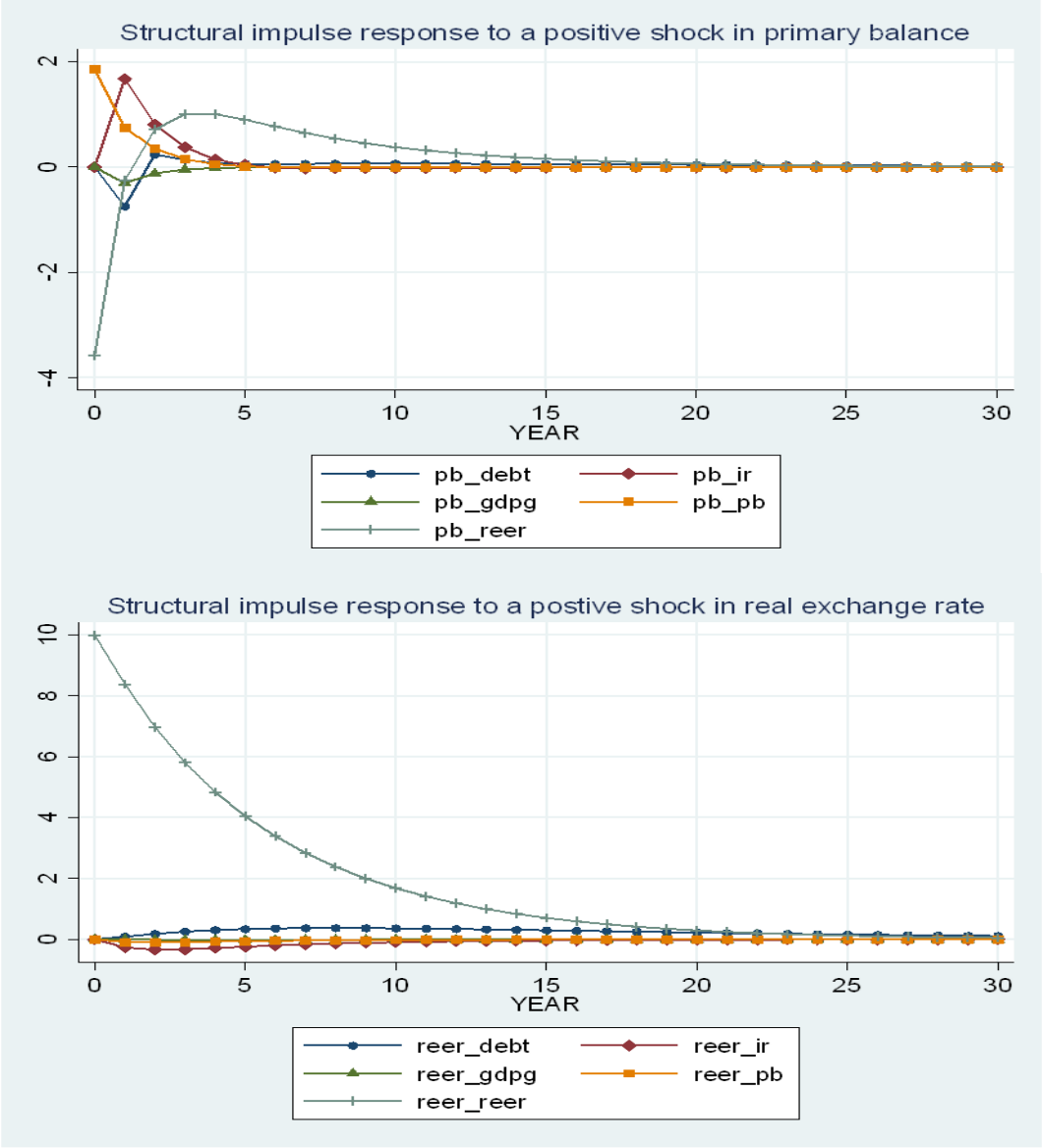
Considering the impulse responses to the four shocks, it is evident here that the Ghanaian economy responds most favorably to an increase in the real GDP growth rate. These results are similar to Garcia and Rigobon (2004) findings as their study also shows that a similar shock has an overall positive effect on the economy. Additionally, the most significant impact on all the variables and mostly the debt ratio comes from structural shocks to the real GDP growth rate. In contrast, their study shows that primary balance (deficit) has the greatest impact. The policy recommendation stemming from here is that growth-enhancing reforms could go a long way in solving the debt problem of this country.

Figure 9: Structural impulse response graph of Ghana's macro-economic determinants of debt and debt level



Note: the first variable is the impulse and the second is the response. Also, ir, gdpg, pb, reer, refers to the real effective interest rate, real GDP growth rate, primary balance, and real effective exchange rate, respectively. *Source:* Author's calculations from IMF (2021) and World Bank (2021) data.

Figure 9 continued: Structural impulse response graph of Ghana's macro-economic determinants of debt and debt level



Note: the first variable is the impulse and the second is the response. Also, ir, gdpg, pb, reer, refers to the real effective interest rate, real GDP growth rate, primary balance, and real effective exchange rate, respectively. *Source:* Author's calculations.

Figure 10 gives an overview of the structural impulse responses of the variables to shocks in the endogenous variables that affect the Nigerian economy. As expected, an innovation in the interest rate causes a significant permanent increase in the debt to GDP ratio. The real exchange rate initially responds to the shock by an increase (depreciation), followed by a decrease and subsequent increase in the later periods. However, the impact on real exchange is less than the effect on the debt ratio. The interest rate response to its innovation is positive but not significant. Likewise, the primary balance and real GDP growth rate reaction is adverse. All this aligns with economic theory, as an increase in the interest rate charged on debt negatively affects the economy.

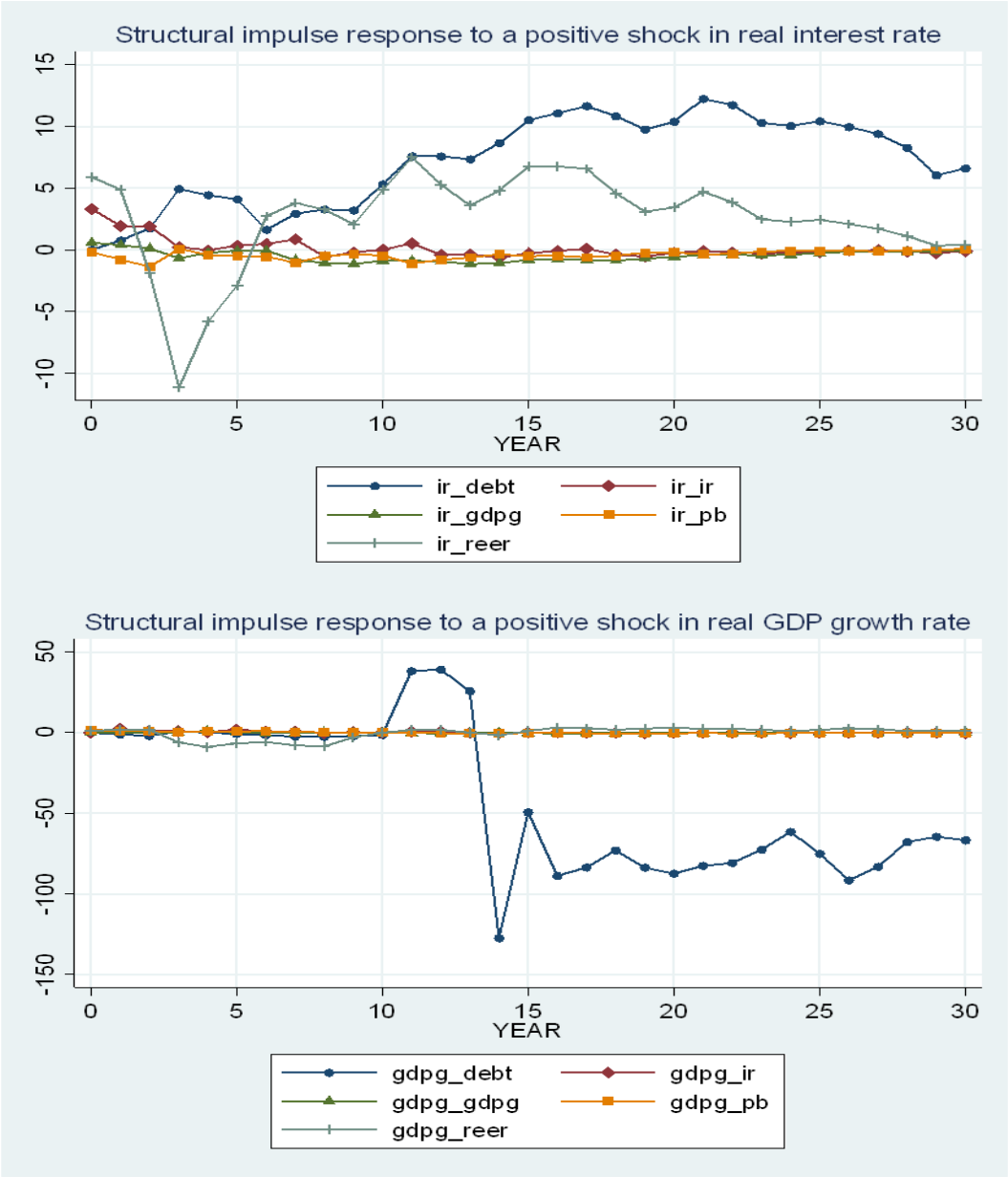
The reaction of the debt-to-GDP ratio to one standard deviation in the real GDP growth rate is much higher and negative in the later periods than in the first few periods. This decrease in the debt level remains permanent. On the other hand, the real GDP growth rate responds to its own shock by increasing and later reducing before returning to its steady state. The corresponding effect on this shock also increases the real interest rate and primary balance. The exchange rate declines as expected. As it turns out, the positive results cancel out the negative effect, and the debt level shows a highly significant decrease due to this structural shock.

