Essays in Applied Econometrics: Global Fiscal Dynamics, Spillovers, and Debt Sustainability

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To my Dad, in Heaven,

Your love and unwavering belief in me have carried me through this journey.

I only wish you were here to see this moment.

Forever loved. Forever missed.

Abstract

In an era of rising public debt, tightening fiscal space, and growing global economic interdependence, understanding the design, sustainability, and cross-border effects of fiscal policy has become more urgent than ever. This thesis explores three critical dimensions of fiscal policy in both advanced and emerging economies: (i) the role of fiscal rules in shaping social sector spending; (ii) the sustainability of public debt under uncertainty and changing policy environments; and (iii) the international transmission of fiscal policy shocks, with a focus on China and its trade partners. Together, these chapters offer novel empirical insights using advanced econometric frameworks and rich cross-country datasets.

Chapter 1 examines the causal effects of fiscal rules on four categories of social sector spending across 34 advanced economies (AEs) and 33 emerging and developing economies (EMDEs) from 1985 to 2020. Using dynamic panel estimation, the study finds that in (EMDEs), balanced budget and debt rules tend to reduce education and health spending highlighting a trade-off between fiscal discipline and long-term human capital investment. In contrast, (AEs) manage to improve their budgetary position without compromising social expenditure. A fiscal rule index further reveals that stronger institutional quality and better-designed rules enhance the effectiveness and equity of fiscal policy.

Chapter 2 develops a stochastic debt sustainability analysis SDSA framework that combines a time-varying fiscal reaction function with a time-varying parameter VAR model. This approach captures shifts in fiscal behavior and macroeconomic conditions, enabling probabilistic projections using simulation-based fan charts. Applied to high-debt advanced and emerging and developing economies, the results show that fiscal responsiveness varies widely: (AEs) exhibit signs of fiscal fatigue at high debt levels, while (EMDEs) demonstrate more consistent responses. The framework improves upon traditional DSAs by incorporating uncertainty and changing policy dynamics.

Chapter 3 explores fiscal spillovers from China to the ASEAN-5 (Malaysia, Indonesia, the Philippines, Singapore, and Thailand) and to other regions using a Global VAR framework. The analysis finds that output expansions in China generate significant cross-border effects, particularly in ASEAN-5 and the broader Asia-Pacific, due to trade linkages and proximity. Spillovers to the Euro Area are temporary, while those to South America are negligible. Importantly, shocks to Chinese output and revenue produce stronger spillovers than expenditure shocks, highlighting China's growing influence on regional fiscal dynamics.

Overall, these chapters provide new evidence on the design, effectiveness, and international transmission of fiscal policy in an increasingly uncertain global landscape.

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Above all, I am deeply grateful to my family. A few months into my PhD, I lost my father, his pride and joy when I began this journey still stays with me. It is one of my greatest regrets that he is not here to witness its completion. I dedicate this thesis to his memory. I am also profoundly thankful to my mother and siblings for their endless love, support, and patience. Their strength and unwavering belief in me have carried me through every challenge.

This thesis is dedicated to my father and to my family with all my love and gratitude.

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Chapter 1

Introduction

Fiscal policy has regained prominence as a key instrument of macroeconomic management, especially following the 2008–09 global financial crisis and the COVID-19 pandemic. Governments worldwide relied on fiscal measures to stabilize economies, support households, and foster recovery, underscoring its indispensable role alongside monetary policy (Blanchard and Leigh, 2013; International Monetary Fund, 2020). At the same time, this renewed reliance on fiscal policy has intensified concerns about debt sustainability, as public debt has risen to historically high levels in both advanced and emerging economies (Reinhart and Rogoff, 2010; Mauro et al., 2015). In response, many countries have strengthened fiscal institutions and adopted fiscal rules to enhance policy credibility, constrain excessive borrowing, and safeguard long-term solvency (Davoodi et al., 2022).

The importance of fiscal policy is further amplified by the increasing interconnectedness of the global economy. Fiscal shocks in large economies can transmit across borders through trade, financial, and confidence channels, affecting economic conditions well beyond national boundaries (Beetsma and Giuliodori, 2011; Auerbach and Gorodnichenko, 2013). These developments highlight three closely related challenges facing policymakers: how to design fiscal institutions that support discipline without undermining priority spending, how to assess debt sustainability when fiscal behavior and macroeconomic conditions evolve over time, and how to account for international spillovers when major economies adjust their fiscal stance.

Despite extensive research, important gaps remain in each of these areas. First, although fiscal rules are widely used to promote discipline and sustainability (Kopits and Symansky, 1998; Schaechter et al., 2012b), less is known about how their design affects the composition of public spending, particularly in health, education, and social protection. Second, in the context of rising debt burdens, especially after COVID-19, limited evidence exists on how fiscal responsiveness changes over time and how this affects debt sustainability under uncertainty (Bohn, 1998; Debrun and Jonung, 2019). Third, much of the international spillover literature focuses on fiscal shocks originating in the United States, with comparatively little attention paid to China's growing role in the global economy. This thesis addresses these gaps by

examining fiscal rules and spending composition, time-varying fiscal responses to debt, and international fiscal spillovers from China.

Chapter 2 investigates how fiscal rules shape public spending in Advanced economies (AEs) and emerging and developing economies (EMDEs). Using a dynamic panel approach based on Generalized Method of Moments (GMM), the chapter examines both the presence of fiscal rules and the quality of their design through a fiscal rule index that captures legal basis, coverage, enforcement, flexibility, and supporting procedures. The results show that fiscal rules significantly influence spending choices. Balanced budget rules exert the strongest effects, while debt rules are particularly relevant in EMDEs and affect health and education spending. Expenditure rules play a more important role in (AEs). The findings also indicate that better-designed fiscal rules are associated with more balanced spending outcomes and stronger fiscal discipline, especially in countries with more developed institutional frameworks.

Chapter 3 develops a novel framework for assessing debt sustainability in high-debt advanced and emerging economies. Unlike conventional approaches that rely on static fiscal reaction functions (Bohn, 1998) or standard vector autoregressions (International Monetary Fund, 2003a), this chapter combines a time-varying fiscal reaction function with a time-varying vector autoregression to generate probabilistic debt forecasts. The framework captures evolving fiscal behavior, changing macroeconomic relationships, and uncertainty in the distribution of shocks. The results reveal evidence of fiscal fatigue in several (AEs), where the responsiveness of the primary balance to rising debt weakens over time. By integrating the two models, the chapter produces fan charts that provide a more realistic assessment of debt dynamics and fiscal risks than traditional debt sustainability methods.

Chapter 4 examines international spillovers from China's fiscal policy using the Global VAR (GVAR) methodology (Pesaran, 2004; Dees et al., 2007). To conduct this analysis, the chapter constructs a new quarterly fiscal dataset for China and identifies both expenditure and revenue shocks. The empirical focus is on ASEAN-5, given their close trade links with China, as well as the euro area, South America, and the wider Asia-Pacific region. The results show that China's fiscal shocks, particularly revenue shocks, generate significant and persistent effects in ASEAN-5, while impacts on other regions are generally more transitory and relatively small. These findings highlight China's increasing importance as a source of regional and global macroeconomic spillovers.

Although each chapter addresses a distinct research question, they are united by a common objective: understanding how fiscal institutions, fiscal behavior, and external spillovers jointly shape fiscal sustainability. Methodologically, all three chapters emphasize the importance of accounting for heterogeneity, endogeneity, and uncertainty in fiscal analysis. Substantively, they show that effective fiscal management requires more than numerical targets. It also depends on the quality

of institutional design, the ability of governments to adapt their fiscal responses over time, and an awareness of cross-border linkages. Together, the chapters suggest that fiscal policy should be designed within flexible and credible frameworks that protect priority spending, incorporate changing economic conditions, and take into account external risks.

Overall, this thesis makes three main contributions to the literature on fiscal policy, fiscal sustainability, and international spillovers. First, it extends the fiscal rules literature by examining not only whether the adoption of fiscal rules affects public spending, but also whether the strength and design of these rules matter. By using both fiscal rule dummy variables and a fiscal rule index, the thesis provides new evidence on how fiscal rules shape the composition of spending, particularly in social protection, health, and education. Second, it contributes to the debt sustainability literature by developing a time-varying framework that combines a time-varying fiscal reaction function with a time-varying vector autoregression to generate probabilistic debt forecasts. This approach offers a more realistic assessment of fiscal risks than conventional fixed-parameter models. Third, it contributes to the literature on international fiscal spillovers by providing one of the first comprehensive analyses of fiscal shocks originating from China using a newly constructed quarterly fiscal dataset and a Global VAR framework.

The findings of this thesis have important implications for policymakers, international organizations, and researchers. National governments can use the results to design stronger fiscal rules that support fiscal discipline while protecting essential spending on health, education, and social protection. Ministries of finance and debt management offices can apply the time-varying debt sustainability framework to improve medium-term fiscal planning and better assess downside risks. Policymakers and central banks in countries with strong trade ties to China can use the findings of Chapter 4 to evaluate how changes in China's fiscal stance may affect domestic growth, inflation, and external balances. International organizations such as the IMF, World Bank, and regional development banks can incorporate these insights into fiscal surveillance, debt sustainability assessments, and macroeconomic forecasting. Researchers may also build on the new methodological approaches and datasets developed in this thesis to advance future work on fiscal institutions, sovereign debt dynamics, and international spillovers.

The empirical chapters are organized as follows. Chapter 2, "The Role of Fiscal Rules in Shaping Social Sector Spending: Evidence from Advanced and Developing Countries," examines how fiscal rules influence spending, particularly in social protection, health, and education. Chapter 3, "Managing Uncertainty: A Time-Varying Fiscal Framework for Probabilistic Debt Sustainability in High-Debt Countries," develops a time-varying model of fiscal responsiveness and debt sustainability. Chapter 4, "International Fiscal Spillovers from China: A Global VAR Approach," investigates how China's fiscal shocks transmit regionally and globally. Chapter

5 synthesizes the findings and discusses their broader implications for fiscal policy design, debt sustainability, and international coordination.

Chapter 2

The Role of Fiscal Rules in Shaping Social Sector Spending: Evidence from Advanced and Developing Countries

2.1 Introduction

Public resources are allocated across a wide range of sectors, but in most countries, health, education, and social protection consistently account for the largest shares of government expenditure. In modern democracies, voters delegate decision-making authority over these resources to elected policymakers, who determine how public funds raised through taxation are distributed across competing priorities. This delegation creates a fundamental principal-agent problem, whereby elected representatives, acting as agents, may not always act in the best interests of citizens. Instead, they may extract rents from holding office, engage in inefficient spending, or prioritize short-term political gains over long-term welfare. As a result, fiscal policy decisions often reflect incomplete contracts between voters and policymakers, in which commitments made during electoral campaigns cannot be perfectly enforced (Persson and Tabellini, 2004; Von Hagen, 2002).

A related issue arises from the collective nature of fiscal decision-making. When multiple actors are involved in the budget process, public spending tends to increase due to the common-pool problem, whereby each decision-maker has an incentive to expand expenditures benefiting their own constituency while sharing the associated costs across the broader population (Persson and Tabellini, 2002; von Hagen and Harden, 1995). These institutional and political frictions can lead to persistent fiscal imbalances, inefficient allocation of resources, and excessive public debt accumulation.

In response to these challenges, governments have increasingly adopted fiscal rules as formal constraints on fiscal policy. Fiscal rules are designed to limit dis-

cretion by imposing numerical targets or procedural requirements on key fiscal aggregates, such as budget balances, public debt, expenditures, or revenues. By constraining policymakers' ability to deviate from pre-specified fiscal objectives, these rules aim to mitigate principal-agent problems, reduce the inefficiencies associated with the common-pool problem, and enhance the credibility and sustainability of fiscal policy. In doing so, fiscal rules are expected to promote fiscal discipline, anchor expectations, and reduce uncertainty regarding the future path of public finances.

Despite their theoretical appeal, an important question remains regarding how fiscal rules affect not only aggregate fiscal outcomes but also the composition of public spending. In particular, it is unclear whether fiscal rules help protect or instead constrain critical social expenditures, such as health, education, and social protection. This issue is especially salient in emerging market and developing economies (EMDEs), where fiscal space is often limited, institutional capacity may be weaker, and governments face competing pressures between maintaining fiscal discipline and addressing pressing development needs.

Over the past three decades, the adoption of fiscal rules has expanded rapidly across the globe. By 2021, approximately 105 countries had implemented at least one fiscal rule, representing a substantial increase from earlier decades (Davoodi et al., 2022). While (AEs) were early adopters, fiscal rules have become increasingly prevalent in (EMDEs), particularly since the late 2000s. In fact, recent evidence indicates that the number of (EMDEs) with fiscal rules now exceeds that of (AEs), reflecting a broader global shift toward rules-based fiscal frameworks.

Countries have adopted fiscal rules for a variety of reasons, including addressing deficit bias, reducing borrowing costs, strengthening policy credibility, and ensuring long-term debt sustainability. However, the effectiveness of these rules in achieving broader economic and social objectives remains a subject of ongoing debate. While a large body of literature has examined the impact of fiscal rules on aggregate fiscal indicators such as deficits and debt much less is known about their effects on the allocation of public spending across sectors.

This gap is particularly important in the context of (EMDEs), where fiscal constraints are often more binding and where social expenditures play a crucial role in promoting inclusive growth and human development. Many (EMDEs) face persistent fiscal deficits, rising debt burdens, and vulnerability to external shocks. In such settings, fiscal consolidation efforts often implemented through fiscal rules or external programs may lead to reductions in public spending, including in key social sectors. Moreover, austerity-oriented policy frameworks, which emphasize fiscal discipline, balanced budgets, and limited government intervention, may further constrain the ability of governments to maintain or expand social protection, healthcare, and education spending during periods of economic stress.

Despite the importance of these issues, empirical evidence on the impact of fiscal rules on spending composition remains limited and inconclusive. Existing

studies, such as (Cordes et al., 2015) and (Dahan and Strawczynski, 2013), have primarily focused on OECD and European Union countries and generally find that fiscal rules are associated with reductions in public spending. However, these studies provide limited insights into how fiscal rules affect different categories of expenditure, particularly in (EMDEs), where institutional environments and policy constraints differ significantly.

Against this backdrop, the objective of this study is to examine how fiscal rules influence the composition of public spending, with a particular focus on social protection, health, and education expenditures. The analysis covers a broad panel of Advanced economies (AEs) and emerging market and developing economies (EMDEs), allowing for a comparative assessment across different institutional and economic contexts.

To address this question, the study employs a dynamic panel data framework that accounts for the persistence and potential endogeneity of fiscal policy decisions. Unlike much of the existing literature, we explicitly recognize the non-stationary nature of fiscal variables and estimate the models in first differences using logarithmic transformations. Furthermore, we control for a comprehensive set of economic, political, and governance factors that may influence both the adoption and effectiveness of fiscal rules. In addition to examining the presence of fiscal rules using binary indicators, we also incorporate a fiscal rule index that captures variations in rule design and strength across countries.

Our findings suggest that fiscal rules are effective tools for regulating public finances, although their impact varies across country groups and rule specifications. In Advanced economies (AEs), fiscal rules particularly budget balance and debt rules are associated with improved fiscal discipline without significantly reducing overall spending, while supporting key social sectors. In contrast, in emerging and developing economies (EMDEs), the presence of fiscal rules is often linked to reductions in spending across categories, reflecting their implementation in more constrained fiscal and institutional environments. Moreover, countries with better-designed fiscal rules, as captured by the fiscal rule index, tend to exhibit more balanced and targeted effects on spending outcomes, particularly in areas such as health, education, and social protection. These results highlight the importance of both rule design and institutional quality in shaping fiscal outcomes.

The remainder of this chapter is structured as follows. Section 2.2 provides the theoretical background on fiscal rules and their impact on government spending. Section 2.3 reviews the relevant literature and identifies key gaps. Section 2.4 describes the data and variables used in the analysis. Section 2.5 outlines the econometric methodology. Section 2.6 presents the empirical results, while Section 2.7 examines the role of fiscal rule design. Finally, Section 2.8 concludes with a discussion of the main findings and policy implications.

2.2 Theoretical Background

The International Monetary Fund (IMF) defines a fiscal rule as a permanent restriction on fiscal policy, established through numerical limits on budgetary indicators. Its main goals are to achieve budgetary balance, curb public spending and deficits, and promote fiscal discipline and debt sustainability. The IMF classifies fiscal rules into four categories:balanced budget rules, expenditure rules, debt rules, and revenue rules.

Balanced budget rules limit the size of budget deficits, debt rules impose explicit limits on public debt stock, expenditure rules cap public spending, and revenue rules set ceilings or floors on revenue or dictate how to use windfall revenues (see, for example, (Bova et al., 2015; Lledó et al., 2017; Schaechter et al., 2012a)). In this study, we adopt the IMF's definition of fiscal rules, which are typically implemented by governments at the national level.

In Advanced economies(AEs), fiscal frameworks typically rely on balanced budget rules, expenditure rules, and debt rules. By contrast, emerging and developing economies (EMDEs) tend to employ a mix of balanced budget and debt rules. Revenue rules remain uncommon in both groups. See Figure 2.2a.

The IMF divides countries into three main categories: Advanced economies (AEs), Emerging and Developing Economies (EMDEs), and Low-Income Countries (LICs). This study concentrates on the first two groups. According to the IMF's World Economic Outlook, 39 economies are classified as "advanced," based on criteria such as high per capita income, diversified exports, and strong integration into global financial markets. Meanwhile, the Fiscal Monitor designates 40 nations as "emerging market and middle-income" economies, reflecting their relatively higher income levels. The (EMDEs) grouping is determined using indicators like nominal GDP, GDP per capita, population size, share in global trade, and global external debt participation. (International Monetary Fund, 2023; Kose and Ohnsorge, 2020).

Beyond fiscal discipline, fiscal rules can serve broader economic stabilization goals. They allow fiscal policy to respond to fluctuations in economic activity. In both advanced and emerging economies, especially those facing fiscal distress, strengthening the fiscal framework and improving coordination among its elements have become priorities. Fiscal rules are seen as crucial for reducing fiscal imbalances, enhancing the credibility of consolidation paths, and maintaining fiscal sustainability. As (Dahan and Strawczynski, 2013) suggest, fiscal rules can also promote macroeconomic sustainability, provided there is sufficient political will.

However, the impact of fiscal rules may differ significantly between (AEs) and (EMDEs) due to differences in economic scale and institutional development. (AEs) tend to have well-developed public administration systems and robust institutions. These systems enforce the rule of law, manage public revenues efficiently, and implement social welfare programs supported by legal frameworks. For example, the U.S.

established its social protection system with the Social Security Act of 1935, which offers old-age, survivors, and disability insurance, and later added Medicare in 1965. Given this strong macro-fiscal and institutional framework, advanced countries are more likely to use fiscal rules to expand or protect social welfare spending.

By contrast, (EMDEs) face several institutional challenges. Weak public administration and limited institutional support for social programs often hinder effective policy implementation. In many of these countries, electoral accountability is weak, reducing pressure on governments to maintain or expand public services. (Dahan and Strawczynski, 2013) found a negative association between fiscal rules and social spending in countries lacking strong legal protections for social rights.

Moreover, (EMDEs) often lack skilled personnel with the technical and managerial capacity to conduct rigorous cost-benefit analyses for fiscal rules. Tax administration is typically weak, and compliance is low, resulting in constrained revenues. Consequently, fiscal targets are often met by cutting expenditures rather than increasing revenues. The growing burden of external debt further forces many of these countries to divert resources away from key public services to meet debt obligations.

The budgetary process comprising planning, forecasting, implementation, and monitoring is a critical component of fiscal policy. In transitional and developing economies, this process is often inefficient and bureaucratic. Limited capacity for budget implementation and oversight means that short-term fiscal targets are frequently achieved by cutting less visible expenditures, such as social programs.

In setting expenditure priorities, governments often evaluate whether a program's benefits exceed its costs.(Stiglitz and Rosengard, 2015) explain that the process entails identifying programs, assessing their total costs and benefits, and evaluating their net profitability. Under fiscal strain, governments typically reduce spending in areas with the smallest marginal impact on social welfare and choose taxes or fees that generate the least deadweight loss. They may also apply equity-efficiency trade-offs and look for Pareto improvements, where some are made better off without harming others, especially in sectors like health, education, and social welfare. Yet, such analytical rigor is rarely observed in (EMDEs) due to institutional and political limitations.

As a result, short-term fiscal compliance in developing countries often comes at the cost of social spending, especially in education, health, and social security.

Decision-making in governments involves multiple policymakers, often with links to different interest groups. The greater the number of decision-makers, the more likely it is that deficits and spending will increase. In democratic systems, elected officials are theoretically accountable to citizens. However, in many (EMDEs), weak party systems (Mainwaring and Scully, 1995) and clientelistic politics (Keefer, 2007) reduce electoral accountability. Party ideologies are fluid and campaigns focus more on personal appeal than policy platforms. Electoral dynamics in many (EMDEs) are often shaped by patron-client relationships, which hinder voters ability to hold

politicians accountable for policy outcomes. As a result, political leaders in these countries enjoy greater leeway to influence fiscal outcomes without incurring electoral costs. Accordingly, we anticipate that fiscal rules may exert a negative effect on social spending in such contexts.

Notably, balanced budget and expenditure rules do not specify which types of spending should be reduced, allowing policymakers to choose cuts that are less politically visible. Due to strong unionization and legal protections, wages are less likely to be reduced. Instead, governments often cut public investment or social transfers.

Furthermore, short electoral cycles discourage investments in long-term projects whose benefits extend beyond the current administration's term. Anticipating their potential replacement, incumbents may limit fiscal flexibility for future governments by increasing debt (Alesina and Tabellini, 1990).

Existing literature also shows that poor voters are generally less informed than wealthier voters, reducing their influence over policy decisions (Bardhan and Mookherjee, 2000; Grossman and Helpman, 1996; Ravallion, 2006). Consequently, during fiscal consolidation, pro-poor spending is often cut before programs favored by more influential interest groups.

In sum, when governments operate under strict fiscal constraints, particularly binding fiscal rules, they are more inclined to cut expenditures in social sectors such as health, education, and welfare, areas that predominantly serve lower-income groups. Given time constraints and political realities, revenue-enhancing reforms are often deferred in favor of expenditure cuts, making social spending the most vulnerable area in many (EMDEs).

2.3 Related Literature

An expanding literature on fiscal rules emphasizes their role in promoting fiscal discipline and consolidation. Evidence from several studies suggests that such rules can help reduce deficits and enhance overall fiscal performance (Bergman and Hutchison, 2018; Debrun et al., 2008; Krogstrup and Wälti, 2008; Von Hagen, 2005).

(Badinger and Reuter, 2017) empirically examine the impact of fiscal rules on macroeconomic outcomes using 2SLS estimation with panel data from 74 countries. Their results show that stricter fiscal rules are linked to stronger fiscal discipline, more countercyclical fiscal policies, and reduced output volatility. Similarly, (Holm-Hadulla et al., 2012) analyze the role of expenditure rules in shaping the cyclical behavior of government spending within EU countries. They find that government expenditure tends to react procyclically to unexpected output gap fluctuations, but that stringent expenditure rules help curb this pattern.

Fiscal rules are primarily considered a tool to correct distorted fiscal balances and improve budgetary processes, as governments are typically composed of many

agents competing for limited fiscal resources. This setting gives rise to a common-pool problem, leading to inefficiencies in the allocation of public spending. Moreover, interest groups and legislators may benefit disproportionately from higher spending in their constituencies (von Hagen and Harden, 1995). There is also evidence that governments tend to spend more during economic upturns and cut spending during downturns, resulting in procyclical fiscal policy. However, (Turrini, 2008) found that countries with strong expenditure rules were less prone to procyclical spending biases.

In parliamentary systems, ministers frequently push for larger allocations to their respective ministries, often contributing to budget deficits. Some studies argue that fiscal rules can help mitigate both deficit biases and common-pool problems (Alesina et al., 1999; von Hagen and Harden, 1995). The literature further shows that overspending driven by common-pool dynamics and political budget cycles can be contained through the implementation of fiscal rules. (Buchanan and Wagner, 1977; Persson and Tabellini, 2004) also examine how electoral systems and forms of government influence fiscal outcomes across a broad set of democracies. Their findings indicate that parliamentary regimes tend to provide more public goods, expand universalistic welfare programs, and sustain a generally larger government size.

However, several studies also criticize strict adherence to fiscal rules. It may hinder tax smoothing and complicate fiscal management, particularly during economic downturns. Moreover, fiscal rules may exacerbate recessions. Researchers argue that if the adoption of fiscal rules does not reflect the preferences of policymakers or the public, adherence to these rules may be weak or inconsistent, potentially distorting fiscal balances e.g., (Alesina, 2012; Barro, 1979; Kopits, 2001).

Research exploring the link between fiscal rules and government spending remains relatively scarce, with much of the existing work concentrating on Advanced economies (AEs). (Dahan and Strawczynski, 2013) analyze 22 OECD countries and find that fiscal rules enhance fiscal balances by reducing deficits, though they also note a decline in social transfers relative to government consumption. Along similar lines, (Galí and Perotti, 2003) study the effects of fiscal rules specifically the Maastricht Treaty and the Stability and Growth Pact, on public investment within the European Union. Their results show a decline in public investment due to the adoption of fiscal rules. (Cordes et al., 2015) find that expenditure rules lead to a decrease in public investment in (EMDEs) but not in (AEs). One possible explanation is that (AEs) are better able to mitigate the negative effects on investment due to stronger fiscal management and budgetary controls. In contrast, (EMDEs) often resort to cutting spending to meet short-term compliance requirements. (Alesina and Perotti, 1995a) argue that governments may reduce public investment in politically acceptable ways that are not always effective in reducing debt. Similarly, (Roubini and Sachs, 1988) and (Luca and Sousa, 2012) find that governments tend to cut

spending in ways that help meet deficit targets but may also reduce the chances of re-election and increase poverty and inequality.

The literature also provides evidence that successful fiscal consolidation episodes are often driven by expenditure cuts rather than tax increases see (Alesina and Ardagna, 1998; Afonso and Jalles, 2012; Alesina and Perotti, 1995a; Westcott and McDermott, 1996).

Recent studies have shifted their focus to second-generation fiscal rules, which include flexibility clauses to accommodate exogenous shocks see, for example, (Ardanaz et al., 2021; Caselli and Reynaud, 2020a). These studies often use a fiscal rules index, based on (Schaechter et al., 2012a), to evaluate the effects of rule design on fiscal outcomes and public investment. (Ardanaz et al., 2021), using panel data on 75 advanced and (EMDEs), find that flexible fiscal rules help eliminate the negative effects of fiscal adjustments. (Caselli and Reynaud, 2020a) study the impact of fiscal rules on fiscal balances using a panel of 142 countries and an instrumental variable approach. They find that well-designed fiscal rules have a statistically significant and positive impact on fiscal outcomes.

Some recent research has applied treatment effect methods to identify the causal impact of fiscal rules. For example, (Grembi et al., 2016) employ a quasi-experimental approach in Italy to analyze their effects on local governments, while (Caselli and Wingender, 2018) use inverse probability weighting to evaluate how the 3 percent deficit ceiling influences the distribution of fiscal balances across European countries.

The literature on the effectiveness of fiscal rules remains inconclusive. Most prior studies have focused on controlling deficits and ensuring fiscal discipline, while the effect of fiscal rules on public spending patterns has received less attention. Moreover, much of the literature centers on (AEs) particularly OECD, EU countries, and the United States. A common limitation is that many studies rely on a simple fiscal rule dummy, ignoring the stringency and design of fiscal rules as captured by more nuanced indices.

In addition, evidence on the impact of fiscal rules in (EMDEs) remains scarce, partly due to limited data availability and the relatively recent adoption of such rules in these contexts. Furthermore, many previous studies suffer from methodological limitations. For example, most do not account for the fact that both dependent and control variables may be non-stationary, which can lead to spurious regression results. The estimated effects of fiscal rules on fiscal outcomes may be overstated due to problems of non-stationarity and endogeneity.

The distinctive contribution of this study lies in three main aspects. First, it provides a cross-country analysis of how fiscal rules affect the composition of public spending in both (AEs) and emerging and developing economies, while most existing studies focus on aggregate fiscal outcomes or a narrower set of countries. Second, it goes beyond the presence of fiscal rules by using a fiscal rule index to capture differences in rule design, allowing us to distinguish between the effects of adopting

rules and their strength. Third, it employs a dynamic panel approach that addresses endogeneity and non-stationarity, providing more reliable estimates of the impact of fiscal rules on spending. Together, these contributions offer new evidence on how fiscal rules influence both fiscal discipline and the allocation of public expenditure.

2.4 Empirical Approach

2.4.1 Data and Variables

The study builds up a panel database for the period of 1985–2020 for thirty-four (AEs) and thirty-three (EMDEs), currently following national fiscal rules. (See Table 2.6 for the list of countries included in each set of samples.)

Two key sets of variables in this study are fiscal rules (independent/policy variables) and public spending categories (dependent / outcome variables of interest). Fiscal rules dataset is obtained from Fiscal Affairs Deportment (FAD) IMF, (for details on the Fiscal Rules-FAD dataset-2015, see (Lledó et al., 2017). Fiscal rules comprise, balanced budget rules, expenditure rules, debt rules, and revenue rules (See Figure 2.2, panels a and b) for mean Fiscal rules and differences regarding the type of fiscal rules in (AEs) and (EMDEs). Figure 2.1 shows that the number of countries adopting fiscal rules increased steadily in both advanced economies (AEs) and emerging and developing economies (EMDEs) between 1990 and 2020. Advanced economies adopted fiscal rules earlier and in greater numbers, with budget balance and debt rules being the most widely used, while expenditure rules became more common after 2010. In EMDEs, the adoption of fiscal rules accelerated after 2000, particularly for budget balance, debt, and expenditure rules, whereas revenue rules remained relatively uncommon in both groups. Further, dataset provides information on five key characteristics of fiscal rules. We construct an index as follows:

The fiscal rules index is constructed using a composite index approach that captures key dimensions of fiscal rule design, including flexibility, legal basis, enforcement, coverage, and supporting procedures. Each component is first coded based on institutional characteristics derived from the IMF fiscal rules dataset. Binary indicators are used where applicable, while categorical variables such as legal basis and coverage are rescaled to lie between 0 and 1 using min–max normalization. For components comprising multiple indicators, such as enforcement and supporting procedures, individual variables are aggregated using simple averages. The overall fiscal rules index is then obtained by summing the five normalized components, resulting in an index ranging from 0 to 5, where higher values indicate stronger and more comprehensive fiscal frameworks.

This construction closely follows the methodology of (Schaechter et al., 2012a), who develop composite indices of fiscal rule strength based on institutional charac-

teristics such as legal foundation, coverage, and enforcement mechanisms. However, the present study extends this approach by explicitly incorporating a flexibility dimension capturing well-defined escape clauses and by adopting a simplified aggregation procedure tailored to the available data. This modification allows the index to better reflect the trade-off between rule credibility and adaptability, while maintaining consistency with the broader IMF-style framework widely used in the literature. (See Appendix for chapter 2 section 2.2 for detail on the Fiscal Rule index construction).

Public spending categories cover total spending, social spending, education spending, and health spending. Data on public spending categories is extracted from the International Food Policy Research Institute (IFPRI) (for a detailed description, see Statistics of Public Expenditures for Economic Development (SPEED), 2019).

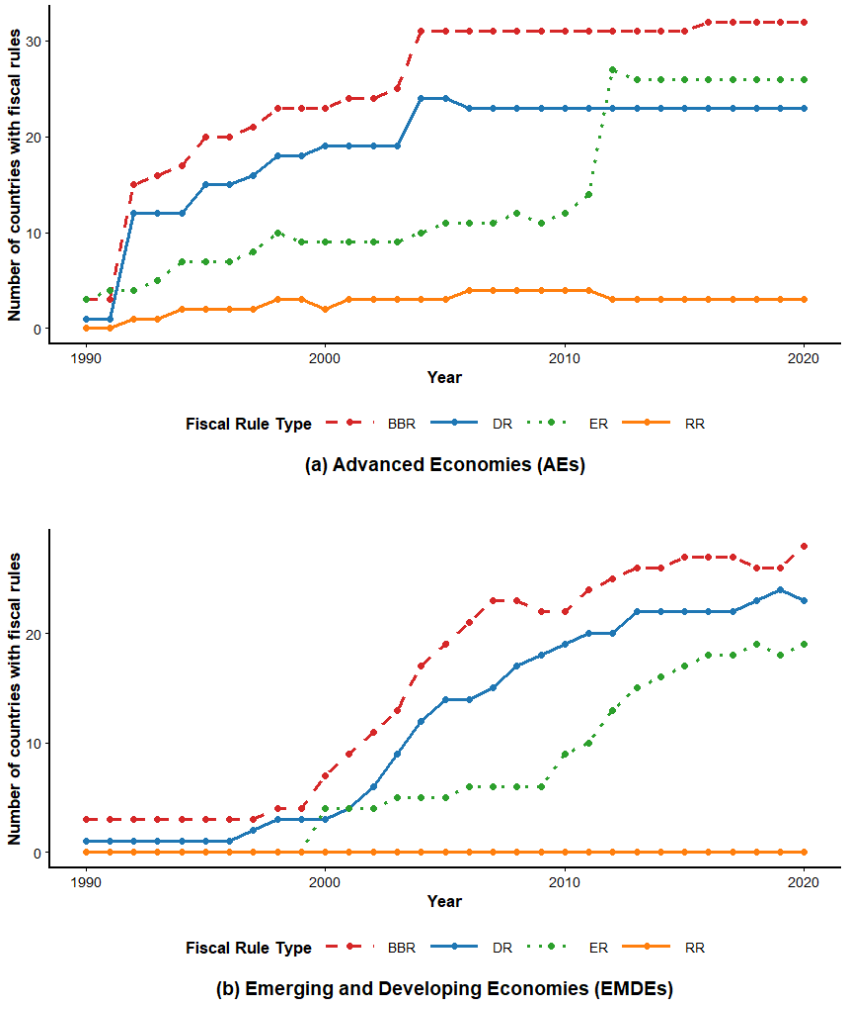


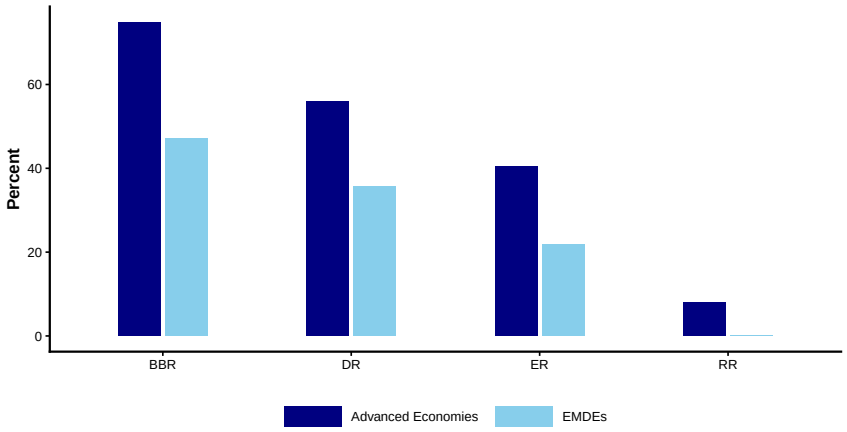
Figure 2.1: Types of Fiscal Rules Adopted in Advanced and Emerging Economies

Note: The top panel of the figure displays the adoption of four types of fiscal rules in Advanced economies (AEs) over time, while the bottom panel presents the same for Emerging and Developing Economies (EMDEs). As shown, budget balance rules (BBRs) and expenditure rules (ERs) are more commonly adopted in (AEs). In contrast, (EMDEs) tend to adopt BBRs, expenditure rules (ERs), and Debt rules (DRs) more frequently. Revenue rules (RRs), however, remain the least adopted rule type across both groups, especially in (EMDEs).

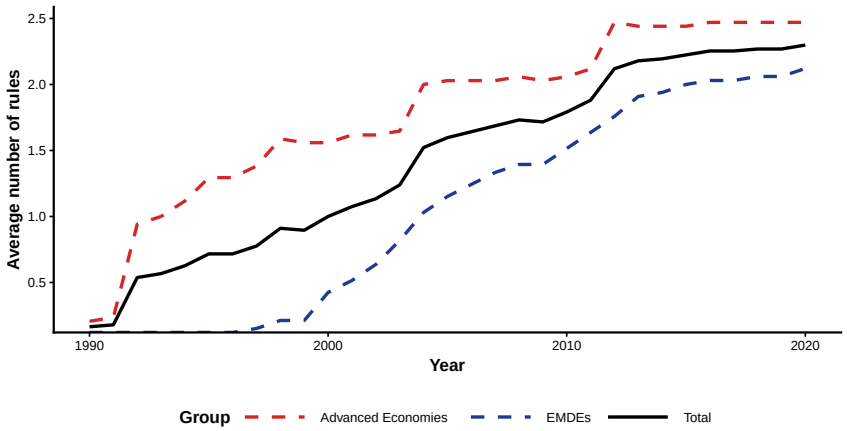
Following the literature, this study employs four sets of control variables representing economic, demographic, governance and political subjects. In the category of economic variables, we include GDP constant US $ to capture the overall size of the economy and GDP per capita to capture the growth of the economy. The output gap is calculated by a Hodrick Prescott filter, showing whether the economy is overworking or underworking its resources see (Hodrick and Prescott, 1997; Powell, 2016; Delgado, 2020; Reuter, 2015) we add trade openness (exports plus imports as a percentage of GDP) in the line of studies (e.g., (Caselli and Reynaud, 2020b; Reuter, 2015). Trade openness explains the extent to which an economy is open to external shocks. Moreover, the unemployment rate to capture the labour market, debt as a percentage of GDP, revenue as a percentage of GDP, and inflation rate are also included as determinants of public spending following previous studies (see, for instance, (Ardanaz et al., 2020; Bamba et al., 2020; Dahan and Strawczynski, 2013; Fan and Rao, 2003; Reuter, 2015) The second category of control variables is demographic variables. Following (Dahan and Strawczynski, 2013), we include the dependency ratio of the population, defined as the population below 14 years plus the population above the age of 65 years, to capture the demand for public goods and resources. Data on these two categories of control variables is obtained from the IMF's Government Finance Statistics and World Economic Outlook (WEO-IMF).

The third group of control variables consists of governance measures obtained from the Worldwide Governance Indicators (WGI), which encompass six key dimensions: control of corruption, government effectiveness, political stability and absence of violence/terrorism, regulatory quality, rule of law, and voice and accountability. Control of corruption captures the extent to which public power is diverted for private gain, covering both petty and grand corruption, as well as undue influence by elites or private actors. Government effectiveness reflects perceptions of the quality of public services, the professionalism and autonomy of the civil service, the quality of policy formulation and execution, and the credibility of government commitments. Political stability and absence of violence/terrorism measure the risk of political unrest or violence, including terrorist activities. Regulatory quality assesses perceptions of the state's capacity to formulate and enforce sound policies and regulations that encourage private sector development. Rule of law reflects confidence in contract enforcement, protection of property rights, the functioning of police and judicial institutions, and the prevalence of crime and violence. Finally, voice and accountability capture the degree to which citizens are able to participate in government selection and enjoy freedoms of expression, association, and access to independent media. Each indicator provides country-level scores expressed as an aggregate index in units of a standard normal distribution, generally ranging from -2.5 to +2.5.

The last category of control variables is political and institutional variables. There is ample evidence in political economy literature that democracies and left-



(a) Differences in Fiscal Rule Types across AEs and EMDEs



(b) Average Number of Rules by Country Group

Figure 2.2: Average Fiscal Rules and Differences in Rule Types Across Advanced and Emerging Economies

Note: The top panel illustrates the types and differences in fiscal rules adopted across Advanced economies (AEs) and Emerging and Developing Economies (EMDEs). Budget balance rules (BBRs) are the most commonly adopted in both groups, while revenue rules are the least common. The bottom panel shows the average number of fiscal rules implemented by country groups. The red dotted line represents (AEs) average number of rules, the blue dotted line represents (EMDEs) average number of rules, and the black solid line shows the overall average number of fiscal rules across all countries.

party governments emphasize more social security programmes to reduce poverty and inequality. Hence, they are prone to spending more. In the study, we controlled for democracy, which is a dummy variable that takes a value of 1 if a country has a democracy and 0 otherwise. Following (Armingeon et al., 2019; Heinemann et al., 2018; Reuter, 2015), we include a political ideology dummy variable, taking value 1 if the government is left and 0 otherwise. There is evidence that public spending rises rampantly in election years. Political agents spend more in order to gain voters support to re-elect them in the coming election (See e.g., (Brender and Drazen, 2005b)). To capture this effect, we add an election year dummy variable in line with (Heinemann et al., 2018; Reuter, 2015), which represents value 1 for election year 0 otherwise. Lastly, the dummy for the system of government defined as parliamentary system = 1, presidential = 0 is also included in the category of political variables. The data on the political variables is extracted from the polity variables series published by the World Bank.

We start merging the IMF fiscal rules dataset on the countries, with the spending categories dataset and control variables dataset. The study used two samples, one for (AEs), and another for (EMDEs). Finally, in these datasets, several variables have missing observations for some time periods, which leads to an unbalanced panel dataset. Differently from previous studies, we use difference log transformation on dependent variables and control variables due to the non-stationary nature of the series. Appendix to chapter 2, Table 2.5 represents a detailed description and sources of all the variables included in the study.

2.5 Econometric Model

In our econometric analysis, we employ two complementary approaches. In the first approach, we use fiscal rules dummy variables (policy variables) to examine the impact of fiscal rules on various social spending categories. These dummy variables capture the presence or absence of a fiscal rule, allowing us to identify whether simply adopting a rule has any effect on spending outcomes. However, this approach does not account for differences in how rules are designed or enforced. Therefore, in the second approach, we replace the dummy variables with a fiscal rules index. The index provides a more nuanced measure by capturing the strength, design, and institutional quality of fiscal rules, including aspects such as legal basis, coverage, monitoring, and enforcement mechanisms (Schaechter et al., 2012a; Caselli and Reynaud, 2020a). While the dummy-based approach focuses on the existence of fiscal rules, the index-based approach allows us to assess whether stronger and better-designed rules have a more significant impact.

As a first step, we apply panel unit root tests to check the stationarity of the variables in our model, using the Im, Pesaran, and Shin (IPS) panel unit root test, which is recommended for unbalanced panels (see Table 2.3 and 2.4). We transform

nonstationary variables into log differences (Dlog) before analysis.

To analyze the impact of fiscal rules on four categories of public spending, we specify the following equations:

$$\Delta y_{it} = \gamma FR_{it} + \beta \Delta x_{it} + \alpha_i + \varepsilon_{it} \tag{1}$$

$$\Delta y_{it} = \gamma FR^I_{it} + \beta \Delta x_{it} + \alpha_i + \varepsilon_{it} \tag{2}$$

Here, y_{it} is the dependent variable, representing the spending category of interest (Dlog total spending, Dlog social spending, Dlog education spending, and Dlog health spending). FR_{it} is a dummy variable for fiscal rules, taking the value of 1 if a rule is in place in country i at time t, and 0 otherwise. The parameter γ measures the impact of fiscal rules on spending categories. x is a vector of control variables,[1] α_i denotes country fixed effects, and ε_{it} is the idiosyncratic error term. Equation (2) introduces the fiscal rule index FR^I_{it}, which measures the strength of fiscal rules in a country, in place of the dummy.

We estimate the baseline models using fixed effects, including both country and time fixed effects, and compute robust standard errors clustered at the country level to account for heteroskedasticity and serial correlation within countries over time. However, fixed effects estimators may be inconsistent given the short time dimension of our panel. Moreover, the model does not rule out endogeneity. If the right-hand side variables are strictly exogenous, fixed effects might still provide reliable estimates (Bond, 2002). Since this study does not assume strict exogeneity of fiscal rules, identifying the influence of fiscal rules on spending categories based on Equation (1) is challenging due to the potential threat of endogeneity.

Endogeneity in our model may arise from: (i) selection bias, (ii) unobservable or observable confounding factors, and (iii) the adoption process of fiscal rules.

The first source, selection bias, arises if past levels of spending influence the probability that a country implements fiscal rules. To address this, we include spending dynamics by augmenting Equations (1) and (2) as follows:

$$\Delta y_{it} = \gamma FR_{it} + \beta \Delta x_{it} + \delta \Delta y_{it-1} + \alpha_i + \varepsilon_{it} \tag{3}$$

$$\Delta y_{it} = \gamma FR^I_{it} + \beta \Delta x_{it} + \delta \Delta y_{it-1} + \alpha_i + \varepsilon_{it} \tag{4}$$

[1] Following the literature, we control for a set of economic, demographic, governance, and political variables that may influence public spending. Economic controls include GDP (constant US$), GDP per capita, the output gap (constructed using the Hodrick–Prescott filter), trade openness, unemployment rate, public debt (% of GDP), government revenue (% of GDP), and inflation. Demographic factors are captured by the dependency ratio. Governance indicators are drawn from the Worldwide Governance Indicators and include control of corruption, government effectiveness, political stability, regulatory quality, rule of law, and voice and accountability. Political and institutional controls include democracy, government ideology, election year, and the system of government.

In these equations, $\delta \Delta y_{it-1}$ captures spending dynamics. Lagged values of the dependent variable are used as instruments to control for the endogenous relationship (Ullah et al., 2018). Our empirical strategy relies on the assumption that endogeneity arising from selection bias is mitigated once the model accounts for spending dynamics that could influence the adoption of fiscal rules.

A second source of endogeneity may stem from omitted variable bias, if unobserved or omitted factors are correlated with both spending categories and the probability that a country implements fiscal rules. For instance, fiscal institutions are unlikely to be exogenous: the adoption of certain rules and regulations and overall fiscal performance may be correlated with unobserved country-specific preferences Inman (1998); Poterba (1996). According to (Debrun and Kumar, 2009), a government's self-commitment to fiscal targets can motivate it to adopt strict fiscal rules. Furthermore, countries may adopt rules during crises or periods of fiscal distress, leading to reverse causality, as deteriorating fiscal conditions such as rising deficits, increasing debt levels, or loss of market confidence can trigger the introduction of fiscal rules rather than the rules themselves driving fiscal outcomes. Countries might also implement fiscal rules when they join economic unions or enter IMF programs.

To the extent these factors are observable, we control for them by including variables such as a dummy for economic union membership, a dummy for IMF fiscal programs, and a variable for the global financial crisis. To the extent these confounding factors are time-invariant and unobservable, they are addressed by country fixed effects. A related concern is that one could, in principle, adopt an instrumental variable (IV) strategy to address reverse causality. The literature highlights several factors such as political institutions or external constraints like EU fiscal frameworks and IMF-supported programs that are associated with the adoption of fiscal rules (Ayuso-i Casals et al., 2009; Debrun et al., 2008). However, these variables are typically used as determinants rather than valid instruments, as they may also directly affect fiscal outcomes and thus violate the exclusion restriction. As a result, identifying a credible external instrument that influences fiscal rule adoption without directly affecting public spending remains challenging in a cross-country setting.

A final source of endogeneity may arise from political and institutional characteristics influencing the adoption of fiscal rules. Policymakers may have unobservable preferences for maintaining fiscal discipline that shape policies regardless of formal institutions (Combes et al., 2017). To address this, we include a variety of political and governance control variables that could influence fiscal policy outcomes.

The Generalized Method of Moments (GMM) approach provides consistent estimates in the presence of these different sources of endogeneity. The GMM model addresses endogeneity by internally transforming the data (Roodman, 2009c). Two main transformation methods exist: the first-difference GMM (one-step GMM) proposed by Arellano and Bond (1991) and the system GMM (two-step GMM) proposed by (Arellano and Bover, 1995).

While first-difference GMM can lead to data loss when recent values are missing and may introduce correlation between differenced errors (Roodman, 2009c), the two-step system GMM uses forward orthogonal deviations, subtracting the average of all future available observations instead of the previous observation. This approach helps avoid data loss and imprecision.