Following a positive shock in the primary balance is a corresponding increase in the primary balance, a rise in the interest rate, and a decline in the real GDP growth rate. The real exchange rate appreciates significantly, but the effect is transitory. At first, the debt level declines, and then it wavers throughout the periods. We observe that all the variables are close to their steady-state after 30 years.

An increase in the real exchange rate leads to a significant and permanent rise in the debt level, an increase in the real interest rate, a reduction in the primary balance, and a real GDP growth rate reduction. The real exchange rate response to its own innovation is primarily positive. All these are in line with prior economic beliefs and theories.

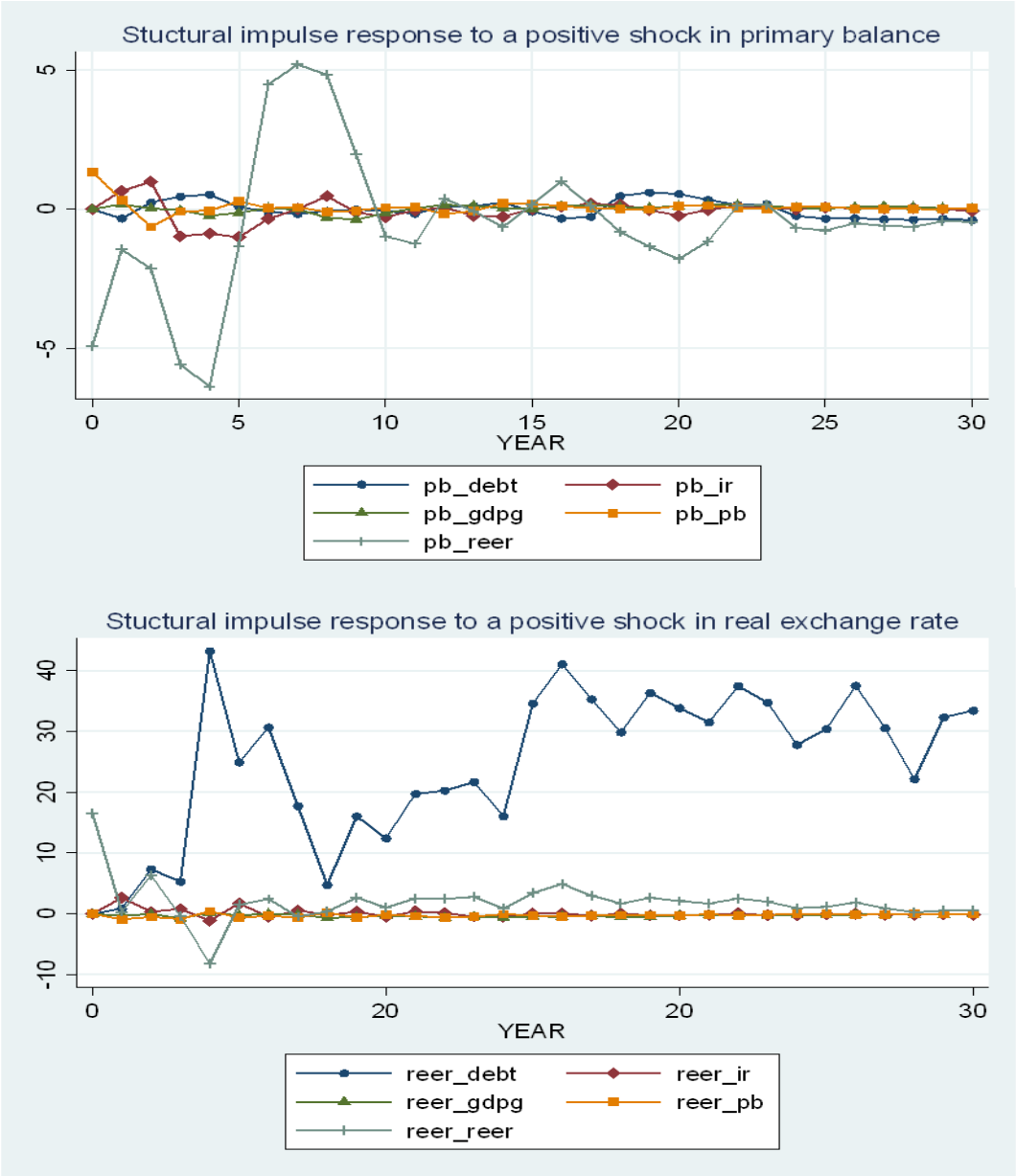
In all, the debt level is heavily impacted by a shock to the real GDP growth rate and also by shocks to the real exchange rate. The former is favorable to the Nigerian economy, while the latter is quite harmful to the economy.

Figure 10: Structural impulse response graph of Nigeria's macro-economic determinants of debt and debt level.



Note: the first parameter is the impulse and the second is the response. Also, ir, gdpg, pb, reer, refers to the real effective interest rate, real GDP growth rate, primary balance, and real effective exchange rate, respectively. *Source:* Author's calculations from IMF (2021) and World Bank (2021) data.

Figure 10 continued: Structural impulse response graph of Nigeria's macro-economic determinants of debt and debt level.



Note: the first parameter is the impulse and the second is the response. Also, ir, gdpg, pb, reer, refers to the real effective interest rate, real GDP growth rate, primary balance, and real effective exchange rate, respectively. *Source:* Author's calculations from IMF (2021) and World Bank (2021) data.

Finally, we show the impulse response graphs for Zambia in Figure 11. Surprisingly, a one-time increase to the real interest rate causes a decline in the debt level, contrasting with economic theory. However, we notice that this decrease is not permanent, and eventually, the debt ratio rises after the 7^{th} period. We also see that this shock increases the real interest rate, the real GDP growth rate, and the real exchange rate. The primary balance responds to this shock by declining. However, this decline is transitory.