Therefore, we rely on system GMM, following (Arellano and Bover, 1995), to estimate Equations (3) and (4), consistent with prior applications in Bergman and Hutchison (2018), (Combes et al., 2017), and (Celasun et al., 2007). This estimator uses lagged first differences and levels of the explanatory variables as instruments. The two-step system GMM relies on the assumption of mean stationarity and requires strong conditions for instrument validity (Bontempi and Mammi, 2015; Roodman, 2009a,b). To address these concerns, we conduct tests of instrument validity and over-identifying restrictions, as well as checks for higher-order serial correlation. For all estimated models, we report p-values for the Hansen J test (assessing joint validity of instruments) and for first-order [AR(1)] and second-order [AR(2)] autocorrelation tests. A properly specified model should exhibit significant first-order serial correlation (i.e., reject the null hypothesis of no AR(1)), while showing no evidence of second-order serial correlation (i.e., fail to reject the null of no AR(2)). In addition, the Hansen J test should not reject the null hypothesis, indicating that the instruments used are jointly valid. Further details on the data-generating process underlying difference and system GMM are provided in Appendix 2.3 of Chapter 2.

2.6 Results and Discussion

2.6.1 Results for Emerging and Developing Economies - (EMDEs)

Table 2.1 presents the empirical findings for (EMDEs) across various spending categories, including total spending, social spending, education spending, and health spending. The results from fixed effects models (Equations 1 and 2) as well as dynamic panel estimations using difference GMM and system GMM (Equations 3 and 4) are reported, with clustered standard errors shown in parentheses. Diagnostic statistics, including AR and Hansen tests, are provided below the table to ensure the validity of instruments and absence of serial correlation.

The discussion primarily centers on the results from the system GMM estimations, which effectively address endogeneity concerns and capture the persistence in fiscal variables. Consistent with the theoretical arguments by (Persson and Svensson, 1989) and the empirical analyses by (Debrun and Kumar, 2007), the adoption of balanced budget rules (BBRs) in (EMDEs) appears to significantly reduce budget deficits see Table 2.1 Column (3). Many (EMDEs) face chronic fiscal imbalances and often adopt such rules either under external fiscal consolidation programs or through institutional diffusion to enhance fiscal credibility and market confidence.

This result also echoes the broader findings from IMF studies (International Monetary Fund, 2009), which highlight the role of fiscal rules as commitment mechanisms that constrain policymakers discretion and curb excessive deficits.

The system GMM estimates for total spending, presented in Column 3 of Table 2.1, show that BBRs significantly lower the growth rate of aggregate public spending, with a coefficient of $\beta = -0.046$ significant at the 5% level. This supports the argument advanced by (Kopits and Symansky, 1998) that balanced budget rules are effective instruments for restraining overall spending growth, thereby contributing to the restoration of fiscal sustainability.

Turning to the composition of spending, the results indicate a notable trade-off. Column (6) of Table 2.1 shows a negative and statistically significant relationship between BBRs and social spending, with an estimated coefficient of $\beta = -0.149$ significant at the 10% level. This suggests that (EMDEs) implementing BBRs often cut social transfer programs to meet short-term fiscal targets compared to countries that do not have fiscal rules. This finding aligns with the political economy literature, such as (von Hagen, 1992) and (Hallerberg et al., 2009), which argues that in contexts of binding fiscal constraints, less visible expenditures like social protection are more likely to be reduced. This is further supported by Dahan and Strawczynski (2013), who show that countries with weaker legal guarantees for social rights tend to allocate less to social programs when under fiscal pressure. Interestingly, expenditure rules (ERs) show a positive and significant association with social spending ($\beta = 0.249$, significant at the 5% level), indicating that well-designed expenditure ceilings might protect essential social programs by forcing prioritization within a constrained envelope, as highlighted by (Cordes et al., 2015).

Regarding education spending, the estimates in Table 2.1 column 9 reveal that BBRs exert downward pressure on education budgets, with a coefficient significant at the 5% level. This pattern is consistent with earlier findings by (Alesina and Bayoumi, 1996), who document that fiscal adjustments often disproportionately target long-term investments such as education. In contrast, debt rules (DRs) are associated with an increase in education spending. This may reflect that debt-targeted fiscal frameworks allow space for strategic investments in education, especially in (EMDEs) facing demographic pressures due to large youth populations, as discussed in the World Bank's 2018 World Development Report.

In the case of health spending, the results reported in Table 2.1 Column 12 indicate that both BBRs and DRs are negatively associated with health expenditures, with coefficients significant at the 1% level. This suggests that fiscal constraints imposed by these rules may lead governments to reduce health spending as part of their adjustment strategies. This is in line with (Clements et al., 2013), who show that under tight fiscal conditions, social sectors often become the adjustment margins, particularly in countries lacking robust institutional protections for health. However, ERs again demonstrate a positive impact on health spending, significant at

the 5% level, underscoring the potential of well-calibrated expenditure frameworks to safeguard critical sectors.

Overall, these findings suggest that while fiscal rules, particularly BBRs, play a crucial role in enhancing fiscal discipline in (EMDEs), they may also entail important trade-offs in terms of reduced allocations to social sectors, unless accompanied by well-designed expenditure rules that explicitly protect priority spending. This highlights the importance of tailoring fiscal rule frameworks to balance the objectives of sustainability with the need to support human capital and social development.

Lastly, results reported in Table 2.1 indicate that the Hansen J test p-values are consistently above conventional significance thresholds, suggesting that the instruments used in all models are valid. Additionally, all specifications reject the null hypothesis of no first-order serial correlation (AR(1)), as expected in first-differenced residuals. Most models also fail to reject the null of no second-order serial correlation (AR(2)), indicating that the moment conditions are correctly specified. Together, these diagnostic tests support the validity of the system GMM estimation strategy.

Table 2.1: Fiscal Rules Dummy and (EMDEs) sample Results

	Total Spending			**Social Spending**			**Education Spending**			**Health Spending**		
	(1) Fixed	(2) Diff GMM	(3) Sys GMM	(4) Fixed	(5) Diff GMM	(6) Sys GMM	(7) Fixed	(8) Diff GMM	(9) Sys GMM	(10) Fixed	(11) Diff GMM	(12) Sys GMM
BBR	0.757*	-0.070*	-0.046**	-0.165***	-0.454**	-0.149*	0.119**	0.082***	-0.091**	-0.030***	-0.293***	-0.343***
	(0.041)	(0.043)	(0.021)	(0.054)	(0.216)	(0.084)	(0.059)	(0.014)	(0.045)	(0.012)	(0.012)	(0.096)
ER	0.013	0.031	0.021	0.047	0.245*	0.249**	-0.015	0.025	-0.016	0.002	0.085	0.221**
	(0.025)	(0.343)	(0.247)	(0.051)	(0.144)	(0.106)	(0.037)	(0.023)	(0.049)	(0.022)	(0.076)	(0.111)
DR	0.048	0.084**	0.155	0.177	0.360	0.021	0.101*	-0.074**	0.090*	0.215*	0.298***	-0.305***
	(0.031)	(0.335)	(0.023)	(0.586)	(0.145)	(0.095)	(0.057)	(0.007)	(0.514)	(0.125)	(0.150)	(0.108)
RR	0.546	0.019	0.040	–	–	–	–	–	–	–	–	–
	(0.096)	(0.069)	(0.787)	–	–	–	–	–	–	–	–	–
Obs	349	283	378	315	238	330	310	282	337	320	283	340
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Instrum.	–	42	31	–	44	30	–	41	29	–	40	31
AR1 Test	–	–	0.000	–	–	0.000	–	–	0.000	–	–	0.010
AR2 Test	–	–	0.079	–	–	0.181	–	–	0.141	–	–	0.276
Hansen J	–	–	0.288	–	–	0.406	–	–	0.139	–	–	0.306

Notes: "Fixed" refers to the fixed effects estimator. "Diff GMM" denotes the Arellano–Bond difference GMM estimator. "Sys GMM" refers to the Arellano–Bover/Blundell–Bond system GMM estimator. Clustered and Robust Standard errors are shown within parenthesis below each point estimate. *** denotes significance at 0.01 level, ** at the 0.05 level and * at the 0.10 level. Hansen J test for over identification restriction. AR1 and AR2 test report first and second order correlation. Intercepts and control variables are included but not reported.

2.6.2 Results for Advance Economies - (AEs)

Table 2.2 presents the empirical estimates examining the impact of fiscal rules on various spending categories in (AEs). Column (3) of Table 2.2 reports the results for total spending, indicating that balanced budget rules (BBRs) are positively associated with aggregate expenditure growth, with a coefficient of $\beta = 0.150$, significant at the 5% level. This finding may seem counterintuitive, but it aligns with theoretical arguments and empirical observations suggesting that in fiscally mature institutional environments, balanced budget rules can enhance credibility and reduce borrowing costs, thereby creating fiscal space that governments may use to maintain or even expand spending levels (Bohn and Inman, 1996; Alt and Lowry, 1994). Such mechanisms are typically described as "credibility effects," whereby stronger rules reassure markets, lower interest premia, and allow more stable public spending even under tighter constraints. However, credibility itself may also represent an omitted variable, since it is difficult to measure directly and may influence both the adoption and effectiveness of fiscal rules as well as expenditure outcomes. More credible governments are likely to face lower borrowing costs and greater market confidence irrespective of the presence of fiscal rules, while also being more capable of implementing and adhering to such rules. Consequently, part of the estimated positive association between balanced budget rules and expenditure growth may reflect underlying government credibility rather than the causal effect of the rules alone. Consequently, rather than forcing abrupt cutbacks, BBRs in advanced countries appear to support a stable fiscal path, consistent with the notion of rules serving as anchors rather than strict ceilings (Wyplosz, 2012). Column (6) of Table 2.2 shows that fiscal rules have no significant impact on social sector spending.

Turning to the results for education spending, shown in Column (9) of Table 2.2, the parameter estimate for BBRs is negative and highly significant. The findings suggest that advanced countries with BBRs experience roughly 25% lower growth in education investment compared to those without such rules. This evidence resonates with the argument in (Alesina and Perotti, 1996) that fiscal consolidations under rigid rule-based systems often disproportionately affect long-term expenditure items such as education. However, the coefficient on DRs is positive and significant at the 10% level, indicating that while debt rules aim to stabilize debt burdens, they may not necessitate reductions in education budgets. This is consistent with results from (EMDEs) and supported by empirical analyses such as (Debrun et al., 2008), who show that well-designed debt rules can allow room for productive investment by setting medium-term anchors rather than short-run hard constraints.

Column (12) of Table 2.2 also reports results for health spending. Here, the association between health expenditure and debt rules is positive and significant at the 5% level ($\beta = 0.233$). This suggests that (AEs) employing debt-targeted frameworks may prioritize health spending, possibly reflecting political economy considerations where health is viewed as politically sensitive and often safeguarded

even during fiscal adjustments (Clements et al., 2013; for Economic Co-operation and Development, 2015). The positive relationship underscores how debt rules when credibly anchored can help maintain or increase social investments by containing debt servicing costs and avoiding the crowding out of essential expenditures.

Table 2.2 also that the system GMM estimation is well-specified across all model specifications. The Hansen J test fails to reject the null of instrument validity in all cases, and the AR(1) test appropriately rejects the null of no first-order autocorrelation. Additionally, the AR(2) test fails to reject the null of no second-order serial correlation, indicating that the model's moment conditions are correctly specified. The number of instruments remains within acceptable bounds relative to the sample size, supporting the reliability of the estimation strategy.

Overall, the results suggest that fiscal rules particularly budget balance rules (BBRs) and debt rules (DRs) play an important role in shaping spending patterns in (AEs), although their effects vary across spending categories and institutional contexts. Existing evidence indicates that BBRs are generally associated with improved fiscal discipline and more sustainable budget positions, as they directly target deficits and constrain discretionary fiscal policy (Badinger, 2009; Von Hagen, 2005). At the same time, their impact on aggregate spending is not necessarily contractionary, as governments may adjust the composition of expenditures or revenues rather than reducing overall spending levels (Vinturis, 2023), consistent with findings that fiscal rules often influence the composition and efficiency of spending rather than simply its size (Gootjes et al., 2021; Schakel et al., 2018)

In (AEs), relatively stronger institutional frameworks, higher fiscal transparency, and greater policy credibility help explain why BBRs can support fiscal discipline without sharply reducing total spending. However, they may still constrain specific long-term investments, such as education, highlighting the importance of complementing fiscal rules with frameworks that protect growth-enhancing expenditures (Schaechter et al., 2012b). At the same time, the positive impact of debt rules on both education and health spending suggests that debt-based anchors can accommodate targeted social investments, provided they are designed with sufficient flexibility and supported by robust fiscal institutions.

The results for (EMDEs) differ from those of (AEs): while BBRs in (AEs) improve budgetary positions without reducing total spending, in (EMDEs) they are largely adopted to enhance fiscal discipline, often under external guidance. Consequently, BBRs in (EMDEs) tend to have a negative impact across all major spending categories, including social sectors, as governments implement them in contexts of fiscal stress and institutional fragility.

Table 2.2: Fiscal Rules Dummy and (AEs) sample Results

	Total Spending			**Social Spending**			**Education Spending**			**Health Spending**		
	(1) Fixed	(2) Diff GMM	(3) Sys GMM	(4) Fixed	(5) Diff GMM	(6) Sys GMM	(7) Fixed	(8) Diff GMM	(9) Sys GMM	(10) Fixed	(11) Diff GMM	(12) Sys GMM
BBR	-0.027	-0.021	0.150**	-0.017	-0.003	-0.136	0.003	0.011	-0.255***	0.049	0.061	-0.055
	(0.022)	(0.020)	(0.071)	(0.035)	(0.031)	(0.116)	(0.045)	(0.039)	(0.092)	(0.652)	(0.058)	(0.102)
ER	-0.330	-0.033*	0.057*	-0.040	0.062**	0.097	-0.035	0.033**	0.083	0.003	0.006	0.063
	(0.019)	(0.020)	(0.052)	(0.184)	(0.025)	(0.089)	(0.0147)	(0.014)	(0.057)	(0.023)	(0.014)	(0.072)
DR	0.079	0.076**	-0.011	0.070	0.071*	0.093	-0.018	-0.010	0.186*	0.181	0.119*	0.233**
	(0.040)	(0.039)	(0.090)	(0.041)	(0.038)	(0.135)	(0.370)	(0.028)	(0.105)	(0.776)	(0.065)	(0.114)
RR	0.039	-0.028	0.091	-0.047	0.017	0.261	0.012	0.026	-0.286	0.003	0.027	-0.104
	(0.377)	(0.045)	(0.176)	(0.031)	(0.048)	(0.305)	(0.026)	(0.030)	(0.192)	(0.038)	(0.049)	(0.188)
Observations	424	427	518	424	423	520	424	424	520	424	422	517
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Instruments	–	79	30	–	75	28	–	75	30	–	77	27
AR1 Test	–	–	0.00	–	–	0.001	–	–	0.001	–	–	0.001
AR2 Test	–	–	0.507	–	–	0.288	–	–	0.210	–	–	0.197
Hansen J	–	–	0.081	–	–	0.098	–	–	0.579	–	–	0.123

Notes: "Fixed" refers to the fixed effects estimator. "Diff GMM" denotes the Arellano–Bond difference GMM estimator. "Sys GMM" refers to the Arellano–Bover/Blundell–Bond system GMM estimator. Clustered and Robust Standard errors are shown within parenthesis below each point estimate. *** denotes significance at 0.01 level, ** at the 0.05 level and * at the 0.10 level. Hansen J test for over identification restriction. AR1 and AR2 test report first and second order correlation. Intercepts and control variables are included but not reported.

2.7 Results - Fiscal Rule Index

2.7.1 Results for Emerging and Developing Economies - (EMDEs)

Table 2.3 presents the empirical estimates for (EMDEs) using the fiscal rule index, which captures not merely the presence of fiscal rules but also their design characteristics, including legal basis, coverage, escape clauses, and enforcement mechanisms. This distinction is essential, as emphasized by (Caselli and Reynaud, 2020b) and (International Monetary Fund, 2018b), who argue that the quality of rule design is crucial for fiscal rules to exert meaningful influence on fiscal outcomes.

Column (3) of Table 2.3 shows that the balanced budget rule index has a negative and significant impact on total spending, indicating that stronger fiscal rule design contributes to fiscal discipline by curbing overall expenditure. However, the relatively modest magnitude of the coefficient ($\beta = -0.022$) suggests that the effectiveness of these rules may be constrained by limited institutional capacity and enforcement in many (EMDEs). This is consistent with (Lledó et al., 2017), who find that fiscal rule strength often does not fully translate into effective implementation in developing country contexts.

Turning to social spending, Column (6) of Table 2.3 shows that the balanced budget rule index is negatively associated with social sector expenditures, with a coefficient significant at the 5% level. This implies that improvements in the design of balanced budget frameworks in (EMDEs) continue to exert downward pressure on social transfers in order to achieve budget balance. This pattern is consistent with theoretical insights from the political economy of budgeting (Milesi-Ferretti, 2003), which suggest that tighter rule frameworks constrain discretionary spending, often making social programs the primary adjustment channel in weaker institutional environments.

For education spending, Column (9) of Table 2.3 shows that the negative and significant coefficient on the balanced budget rule index reinforces the idea that enhancing the quality of rule design through stricter legal mandates or broader coverage can lead to reduced educational allocations as countries strive to comply with budget targets. This finding is also aligned with empirical results by (Guerguil et al., 2017), who show that stringent fiscal rules in low- and middle-income countries tend to crowd out long-term investment components, including education.

Column (12) of Table 2.3 reports that the debt rules index is negatively and significantly associated with health expenditures. This suggests that stronger debt rule designs, intended to credibly anchor debt sustainability, may also constrain the fiscal space available for health spending in (EMDEs). However, the positive and significant effect of the expenditure rule index on health expenditures highlights that improvements in expenditure rule design such as explicit protection of priority spending or exemption clauses for health can support allocations to this vital sector.

This complements theoretical discussions by (Ter-Minassian, 2010), who argues that well-crafted expenditure rules can be instrumental in protecting key social sectors from fiscal consolidation pressures.

The results in Table 2.3 confirm that the system GMM estimates are valid, with appropriate instrument validity (Hansen J), expected AR(1) rejection, and no evidence of second-order serial correlation (AR(2)).

As highlighted by (International Monetary Fund, 2018b) and (Debrun and Jonung, 2019), the translation of strong formal design into actual fiscal outcomes is mediated by factors such as fiscal transparency, public financial management systems, and political commitment, which vary widely across (EMDEs). This implies that the effectiveness of fiscal rules depends not only on their formal adoption but also on the broader institutional environment in which they operate. Overall, these findings underscore the importance of not only adopting fiscal rules but also investing in their careful design and supporting institutional infrastructure to ensure they achieve their intended objectives without unduly compromising critical social and developmental spending.

Table 2.3: Fiscal Rules Index and (EMDEs) Sample Results

	Total Spending			**Social Spending**			**Education Spending**			**Health Expenditure**		
	(1) Fixed	(2) Diff GMM	(3) Sys GMM	(4) Fixed	(5) Diff GMM	(6) Sys GMM	(7) Fixed	(8) Diff GMM	(9) Sys GMM	(10) Fixed	(11) Diff GMM	(12) Sys GMM
BBR	-0.009	0.030**	-0.022**	-0.103*	-0.232*	-0.108**	-0.064*	-0.006	-0.038**	0.087**	0.134***	0.100
	(0.025)	(0.013)	(0.009)	(0.052)	(0.420)	(0.046)	(0.036)	(0.037)	(0.022)	(0.041)	(0.041)	(0.065)
ER	-0.006	-0.007	0.010	-0.024	0.025	0.045	-0.011	-0.014**	0.009	0.024	0.086**	0.081*
	(0.004)	(0.005)	(0.008)	(0.018)	(0.019)	(0.035)	(0.010)	(0.007)	(0.146)	(0.038)	(0.044)	(0.046)
DR	-0.001	-0.034	0.001	0.0631*	0.108**	0.040	0.038*	-0.327*	0.015	-0.030	-0.052**	-0.087*
	(0.014)	(0.013)	(0.009)	(0.031)	(0.048)	(0.461)	(0.021)	(0.020)	(0.191)	(0.023)	(0.027)	(0.052)
RR	–	–	–	–	–	–	–	–	–	–	–	–
Observations	353	295	359	310	238	309	299	289	337	310	263	352
Country effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Instruments	–	42	36	–	30	42	–	33	40	–	36	39
AR1 Test	–	–	0.001	–	–	0.000	–	–	0.000	–	–	0.000
AR2 Test	–	–	0.112	–	–	0.368	–	–	0.794	–	–	0.070
Hansen J	–	–	0.190	–	–	0.320	–	–	0.248	–	–	0.282

Notes: "Fixed" refers to the fixed effects estimator. "Diff GMM" denotes the Arellano–Bond difference GMM estimator. "Sys GMM" refers to the Arellano–Bover/Blundell–Bond system GMM estimator. Clustered and Robust Standard errors are shown within parenthesis below each point estimate. *** denotes significance at 0.01 level, ** at the 0.05 level and * at the 0.10 level. Hansen J test for over identification restriction. AR1 and AR2 test report first and second order correlation. Intercepts and control variables are included but not reported.

2.7.2 Results for (Advance Economies) - (AEs)

Table 2.4 presents the empirical estimates for the impact of fiscal rule indexes on spending categories in (AEs). Column (3) of Table 2.4 reveals that the balanced budget rule index exerts a positive and significant effect on total spending, social spending, and health spending. This finding suggests that improvements in the legal, procedural, and enforcement dimensions of balanced budget rules in (AEs) not only strengthen overall fiscal positions but also provide governments with the credibility needed to sustain or expand critical public expenditures. Theoretically, this aligns with the "credibility effect" framework (Bamba et al., 2020), which posits that well-designed fiscal rules reduce sovereign risk premia, lower borrowing costs, and thereby create fiscal space that can be allocated to priority sectors without compromising fiscal sustainability.

Moreover, the positive associations with social and health spending Columns (6) and (12) of Table 2.4 underscore the idea that (AEs) often embed balanced budget rules within broader social compacts that protect key welfare components. This is consistent with the institutional view advanced by (von Hagen and Eichengreen, 1996), which argues that fiscal rules in mature democracies are typically accompanied by strong political and legal safeguards for social programs. The evolution of extensive welfare states in many (AEs) driven by demographic pressures such as aging populations has further entrenched these spending patterns (Deza Delgado et al., 2020). Indeed, pension systems and healthcare entitlements represent significant structural components of advanced country budgets, so improvements in fiscal rule design often aim to preserve these commitments by ensuring long-term fiscal viability.

Turning to the results for the expenditure rule index, Columns (9) and (12), Table 2.4 show positive and significant impacts on social, education and health spending. Additionally, expenditure rules are more widely adopted in (AEs) than in (EMDEs), primarily as tools to monitor and manage public spending. This aligns with the rationale that well-calibrated expenditure rules can prioritize or protect essential outlays. Theoretically, expenditure rules that include explicit exemptions or separate caps for priority sectors are more likely to sustain investments in human capital (Vammalle, 2015). This approach is reinforced by EU fiscal governance frameworks, where expenditure rules often include clauses that safeguard critical health and education expenditures, reflecting commitments under the European Pillar of Social Rights and the Health in All Policies strategy (European Commission, 2017).