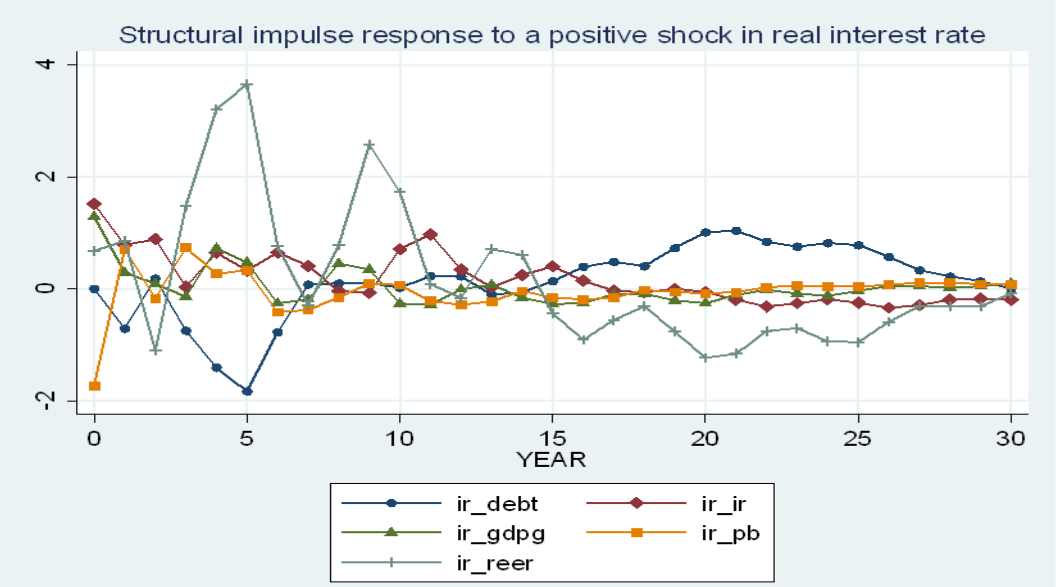
A positive shock in the growth rate creates an initial appreciation in the real exchange rate and eventually a depreciation in later periods. Similarly, the debt ratio responds to this one-time shock by a decline and later an increase. The primary balance and growth rate rise marginally due to this shock, while the interest rate does not react when the initial shock occurs.

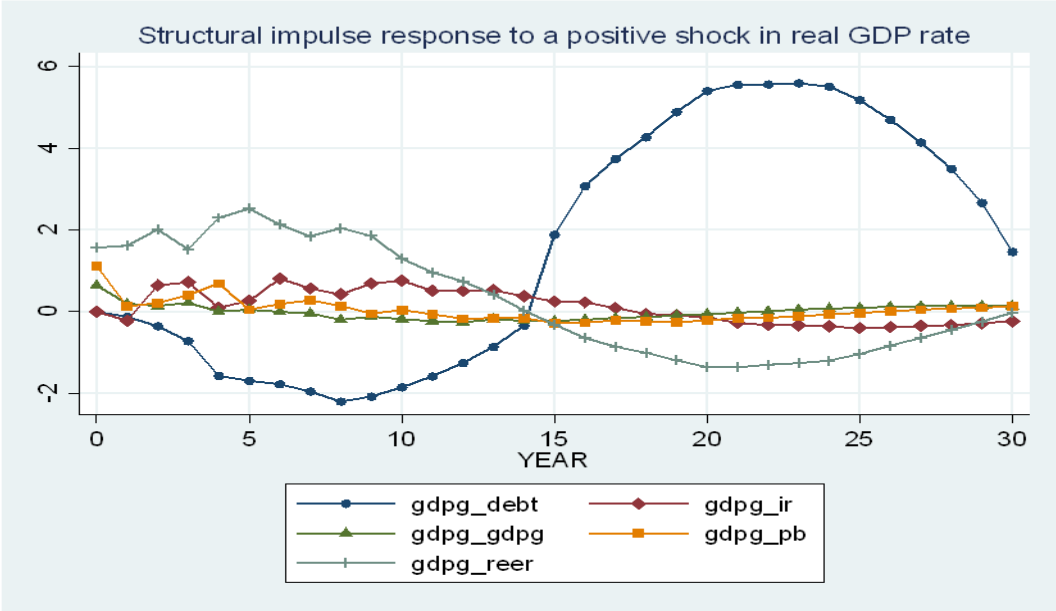
An increase in the primary balance causes a significant rise in the debt level in the latter periods, which contrasts with economic theory. The shock to the primary balance leads to a corresponding increase in primary balance, growth rate, and real exchange rate. Asides from the debt level, all the endogeneous variables remain close to their steady-state. Similar to the Ghanaian and Nigerian data, increasing the real exchange rate raises the debt level. On the other hand, a shock to the real exchange rate increases primary balance and interest rates.

Overall, the debt level is heavily impacted by a shock to the real GDP growth rate, primary balance (in later periods), and real exchange rate. While positive shocks to growth rates are favorable to the Zambian economy, the increase in exchange rates has opposite effects.

In general, we see that positive shocks to the real GDP growth rate reduce debt levels significantly across all three countries. This common phenomenon implies that the GDP growth rates play a vital role in debt reduction and suggests the necessity of growth reforms.

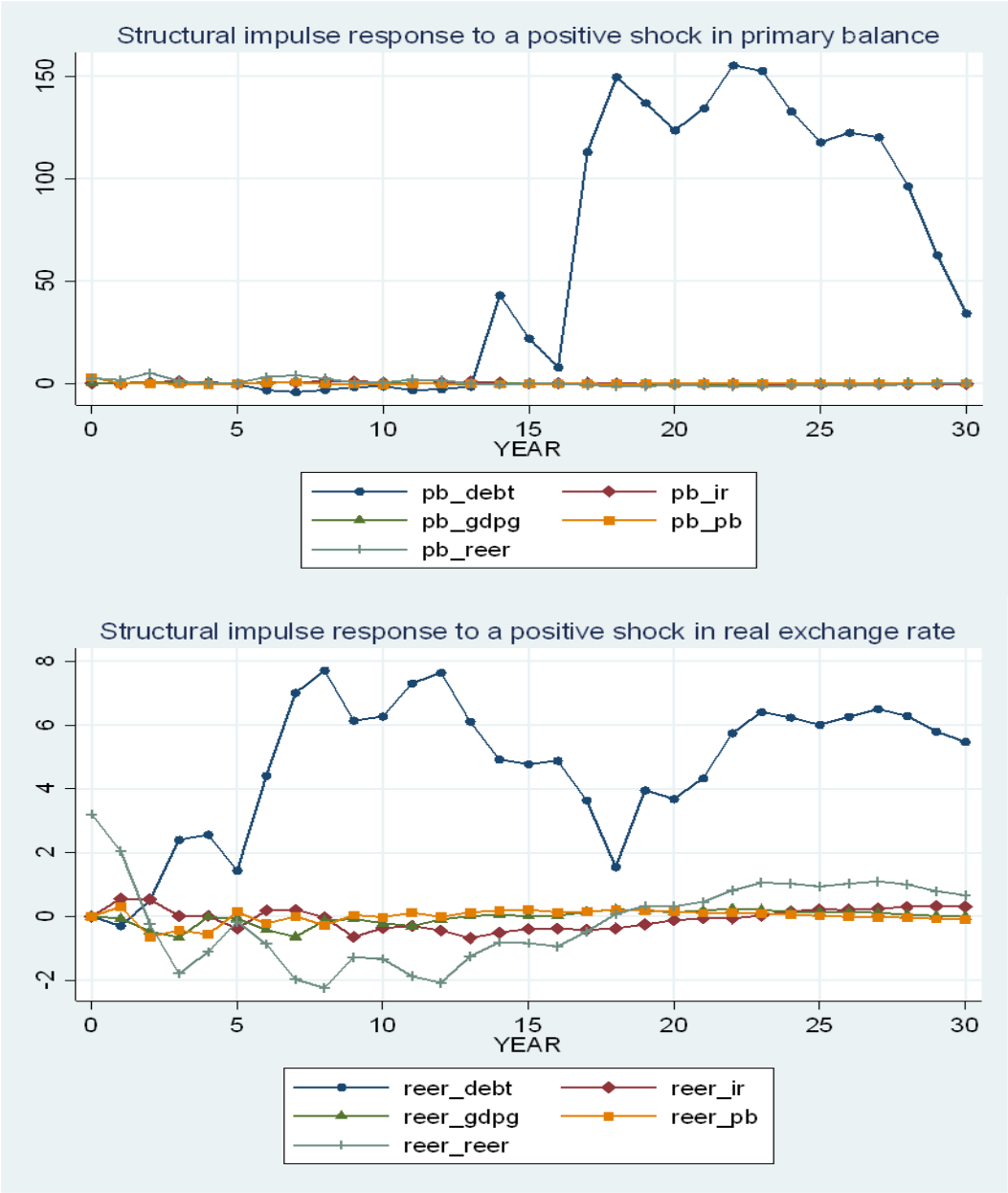
Figure 11: Structural impulse response graph of Zambia's macro-economic determinants of debt and debt level.