Lastly, the debt rule index exhibits a negative and significant effect on total spending, indicating that enhancements in debt rule design such as stricter numerical debt anchors or improved compliance mechanisms help (AEs) contain aggregate expenditure growth, thereby reducing debt burdens. This is consistent with empirical findings by (Bergman and Hutchison, 2018), who show that credible debt

Table 2.4: Fiscal Rules Index and (AEs) Sample Results

	Total Spending			**Social Spending**			**Education Spending**			**Health Spending**		
	(1) Fixed	(2) Diff GMM	(3) Sys GMM	(4) Fixed	(5) Diff GMM	(6) Sys GMM	(7) Fixed	(8) Diff GMM	(9) Sys GMM	(10) Fixed	(11) Diff GMM	(12) Sys GMM
BBR	0.014**	0.020*	0.023*	0.020**	0.016**	0.023*	0.005	-0.004	0.028	0.001	-0.006	0.086*
	(0.007)	(0.012)	(0.013)	(0.009)	(0.009)	(0.012)	(0.005)	(0.005)	(0.028)	(0.012)	(0.008)	(0.043)
ER	-0.003	-0.016**	-0.112	-0.012*	-0.021**	0.053**	-0.007	-0.009	0.047*	0.003	0.063	0.089*
	(0.004)	(0.021)	(0.007)	(0.021**)	(0.027)	(0.002)	(0.050)	(0.025)	(0.007)	(0.015)	(0.015)	(0.054)
DR	0.003	0.005	-0.058**	-0.011	0.010	0.014	0.005***	-0.002*	0.014**	0.049***	0.046**	0.038**
	(0.004)	(0.005)	(0.008)	(0.010)	(0.041)	(0.007)	(0.007)	(0.005)	(0.006)	(0.003)	(0.008)	(0.018)
RR	-0.007	-0.062	-0.010	-0.002	-0.008	0.030	0.001	-0.007	-0.021	0.001	0.007	-0.036
	(0.002)	(0.042)	(0.034)	(0.002)	(0.009)	(0.040)	(0.002)	(0.009)	(0.043)	(0.002)	(0.011)	(0.080)
Observations	525	407	529	516	413	500	519	423	521	517	422	519
Country effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Instruments	–	32	32	–	30	33	–	32	31	–	30	33
AR1 Test	–	–	0.000	–	–	0.000	–	–	0.010	–	–	0.025
AR2 Test	–	–	0.462	–	–	0.069	–	–	0.288	–	–	0.619
Hansen J	–	–	0.322	–	–	0.196	–	–	0.183	–	–	0.199

Notes: "Fixed" refers to the fixed effects estimator. "Diff GMM" denotes the Arellano–Bond difference GMM estimator. "Sys GMM" refers to the Arellano–Bover/Blundell–Bond system GMM estimator. Clustered and robust standard errors are shown in parentheses below each point estimate.
*** denotes significance at the 0.01 level, ** at the 0.05 level, and * at the 0.10 level. Hansen J test is for overidentifying restrictions. AR1 and AR2 tests report first- and second-order correlation. Intercepts and control variables are included but not reported.

rules in (AEs) are associated with sustained fiscal consolidations. However, the debt rule index also demonstrates positive and significant associations with health and education spending, suggesting that these better-designed rules not only reduce overall spending pressures but also enable a reallocation of resources toward priority sectors. In particular, stronger debt rules may impose discipline on less productive or discretionary expenditures, thereby creating fiscal space that can be preserved or redirected toward essential social services. This indicates that, rather than uniformly compressing all categories of spending, well-designed debt rules can support a more strategic composition of public expenditure, allowing governments to maintain or even enhance investment in human capital while pursuing overall fiscal consolidation. This pattern reflects the nuanced trade-off documented by (Fabrizio and Mody, 2006), where fiscal consolidations under robust rule-based regimes in (AEs) often protect or even bolster spending on key public goods to maintain social cohesion and support long-term growth. The specification tests in Table 2.4 confirm the validity of the system GMM regressions. The Hansen J test supports instrument validity, AR(1) is appropriately rejected, and AR(2) is not, indicating correctly specified models

The results show that fiscal rule design plays an important role in shaping public spending outcomes, particularly in (AEs). Well-designed fiscal rules, including balanced budget, expenditure, and debt rules, are associated with meaningful effects across different spending categories. In particular, expenditure rules appear to have a significant influence on spending patterns in (AEs), while their impact remains limited in emerging and developing economies (EMDEs). Overall, these findings suggest that stronger and better-designed fiscal frameworks can support fiscal discipline while also allowing governments to maintain and prioritize key areas of public spending, contributing to long-term fiscal stability.

2.8 Conclusion

This study examined the impact of fiscal rules on public expenditure composition, focusing on how total government spending, as well as social protection, health, and education spending, respond to different types of fiscal rules across a broad sample of (AEs) and emerging and developing economies (EMDEs). Given the dynamic and potentially endogenous nature of fiscal policy decisions, we employed a dynamic panel framework with appropriate controls and instruments, capturing economic, political, and governance factors that influence both the adoption and effectiveness of fiscal rules.

To explore these relationships, we implemented two complementary approaches. First, we used binary indicators to capture the mere presence of fiscal rules. Recognizing, however, that not all fiscal rules are equally stringent or well-designed, we then utilized a fiscal rule index that reflects the quality of rule design across multiple

dimensions, including legal basis, coverage, enforcement, and escape clauses.

Our findings highlight important differences across country groups. In (EMDEs), balanced budget rules are generally effective in restraining overall spending and social transfers, consistent with the view that such rules primarily act as tools to enforce fiscal discipline where institutional frameworks are weaker. However, the adoption of debt rules in these countries also tends to be associated with reductions in education and health spending, suggesting that in efforts to meet debt targets, governments often adjust by cutting social sector expenditures. These results underscore the risk that, in settings with less mature institutions, fiscal rules may disproportionately compress long-term human capital investments.

In contrast, in (AEs), balanced budget rules are positively associated with total spending, social spending, and health spending, indicating that improvements in rule design enhance fiscal credibility, reduce borrowing costs, and support sustained investment in social sectors. Similarly, well-designed expenditure rules in these countries appear to safeguard priority spending, particularly in health and education. The positive association between stronger debt rules and social spending in (AEs) suggests that robust fiscal anchors, when credibly enforced, can create fiscal space to protect or expand key public services.

The comparative analysis also reveals that the magnitude and consistency of these effects are larger in (AEs), particularly when employing the fiscal rule strength index. This suggests that beyond the mere existence of fiscal rules, their detailed design and integration within broader fiscal institutions critically determine their ability to balance fiscal sustainability with the protection of essential social expenditures. The stronger institutional environments in (AEs) including transparent budget processes, independent fiscal councils, and well-defined social compacts likely amplify the effectiveness of fiscal rules in achieving these dual objectives.

Overall, the study highlights that fiscal rules are not a one-size-fits-all solution. Their effectiveness in managing public finances and protecting social investment depends fundamentally on their design quality and the institutional and political contexts in which they operate. As such, for (EMDEs), strengthening the design and enforcement of fiscal rules, alongside broader reforms to enhance fiscal institutions, remains crucial to ensure that efforts to maintain fiscal discipline do not come at the expense of critical investments in social development and human capital.

Chapter 3

Managing Uncertainty:A Time-Varying Fiscal Framework for Probabilistic Debt Sustainability in High-Debt Countries

3.1 Introduction

Over the past two decades, public debt has surged across both advanced economies (AEs) and emerging and developing economies (EMDEs), driven by successive global shocks and structural challenges. The 2008 financial crisis and the COVID-19 pandemic led to major fiscal interventions, sharply raising debt-to-GDP ratios. (Reuters, 2024; Financial Times, 2024). More recently, inflation and tighter global financial conditions have renewed concerns about debt sustainability, especially in fiscally constrained economies. Although inflation may reduce debt in real terms, rising interest rates often offset this by increasing borrowing costs and complicating debt management.

In this context, ensuring the sustainability of public debt is more important than ever. (EMDEs) such as Argentina, Brazil, Pakistan, Poland, Hungary and Sri Lanka continue to grapple with chronic fiscal imbalances and high debt burdens, often relying on external support and facing elevated sovereign risk premia. Meanwhile, even fiscally stable (AEs) including Japan, the UK, and Canada are experiencing rising debt trajectories due to aging populations, crisis-driven spending, and evolving macroeconomic conditions. Maintaining debt sustainability is therefore essential to safeguard economic stability and preserve policy space for future shocks. IMF, (2021) (Gaspar et al., 2021)

Conventional debt sustainability analysis DSA, often deterministic in nature, provides useful baseline projections under fixed assumptions about macroeconomic

and fiscal variables. However, this approach fails to adequately capture the evolving nature of fiscal behavior and the uncertainty surrounding macroeconomic dynamics. In particular, fiscal reaction functions describing how governments adjust their primary balance in response to rising debt are unlikely to remain stable over time, especially when political regimes change, crisis conditions emerge, or fiscal fatigue [1] sets in at high debt levels.

This study addresses three interrelated research questions at the intersection of fiscal policy behavior and debt sustainability. First, how does the fiscal response to public debt evolve over time in advanced and emerging economies, and what are the implications for debt sustainability? Second, can a stochastic debt sustainability framework built on time-varying fiscal reaction functions and time varying macroeconomic dynamics produce more realistic and policy-relevant forecasts of debt trajectories than conventional DSA with fixed parameters (Celasun et al., 2006a) Finally, it tests for fiscal fatigue (Ghosh et al., 2013c) within the time-varying fiscal reaction function framework i.e what is the nature of fiscal responses when the debt-to-GDP ratio exceeds the threshold defined by a country's debt fiscal rule [2] and how does this threshold-crossing affect fiscal behavior over time?

The Debt Sustainability Framework DSF, developed by the IMF and World Bank, provides a structured approach to assessing debt vulnerabilities through threshold-based indicators, macroeconomic projections, and deterministic stress tests. While it offers useful risk diagnostics, the DSF does not adequately incorporate the range of macroeconomic shocks and structural changes many countries face such as climate-related disasters, commodity price volatility, pandemics, and geopolitical instability. These factors introduce high levels of uncertainty that the framework's static assumptions cannot fully address, limiting its relevance for forward-looking and resilient debt sustainability assessments, especially in vulnerable or shock-prone economies.

To address these shortcomings, this paper develops a stochastic debt sustainability analysis SDSA framework that extends traditional approaches by incorporating time-varying fiscal and macroeconomic dynamics. Drawing on (Berger et al., 2021a), it first estimates a time-varying fiscal reaction function TVP-FRF, which models how the primary balance responds to public debt, macroeconomic conditions, and political factors, allowing fiscal behavior to evolve over time. In parallel, it estimates a time-varying parameter vector autoregression TVP-VAR to project

[1] Fiscal fatigue, as introduced by (Ghosh et al., 2013a), describes the weakening relationship between public debt and fiscal adjustment. At high levels of debt, governments face increasing difficulty in maintaining or raising primary surpluses, due to political resistance, economic constraints, or diminishing returns to fiscal effort. As a result, the primary balance may deteriorate even as debt continues to grow, threatening long-term debt sustainability.

[2] IMF set fiscal rules for its member countries which aim to prevent countries from unsustainable debt levels that could pose risk to economic stability. Among other rules, debt rules are set at 60 percent of GDP, and the countries cross this limit are considered in high debt zone. (AEs) typically have their own domestic fiscal frameworks, which include national fiscal rules tailored to their institutional and economic contexts.

the joint paths of key macroeconomic variables such as GDP growth, inflation, and interest rates while allowing the relationships among these variables to change over time.[3] The TVP-FRF is used to generate projections for the primary balance. These projections, together with simulated macroeconomic scenarios from the TVP-VAR, are then fed into a standard debt accumulation equation to compute the debt-to-GDP ratio over the forecast horizon. By repeating this simulation process numerous times, the framework produces a distribution of possible debt trajectories, enabling the construction of fan charts and probabilistic assessments of debt sustainability under uncertainty.

This study makes four main contributions. First, it extends the time-varying fiscal reaction function (TVP-FRF) framework of (Berger et al., 2021a) to a broader sample comprising both advanced economies (AEs) and high-debt emerging market and developing economies (EMDEs), allowing a systematic comparison of fiscal behavior across countries with different institutional and debt characteristics. Second, it augments the standard TVP-FRF specification by incorporating economic, political, and institutional determinants—including election cycles, government ideology, IMF-supported programs, and global crisis episodes—to capture factors that influence the evolution of fiscal responses over time. Third, it provides a direct test of fiscal fatigue by introducing country-specific debt thresholds and examining whether the responsiveness of primary balances to debt weakens once debt exceeds these levels. Finally, it combines a time-varying parameter VAR (TVP-VAR) model with the TVP-FRF to generate probabilistic forecasts of key macroeconomic variables and fiscal balances, which are then used to construct stochastic debt paths and fan charts. This framework captures both macroeconomic and fiscal policy uncertainty, providing a more realistic assessment of debt sustainability than conventional approaches based on fixed coefficients and point forecasts.

Empirical results from the time-varying fiscal reaction function TVP-FRF reveal that fiscal responses to debt, the output gap, and lagged primary balances shift over time. In (AEs), clear evidence of fiscal fatigue emerges, with weakening primary balance responsiveness at higher debt levels, particularly during crisis periods. In contrast, emerging and developing economies (EMDEs) show more varied behavior: while the fiscal response is generally weaker, signs of fatigue are less pronounced, and some countries maintain or even strengthen their fiscal efforts despite rising debt. Moreover, Stochastic debt sustainability analysis SDSA-fan charts constructed under both the standard fixed-parameter model and time-varying frameworks reveal that debt forecasts are more realistic under the time-varying model for both (AEs) and (EMDEs). In comparison, the fixed-parameter model tends to overestimate median debt and understate the uncertainty surrounding future debt paths.

These findings have important policy and methodological implications. The

[3]In the literature, GDP growth rate, interest rate (long term and short term) and inflation are called deep determinants of debt.

evidence of fiscal fatigue in (AEs) suggests that high debt levels can weaken governments ability to sustain fiscal discipline over time, particularly during periods of economic stress, highlighting the need for credible fiscal frameworks and countercyclical buffers. For (EMDEs), the more heterogeneous responses indicate that institutional quality and policy credibility play a critical role in shaping fiscal behavior. More broadly, the results demonstrate that relying on fixed-parameter models can lead to misleading assessments of debt sustainability, as they fail to capture evolving fiscal dynamics and uncertainty. Incorporating time-varying approaches therefore provides more realistic and policy-relevant debt projections, which are essential for effective fiscal planning and risk management.

The rest of the paper is organized as follows. Section 3.2 reviews the relevant literature, while Section 3.3 sets out the methodological framework. Section 3.4 discusses the data, and Section 3.5 reports the empirical findings from the time-varying fiscal reaction function. Section 3.6 presents the stochastic debt sustainability analysis for both (AEs) and emerging market and developing economies (EMDEs). Finally, Section 3.7 concludes with key policy implications.

3.2 Literature Review

Debt sustainability is a multifaceted and evolving concept, open to varying interpretations and methodologies. The earliest treatments emphasized normative assessments of debt burdens based on historical ratios or fixed thresholds. (Domar, 1944) was among the first to explore the implications of debt accumulation on national income, introducing the notion of a "burden of debt" and its effects on macroeconomic stability. His analysis highlighted that as long as the growth rate of output exceeds the interest rate, public debt can be stabilized even with persistent deficits.

In the European context, (Heinemann, 1992) explored debt sustainability through a time-series lens, emphasizing the policy relevance of the debt-stabilizing primary balance and balance sheet indicators within the European Monetary Union (EMU). This marked an early application of formal econometric techniques to assess fiscal solvency in developed regions.

Building on this, the International Monetary Fund (IMF) institutionalized deterministic Debt Sustainability Analysis DSA frameworks. The IMF's early work (International Monetary Fund, 1996, 2003b) relied on assessing the debt-stabilizing primary balance over a 15-year horizon using macroeconomic assumptions for growth, interest rates, and inflation. Scenario analyses were introduced through baseline trajectories and stress scenarios, with risk incorporated via fan charts (International Monetary Fund, 2002, 2003a). These visualizations aimed to account for future uncertainty while retaining the core deterministic structure. Later, (International Monetary Fund, 2015) expanded this by introducing intertemporal balance sheet analysis, estimating the present value of public sector assets and liabilities to

assess solvency. Despite their policy relevance, these deterministic models were increasingly criticized for underestimating risks and ignoring macroeconomic feedback mechanisms (Baduel and Price, 2012).

To address these shortcomings, (Garcia and Rigobon, 2004) and (Celasun et al., 2006a) pioneered a stochastic DSA approach. This framework integrates Monte Carlo simulations with macroeconomic shocks derived from VAR models and embeds a fiscal reaction function FRF to reflect endogenous policy responses. By modeling joint distributions of debt determinants growth, interest rates, and primary balances the stochastic DSA offers probability distributions for debt paths and tail risks.

The empirical foundation for fiscal reaction functions FRFs originates from the seminal work of (Bohn, 1995), who demonstrated that a positive response of the primary surplus to lagged public debt serves as evidence of fiscal solvency. This linear framework has since underpinned many empirical debt sustainability analyses DSAs. Subsequent studies extended Bohn's specification to incorporate macroeconomic and institutional nuances. For instance, (Galí and Perotti, 2003) introduced cyclical output gaps into the FRF to account for the role of economic fluctuations, while (Wyplosz, 2007) highlighted the importance of institutional and political factors in determining fiscal responsiveness.

A major advancement in the literature emerged with the introduction of non-linearities in fiscal behavior. (Melou et al., 2014) and (Afonso et al., 2018) showed that fiscal authorities may react more aggressively to debt once it crosses certain thresholds, especially during periods of financial distress. Afonso et al. employed a threshold VAR framework for (AEs) and found that fiscal multipliers tend to increase significantly under high-debt regimes, supporting a regime-switching interpretation of fiscal policy effectiveness. These findings challenged the adequacy of fixed-parameter FRFs, which may not capture behavioral shifts during economic crises.

Building on this, (Ghosh et al., 2013b) introduced the concept of fiscal fatigue, where governments capacity to generate primary surpluses diminishes as debt burdens grow. Using non-linear FRFs and stochastic simulations, they estimated country-specific debt limits beyond which further fiscal effort becomes counterproductive. This approach provided a more dynamic view of solvency risks, offering early warning signals grounded in empirical behavior.

The operationalization of these insights into policy frameworks is illustrated by (Bouabdallah et al., 2017), who developed a comprehensive DSA toolkit for euro area countries. By integrating deterministic scenarios, stochastic simulations, and VAR-based fan charts, they assessed fiscal risks in terms of liquidity, solvency, and fiscal fatigue bringing empirical modeling closer to real-world policy applications.

Panel-based analyses further enriched the literature by focusing on cross-country heterogeneity. (Checherita-Westphal and Žďárek, 2017) found generally weak but positive responsiveness of primary balances to debt across the euro area, and in-

troduced a fiscal fatigue risk indicator based on historical fiscal effort. In contrast, (Everaert and Jansen, 2018) argued that once country-specific slope heterogeneity is taken into account, evidence for non-linear fiscal fatigue weakens. Their results underscore the importance of allowing for flexibility and differentiation in cross-country fiscal analysis.

While several studies have modeled fiscal fatigue through regime-switching frameworks including threshold regressions, smooth transitions, and threshold VARs they typically assume static behavior within regimes. A notable departure is (Berger et al., 2021a), who estimate a fully Bayesian time-varying fiscal reaction function TVP-FRF, allowing fiscal responsiveness to evolve gradually over time.

Parallel to the evolution in FRFs, time-varying parameter (TVP) models have gained traction in the macroeconomic literature for capturing structural change and dynamic policy effects. Early contributions by (Cogley and Sargent, 2005) and (Primiceri, 2005b) introduced frameworks with drifting coefficients and stochastic volatility. Koop and Korobilis (2010, 2014) applied Bayesian shrinkage and forgetting factors to develop computationally efficient TVP-VARs. In the fiscal domain, (Carriero et al., 2015) used large BVARs and time-varying models to forecast fiscal aggregates more accurately, while (Blake and Mumtaz, 2012) emphasized the importance of time variation in understanding policy transmission and macroeconomic uncertainty. Similarly, (Baum et al., 2012) showed that fiscal multipliers vary across the business cycle, and (Clark and Ravazzolo, 2015) found Bayesian stochastic volatility models to outperform constant-variance alternatives, particularly during periods of elevated uncertainty.

In conclusion, the literature on debt sustainability has advanced considerably from early deterministic models and static fiscal rules to more flexible, probabilistic, and state-contingent approaches. Recent research incorporates non-linear fiscal reaction functions, stochastic simulations, and time-varying parameter models to better capture fiscal heterogeneity, regime shifts, and macroeconomic uncertainty. However, these innovations have largely focused on (AEs), particularly within the OECD and euro area, with limited empirical attention to emerging and developing economies (EMDEs), where fiscal vulnerabilities and institutional constraints are often more severe.

This study contributes to the literature by applying advanced empirical frameworks to a broader set of high-debt countries, spanning both (AEs) and (EMDEs). It develops a time-varying fiscal reaction function TVP-FRF embedded within a stochastic debt sustainability analysis DSA, while also incorporating institutional and political variables such as election cycles, IMF program participation, and the ideological stance of governments. A novel contribution lies in introducing a debt threshold consistent with fiscal rules, allowing fiscal responsiveness to adjust once debt exceeds prudential limits. In addition, the study employs a time-varying Bayesian VAR TVP-BVAR to generate probabilistic forecasts under uncer-

tainty. Collectively, these contributions provide a more nuanced, forward-looking, and policy-relevant framework for assessing sovereign risk across diverse economic contexts.

3.3 Methodology

3.3.1 Fiscal Reaction Function with Time-Varying Parameters

Accurately modeling the fiscal reaction function (FRF) is central to any assessment of fiscal sustainability and to generating realistic projections of the primary balance and public debt. Traditional FRFs, such as that proposed by (Bohn, 1998), typically assume constant coefficients over time. However, recent contributions, including (Berger et al., 2021a), suggest that this assumption may be too restrictive, particularly in the presence of structural changes in economic conditions, fiscal institutions, and political dynamics. To address this, we adopt a time-varying parameter (TVP) framework, estimated separately for each country, which allows fiscal policy responses to evolve over time.

Alternative approaches to modeling such nonlinearities include threshold models, Markov-switching models, and smooth transition models. Threshold models allow for discrete changes once a variable crosses a given level, while Markov-switching models capture shifts between unobserved regimes, and smooth transition models permit gradual changes depending on a transition variable. Although these approaches can capture nonlinear behavior, they typically require specifying thresholds, regimes, or transition functions, which may be difficult to justify in macro-fiscal settings.

In contrast, the TVP approach allows coefficients to evolve continuously over time without imposing predefined nonlinear structures. This makes it particularly suitable for fiscal policy analysis, where changes tend to be gradual, and for applications with relatively short macroeconomic time series.

The starting point is a conventional linear FRF of the form:

$$pb_t = \alpha + \beta_1 debt_{t-1} + \gamma X_t + \varepsilon_t \tag{3.1}$$

where pb_t denotes the primary balance-to-GDP ratio, $debt_{t-1}$ is the lagged public debt ratio, and X_t is a vector of additional regressors, such as the lagged primary balance and the output gap. The error term ε_t is assumed to be normally distributed. In this static specification, the parameters α, β_1, and γ are constant over time.

There are several reasons to expect fiscal policy behaviour to change over time. Economically, governments may respond more aggressively to rising debt levels during periods of fiscal consolidation but reduce responsiveness when debt becomes un-

sustainable a phenomenon known as "fiscal fatigue" (Ghosh et al., 2013a). Macroeconomic developments such as growth fluctuations, interest rate changes, and structural shifts in the economy can also alter fiscal constraints and incentives. Politically, electoral budget cycles may lead to expansionary fiscal policies in election years to boost voter support (Alesina et al., 1993; Brender and Drazen, 2005a), while the presence of IMF-supported programs can enforce fiscal discipline through conditionalities (Dreher, 2006; International Monetary Fund, 2018a). Moreover, the ideological orientation of ruling parties may influence fiscal priorities, with left-leaning governments typically favouring higher spending and right-leaning ones emphasising consolidation (Alesina and Perotti, 1995b; Potrafke, 2010). These evolving economic and political dynamics underscore the need for a time-varying approach to modelling fiscal reactions.

3.3.2 Model Specification

The empirical model is specified as a state-space system, where the observed primary balance-to-GDP ratio is regressed on a set of fiscal and macroeconomic variables, with coefficients that evolve over time. The observation (measurement) equation is:

$$pb_t = \alpha + H_t\beta_t + X_t\gamma + \varepsilon_t, \quad \varepsilon_t \sim \mathcal{N}(0, R) \tag{3.2}$$

where pb_t is the primary balance-to-GDP ratio, $H_t \in \mathbb{R}^{1\times k}$ is a row vector of regressors with time-varying coefficients $\beta_t \in \mathbb{R}^{k\times 1}$ (e.g., lagged public debt, output gap, lagged primary balance), $X_t \in \mathbb{R}^{1\times m}$ is a row vector of control variables with fixed coefficients $\gamma \in \mathbb{R}^{m\times 1}$, and ε_t is the measurement error. [4]

The transition equation governing the evolution of the time-varying coefficients is given by:

$$\beta_t = \beta_{t-1} + \eta_t, \quad \eta_t \sim \mathcal{N}(0, Q_\beta) \tag{3.3}$$

where $\eta_t \in \mathbb{R}^{k\times 1}$ is a vector of state innovations and $Q_\beta \in \mathbb{R}^{k\times k}$ is the covariance matrix governing the evolution of the time-varying coefficients.

This specification allows each fiscal policy coefficient to follow a random walk, evolving gradually over time in response to policy shifts, institutional reforms, and macroeconomic developments. (Primiceri, 2005a; Cogley and Sargent, 2005; Canova et al., 2006).

[4]The choice of which variables enter H_t (time-varying coefficients) and which enter X_t (fixed coefficients) is guided by both economic reasoning and empirical considerations. In particular, time variation is allowed for the key parameters of the fiscal reaction function namely the response to lagged debt, lagged primary balance, and the output gap, as these capture the core behavior of fiscal policy and are likely to change over time. In contrast, control variables are assigned constant coefficients to keep the model simple and avoid overparameterization. Allowing all coefficients to vary would greatly increase the number of parameters, which can lead to imprecise estimates, especially with relatively short macro-fiscal data. This approach is consistent with the TVP literature, which highlights the need to balance flexibility with parsimony in high-dimensional models (Koop and Korobilis, 2010).

Fiscal policy adjustments are often gradual due to implementation lags, legislative processes, and multi-year budgeting. This structure captures such inertia effectively and reflects the evolving nature of fiscal behaviour. Given the substantial heterogeneity between (AEs) and Emerging Market and Developing Economies (EMDEs), in terms of institutional strength, fiscal capacity, exposure to external shocks, and access to financing, estimating a pooled panel FRF would impose overly restrictive assumptions (Ghosh et al., 2013a; International Monetary Fund, 2018a).

For example, (EMDEs) are more likely to operate under IMF-supported programs, face higher borrowing costs, and experience greater macroeconomic and political volatility, whereas (AEs) typically benefit from stronger institutions, deeper financial markets, and greater fiscal space (Ostry et al., 2010; Escolano, 2010). To account for these differences, we estimate the fiscal reaction function separately for each country.

A key concern in this setting is the potential endogeneity of the output gap. Since fiscal policy can influence economic activity contemporaneously, the output gap may not be strictly exogenous. To address this, we instrument the output gap using its own lags, following the approach in (Berger et al., 2021a). Specifically, we regress the output gap on its first two lags and on other exogenous regressors in the model, using the fitted values in place of the original series during estimation.

3.3.3 Estimation Algorithm and Priors

The time-varying fiscal reaction function TVP-FRF is estimated within a Bayesian state-space framework. This approach is particularly well suited to the present setting, as it allows coefficients to evolve flexibly over time while addressing the limited length of macro-fiscal time series. Bayesian methods incorporate prior information to regularize estimation and mitigate over-parameterization, which is especially important in time-varying parameter models. In addition, they provide a coherent framework for quantifying uncertainty and enable efficient estimation of latent states and stochastic volatility through simulation-based techniques such as MCMC. These features make Bayesian estimation a standard and robust choice for TVP models, as emphasized in (Primiceri, 2005a; Koop and Korobilis, 2010). The observation equation represents the fiscal policy, linking the primary balance-to-GDP ratio to a set of explanatory variables, while the transition equation governs the evolution of time-varying fiscal coefficients.

Given the time-varying nature of fiscal coefficients and the limited length of macro-fiscal time series, a Bayesian estimation approach provides a robust and flexible framework. The methodology closely follows Primiceri (2005), a standard reference for estimating time-varying parameter TVP models.

Estimation proceeds via a Markov Chain Monte Carlo (MCMC) algorithm based on Gibbs sampling. The model is cast in state-space form, and inference is conducted by iteratively drawing from the full conditional posterior distributions of the

unobserved state vector, the state innovation variance, and the observation error variance. The time-varying coefficient vector β_t evolves as a random walk process as mentioned in equation (3.3).

This specification captures gradual shifts in fiscal behavior arising from institutional reforms, political dynamics, or macroeconomic shocks. The observation equation includes lagged debt, lagged primary balance, output gap, IMF program participation, election year dummies, and a debt-threshold indicator as regressor.[5]

Initialization

Initial values are assigned for the state innovation covariance matrix Q_β, the observation error variance R, and the coefficient vector β_t. The initial state β_0 is drawn from a diffuse Normal prior:

$$\beta_0 \sim \mathcal{N}(0, 10^6 \cdot I_k) \tag{3.4}$$

where k is the number of regressors. This prior imposes minimal assumptions, allowing the data to inform the initial parameter values.

Sampling the Coefficients

The full time path of the coefficients ($\beta_{1:T}$) is sampled conditional on current values of Q_β and R, using a Kalman filter and simulation smoother. The resulting smoothed estimates $\hat{\beta}_t$ provide posterior means for each time period.

Updating the State Innovation Variance (Q_β)

The covariance matrix of the state innovations, Q_β, governs the degree of time variation in the coefficients and is updated using an Inverse-Wishart prior:

$$Q_\beta \sim \mathcal{IW}(T - 1 + k, S_\eta + Q_0) \tag{3.5}$$

where

$$S_\eta = \sum_{t=2}^{T} (\beta_t - \beta_{t-1})(\beta_t - \beta_{t-1})', \quad Q_0 = 0.01 \cdot I_k$$

The term S_η summarizes the variability in the innovations of the state equation, i.e., the increments of the time-varying coefficients under the random walk assumption. Combining this with the prior scale matrix Q_0 yields the posterior scale parameter, while the degrees of freedom reflect the sample size and prior information.

The use of an Inverse-Wishart prior is standard in the Bayesian time-varying parameter literature due to its conjugacy, which allows for straightforward Gibbs

[5] In the analysis, the coefficients for lagged debt, lagged primary balance and output gap are allowed to evolve, while the control variables are kept fixed.

sampling of Q_β. This specification implies that the degree of parameter variation is largely data-driven, while the prior Q_0 introduces a small amount of shrinkage that favors gradual rather than abrupt changes in coefficients. Consequently, $Q_thesmoothnessofcoefficientevolution, withsmallervaluesimplyingmorestablefiscalbehavi$ $VARliterature$.

Updating the Observation Error Variance (R)

The variance R, which captures the noise in the observation equation, is updated using an Inverse-Gamma prior:

$$R \sim \mathcal{IG}\left(\frac{T}{2}, \frac{SSR}{2} + R_0\right) \tag{3.6}$$

where SSR is the sum of squared residuals from the smoothed observation equation, and $R_0 = 0.01$ is a small scale factor.

Posterior Inference and Forecasting

The Gibbs sampler is run for 10,000 iterations, with the first 5,000 draws discarded as burn-in. The remaining 5,000 draws are used to construct posterior distributions of β_t, Q_β, and R, and to generate simulation-based forecasts of the primary balance. By consistently applying weakly informative priors and country-specific estimation, this methodology captures gradual policy shifts and accommodates structural differences across fiscal regimes.

3.3.4 Bayesian VAR with Time-Varying Parameters

Following (Celasun et al., 2006b) and (Medeiros, 2012), we employ a vector autoregression (VAR) framework to estimate the dynamic interactions among macroeconomic variables that are central to the evolution of public debt and the primary balance. These estimated relationships, along with the joint distribution of shocks, provide the basis for generating macroeconomic forecasts, which are subsequently incorporated into a stochastic debt sustainability analysis.

Unlike the constant-parameter VAR models [6] used in (Celasun et al., 2006b) and (Medeiros, 2012), we adopt a time-varying parameter Bayesian VAR (TVP-BVAR) model. This specification accounts for potential structural changes in the economy over time by allowing the autoregressive coefficients to evolve according to a random walk. The reduced-form TVP-VAR model for each country is given by:

$$y_t = \phi_{1,t} y_{t-1} + \phi_{2,t} y_{t-2} + \cdots + \phi_{p,t} y_{t-p} + u_t, \quad u_t \sim \mathcal{N}(0, \Sigma), \tag{3.7}$$

$$\Phi_t = \Phi_{t-1} + e_t, \quad e_t \sim \mathcal{N}(0, Q_\Phi), \tag{3.8}$$

[6] Methodology on constant constant-parameters model for DSA analysis is summarized in Appendix C.

where y_t is an $M \times 1$ vector of stationary endogenous variables, $\phi_{j,t}$ for $j = 1, \ldots, p$ are time-varying $M \times M$ coefficient matrices corresponding to the j-th lag, and u_t denotes the vector of reduced-form shocks. The time-varying coefficients are collected in $\Phi_t = (\text{vec}(\phi_{1,t}), \ldots, \text{vec}(\phi_{p,t}))'$ and are assumed to follow a random walk governed by innovations e_t with covariance matrix Q_Φ. The number of lags p is fixed at two, consistent with both (Celasun et al., 2006b) and (Medeiros, 2012), to mitigate the risk of overparameterization given the limited time-series observations.

To estimate the model, we use a Bayesian approach, which allows for efficient inference in the presence of parameter uncertainty and limited data. The estimation relies on a Markov Chain Monte Carlo (MCMC) algorithm, specifically a three-step Gibbs sampling routine as outlined in (Blake and Mumtaz, 2015):

Sampling Φ_t: The time-varying coefficients are drawn conditional on the data and the current values of Σ and Q_Φ, using the forward-filtering backward-sampling (FFBS) algorithm of Carter and Kohn (1994).

Sampling Q_Φ: The covariance matrix of the coefficient innovations is drawn from an inverse Wishart distribution, conditional on the differenced coefficient paths $\Delta\Phi_t$.

Sampling Σ: The residual covariance matrix is drawn from an inverse Wishart distribution, conditional on the time-varying coefficients and the model residuals.

This algorithm is repeated for 10,000 iterations, with the initial 5,000 discarded as burn-in. The remaining posterior draws are used to summarize the distributions of the parameters and to generate forecasts.

3.3.5 BVAR-Priors

The priors for the model follow those proposed in (Blake and Mumtaz, 2015), with adaptations to accommodate data limitations in some country samples. Both the measurement error variance Σ and the state error variance Q_Φ are assigned Inverse Wishart priors.

The prior for Σ is specified as:

$$\Sigma \sim \mathcal{IW}(\Sigma_0, \nu_0), \tag{3.9}$$

where Σ_0 is the residual covariance matrix from the constant-parameter OLS estimation of the VAR, and $\nu_0 = k + 2$ is the prior degrees of freedom.

The prior for Q_Φ is defined as:

$$Q_\Phi \sim \mathcal{IW}(Q_0, T_0), \quad \text{with} \quad Q_0 = P \cdot T_0 \cdot \tau, \tag{3.10}$$

where $P = \Sigma_0 \otimes (X'X)^{-1}$ is the Kronecker product of the OLS residual variance and the inverse regressor matrix, and τ is a small positive constant set to 3.5×10^{-4}, indicating a diffuse prior that permits limited time variation in the coefficients. The

shape parameter T_0 is set equal to the number of time observations.

Given the relatively short sample size in some cases, the full dataset is used to inform prior moments, rather than reserving a training sample.

3.3.6 Forecasting Procedure

The forecasting stage integrates the outputs of the TVP-FRF and the TVP-BVAR within a unified simulation framework to project the evolution of public debt. The TVP-FRF generates conditional forecasts of the primary balance, capturing changes in fiscal policy behaviour over time, while the TVP-BVAR produces stochastic forecasts of key macroeconomic variables, including output growth and interest rates. These two components jointly determine debt dynamics through the government budget constraint. Specifically, simulated paths of macroeconomic variables are combined with the corresponding primary balance projections to generate forward-looking debt trajectories, ensuring that both evolving fiscal behaviour and macroeconomic uncertainty are consistently incorporated into the stochastic debt sustainability analysis (SDSA).

The TVP-BVAR produces multi-period projections by recursively simulating future paths of the endogenous variables conditional on posterior draws of the time-varying coefficients and covariance matrix. Forecasting is conducted over a horizon $h_{\max}$, with $h = 1, \ldots, h_{\max}$ indexing the forecast steps. Let $\{\Phi_T, \Sigma_T\}$ denote a posterior draw of the time-varying VAR coefficients and residual covariance matrix at the final observed period T. The last p observations of the endogenous variable vector y_t are used as initial conditions to begin the forecast recursion. For each future period, the projected value of y_{T+h} is obtained recursively as

$$y_{T+h} = \sum_{j=1}^{p} \phi_{j,T} y_{T+h-j} + \varepsilon_{T+h}, \qquad \varepsilon_{T+h} \sim \mathcal{N}(0, \Sigma_T), \tag{3.11}$$

where $\phi_{j,T}$ denotes the j-th lag coefficient matrix from the posterior draw and ε_{T+h} is a simulated innovation drawn from the residual distribution. This recursive projection method generates stochastic paths for the macroeconomic variables, which are subsequently combined with the TVP-FRF projections of the primary balance to obtain probabilistic debt trajectories and fan charts.

Primary balance projection: For each simulated path of macroeconomic variables generated by the TVP-BVAR, the corresponding path of the primary balance is obtained using the estimated TVP-FRF. Specifically, the simulated values of the explanatory variables (e.g., output gap, lagged debt) are combined with draws of the time-varying fiscal coefficients to generate conditional forecasts of the primary balance. This ensures that fiscal policy projections are consistent with the evolving macroeconomic environment.

This process is repeated across all retained posterior draws of the parameters, generating a distribution of simulated forecast paths. The resulting forecast density

incorporates both parameter uncertainty and shock uncertainty.

This forecasting approach builds on the conceptual framework of (Celasun et al., 2006b) and (Medeiros, 2012), but extends it by incorporating time-varying parameters and full posterior simulation.

A potential limitation of the proposed framework is that it combines two separate models rather than estimating a fully joint system. As a result, the interaction between fiscal policy and macroeconomic dynamics is only partially captured, with the structure effectively imposing a unidirectional relationship from macroeconomic conditions to fiscal outcomes. This may limit the ability of the model to fully account for feedback effects and cross-equation dependencies, leading to a less complete representation of the underlying economic system.

However, this modular approach also offers important advantages. By separating fiscal behavior from macroeconomic dynamics, it allows for greater flexibility in model specification and reduces the risk of overparameterization, which is particularly relevant given the limited length of macro-fiscal time series. Moreover, this approach is consistent with the stochastic debt sustainability literature, where fiscal reaction functions are combined with macroeconomic projections to assess debt dynamics under uncertainty (Celasun et al., 2006b; Berger et al., 2021a; Dubbert, 2024). In this context, the framework provides a tractable and transparent way to incorporate both evolving fiscal behavior and macroeconomic uncertainty, while maintaining empirical feasibility.

3.4 Data

This study uses macroeconomic data for estimating both the Fiscal Reaction Function FRF and the Vector Autoregression VAR models across two groups of countries: (AEs) and emerging and developing economies (EMDEs). The (AEs) included are the United Kingdom, Japan, and Canada, while the (EMDEs) comprise Brazil, Argentina, and Pakistan.

The selection of these six countries is motivated by three primary considerations. First, all selected countries have historically exhibited high-debt profiles, making them suitable for analyzing fiscal sustainability and policy responses under debt stress. Second, they possess relatively independent institutional frameworks that allow for meaningful identification of fiscal behavior and constraints. Third, the availability and quality of macro-fiscal and institutional data for these countries enables robust empirical modeling.[7]

These criteria align with the approach taken in prior studies on fiscal policy under

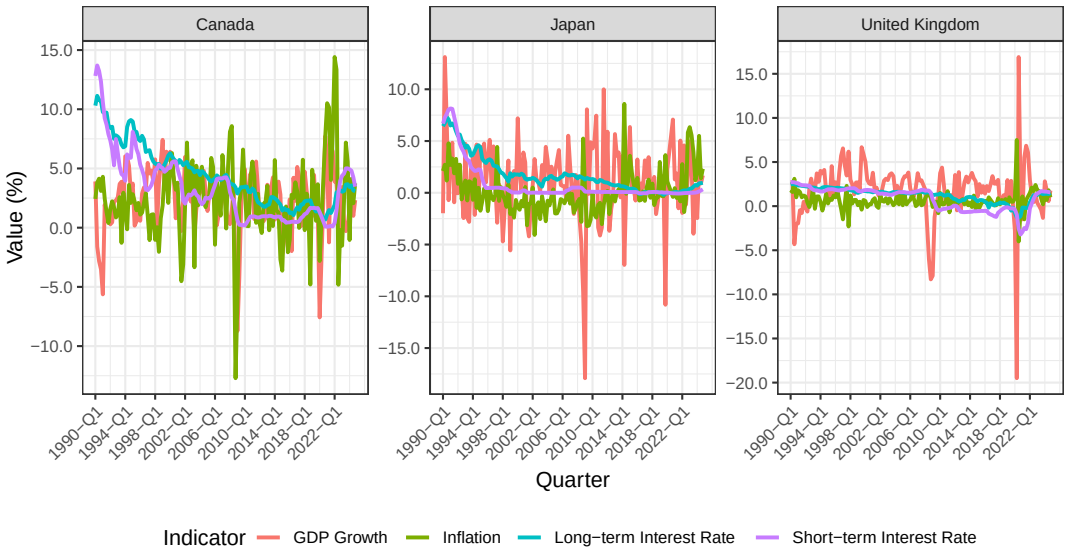
[7]Another candidate for the analysis was the United States, which also has a history of a high debt-to-GDP ratio. However, due to the unavailability of consistent debt-to-GDP data before the year 2000, we excluded the country from the analysis. Similarly, some EU countries also have high debt histories, but we did not include them as they are regulated under the European Union and lack independent fiscal institutions, which limits the comparability of their fiscal frameworks.

debt stress (e.g., (Ghosh et al., 2013a; Mauro et al., 2015; Berger et al., 2021b)).

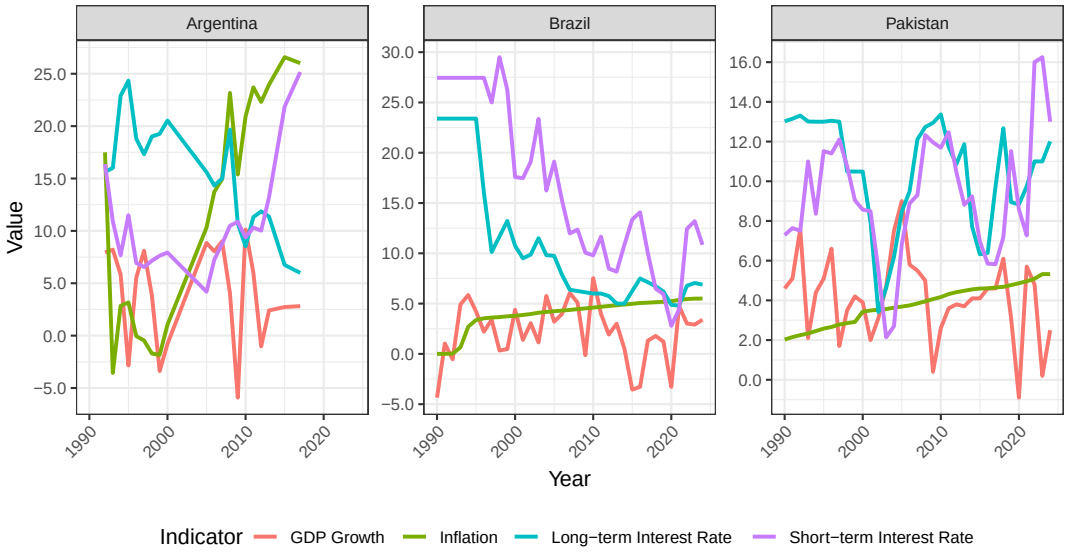
For the VAR analysis, the macroeconomic variables include real GDP growth, long-term interest rates, short-term interest rates, and inflation. Quarterly data from 1985 to 2024 are used for (AEs), (See Figure 3.1, a) whereas annual data from 1990 to 2024 are used for (EMDEs) (See Figure 3.1, b) This approach reflects standard practice in addressing data limitations in low- and middle-income countries and allows for meaningful cross-country comparisons over time.

For the FRF estimation, annual data from 1990 to 2024 are employed for all countries. The core fiscal variables include the primary balance -to-GDP ratio and the public debt-to-GDP ratio (See Figure 3.2, a, b). To account for macroeconomic conditions, the output gap (Figure 3.2 c) is also included as a key explanatory variable, consistent with the literature on countercyclical fiscal policy (e.g., (Galí and Perotti, 2003)). In addition to these core variables, several control variables are introduced to capture political and institutional influences on fiscal behavior. For all countries both (AEs) and (EMDEs) controls include election years, government orientation (left, right, or center), and fiscal rule thresholds that indicate episodes where countries exceed predefined debt or deficit limits. We adopt the IMF's 60% debt-to-GDP threshold as a benchmark for emerging market and developing economies (EMDEs), consistent with its fiscal frameworks. For (AEs), where no universal threshold exists, we apply an 80% threshold for both the UK and Canada in line with national reference points such as the UK's Office for Budget Responsibility (OBR), which has used 80% as a debt sustainability benchmark in prior assessments.[8]For (EMDEs) specifically, an additional dummy variable is included to reflect participation in IMF-supported programs, capturing the fiscal adjustment and conditionality effects associated with program engagement. This specification builds on the frameworks proposed by (Bohn, 1998; Mendoza and Ostry, 2008), and more recent advances by Berger et al. (2021b).

[8]Since Japan has not adopted a formal debt limit and existing literature does not provide a consensus threshold, we adopt a 200% debt-to-GDP benchmark as a stylized threshold to assess fiscal fatigue—aligning with the country's persistent high debt environment

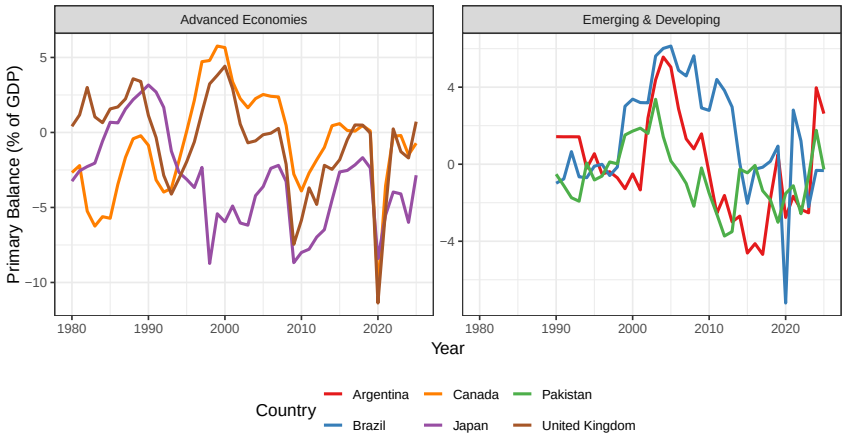


(a) Macroeconomic indicators in (AEs) (Canada, Japan, UK)

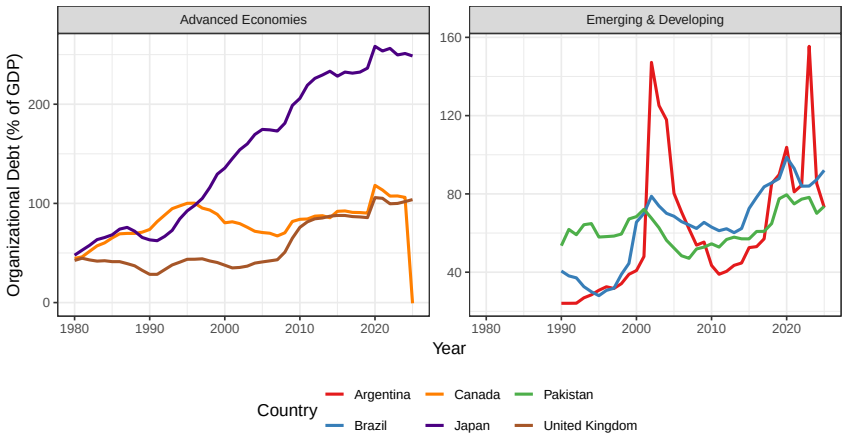


(b) Macroeconomic indicators in Emerging Market Economies (Argentina, Brazil, Pakistan)

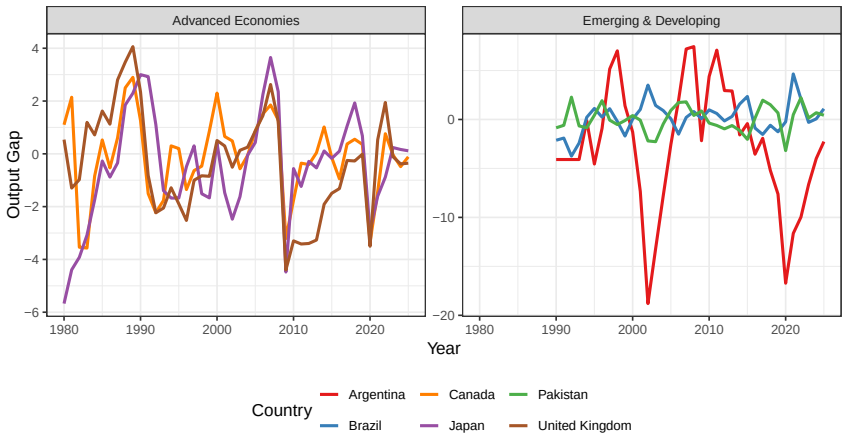
Figure 3.1: Comparison of key VAR indicators across Advanced and Emerging and Developing Countries. Indicators include GDP growth, inflation, and long- and short-term interest rates. The graphs for (AEs) are drawn using quarterly series; however, the series for (EMDEs) are drawn using annual data.