Notes: the first parameter is the impulse and the second is the response. Also, ir, gdpg, pb, reer, refers to the real effective interest rate, real GDP growth rate, primary balance, and real effective exchange rate, respectively. *Source:* Author's calculations from IMF (2021) and World Bank (2021) data.

Figure 11 continued: Structural impulse response graph of Zambia's macro-economic determinants of debt and debt level.



Notes: the first parameter is the impulse and the second is the response. Also, ir, gdpg, pb, reer, refers to the real effective interest rate, real GDP growth rate, primary balance, and real effective exchange rate, respectively. *Source:* Author's calculations from IMF (2021) and World Bank (2021) data.

6. Conclusions and Policy Recommendations

Rising debt accumulation and the growing concern that sub-Saharan countries are at risk of another debt crisis with similar magnitude as the 1980's debt crises gave rise to this research. This study was conducted to determine whether debt relief is enough to resolve the debt problem in Sub-Saharan Africa. Unlike previous studies analyzing past effects of debt relief, this research looks at the future effects of stylized debt relief through a deterministic and stochastic debt projection. The results from both the deterministic and stochastic approaches to debt projection show that regardless of the debt relief package employed, only temporary relief is achieved. It does not deter the debt accumulation process as the debt-to-GDP ratio eventually caught up with the pre-relief path for all countries. We also observe that the debt path does not change significantly after a debt reduction and standstill, which shows that debt cancellation alone does not necessarily deter future debt accumulation.

In addition to these projections, we also examine the structural impulse responses of the debt level to a shock (increase) in the endogenous variables. We notice that for most of the countries assessed, a shock to the real GDP growth rate has the most significant impact on the debt level, and it has permanent positive effects on the economy. Given that real GDP growth rate and public debt are negatively correlated, it would be highly beneficial if macro-economic policies encouraging real GDP growth rate are utilized rather than relying solely on debt relief packages.

The policy recommendation stemming from this is that growth reforms and policies that expand the tax base can improve public finances, thereby lowering the debt trajectory. This can be done by expanding the tax base to bring more of the informal sector into the formal (taxable) sector. Another way to achieve this is to increase the taxes of high-income earners and corporations. However, as this might lead to some adverse effects on the economy, care should be given to ensure that the tax increase is moderate and should be implemented when there is a significant recovery from the COVID-19 economic crisis (IFS, 2021). Also, the introduction of property taxes can be efficient since it is not yet practiced in this region and could significantly increase revenues. Windfall tax on wealth or inheritance could also prove to be helpful. In addition to this, diversification of exports could boost revenues and solve the problem of over-reliance on a single

commodity like oil. Exporters' tax incentives can also help to stimulate exports and boost local demand.

Furthermore, greater currency flexibility would help manage external shocks as it removes the additional pressure on the federal reserve and provides more fiscal space to tackle economic shocks. Also, considering the rate of capital flight in these countries, the government should look deeply into the channels of illicit capital outflows like the banking sector, other financial institutions, and crypto trading platforms where massive monetary transfers have occurred over the years.

The analysis can be improved with quarterly data, which was largely unavailable. Since annual data is used, the number of observations could have been larger if shorter frequency data had been used. Secondly, the interest rate on debt is much lower than expected. This is because it is calculated in terms of interest payments on previous debt outstanding, which differs in reality from the actual interest rate charged and is subject to transparency or reporting bias. Also, other stylized debt relief packages that affect nominal interest rates, such as interest waivers or interest ceilings, can be added to future studies. In addition to these, future studies can incorporate a model where future debt forecast is not only dependent on the interaction between the macro-economic determinants of debt and its past debt, but also considers the likely feedback effects of debt values on those determinants. Lastly, future research can be done by deep diving into countries' creditor profiles for a richer analysis.

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Appendices

Appendix A. Acronyms

AIC	Akaike's Information Criterion
DSF	Debt Sustainability Framework
DSSI	Debt Service Suspension Initiative
FDI	Foreign Direct Investment
FPE	Final Prediction Error
GDP	Gross Domestic Product
GFC	Global Financial Crisis

GNI	Gross Domestic Income
HIPCs	Heavily Indebted Poor Countries
IBRD	International Bank for Reconstruction and Development
ICSID	International Centre for Settlement of Investment Disputes
IDA	International Development Association
IDS	International Debt Statistics (World Bank)
IFS	Institute of Fiscal studies
IFS*	International Financial Statistics (IMF)
IIF	Institute of International Finance
IMF	International Monetary fund
IRGD	Interest-rate-growth-rate-differential (r-g)
LM	Lagrange Multiplier
MDGs	Millennium Development Goals
MDRI	Multilateral Debt Relief Initiative
MIGA	Multilateral Investment Guarantee Agency
REER	Real Effective Exchange Rate
PRSP	Poverty Reduction Strategy Paper
SBIC	Schwartz Bayesian information criteria
SIRF	Structural Impulse Response Function
SSA	Sub-Saharan Africa
SVAR	Structural Auto-Regressive
UN	United Nations
VAR	Vector Autoregressive

Appendix B. Country Specific Tables and Figures

B.1 Ghana

Table B.1.1: Correlation matrix of the debt-to-GDP ratio and its macro-economic determinants

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. corr gdp pb reer ir debt
(obs=31)
```

	gdpg	pb	reer	ir	debt
gdpg	1.0000				
pb	0.0085	1.0000			
reer	-0.1050	-0.0175	1.0000		
ir	0.0565	-0.0293	-0.2437	1.0000	
debt	-0.3942	0.0722	-0.2753	-0.0106	1.0000

Note: gdpg, pb, reer, ir, and debt, refer to the real GDP growth rate, primary balance, real effective exchange rate, real effective interest rate, and debt ratio, respectively. *Source:* Author's calculations.

Table B.1.2: Optimal SVAR(p) lag selection

```
Selection-order criteria
Sample:  1994 - 2020                        Number of obs      =        27
```

lag	LL	LR	df	p	FPE	AIC	HQIC	SBIC
0	-345.324				2.0e+06	25.8759	25.933	26.0679
1	-313.689	63.27	16	0.000	649207*	24.7177*	25.0031*	25.6776*
2	-304.648	18.082	16	0.319	1.2e+06	25.2332	25.747	26.961
3	-290.165	28.966	16	0.024	1.7e+06	25.3456	26.0877	27.8413
4	-270.748	38.835*	16	0.001	2.3e+06	25.0924	26.0628	28.356