(a) Primary Balance as a % of GDP in Advanced and Emerging and Developing Countries.



(b) Debt-to-GDP Ratio in Advanced and Emerging and Developing Countries.



(c) Output Gap in Advanced and Emerging and Developing Countries.

Figure 3.2: Panel (a) shows fluctuations in primary balances, with greater stability in advanced economies. Panel (b) shows rising debt-to-GDP ratios, particularly among advanced economies, while EMDEs display more volatile debt dynamics. Panel (c) presents output gaps, which fluctuate around zero but exhibit larger swings in EMDEs during periods of economic stress.

The data for the (AEs) are sourced primarily from the OECD Economic Outlook. For (EMDEs), the IMF World Economic Outlook (WEO) serves as the principal source, supplemented by institutional and political indicators from IMF Monitoring of Fund Arrangements. All variables are made consistent across countries to allow comparison. This includes using the same definitions and units, checking for stationarity, applying necessary transformations, and doing minor interpolation to fill small data gaps. More details on variable definitions, transformations, and necessary tests are provided in Appendix for Chapter three B.2.

3.5 Results and Discussion

This section primarily discusses and reports the results related to the time-varying response of fiscal policy to lagged public debt and the estimated debt threshold, which captures potential non-linearities in fiscal behavior at elevated debt levels. The figures for these results are presented to aid interpretation and are based on a subset of selected countries, rather than the full sample. Results / figures for the other time-varying parameters, such as the lagged primary balance and the output gap, are provided in the appendix B for Chapter three Section 3.2. Additionally, this section discusses the results of the stochastic debt sustainability analysis for both country groups, illustrated using fan charts.

3.5.1 Fiscal Reaction Function FRF Results - (AEs)

Figure 3.3a presents the time-varying fiscal response coefficients to the lagged debt-to-GDP ratio for the United Kingdom. The dark blue line represents the posterior mean estimate of the time-varying fiscal responsiveness, while the shaded area reflects the 90% highest posterior density interval. These estimates are derived from a time-varying fiscal reaction function TVP-FRF model, which allows us to track how the UK's fiscal response to debt has evolved under shifting macroeconomic and political conditions. During the 1980s and early 2000s, the estimated coefficient on debt is strongly positive, indicating a robust fiscal consolidation response in line with (Bohn, 1998) criterion for debt sustainability. This suggests that rising debt levels were systematically met with tighter fiscal policy, a pattern also reflected in the broader adoption of fiscal rules and medium-term frameworks across (AEs) during this period (OECD, 2010).

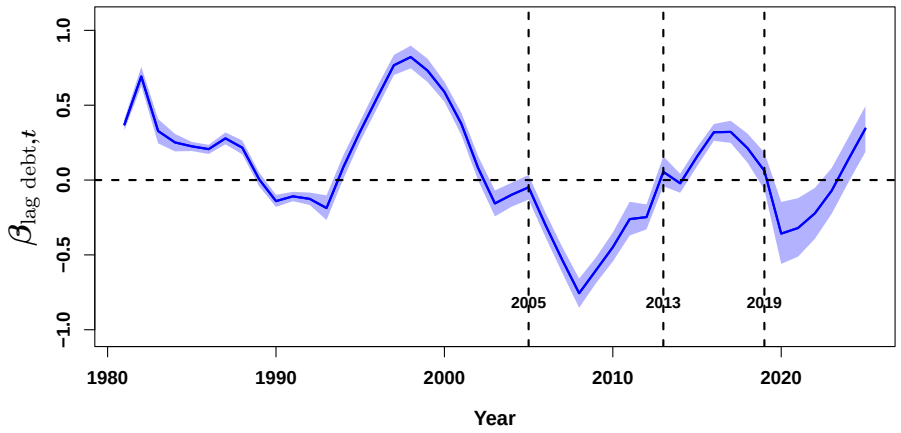
However, the fiscal response becomes notably more volatile following the Global Financial Crisis (GFC) of 2008–2009. This volatility suggests a shift toward a more accommodative fiscal stance, as the UK government prioritized macroeconomic stabilization over consolidation in the face of a deep recession. The weakening fiscal response in the 2010s may also reflect prolonged political uncertainty associated with Brexit, along with greater polarization in fiscal policymaking. A further decline in the responsiveness coefficient during the COVID-19 pandemic highlights the crisis-

driven nature of fiscal loosening, as emergency support packages were implemented despite rising debt burdens. In contrast, Figure 3.3b displays the time-varying fiscal response to lagged debt for Canada. The coefficient is negative during the early 1990s, reflecting limited fiscal space and a delayed reaction to mounting debt. However, the fiscal response improves substantially through the early to mid-2000s, consistent with a deliberate policy shift toward fiscal consolidation amid rising debt concerns. Similar to the UK, Canada's fiscal responsiveness weakened during the GFC, turning negative and reflecting countercyclical policy action. While the coefficient remained in negative territory during the pandemic period, a modest recovery afterward suggests a cautious reorientation toward consolidation, though not yet reaching pre-crisis responsiveness levels.

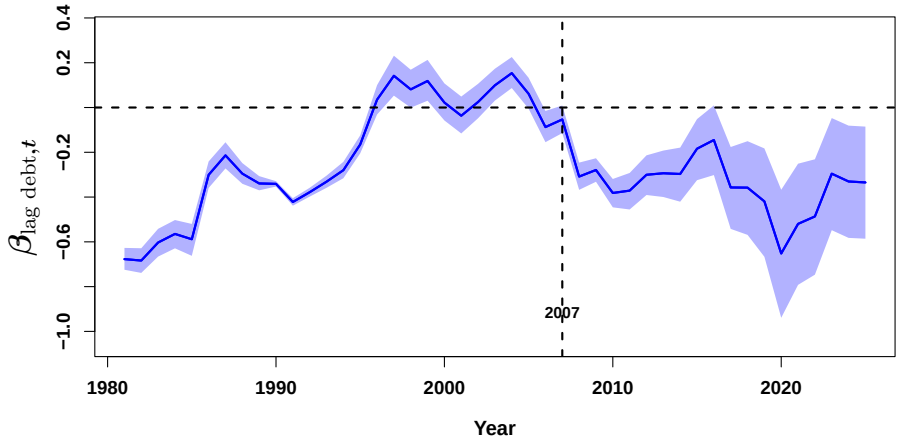
We also tested for fiscal fatigue within the TVP-FRF model by introducing a debt threshold of 80% of GDP for (AEs). Figure 3.4a shows the estimated debt threshold coefficient for the UK. While it fluctuates around zero for most of the period, it turns negative during the COVID-19 crisis, when the debt-to-GDP ratio exceeded the threshold. This suggests signs of fiscal fatigue, where the government becomes less willing or able to generate primary surpluses at higher debt levels (Ghosh et al., 2013c; Bi et al., 2013). This period was marked by unprecedented pandemic-related spending, such as the Coronavirus Job Retention Scheme, combined with limited political appetite for renewed austerity after a decade of fiscal tightening post-GFC and further constraints from Brexit-related political fragmentation. Similarly, Figure 3.4b reports the threshold effect for Canada. The coefficient remains mildly positive for most of the sample, but turns negative during the COVID-19 period. Canada implemented substantial fiscal support, including the Canada Emergency Response Benefit (CERB) and wage subsidies, pushing public debt beyond 100% of GDP. Despite elevated debt, there was no immediate move toward consolidation, reflecting weakened fiscal responsiveness. These findings provide empirical support for the fiscal fatigue hypothesis in both countries, particularly in the face of crisis-driven spending pressures and political constraints. We observed the similar pattern in Japan where fiscal fatigue is more prevalent.

Time-varying fiscal reaction parameter for lagged Debt, (AEs)

(a) Lagged Debt-to-GDP Coefficient, UK



(b) Lagged Debt-to-GDP Coefficient, Canada



Note: Each panel shows the posterior mean (solid line) and 90% credible interval (shaded region) for the respective fiscal response coefficient over time. The analysis is based on a time-varying parameter model.

Figure 3.3: Time-varying fiscal reaction parameter for lagged debt in (AEs) (UK and Canada).

The estimated coefficients on the lagged primary balance, presented in Appendix B Figures B.2 reveal notable differences in fiscal policy persistence across the UK, Canada, and Japan. For both the UK and Canada, the coefficients are largely positive, indicating that current fiscal actions tend to follow past efforts—reflecting a degree of fiscal inertia. However, in Canada, the coefficient dips briefly during the COVID-19 period, suggesting a temporary deviation from past fiscal behavior likely driven by emergency spending needs. In contrast, Japan's coefficient remains

mostly negative and volatile over time, with only a short-lived positive phase in the early 2010s. This pattern indicates weak fiscal persistence, potentially stemming from political turnover, short-term policy adjustments, and the ongoing challenge of managing high public debt amid low growth.

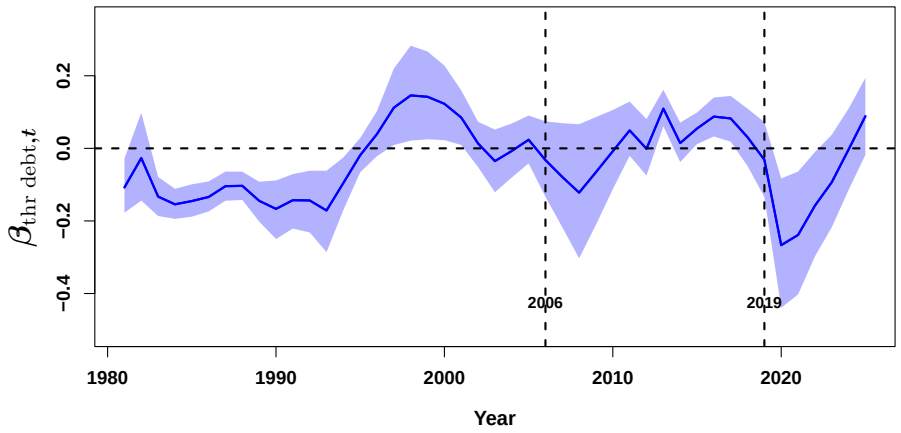
Across all (AEs), the fiscal response to the output gap remains consistently positive, indicating that fiscal policy has generally followed a countercyclical pattern. See Appendix B figures B.3. This suggests that governments tend to tighten fiscal policy during economic booms and loosen it during downturns, aligning with macroeconomic stabilization goals. This behavior has been increasingly observed, especially after the Global Financial Crisis (GFC), as many (AEs) adopted more active fiscal strategies despite elevated debt levels (Monitor, 2015; Alesina et al., 2019; Guajardo et al., 2014).

Lastly, Figure 3.5 compares the posterior distributions of the lagged debt and debt threshold coefficients from the time-varying fiscal reaction function with the corresponding fixed-parameter estimates. The clear divergence between the posterior means (blue lines) and fixed estimates (black dashed lines) highlights that fiscal responses are not constant over time. The TVP model captures evolving fiscal behavior and nonlinearities such as threshold effects ignored by the fixed model. This temporal variation is crucial for understanding state-dependent adjustments, particularly under high-debt conditions where fiscal fatigue may arise.

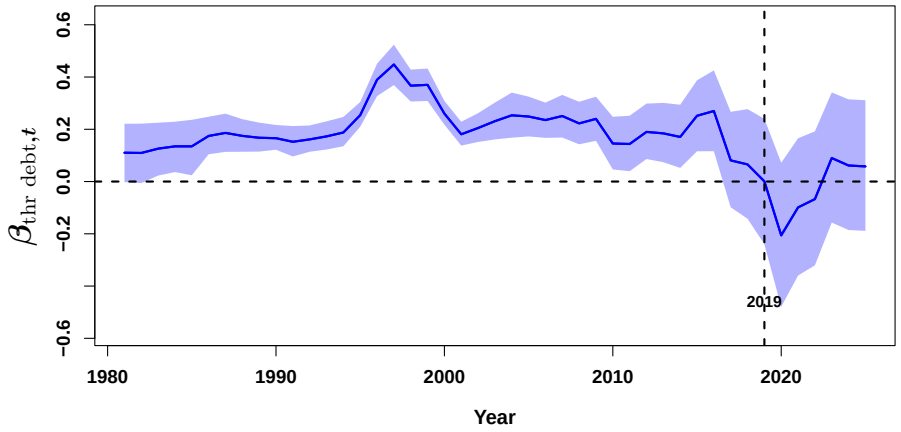
Overall, The TVP-FRF results highlight that fiscal responses in (AEs) are state-dependent and evolve over time. While countercyclical behavior remains prevalent, responsiveness to debt weakens during crises, revealing signs of fiscal fatigue particularly when debt exceeds critical thresholds.

Time-varying fiscal reaction parameter for Threshold Debt, (AEs)

(a) Threshold Debt Coefficient, UK



(b) Threshold Debt Coefficient, Canada

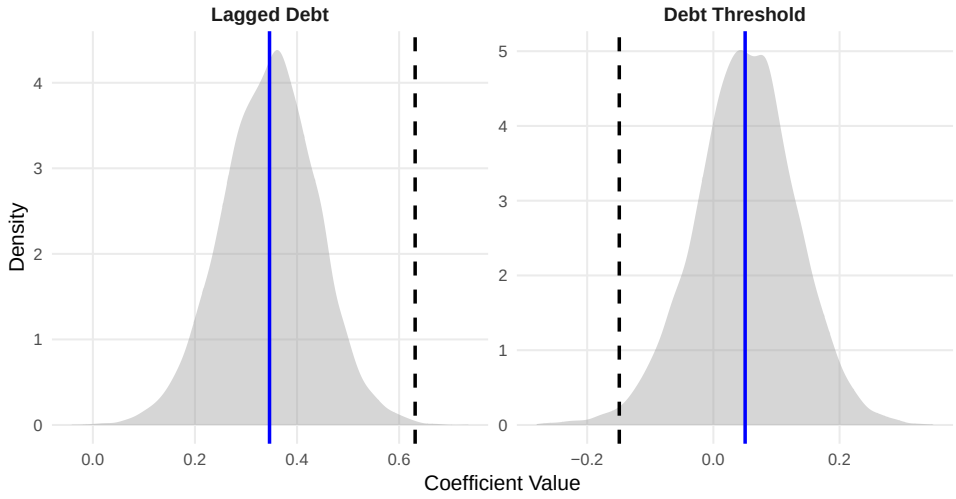


Note: Each panel shows the posterior mean (solid line) and 90% credible interval (shaded region) for the respective fiscal response coefficient over time. The estimation uses a time-varying parameter model.

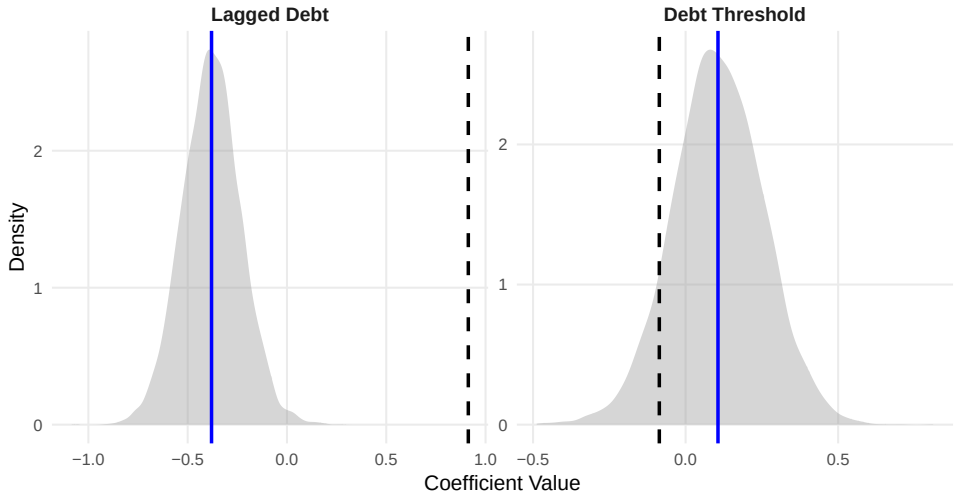
Figure 3.4: Time-varying fiscal reaction parameter for threshold debt in (AEs) (UK and Canada).

Density Plots for Advanced Countries, (AEs)

(a) UK



(b) Canada



Note: The figure displays kernel density estimates for the lagged debt and threshold debt coefficients from the time-varying fiscal reaction function. The black dashed vertical lines represent benchmark coefficients from the fixed-parameter fiscal reaction function, while the blue solid lines show the posterior mean estimates from the Time varying parameters model.

Figure 3.5: Density plots of lagged and threshold debt coefficients for (AEs) (UK and Canada).

3.5.2 Fiscal Reaction Function FRF Results - (EMDEs)

Here we discuss the time-varying fiscal response to debt and threshold effects for a set of emerging and developing economies (EMDEs). Figures 3.6 The time-varying fiscal response to debt in Argentina and Brazil reveals shifting consolidation behavior shaped by crises and institutional constraints. In Argentina, Figure 3.6 a

shows fiscal responsiveness was weak during the 1990s but turned modestly positive post-2001 crisis, reflecting short-lived consolidation efforts. However, the coefficient declined and turned negative after 2011 signaling fiscal fatigue before rebounding post-COVID, suggesting renewed adjustment efforts. In Brazil, responsiveness increased steadily in the 2000s, peaking around the global financial crisis, but declined sharply after 2015 amid heightened political turmoil and macroeconomic volatility. These dynamics align with literature on emerging market fiscal fatigue and institutional fragility (International Monetary Fund, 2009; Frankel et al., 2013). In Argentina, fiscal responsiveness to debt appears to have weakened after 2011, reflecting expansionary fiscal policies, limited IMF engagement, and institutional constraints, with some signs of adjustment in the post-COVID period following renewed engagement with the International Monetary Fund. In Brazil, strong fiscal responsiveness in the 2000s followed fiscal rule adoption, while the post-2015 drop reflected political scandals, fiscal slippages, and crisis-driven spending. Appendix B figure B.1 c shows Pakistan's persistently weak and negative fiscal response to rising debt, reflecting structural constraints, limited tax capacity, and repeated IMF programs, with further deterioration post-COVID.

For emerging and developing economies following IMF fiscal frameworks, we set the debt threshold at 60% of GDP. The results for the threshold debt-to-GDP coefficient further illuminate country-specific patterns. In Argentina, the fiscal response remains positive even after surpassing the 60% threshold, indicating no clear signs of fiscal fatigue. In contrast, Brazil's threshold coefficient declines toward zero by 2019 and turns negative at very high debt levels, suggesting fiscal exhaustion beyond a critical point (See figures 3.8). This aligns with the non-linear adjustment dynamics proposed by (Ghosh et al., 2013c; Baum et al., 2012), where high debt levels constrain policy response. For Pakistan, the Appendix B figure B.1 d shows a temporarily positive fiscal response above the threshold, which weakens sharply around the COVID period before stabilizing during recovery. Overall, emerging market economies do not exhibit the same degree of fiscal fatigue observed in (AEs).

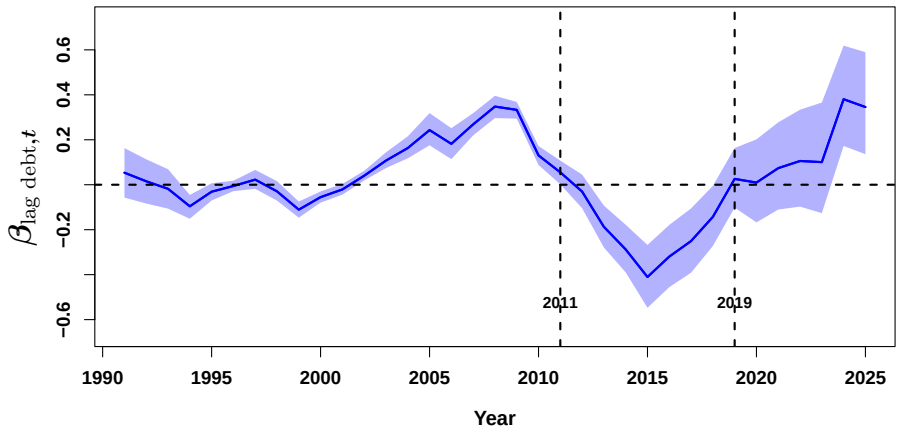
The primary balance estimates Appendix B, Figures B.4 offer further insights into fiscal behavior. Argentina displays a consistently positive primary balance coefficient, reflecting a relatively prudent stance despite volatility. Brazil, however, exhibits a declining response from 2013 onward, becoming increasingly negative post-COVID. Pakistan's primary balance coefficient fluctuates around zero but turns distinctly negative after 2020, pointing to fiscal deterioration amid pandemic-related pressures. These results mirror the findings of (Bohn, 1998) and (Ilzetzki and Végh, 2008), emphasizing that persistent deficits in response to rising debt undermine long-term fiscal solvency.

The output gap coefficient across (EMDEs) generally indicates counter-cyclical behavior, though the patterns vary. Argentina and Brazil both show negative TVP coefficients for the output gap before 2016–2018, suggesting procyclical or neutral

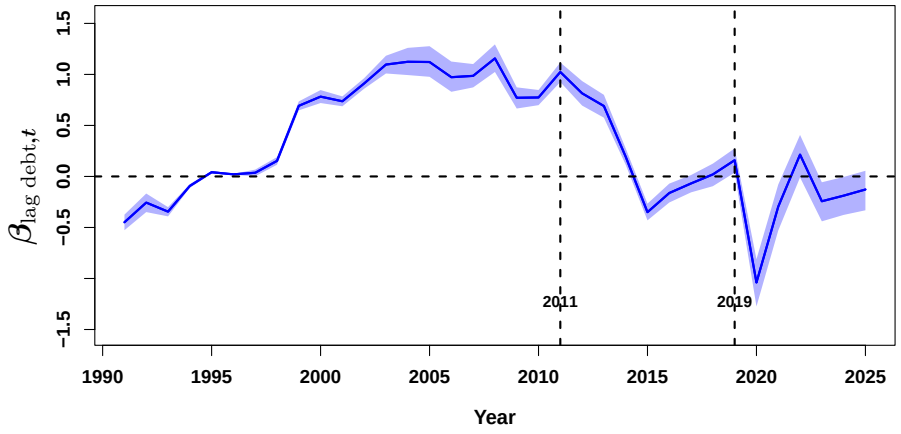
policy during expansions, See Appendix B Figures B.5. However, fiscal responsiveness improved during and after COVID, reflecting greater counter-cyclicality, possibly due to emergency stimulus efforts. Pakistan, by contrast, shows a consistently negative output gap coefficient throughout, indicating procyclical fiscal policy spending during booms and cutting during downturns, a typical pattern in low-capacity states as described by (KAMINSKY et al., 2004). This procyclicality in (EMDEs) often stems from financing constraints and weak automatic stabilizers, as confirmed by (Furman et al., 2016).