```
Endogenous:  ir gdpg pb reer
 Exogenous:  _cons
```

Note: LL is the log-likelihood, LR refers to the likelihood ratio, df is the degrees of freedom, p is the p-value, FPE refers to the final prediction error, AIC refers to Akaike's information criteria, HQIC is Hannan and Quinn information criteria, and SBIC refers to Schwarz's Bayesian information criteria. *Source:* Author's calculations.

Table B.1.3: Short-run parameters estimates of the Structural Vector Autoregression model

Sample: 1991 - 2020 Number of obs = 30
Exactly identified model Log likelihood = -345.2998

	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
/a_1_1	1	(constrained)				
/a_2_1	.0050757	.0474819	0.11	0.915	-.0879871	.0981385
/a_3_1	.0117962	.0403028	0.29	0.770	-.0671959	.0907883
/a_4_1	.2085122	.2172079	0.96	0.337	-.2172074	.6342318
/a_1_2	0	(constrained)				
/a_2_2	1	(constrained)				
/a_3_2	-.289361	.1549403	-1.87	0.062	-.5930383	.0143163
/a_4_2	-1.964504	.8809836	-2.23	0.026	-3.6912	-.2378082
/a_1_3	0	(constrained)				
/a_2_3	0	(constrained)				
/a_3_3	1	(constrained)				
/a_4_3	1.926158	.9825627	1.96	0.050	.0003701	3.851945
/a_1_4	0	(constrained)				
/a_2_4	0	(constrained)				
/a_3_4	0	(constrained)				
/a_4_4	1	(constrained)				
/b_1_1	8.414639	1.086325	7.75	0.000	6.285481	10.5438
/b_2_1	0	(constrained)				
/b_3_1	0	(constrained)				
/b_4_1	0	(constrained)				
/b_1_2	0	(constrained)				
/b_2_2	2.188387	.2825195	7.75	0.000	1.634659	2.742115
/b_3_2	0	(constrained)				
/b_4_2	0	(constrained)				
/b_1_3	0	(constrained)				
/b_2_3	0	(constrained)				
/b_3_3	1.857158	.2397581	7.75	0.000	1.387241	2.327076
/b_4_3	0	(constrained)				
/b_1_4	0	(constrained)				
/b_2_4	0	(constrained)				
/b_3_4	0	(constrained)				
/b_4_4	9.994701	1.29031	7.75	0.000	7.465739	12.52366

Source: Author's calculations.

Table B.1.4: Results of Granger causality test between the dependent variables and the corresponding independent variables.

Granger causality Wald tests

Equation	Excluded	chi2	df	Prob > chi2
ir	gdpg	.22165	1	0.638
ir	pb	.89812	1	0.343
ir	reer	.20388	1	0.652
ir	ALL	1.49	3	0.685
gdpg	ir	1.9513	1	0.162
gdpg	pb	.49945	1	0.480
gdpg	reer	.0014	1	0.970
gdpg	ALL	2.1989	3	0.532
pb	ir	.37871	1	0.538
pb	gdpg	4.7124	1	0.030
pb	reer	.42412	1	0.515
pb	ALL	5.6505	3	0.130
reer	ir	1.2166	1	0.270
reer	gdpg	.92448	1	0.336
reer	pb	1.5324	1	0.216
reer	ALL	4.8137	3	0.186

Source: Author's calculations.

Table B.1.5: Results of Lagrange multiplier test for autocorrelation in residuals

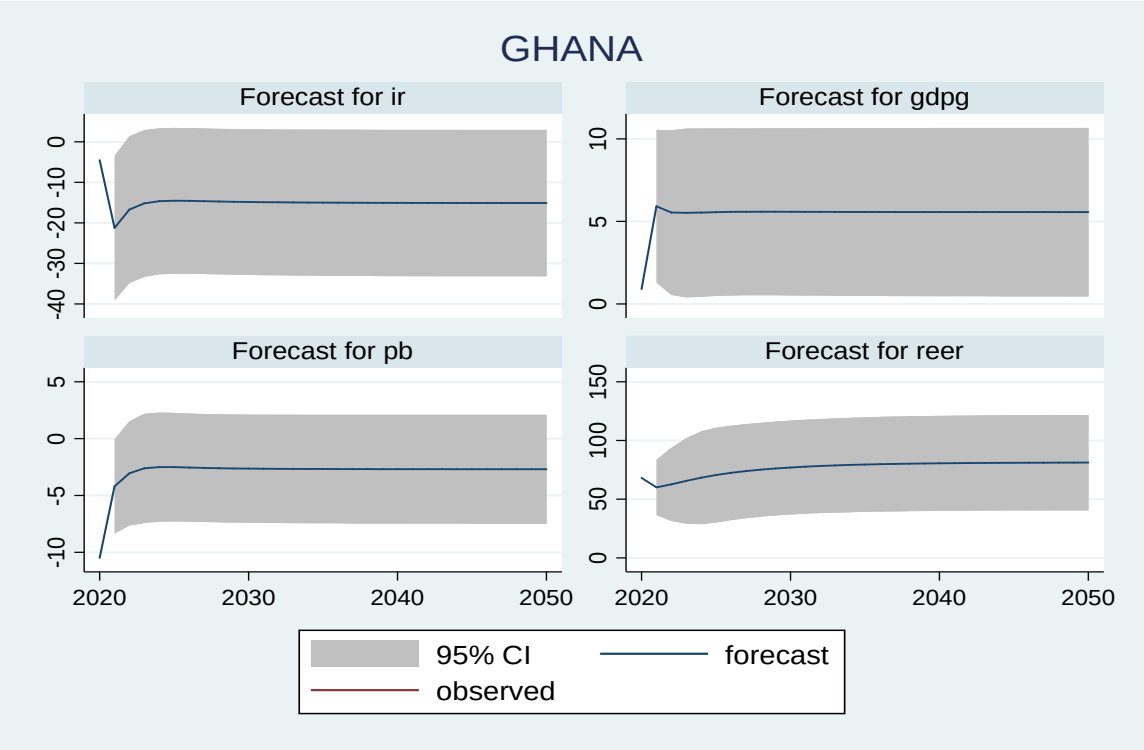
Lagrange-multiplier test

lag	chi2	df	Prob > chi2
1	12.3788	16	0.71752
2	12.8387	16	0.68451

H0: no autocorrelation at lag order

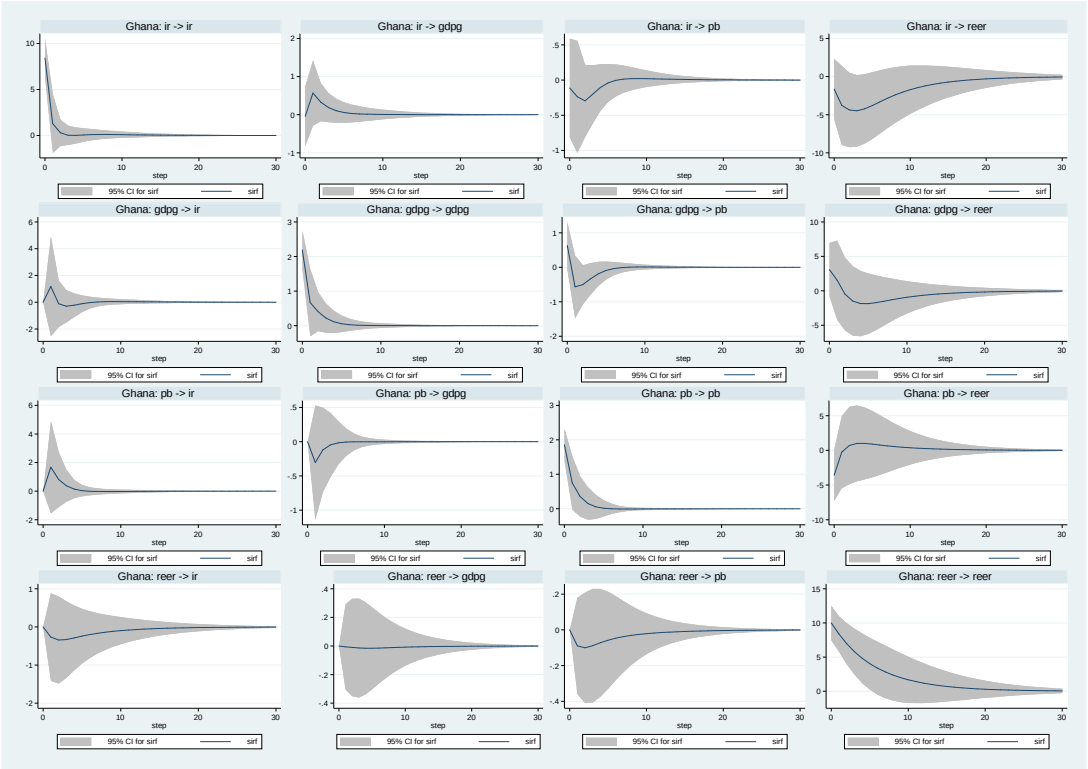
Source: Author's calculations.

Figure B.1.1: SVAR Stochastic forecast of the macro-economic determinants of debt.



Note: ir, gdpg, pb, reer, refers to the real effective interest rate, real GDP growth rate, primary balance, and real effective exchange rate, respectively. *Source:* Author's calculations.

Figure B.1.2: Structural impulse response graph of the macro-economic determinants of debt at 95% confidence interval.



Note: the first parameter is the country, the second is the impulse, and the third is the response. Also note that, ir, gdpg, pb, reer, refers to the real effective interest rate, real GDP growth rate, primary balance, and real effective exchange rate, respectively. *Source:* Author's calculations.

B.2 Nigeria

Table B.2.1: Correlation matrix of the debt-to-GDP ratio and its macro-economic determinants

```
. corr gdp pb reer ir debt
(obs=31)
```

	gdpg	pb	reer	ir	debt
gdpg	1.0000				
pb	0.3327	1.0000			
reer	-0.1955	-0.1628	1.0000		
ir	0.2335	-0.4111	0.1272	1.0000	
debt	-0.3613	0.1906	-0.0765	-0.5584	1.0000

Note: gdpg, pb, reer, ir, and debt, refer to the real GDP growth rate, primary balance, real effective exchange rate, real effective interest rate, and debt ratio, respectively. *Source:* Author's calculations.

Table B.2.2: Optimal SVAR(p) lag selection

```
Selection-order criteria
Sample:  1994 - 2020                              Number of obs      =        27
```

lag	LL	LR	df	p	FPE	AIC	HQIC	SBIC
0	-385.368				3.9e+07	28.8421	28.8992	29.034
1	-355.009	60.717	16	0.000	1.4e+07	27.7785	28.0639	28.7384*
2	-337.005	36.008	16	0.003	1.3e+07	27.63	28.1438	29.3578
3	-318.887	36.236	16	0.003	1.4e+07	27.4731	28.2152	29.9688
4	-283.462	70.851*	16	0.000	5.8e+06*	26.0342*	27.0046*	29.2978

```
Endogenous:  ir gdpg pb reer
 Exogenous:  _cons
```

Note: LL is the log-likelihood, LR refers to the likelihood ratio, df is the degrees of freedom, p is the p-value, FPE refers to the final prediction error, AIC refers to Akaike's information criteria, HQIC is Hannan and Quinn information criteria, and SBIC refers to Schwarz's Bayesian information criteria. *Source:* Author's calculations.

Table B.2.3: Short-run parameters estimates of the Structural Vector Autoregression model

Sample: 1994 - 2020 Number of obs = 27
Exactly identified model Log likelihood = -283.4617

	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
/a_1_1	1	(constrained)				
/a_2_1	-.1742299	.0969218	-1.80	0.072	-.3641932	.0157335
/a_3_1	.047388	.0827722	0.57	0.567	-.1148425	.2096185
/a_4_1	-1.485906	1.022802	-1.45	0.146	-3.490562	.5187496
/a_1_2	0	(constrained)				
/a_2_2	1	(constrained)				
/a_3_2	.0342413	.155322	0.22	0.826	-.2701842	.3386668
/a_4_2	-.5723663	1.90946	-0.30	0.764	-4.314839	3.170106
/a_1_3	0	(constrained)				
/a_2_3	0	(constrained)				
/a_3_3	1	(constrained)				
/a_4_3	3.643851	2.36377	1.54	0.123	-.9890538	8.276755
/a_1_4	0	(constrained)				
/a_2_4	0	(constrained)				
/a_3_4	0	(constrained)				
/a_4_4	1	(constrained)				
/b_1_1	3.321047	.4519373	7.35	0.000	2.435267	4.206828
/b_2_1	0	(constrained)				
/b_3_1	0	(constrained)				
/b_4_1	0	(constrained)				
/b_1_2	0	(constrained)				
/b_2_2	1.672548	.227605	7.35	0.000	1.226451	2.118646
/b_3_2	0	(constrained)				
/b_4_2	0	(constrained)				
/b_1_3	0	(constrained)				
/b_2_3	0	(constrained)				
/b_3_3	1.349875	.1836947	7.35	0.000	.9898397	1.70991
/b_4_3	0	(constrained)				
/b_1_4	0	(constrained)				
/b_2_4	0	(constrained)				
/b_3_4	0	(constrained)				
/b_4_4	16.57985	2.256232	7.35	0.000	12.15772	21.00198

Source: Author's calculations.

Table B.2.4: Results of Granger causality test between the dependent variables and the corresponding independent variables.

Granger causality Wald tests

Equation	Excluded	chi2	df	Prob > chi2
ir	gdpg	31.933	4	0.000
ir	pb	26.734	4	0.000
ir	reer	46.246	4	0.000
ir	ALL	105.39	12	0.000
gdpg	ir	4.3641	4	0.359
gdpg	pb	3.0027	4	0.557
gdpg	reer	34.345	4	0.000
gdpg	ALL	45.823	12	0.000
pb	ir	136.56	4	0.000
pb	gdpg	35.265	4	0.000
pb	reer	40.431	4	0.000
pb	ALL	158.05	12	0.000
reer	ir	20.358	4	0.000
reer	gdpg	3.8052	4	0.433
reer	pb	11.291	4	0.023
reer	ALL	74.209	12	0.000

Source: Author's calculations.

Table B.2.5: Results of Lagrange multiplier test for autocorrelation in residuals

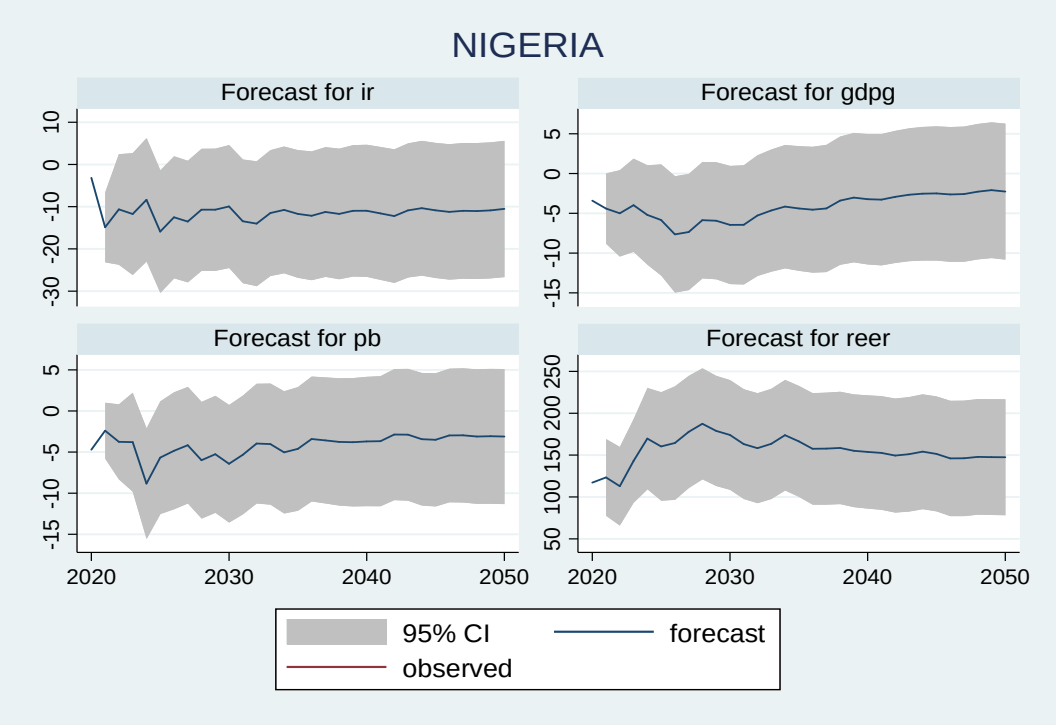
Lagrange-multiplier test

lag	chi2	df	Prob > chi2
1	21.2433	16	0.16935
2	32.6250	16	0.00828
3	14.4086	16	0.56830
4	12.6013	16	0.70166

H0: no autocorrelation at lag order

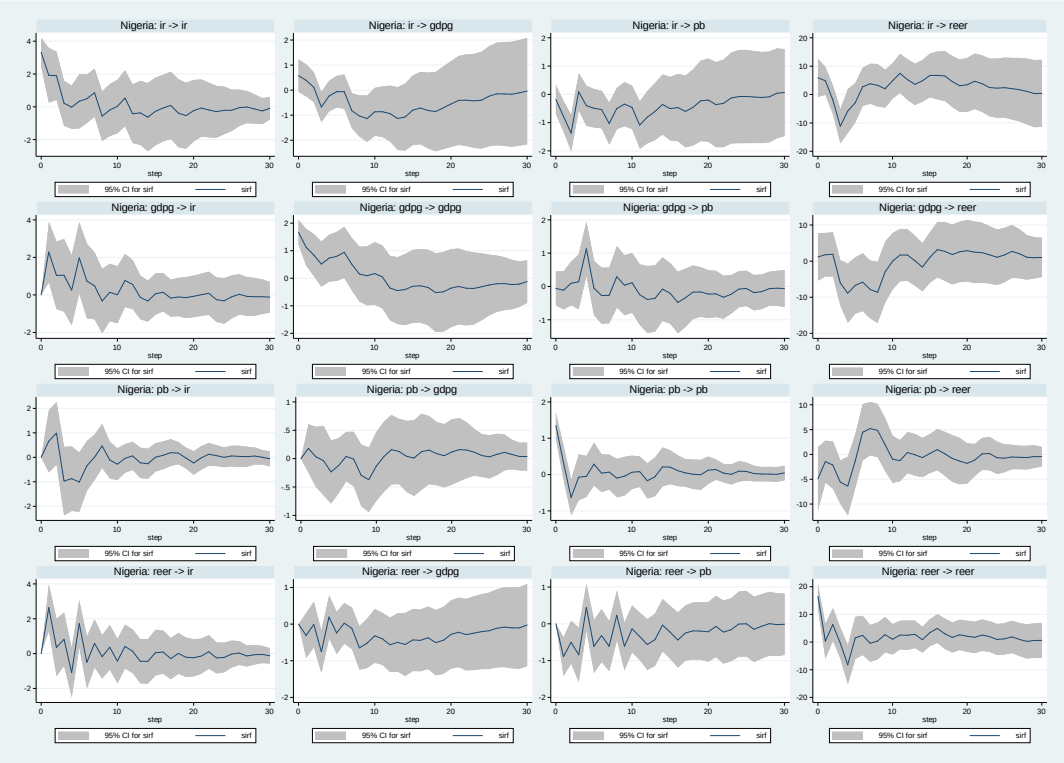
Source: Author's calculations.

Figure B.2.1: SVAR Stochastic forecast of the macro-economic determinants of debt.



Note: ir, gdpg, pb, reer, refers to the real effective interest rate, real GDP growth rate, primary balance, and real effective exchange rate, respectively. *Source:* Author's calculations.

Figure B.2.2: Structural impulse response graph of the macro-economic determinants of debt at 95% confidence interval.



Note: the first parameter is the country, the second is the impulse, and the third is the response. Also note that, ir, gdpg, pb, reer, refers to the real effective interest rate, real GDP growth rate, primary balance, and real effective exchange rate, respectively. *Source:* Author's calculations.

B.3 Zambia

Table B.3.1: Correlation matrix of the debt-to-GDP ratio and its macro-economic determinants