Time-varying fiscal reaction parameter for lagged Debt, (EMDEs)

(a) Lagged Debt-to-GDP Coefficient, Argentina



(b) Lagged Debt-to-GDP Coefficient, Brazil

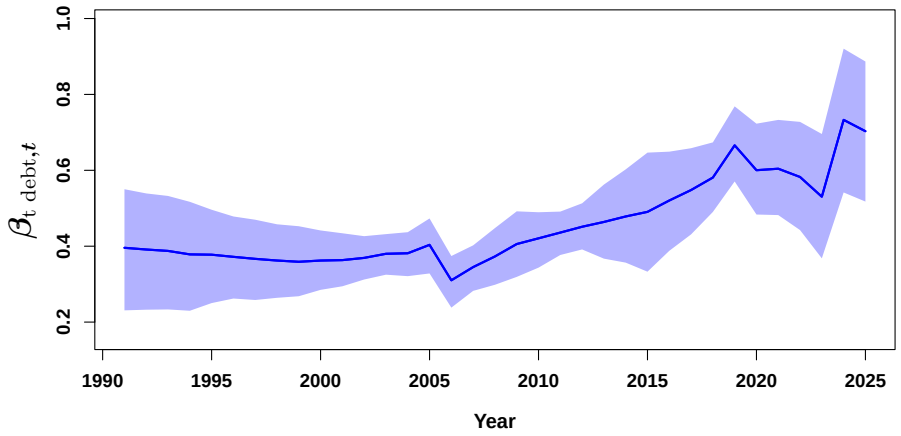


Note: Each panel shows the posterior mean (solid line) and 90% credible interval (shaded region) for the respective fiscal response coefficient over time. The estimation relies on a time-varying parameter model.

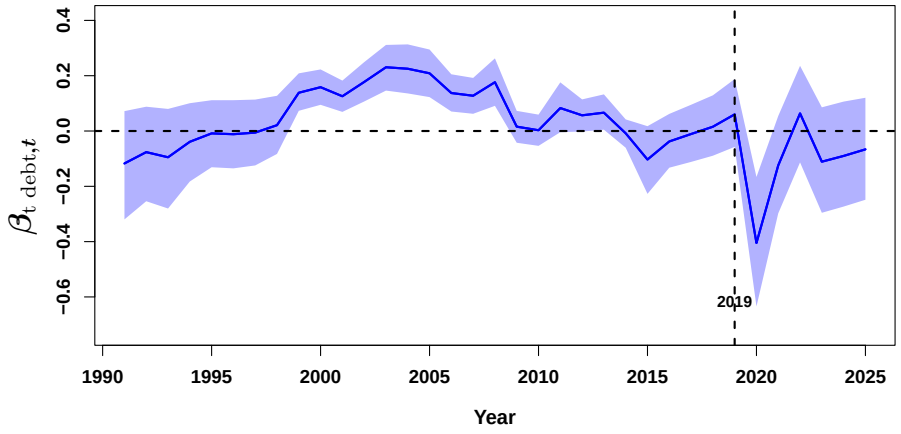
Figure 3.6: Time-varying fiscal reaction parameter for lagged debt in Emerging Market and Developing Economies (Argentina and Brazil).

Time-varying fiscal reaction parameter for Threshold Debt, (EMDEs)

(a) Threshold Debt Coefficient, Argentina



(b) Threshold Debt Coefficient, Brazil

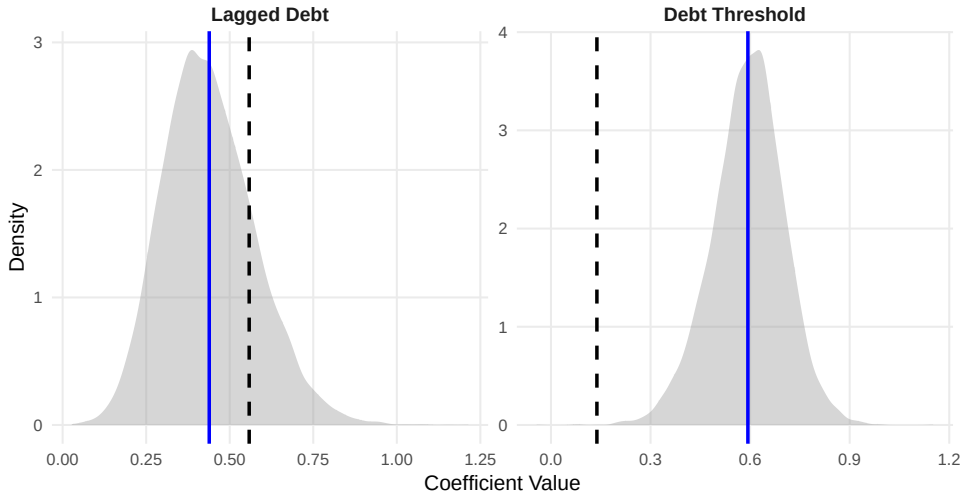


Note: Each panel shows the posterior mean (solid line) and 90% credible interval (shaded region) for the respective fiscal response coefficient over time. The estimation relies on a time-varying parameter model.

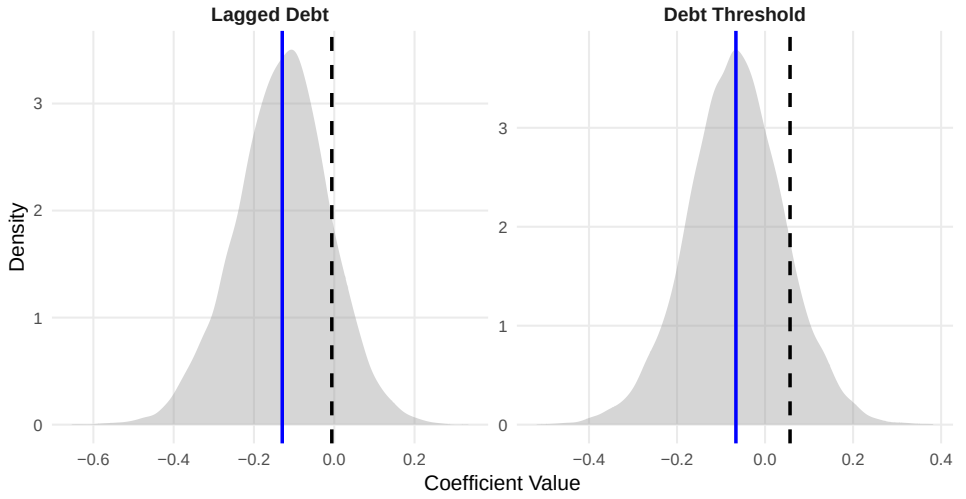
Figure 3.7: Time-varying fiscal reaction parameter for threshold debt in Emerging Market and Developing Economies (Argentina and Brazil).

Density Plots for Emerging and Developing Countries, (EMDEs)

(a) Argentina



(b) Brazil



Note: The figure displays kernel density estimates for the lagged debt and threshold debt coefficients from the time-varying fiscal reaction function. The black dashed vertical lines represent benchmark coefficients from the fixed-parameter fiscal reaction function, while the blue solid lines show the posterior mean estimates from the time varying parameters model.

Figure 3.8: Density plots of lagged and threshold debt coefficients for (EMDEs).

Figure 3.8 the comparison shows that fixed-parameter models tend to overestimate the fiscal response to debt in (EMDEs). In both Argentina and Brazil, the posterior means from the TVP model for lagged debt lie to the left of the fixed estimates, indicating a weaker average response when time variation is allowed. For the threshold effect, the fixed model also overstates the response in Brazil, while in Argentina the TVP estimate is slightly stronger. These results highlight that fixed models may not capture evolving fiscal behavior, leading to biased or overstated

estimates in (EMDEs).

Emerging and developing economies show varied fiscal responses to debt. Argentina and Brazil shift between consolidation and fatigue phases, while Pakistan's response remains weak and procyclical. Only Brazil shows signs of fiscal exhaustion at high debt levels. Overall, (EMDEs) do not display the same degree of fiscal fatigue as (AEs).

3.6 Stochastic Debt Sustainability Analysis (SDSA) and Fan Charts

The Stochastic Debt Sustainability Analysis (SDSA) provides a structured approach to evaluating the evolution of public debt under uncertainty. Widely adopted by institutions such as the IMF, the European Commission, SDSA relies on simulating the dynamics of the public debt-to-GDP ratio using macroeconomic forecasts and stochastic scenarios. The foundation of this method is based on the debt accumulation equation, as outlined by (Celasun et al., 2006b) and extended in subsequent studies (e.g., (Medeiros, 2012; Everaert and Jansen, 2018; Paret, 2017). The standard debt motion equation is given by:

$$\text{debt}_t = \left(\frac{1+i_t}{1+g_t}\right)\text{debt}_{t-1} - pb_t, \quad t = 1, 2, ..., T, \tag{3.12}$$

Here, debt_t denotes the public debt-to-GDP ratio in period t, i_t represents the real interest rate on outstanding debt, g_t is the real GDP growth rate, and pb_t refers to the primary balance net of interest payments.

In our implementation, projections of public debt are based on two complementary components. First, the primary balance is forecast using the estimated TVP-FRF model, which captures the time-varying fiscal policy response as a function of its economic and institutional determinants. Conditional on simulated paths of these determinants, the model generates forward-looking projections of the primary balance that reflect evolving fiscal behavior.

Second, the macroeconomic drivers of debt dynamics such as output growth, interest rates, and other relevant variables are projected using the TVP-BVAR model. This model captures the joint stochastic evolution of macroeconomic variables and allows for structural changes over time.

The two sets of forecasts are combined within a unified simulation framework, where macroeconomic paths generated by the TVP-BVAR are used as inputs into the TVP-FRF to obtain consistent primary balance projections. These are then incorporated into the debt accumulation equation, which is applied iteratively to generate a large number of simulated debt trajectories. This approach captures both macroeconomic and fiscal uncertainty by accounting for shocks and parameter variability, thereby providing a distribution of possible debt paths.

The results of these simulations are summarized using fan charts, which depict the distribution of potential debt paths over the forecast horizon. In these charts: The central band represents the 20% confidence interval around the median projection, the wider cone displays the 80% confidence interval, capturing a broad range of possible outcomes. Fan charts offer a visual and intuitive representation of fiscal risks and the probability of debt stabilization under current and time varying policies and macroeconomic assumptions. They are particularly useful for identifying the likelihood of debt exceeding certain thresholds and assessing the sustainability of fiscal paths under alternative scenarios.

3.6.1 Stochastic Debt Sustainability Analysis - (AEs)

Figure 3.9 presents fan charts of projected debt-to-GDP ratios for the United Kingdom and Japan using two modeling frameworks: a time-invariant (fixed-parameter) model assuming constant fiscal behavior, and a time-varying parameter (TVP) model allowing fiscal responses to evolve over time. Each panel displays the median debt projection (red line), a 20% confidence band (light shaded area), and an 80% confidence band (dark shaded cone), representing forecast uncertainty over the period 2024–2028.

Figures 3.9a and 3.9c show projections under the fixed-parameter model, where governments' responses to macroeconomic conditions and fiscal policy are assumed to remain constant. These scenarios generally produce narrower uncertainty bands, particularly for Japan, suggesting stable policy conduct and institutional predictability. However, the median debt paths under this model for both the UK and Japan are notably increasing, indicating that assuming static fiscal behavior may lead to pessimistic trajectories in the absence of policy adjustment.

In contrast, Figures 3.9b and 3.9d incorporate the TVP framework, allowing fiscal parameters to adjust dynamically in response to evolving conditions. These projections exhibit broader uncertainty bands, most prominently in Japan, where historical fiscal volatility, demographic pressures, and persistent debt accumulation contribute to a wide range of plausible outcomes. In the UK, the TVP model produces a lower median debt path alongside slightly wider bands than the fixed model, reflecting uncertainty in fiscal direction following Brexit-related structural changes and political turnover.[9]

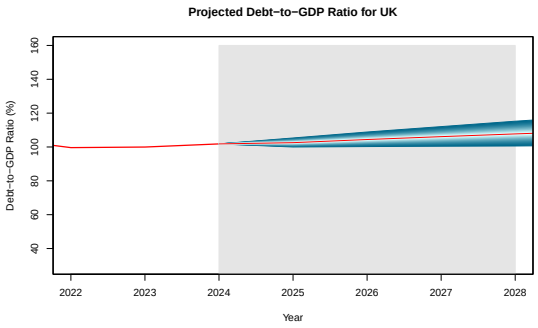
These differences can be explained by the underlying treatment of uncertainty in the two frameworks. Compared to constant-parameter models, the TVP specification produces wider fan charts because it accounts not only for future shocks but also for the evolution of model parameters over time. By allowing coefficients to follow a stochastic process, the model captures potential structural changes in economic relationships (Primiceri, 2005a; Koop and Korobilis, 2010). As a result, forecasts

[9]Projected debt summaries for both (AEs) and (EMDEs) under fixed and time-varying models are provided in Appendix B.1.

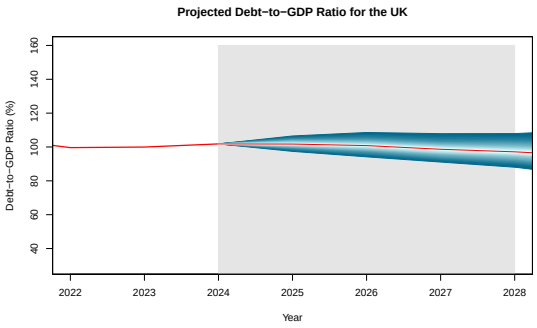
depend on both the realization of future shocks and the uncertain future paths of the parameters, leading to greater dispersion, particularly at longer horizons.

Furthermore, the Bayesian estimation approach integrates over parameter uncertainty, so that forecast densities reflect both shock uncertainty and uncertainty about coefficient evolution. In contrast, constant-parameter models condition on fixed coefficients, implicitly assuming stable relationships and thereby understating uncertainty (Cogley and Sargent, 2005). The wider fan charts produced by the TVP model therefore provide a more realistic assessment of the risks surrounding future debt dynamics.

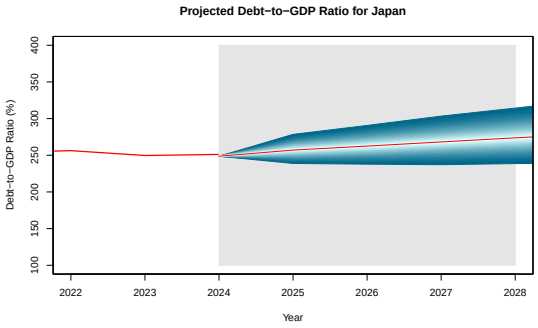
This interpretation is consistent with the broader literature on stochastic debt sustainability analysis. Traditional approaches typically assume fixed fiscal behavior over time (Celasun et al., 2006b), which may fail to capture policy regime shifts. More recent contributions, such as (Berger et al., 2021a) and (Dubbert, 2024), show that allowing for time-varying fiscal responses improves the realism of debt projections by incorporating adaptive policy behavior and macroeconomic uncertainty. In this context, fan charts derived from TVP models offer a probabilistic assessment of fiscal risks that is more consistent with observed policy dynamics.



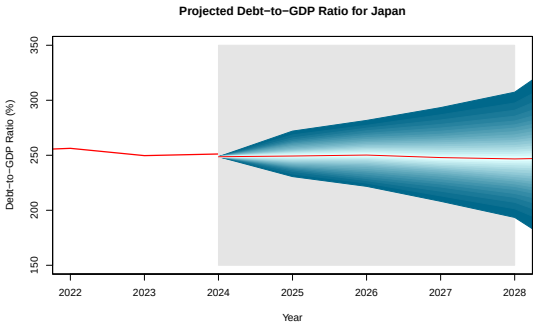
(a) Fixed Parameters – UK



(b) Time-Varying Parameters – UK



(c) Fixed Parameters – Japan



(d) Time-Varying Parameters – Japan

Note: Each panel presents fan-chart projections of the public debt-to-GDP ratio. Fixed parameter models assume constant fiscal behavior and macroeconomic conditions, while time-varying models incorporate evolving fiscal responses and economic dynamics.

Figure 3.9: Fan charts of debt projections under fixed and time-varying parameters for advanced countries (UK and Japan).

3.6.2 Stochastic Debt Sustainability Analysis - (EMDEs)

Figure 3.10 presents fan charts of projected debt-to-GDP ratios for Argentina and Brazil under both time-invariant and time-varying parameter (TVP) models. Each panel illustrates the median projection (red line), along with 20% (light shaded) and 80% (dark shaded) confidence bands over the forecast horizon (2024–2028). These bands, inspired by the stochastic debt sustainability frameworks developed by (Celasun et al., 2006b) and (Medeiros, 2012), reflect uncertainty in fiscal and macroeconomic conditions, offering a probabilistic view of potential debt paths.

As shown in Figures 3.10a and 3.10c, the fixed-parameter models generate higher median debt projections than their TVP counterparts, displayed in Figures 3.10b and 3.10d. Interestingly, this occurs despite the TVP models exhibiting wider uncertainty bands a typical consequence of allowing fiscal behavior to evolve over time. This result suggests that assuming fixed fiscal behavior may overstate future debt burdens in countries where fiscal policy has historically been volatile or subject to reform. In both Argentina and Brazil, frequent policy adjustments and external pressures have influenced fiscal outcomes, and the TVP model captures this adaptability by allowing for gradual changes in fiscal responses.

This difference is also reflected in the shape of the projected debt paths. The fixed-parameter model exhibits a noticeable kink at the end of the forecast horizon for Argentina, reflecting the compounding nature of debt dynamics under constant fiscal responses. In the absence of time variation, the model imposes a fixed relationship between debt and the primary balance, which may be insufficient to stabilize debt as it evolves. As a result, small imbalances accumulate over time and lead to a sharper increase in projected debt at longer horizons, a feature commonly observed in long-horizon debt projections under fixed policy rules (Celasun et al., 2006b; Bohn, 1998).

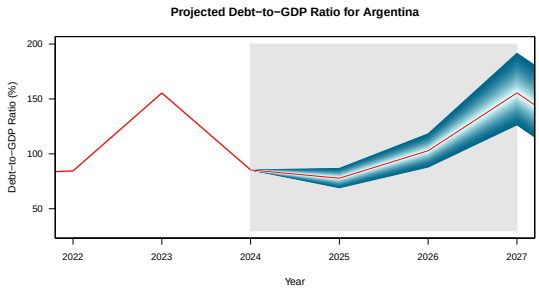
In contrast, the TVP specification allows fiscal responses to adjust over time, as a result, mitigating the buildup of imbalances and producing a smoother trajectory. This distinction is particularly relevant for Argentina, which has a long history of high and volatile debt-to-GDP ratios and recurrent fiscal stress. In such settings, assuming constant policy behavior can be overly restrictive, whereas allowing for time variation better captures evolving fiscal responses and reduces the likelihood of artificial nonlinearities in projections.

Figure 3.10 presents fan charts of projected debt-to-GDP ratios for Argentina Brazil, under both time-invariant and time-varying parameter (TVP) models. Each panel illustrates the median projection (red line), along with 20% (light shaded) and 80% (dark shaded) confidence bands over the forecast horizon (2024–2028). These bands, inspired by the stochastic debt sustainability frameworks developed by (Celasun et al., 2006b) and (Medeiros, 2012), reflect uncertainty in fiscal and macroeconomic conditions, offering a probabilistic view of potential debt paths.

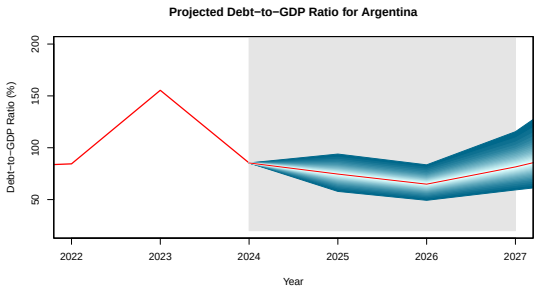
For Pakistan, the time-invariant model yields a lower median debt projection

compared to the TVP model, suggesting a more optimistic debt consolidation path under the assumption of stable fiscal conduct. However, the broader uncertainty captured by the TVP model reflects greater realism regarding Pakistan's volatile macroeconomic environment and possible policy slippages. See Appendix B figures B.7.

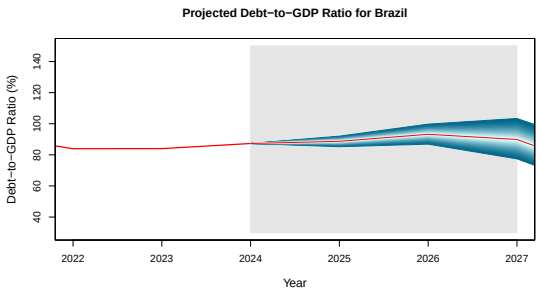
These findings align with (Dubbert, 2024) and IMF studies (Monitor, 2018; Shot, 2021), which underscore the importance of allowing fiscal parameters to evolve in economies with weak or volatile policy frameworks. Moreover, (Frankel et al., 2013) emphasize that emerging markets often struggle with maintaining consistent countercyclical fiscal policy, lending further support to the use of time-varying models for realistic debt sustainability assessments.



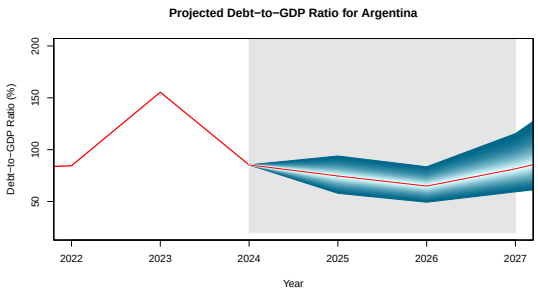
(a) Fixed Parameters – Argentina



(b) Time-Varying Parameters – Argentina



(c) Fixed Parameters – Brazil



(d) Time-Varying Parameters – Brazil

Note: Each panel presents fan-chart projections of the public debt-to-GDP ratio. Fixed parameter models assume constant fiscal behavior and macroeconomic conditions, while time-varying models incorporate evolving fiscal responses and economic dynamics.

Figure 3.10: Fan charts of debt projections under fixed and time-varying parameters for emerging countries (Argentina and Brazil).

3.7 Conclusion

In the wake of the COVID-19 pandemic and amid a shifting global macroeconomic landscape including rising inflation, tightening financial conditions, and increasing debt burdens governments across both advanced and emerging market and developing economies (EMDEs) face growing challenges in maintaining fiscal sustainability. This study is motivated not only by the urgent need to assess the sustainability of

rising public debt, but also by the observation that fiscal policy behavior evolves over time in response to changing economic conditions. Relying solely on static fiscal policy risks misrepresenting the true nature of fiscal dynamics in such a changing environment.

To address these challenges, we implement a flexible modeling framework that explicitly accounts for both evolving fiscal behavior and macroeconomic uncertainty. We compare a conventional fixed-coefficient model with a more adaptive approach combining a time-varying fiscal reaction function TV-FRF and TVP-VAR. This framework is applied to a sample of high-debt countries from both (AEs) and (EMDEs) to assess debt trajectories and associated risks.

The results from the TVP-FRF model reveal that fiscal responses to debt and other macroeconomic variables have changed significantly over time in both (AEs) and (EMDEs). In (AEs), the model captures episodes of fiscal fatigue where fiscal responsiveness diminishes at higher debt levels aligning with theoretical insights from (Ghosh et al., 2013a). In contrast, while (EMDEs) show evolving fiscal behavior as well, signs of fiscal fatigue are less pronounced, likely reflecting weaker institutions or externally imposed fiscal constraints such as IMF-supported programs.

Moreover, fan charts generated from the time-varying models display wider uncertainty bands and more plausible debt paths than those from fixed-parameter models. In (AEs), fixed-coefficient models tend to underestimate uncertainty and overstate debt projections. For emerging and developing economies (EMDEs) such as Brazil and Argentina, the fixed model often overpredicts debt, while the TVP model adjusts to observed fiscal patterns and macroeconomic volatility, yielding more credible forecasts.

These findings reinforce the importance of time-varying fiscal frameworks in debt sustainability analysis, especially in periods of heightened macroeconomic uncertainty and shifting fiscal behavior. However, the model has limitations. Unlike (Primiceri, 2005a), we do not model time-varying volatility in the shocks, which may underestimate the tail risks. Additionally, our fiscal reaction function includes only a limited set of macroeconomic variables; adding more could lead to overparameterization, especially in small samples. Future research could explore alternative model specifications and assess the robustness of results across different countries and macroeconomic environments.