```
. corr gdp pb reer ir debt
(obs=31)
```

	gdpg	pb	reer	ir	debt
gdpg	1.0000				
pb	0.0688	1.0000			
reer	0.5603	0.0137	1.0000		
ir	0.4349	-0.1487	0.7073	1.0000	
debt	-0.4833	0.0097	-0.8675	-0.5271	1.0000

Note: gdpg, pb, reer, ir, and debt, refer to the real GDP growth rate, primary balance, real effective exchange rate, real effective interest rate, and debt ratio, respectively. *Source:* Author's calculations.

Table B.3.2: Optimal SVAR(p) lag selection

```
Selection-order criteria
Sample:  1994 - 2020                        Number of obs      =        27
```

lag	LL	LR	df	p	FPE	AIC	HQIC	SBIC
0	-351.892				3.3e+06	26.3624	26.4194	26.5543
1	-296.626	110.53	16	0.000	183423	23.4538	23.7392	24.4136*
2	-276.958	39.335	16	0.001	152742	23.1821	23.6959	24.9099
3	-264.767	24.383	16	0.081	257850	23.4642	24.2063	25.9599
4	-229.028	71.479*	16	0.000	102735*	22.002*	22.9725*	25.2656

```
Endogenous:  ir gdpg pb reer
 Exogenous:  _cons
```

Note: LL is the log-likelihood, LR refers to the likelihood ratio, df is the degrees of freedom, p is the p-value, FPE refers to the final prediction error, AIC refers to Akaike's information criteria, HQIC is Hannan and Quinn information criteria, and SBIC refers to Schwarz's Bayesian information criteria. *Source:* Author's calculations.

Table B.3.3: Short-run parameters estimates of the Structural Vector Autoregression model

Sample: 1994 - 2020 — Number of obs = 27
Exactly identified model — Log likelihood = -229.0275

	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
/a_1_1	1	(constrained)				
/a_2_1	-.8513931	.1423519	-5.98	0.000	-1.130398	-.5723886
/a_3_1	1.626421	.5869999	2.77	0.006	.4759222	2.77692
/a_4_1	-.6642597	.7026925	-0.95	0.345	-2.041512	.7129922
/a_1_2	0	(constrained)				
/a_2_2	1	(constrained)				
/a_3_2	-.5731295	.5204686	-1.10	0.271	-1.593229	.4469702
/a_4_2	-.9014078	.5619825	-1.60	0.109	-2.002873	.2000576
/a_1_3	0	(constrained)				
/a_2_3	0	(constrained)				
/a_3_3	1	(constrained)				
/a_4_3	-.864602	.2032856	-4.25	0.000	-1.263035	-.4661695
/a_1_4	0	(constrained)				
/a_2_4	0	(constrained)				
/a_3_4	0	(constrained)				
/a_4_4	1	(constrained)				
/b_1_1	1.516944	.2064299	7.35	0.000	1.112349	1.921539
/b_2_1	0	(constrained)				
/b_3_1	0	(constrained)				
/b_4_1	0	(constrained)				
/b_1_2	0	(constrained)				
/b_2_2	1.122056	.1526925	7.35	0.000	.8227842	1.421328
/b_3_2	0	(constrained)				
/b_4_2	0	(constrained)				
/b_1_3	0	(constrained)				
/b_2_3	0	(constrained)				
/b_3_3	3.034526	.4129467	7.35	0.000	2.225166	3.843887
/b_4_3	0	(constrained)				
/b_1_4	0	(constrained)				
/b_2_4	0	(constrained)				
/b_3_4	0	(constrained)				
/b_4_4	3.20538	.436197	7.35	0.000	2.35045	4.06031

Source: Author's calculations.

Table B.3.4: Results of Granger causality test between the dependent variables and the corresponding independent variables.

Granger causality Wald tests

Equation	Excluded	chi2	df	Prob > chi2
ir	gdpg	45.036	4	0.000
ir	pb	24.625	4	0.000
ir	reer	38.736	4	0.000
ir	ALL	140.78	12	0.000
gdpg	ir	38.004	4	0.000
gdpg	pb	15.365	4	0.004
gdpg	reer	28.45	4	0.000
gdpg	ALL	68.325	12	0.000
pb	ir	.72503	4	0.948
pb	gdpg	2.0211	4	0.732
pb	reer	8.5048	4	0.075
pb	ALL	10.127	12	0.605
reer	ir	6.2436	4	0.182
reer	gdpg	16.172	4	0.003
reer	pb	30.586	4	0.000
reer	ALL	70.249	12	0.000

Source: Author's calculations.

Table B.3.5: Results of Lagrange multiplier test for autocorrelation in residuals

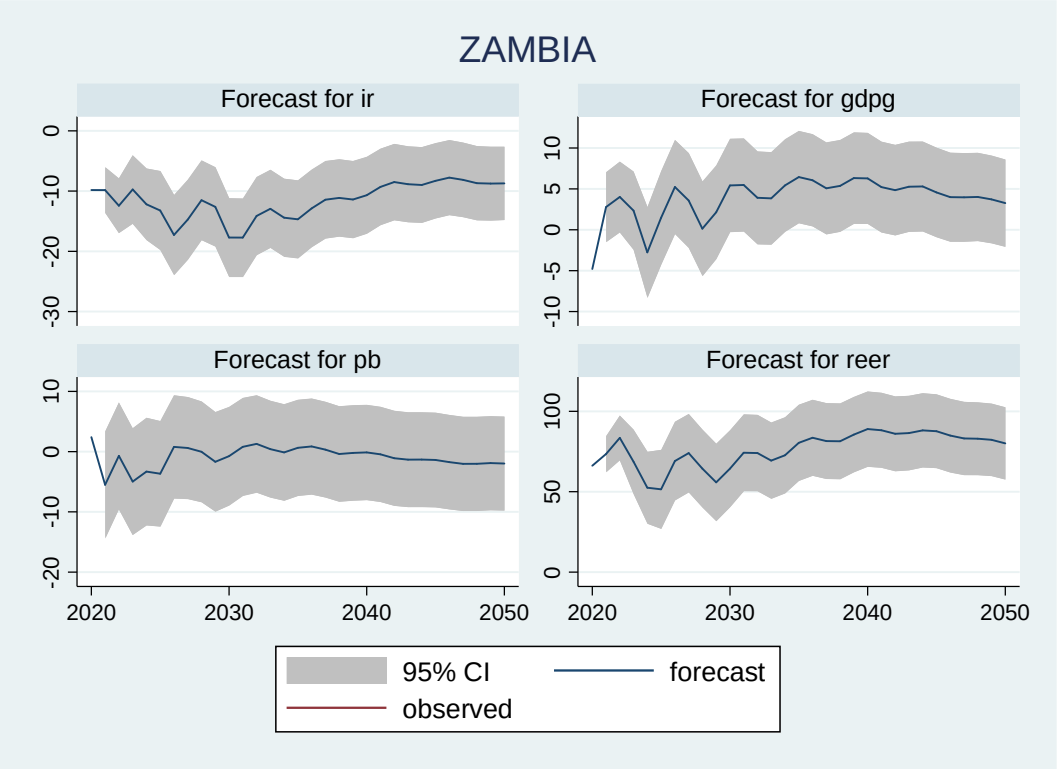
Lagrange-multiplier test

lag	chi2	df	Prob > chi2
1	31.6254	16	0.01118
2	17.4079	16	0.35969

H0: no autocorrelation at lag order

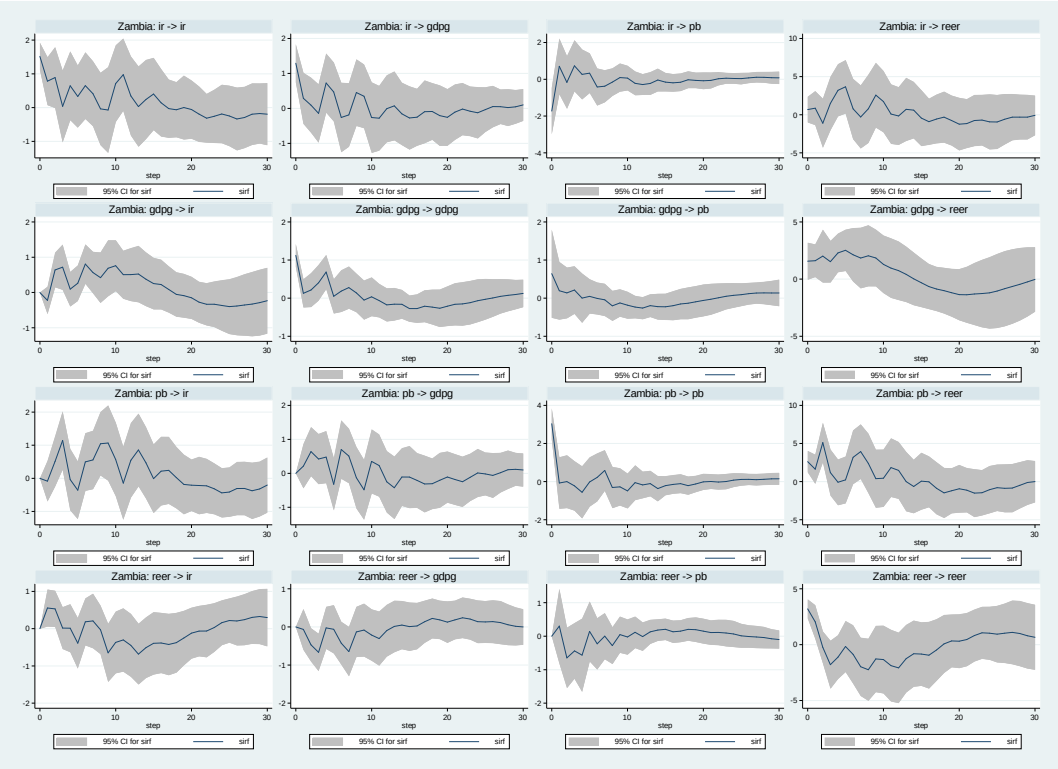
Source: Author's calculations.

Figure B.3.1: SVAR Stochastic forecast of the macro-economic determinants of debt.



Note: ir, gdpg, pb, reer, refers to the real effective interest rate, real GDP growth rate, primary balance, and real effective exchange rate, respectively. *Source:* Author's calculations.

Figure B.3.2: Structural impulse response graph of the macro-economic determinants of debt at 95% confidence interval.



Note: the first parameter is the country, the second is the impulse, and the third is the response. Also note that, ir, gdpg, pb, reer, refers to the real effective interest rate, real GDP growth rate, primary balance, and real effective exchange rate, respectively. *Source:* Author's calculations.

Võlakergenduse piisavus Sahara-taguse Aafrika riigivõla kriisi lahendusena Ghana, Nigeeria ja Sambia näitel

Sarnaselt 1980ndate aastatega on viimasel ajal põhjustanud kasvavat muret Sahara-taguse Aafrikas riigivõla kriisi esile kerkimine. Nii näiteks katkestas 2020. aasta novembris Sambia enda riigivõla maksed, ning mitmed teised Sahara-taguse Aafrika riigid on otsinud abi Rahvusvaheliselt Valuutafondilt ja Maailmapangalt. Eelnevast tulenevalt on tehtud üleskutseid nende riikide võlakoormuse kergendamiseks ja isegi võlgade kustutamiseks. Käesolevas töös uuritakse erinevate võlakergendamise pakettide pikaajalist makromajanduslikku mõju. Analüüs viiakse läbi üksikute uuritud riikide kaupa kasutades riigivõla jätkusuutlikkuse uurimiseks nii deterministlikku kui ka stohhastilist lähenemist. Võlakoormuse kergendamise juures vaadati nelja stsenaariumi: 25% ja 80% suurune võlakoormuse vähendamine, võla tühistamine täies mahus ja võla tagasimaksete peatamine. Kasutades struktuurse vektor autoregressiooni metoodikat tuvastati majandusnäitajates võlakoormuse kergendamisel aja jooksul konvergents esialgse võlakoormuse tasemele vastava raja suunas. Viimane tähendab, et võlakoormuse kergendamisel on uuritud riikides küllaltki piiratud mõju võlataseme pikaajaliselt prognoositavale väärtusele. Analüüsides täiendavalt võlataseme reageerimist positiivsetele šokkidele erinevates endogeensetes muutujates ilmnes, et kõige suurem mõju võlatasemele on sisemajanduse kogutoodangu kasvu kiirenemisel. Niisiis majanduskasvu soodustavad makroökonoomilised reformid on tähtsad muuseas ka võlakoormuse taseme kontrollimisel.

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THE SUFFICIENCY OF DEBT RELIEF AS A PANACEA TO SOVEREIGN DEBT CRISIS IN SUB-SAHARAN AFRICA: A CASE STUDY OF GHANA, NIGERIA, AND ZAMBIA

supervised by, Ricardo Alfredo Mendes Pereira Vicente (PHD)

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