Chapter 4

International Fiscal Spillovers from China: Global VAR Approach

4.1 Introduction

Currently global economy facing increasing volatility driven by several key factor including geopolitical tension, and disruption in global trade and economic stability. These challenges posting significant threat for both advanced and emerging economies. A prudent fiscal policy in coordination with other economic polices has been proposed in literature to tackle the global economic challenges, see for example (Gaspar et al., 2016; Furman et al., 2016).

It is worth highlighting that China has emerged as a major player in the global economy over the past few decades, sustaining rapid economic growth and strengthening its role in global supply chains (Hu et al., 2014). China has positioned itself as a key driver of global production and trade through its investments, industrial expansion, and technological advancements. Its extensive trade links have strengthened economic ties with the countries in close geographical proximity and the worldwide, resulting in strong macroeconomic spillovers (Ahuja and Nabar, 2012; Arora and Vamvakidis, 2011); and IMF (2013 & 2016). Literature shows that spillovers, whether through real or financial channels, have had significant impacts on its trading partners, influencing their growth trajectories, inflation, and even fiscal policies (e.g., (Dieppe et al., 2018; Ricci-Risquete et al., 2018; Bernanke et al., 2005; Gauvin and Rebillard, 2018)).

Theoretically, fiscal spillovers occur when a country's domestic fiscal policy affects economic activity in another country (e.g., (Auerbach and Gorodnichenko, 2013; Belke and Osowski, 2019)). These effects can be positive or negative and vary across countries, regions, and sectors, depending on factors like the size and nature of the fiscal shock, financial linkages, economic integration, geographic proximity, and the economic conditions of both the shock-emitting and shock-receiving coun-

tries. Spillovers occur through several channels. The most common is the demand, or trade, channel, where fiscal expansion in one country boosts domestic output and raises demand for imports, benefiting trading partners, for instance see, (Elekdag and Muir, 2014; Hebous and Zimmermann, 2013; Alloza et al., 2019; Giuliodori and Beetsma, 2005). The financial or interest rate channel is also significant, particularly in fixed exchange rate systems, where fiscal expansion raises domestic interest rates and attracts foreign capital, leading to upward pressure on interest rates in other countries (Caporale and Girardi, 2013), tightening global financial conditions. Lastly, the exchange rate channel comes into play when higher interest rates from fiscal expansion attract foreign capital, causing currencies in countries with flexible exchange rates to appreciate, potentially affecting their competitiveness and trade balances (Hebous and Zimmermann, 2013).

This research is primarily motivated by China's growing global economic influence, making it essential to understand how spillovers from China affect neighboring countries and major trading partners worldwide. While macroeconomic spillovers from China have received considerable attention in recent years (see (Duval et al., 2014; Ahuja et al., 2012; Dizioli et al., 2016)), the specific question of fiscal spillovers remains largely underexplored in the literature. To address this gap, our study investigates fiscal spillovers from China to five ASEAN economies Malaysia, Indonesia, the Philippines, Singapore, and Thailand due to their strong trade ties and geographical proximity to China. Furthermore, we broaden our analysis to include four regional groupings based on high trade exposure to China: (1) the broader Asia-Pacific region, (2) the Euro Area, (3) South America, and (4) ASEAN countries as a distinct regional bloc.[1]

To estimate fiscal spillovers, we first compile novel fiscal data on a country-by-country basis for the ASEAN-5 countries. This data is then aggregated at the regional level, covering four regions: the rest of Asia-Pacific, South America, the Euro Area, and ASEAN as a distinct region on a quarterly basis for the period from Q1 2001 to Q4 2023. Next, we employ the Global Vector Autoregressive (GVAR) methodology, developed by (Pesaran et al., 2004), to examine fiscal spillovers from China to other economies and regions. The GVAR model is particularly suited to this analysis as it addresses the high-dimensionality challenge that arises in standard VAR models. By allowing for heterogeneity across countries, the GVAR framework effectively captures the intricate dynamics of fiscal spillovers by incorporating both domestic and foreign variables. Foreign variables, constructed using trade weights, capture international linkages among economies, enhancing the model's ability to estimate country-specific effects within a globally interconnected context.

The study addresses the following key questions. First, does output expansion in China influence economic output both domestically and in other countries? Second,

[1]The Asia-Pacific region includes Australia, India, Japan, and South Korea. The Euro Area includes France, Germany, Italy, the Netherlands, Spain, and the UK. The South American region includes Argentina, Brazil, Chile, Mexico, and Peru.

does fiscal expansion in China trigger fiscal adjustments in other economies? If so, how long do these effects persist, and what is the direction of the spillovers? Finally, are fiscal spillovers heterogeneous across different countries?

The results of the GVAR analysis demonstrate that both output and fiscal expansion in China lead to significant increases in economic output and government revenues not only within China but also across most ASEAN countries and regional blocs. In several countries, these effects are both statistically significant and persistent. However, the impact of Chinese fiscal expenditure shocks appears less pronounced in ASEAN economies. At the regional level, the analysis reveals that China's output and revenue expansion spill over into other regions, with the strongest effects observed in the Asia-Pacific and ASEAN regions. This is likely due to their close geographical proximity and strong trade linkages with China. In contrast, the Euro Area and South America exhibit only transitory responses to output and revenues shocks from China. Moreover, fiscal expenditure shocks originating in China do not show significant transmission to these other regions.

Overall, the findings underscore the interconnectedness of regional economies and the influential role of China's economic performance on its neighbors and trading partners. This supports earlier findings by (Dizioli et al., 2016), who observed that a decline in China's GDP adversely affects ASEAN-5 countries through trade and other channels. Furthermore, our results indicate that a fiscal expansion in China, particularly a positive revenue shock has a strong and statistically significant effect on partner economies, with estimated output gains ranging from 1.0% to 1.2%. By contrast, positive expenditure shocks have minimal impact compared to revenue and output shocks. This observation aligns with the conclusions of (Dabla-Norris et al., 2017), who argue that tax-based consolidations tend to have a stronger influence on output than expenditure-based adjustments.

The remainder of this chapter is organized as follows: Section 4.2 provides a comprehensive literature review, offering insights into existing empirical and theoretical research on fiscal spillovers. Section 4.3 outlines the GVAR methodology employed in this study. In Section 4.4, we describe the data used in the GVAR analysis, emphasizing its relevance and reliability. Section 4.5 presents the specification tests and main results, interpreting the findings for three distinct shocks to the domestic economies of China and the ASEAN-5 countries. Section 4.6 discusses the shock analysis for the four regions. Section 4.7 discussed result robustness. Finally, Section 4.8 concludes the chapter, summarizing key insights and offering some policy suggestions.

4.2 Literature Review

In today's global and interconnected world, economic and fiscal policies rarely remain isolated. Fiscal decisions in one country impact not only its internal economy but

also have cross-border effects. These fiscal spillovers arise from government actions, such as spending and tax decisions, as well as through trade links and economic integration with other economies. The study of international fiscal spillovers from large economies has gained attention, highlighting how fiscal choices can stabilize or destabilize economies beyond national borders. Recent literature shows that these spillovers are not uniform; they vary by policy type, trade linkages, and country size, underscoring the nuanced and heterogeneous nature of fiscal spillovers (see e.g., (Kumar et al., 2024; Faccini et al., 2016; Hebous and Zimmermann, 2013; Ricci-Risquete and Ramajo-Hernández, 2015)).

The study relies on different strands of literature. First, it focuses on the Global Auto-Regressive methodology (GVAR). The second strand focuses on international fiscal spillovers. Thirdly, it draws on existing literature on spillovers from the Chinese economy.

The Global VAR (GVAR) approach was first developed by (Pesaran et al., 2004) and (Dees et al., 2007) to study spillovers in a multi-country framework. In this framework, each country-specific VAR model is extended by adding a foreign component, which is constructed as a weighted average of other countries domestic variables based on economic or financial linkages. The GVAR can be seen as a large restricted VAR, where the restrictions come from the use of weights in forming foreign variables and from treating the foreign components as weakly exogenous in relation to the long-run parameters of the domestic VAR (Bicu and Lieb, 2015).

The literature on international fiscal spillovers is relatively sparse, with most studies focusing on spending shocks while neglecting revenue / tax shocks. Furthermore, the majority of research has concentrated on (AEs). For example, many studies have focused on the Organization for Economic Cooperation and Development (OECD) countries, EU member states, and the US (e.g., (Giuliodori and Beetsma, 2004; Beetsma et al., 2006; Blanchard et al., 2017; Hollmayr, 2012; Poghosyan, 2020; Blanchard and Perotti, 2002) conducted one of the earliest studies analyzing the impact of fiscal spending shocks on output in the US, employing the structural VAR methodology to explore fiscal shock effects.

A range of methodological approaches has been applied to examine international fiscal spillovers. For example, (Auerbach and Gorodnichenko, 2013) and (Blagrave et al., 2017) use the local projection method introduced by (Jordà, 2005) to analyze the effects of global fiscal shocks. (Auerbach and Gorodnichenko, 2013) report positive fiscal spillovers on output in a panel of OECD countries, while Goujard (2017) employ the same method to study fiscal consolidation spillovers on growth, finding that such effects are stronger among members of currency unions but fade in the medium term. (Bussière et al., 2017) adopt a multi-country DSGE framework to assess how fiscal and monetary policy reforms transmit to foreign economies.

Similarly, (Faccini et al., 2016) examine international fiscal spillovers using theory-robust sign restrictions within a factor model. Their results indicate that higher U.S.

government spending generally benefits its main trading partners, with the transmission working primarily through financial rather than trade channels. In another contribution, (Corsetti et al., 2009) analyze cross-country spillovers of fiscal stimulus policies using a two-country business-cycle model. They highlight the importance of medium-term debt consolidation, stressing that temporary, debt-financed increases in public spending may require future expenditure cuts or tax hikes. These adjustments, in turn, influence long-term real interest rates and can amplify the domestic and international growth effects of fiscal stimulus.

Another strand of literature focuses on studies using the GVAR methodology to analyze fiscal spillovers is also scarce, with these studies primarily focusing on the Euro Area. (Hebous and Zimmermann, 2013) estimate the impact of fiscal shock spillovers from one country to other member countries in the euro area using the GVAR methodology. They compared an area-wide fiscal shock, which is a weighted average of the fiscal shocks of all member countries, with a domestic fiscal shock. Their results show that the impact of a fiscal shock on the output of countries is positive. Additionally, the effects of the area-wide fiscal shock on output are larger compared to the domestic shock of the same size.

(Ricci-Risquete and Ramajo-Hernández, 2015) analyzed the economic consequences of fiscal shocks not only in the eurozone but also in the member countries of the former EU15 and the US. They studied the impact of fiscal shocks on total government receipts and total government expenditure using the GVAR methodology with quarterly data for the period of 1978-2009. The results of the study show that the response of GDP is positive to a positive shock in total expenditure/total receipts and negative for a reduction in total expenditure/total receipts. These results are consistent with (Hebous and Zimmermann, 2013).

(Dragomirescu-Gaina and Philippas, 2015) examine the strategic interactions of fiscal policies within the EU using the GVAR framework for twelve member states, based on annual data from 1978 to 2013. Their analysis underscores the linkages between public and private sector saving–investment balances across these countries. The findings suggest that international private capital flows constrain the set of feasible policy choices and intensify the trade-off between addressing domestic and foreign idiosyncratic shocks. Similarly, Carpoli and Giradi (2011) apply a global VAR approach to study how fiscal imbalances in EMU member states affect the borrowing costs of their EMU partners. Using quarterly data, they show that long-term bond yields on euro-denominated government securities are highly interconnected, with foreign factors explaining a substantial share of the variability in long-term interest rates across all EMU countries over the simulation horizon.

(Nickel and Vansteenkiste, 2013) examine the impact of spending shocks on real variables and financial variables such as corporate bond yields, government bond yields, and equity prices in eight countries, including several European countries, the US, the UK, and Japan. The empirical strategy of the study is GVAR, which

employs quarterly data from 1980 to 2008. The results show that shocks originating from countries where government bonds are perceived as risk-free result in significant spillover effects on the corporate bond market. Furthermore, a shock to spending also has a positive and significant impact on equity prices, with heterogeneity in the results across countries. (Favero et al., 2011) study heterogeneity in the effect of fiscal policy using non-linear GVAR model. They establish that the effect of fiscal policy shock is different depending on different dynamics of country's debt, different fiscal reaction functions across countries, and different degrees of openness. The studies highlighted above focused on a group of countries, i.e., the EU, Eurozone, or US, as a global shock.

The final strand of literature on macroeconomic spillovers from China is also relatively limited. Also, none of the existing studies consider the output effects of fiscal shocks from China on international economies. This paper fills that gap by examining how China's fiscal policies impact global economic performance.

In the literature, many researchers have employed different methods, i.e., the DSGE, and OLG models, VARs, factor-augmented VARs, and event studies, to investigate the spillover effects of the Chinese economy on trading partners. For instance, (Cesa-Bianchi et al., 2012; Ahuja et al., 2012; Duval et al., 2014; Anderson et al., 2015) and (Ahuja and Myrvoda, 2012) studies impact of China slowdown on regions. These studies do not account for indirect exposure to the shocks through trade and financial linkages .

(Sznajderska and Kapuściński, 2019) develop the GVAR model to study macroeconomic spillover effects of the Chinese economy on fifty-nine economies. Their results confirm that the negative demand shock in China has a negative impact on the output of the countries; however, this effect is strong for neighbouring economies, i.e., Malaysia, Indonesia, Singapore, Hong Kong, and Thailand, compared to other countries. Following the China stock market crash in 2015-16, (Ahmed and Huo, 2019), using daily data, find strong spillover from China to most Asia and Pacific stock markets. (Blagrave and Vesperoni, 2018) study China's secondary and territory demand shocks using panel vector auto regressive and conclude that shock to demand growth in the secondary sector has a larger spillover to its trading partners compared to the territory sector.

Another study by (Dizioli et al., 2016) investigates the spillover effects from China's growth slowdown and rebalancing on the ASEAN-5 economies. The GVAR model they employed considers both real and financial drivers of economic activity. Empirical findings suggest that a negative shock to China's GDP has a significant impact on the ASEAN-5, except for the Philippines, while spillovers to other Asia-Pacific economies remain relatively small. However, most of the existing studies focus on growth, trade, or financial shocks, largely overlooking the role of fiscal policy as a source of international spillovers.

This study contributes to the existing literature in several important ways. First,

while the literature on international fiscal spillovers remains limited and largely focused on (AEs) and government spending shocks, this paper provides a broader analysis by jointly examining both expenditure and revenue shocks. Second, although the Global VAR (GVAR) methodology has been applied in previous studies, its use in analysing fiscal spillovers from emerging economies particularly China remains scarce. This study extends the GVAR framework to capture fiscal transmission channels from China to a wide set of global economies. Third, unlike the existing literature on China, which predominantly focuses on growth slowdowns, trade, or financial shocks, this paper is among the first to explicitly analyse the international output effects of China's fiscal policy shocks. By doing so, it fills an important gap and provides new empirical evidence on the global macroeconomic implications of fiscal policy in a major emerging economy.

4.3 GVAR-Methodology

The Global Vector Auto Regressive approach originally proposed by (Pesaran et al., 2004) is designed to model the countries, regions, and markets as sources of shock transmission to other countries and regions. GVAR methodology helps to quantify the magnitude of these shocks across countries and regions. This methodology involves two steps: first, each country i is individually modeled using a single-country VAR model enhanced with exogenous variables (VARX). In these VARX models, the endogenous variables ($X_{i,t}$) are purely domestic, while the country-specific foreign variables ($X^*_{i,t}$), derived as averages of other countries variables, act as proxies for shared unobserved factors. This approach ensures that each country's dynamics are influenced by both domestic developments and global interactions. Each country model is then estimated independently in an error correction framework, conditional on the foreign variables. In the second step, these country-specific VARX models are combined and interconnected using a matrix of cross-country linkages W, forming the global model.

Let's assume there are N+1 countries, which are indexed by i =0, 1, 2, N, where 0 serves as the base, shock-emitting country (in our case, its China). In the GVAR framework, each country model is set up as VARX (p, q) in the following functional form:

$$x_{i,t} = \alpha_{i,0} + \alpha_{i,1}t + \sum_{p=1}^{P} \phi_{i,p} x_{i,t-p} + \sum_{q=0}^{Q} \Lambda_{i,q} x^*_{i,t-q} + u_{i,t} \tag{4.1}$$

where $\alpha_{i,0}$ and $\alpha_{i,1,t}$ are vectors of intercepts and the coefficients of the deterministic time trend, respectively, $x_{i,t}$ is the vector of country i's domestic variables, $\sum_{p=1}^{P} \phi_{i,p}$ are the lagged coefficients of domestic variables, $x^*_{i,t-q}$ is the vector of country i's foreign variables, and $\sum_{q=0}^{Q} \Lambda_{i,q}$ are the lagged values of the respective foreign coefficients, $u_{i,t}$ is the vector of country-specific residuals, which is distributed as

$u_{i,t} \sim$ i.i.d. $(0, \sum_i^u)$. Foreign or starred variables are estimated as weighted averages of the respective domestic variables of all countries through the following equation.

$$x_{it}^* = \sum_{j=0}^{N} w_{ij} x_{jt} \tag{4.2}$$

In the equation above, w_{ij} denotes the proportion of trade allocated by country i to country j. It is important to note that $w_{ij} = 0$ when $i = j$, and the sum of w_{ij} across all j equals 1, i.e., $\sum_{j=0}^{N} w_{ij} = 1$.

The weights are predetermined, and are designed to represent the significance of country j for the ith economy.

GVAR methodology imposes weak exogenity assumption of foreign variables, for instance it assumes that individual country in the model is small economy with respect to the rest of the world. [2]

Further the GVAR estimation is conducted by considering the integration characteristics of the series. This enables us to distinguish between short-run and long-run (co-integrating) relations between domestic and country-specific variables. Hence we can write equation (4.1) in error correction form below in line with the literature (see e.g., (Chudik and Pesaran, 2016; Dees et al., 2007; di Mauro and Smith, 2013; Smith, 2013; Pesaran et al., 2004)).

$$\Delta x_{it} = c_{i0} + \sum_{j=1}^{r_i} \gamma_{ij} ECT_{ij,t-1} + \sum_{k=1}^{k_i} \tilde{\phi}_{ik} \Delta x_{i,t-k} + \sum_{p=0}^{p_i} \tilde{\Lambda}_{ip} \Delta x_{i,t-p}^* + + u_{it} \tag{4.3}$$

where Δx_{it} is the change in the variable x_i at time t. c_{i0} is the constant term, γ_{ij} is the coefficient of the error correction term, indicating the speed of adjustment towards the long-term equilibrium. $\tilde{\phi}_{ip}$ represents the coefficient for the lagged domestic variables and $\tilde{\Lambda}_{iq}$ is coefficient for the lagged foreign specific variables u_{it} the error term, representing random disturbances or shocks to x_i at time t. The estimation is based on reduced rank regression, considering the possibility of co-integration both within x_{it} and between x_{it} and x_{it}^*. This approach allows for the determination of the number of co-integrating relations (r_i), the speed of adjustment coefficients (γ_{ij}).

In the second step the estimated VARX (p, q) are combined and stacked together to form a GVAR model. Lets assume that VARX(2, 2) is estimated country by country :

$$x_{it} = a_{i,0} + a_{i,1} t + \phi_{i,1} x_{i,t-1} + \phi_{i,2} x_{i,t-2} + \Lambda_{i,0} x_{i,t}^* + \Lambda_{i,1} x_{i,t-1}^* + \Lambda_{i,2} x_{i,t-2}^* + u_{i,t} \tag{4.4}$$

Now let's define: $z_{it} = (x_{it}, x_{it}^*)$.

[2] Under weak exogenity assumption, foreign variables (such as the weighted averages of trade partner countries' variables) enter the model as if they were given or not affected by shocks in the domestic economy, thus reducing the complexity of estimation.

Equation (4.4) can be written as:

$$\mathbf{A}_{i,0}\mathbf{z}_{i,t} = a_i + a_{i,1}t + \mathbf{A}_{i,1}\mathbf{z}_{i,t-1} + \mathbf{A}_{i,2}\mathbf{z}_{i,t-2} + \mathbf{u}_{i,t} \tag{4.5}$$

where

$$\mathbf{A}_{i,0} = (\mathbf{I}_{\mathbf{k_i}}, -\Lambda_{i,0}), \quad \mathbf{A}_{i,1} = (\phi_{i,1}, \Lambda_{i,1}), \quad \mathbf{A}_{i,2} = (\phi_{i,2}, \Lambda_{i,2}) \tag{4.6}$$

We can derive the identity (equation 4.7) using the link matrices $\mathbf{W}_i$, which are determined by the country-specific trade weights w_{ij}.

$$\mathbf{z}_{it} = \mathbf{W}_i\mathbf{x}_t, \tag{4.7}$$

$\mathbf{x}_t = (\mathbf{x}_{0t}, \mathbf{x}_{1t}, \ldots, \mathbf{x}_{Nt})$ is the $k \times 1$ vector, which gathers all the endogenous variables of the model. Now, by substituting equation (4.7) in equation (4.5), we get the following:

$$A_{i,0}W_ix_t = a_{i,0} + a_{i,1}t + A_{i,1}W_ix_{t-1} + A_{i,2}W_ix_{t-2} + u_{i,t} \tag{4.8}$$

the country specific models in equation (4.8) are then stacked to built a global var model below :

$$G_0x_t = a_0 + a_1t + G_1x_{t-1} + G_2x_{t-2} + u_t \tag{4.9}$$

$$G_0 = \begin{bmatrix} A_{00}W_0 \\ A_{10}W_1 \\ \vdots \\ A_{N0}W_N \end{bmatrix} \quad G_1 = \begin{bmatrix} A_{01}W_0 \\ A_{11}W_1 \\ \vdots \\ A_{N1}W_N \end{bmatrix}$$

$$G_2 = \begin{bmatrix} A_{02}W_0 \\ A_{12}W_1 \\ \vdots \\ A_{N2}W_N \end{bmatrix}$$

$$a_0 = \begin{bmatrix} a_{00} \\ a_{10} \\ \vdots \\ a_{N0} \end{bmatrix} \quad a_1 = \begin{bmatrix} a_{01} \\ a_{11} \\ \vdots \\ a_{N1} \end{bmatrix} \quad u_t = \begin{bmatrix} u_{0t} \\ u_{1t} \\ \vdots \\ u_{Nt} \end{bmatrix}$$

The matrix $\mathbf{G}_0$ is a non-singular matrix that depends on the parameter estimates and trade weights. If we multiply equation (4.9) by $\mathbf{G}_0^{-1}$, we obtain the GVAR(2) model in equation (4.10).

$$x_t = b_0 + b_1t + F_1x_{t-1} + F_2x_{t-2} + \epsilon_t \tag{4.10}$$

where

$$F_1 = G_0^{-1}G_1, \qquad F_2 = G_0^{-1}G_2,$$
$$b_0 = G_0^{-1}a_0, \qquad b_1 = G_0^{-1}a_1, \qquad \epsilon_t = G_0^{-1}u_t$$

Equation (4.10) GVAR model can be solved recursively and can be used for forecasting and shock analysis with generalized impulse response.

4.3.1 Identification Strategy

We begin our analysis with Generalized Impulse Response Functions (GIRFs), which serve as a model-invariant benchmark and do not require structural assumptions or variable ordering.[3] Full GIRF results are presented in the supplementary appendix.[4]

To investigate the international transmission of macroeconomic disturbances originating in China, specifically fiscal and output shocks, we follow the approach of (Dees et al., 2007) and (Sims, 1980), who identify structural shocks within the first country block of a Global Vector Autoregression (GVAR) model. In our specification, China is placed as the first economy, and structural identification is applied exclusively to China's domestic block.

As emphasized in (Dees et al., 2007), identifying structural shocks in all countries would require 80+ restrictions, which is often neither feasible nor necessary. Hence, we follow their strategy of focusing on China, the shock-originating economy, as the only block with contemporaneous structural identification. This ensures that the transmission of shocks from China to other countries (e.g., ASEAN-5, Other Regions) is not confounded by identification assumptions in other parts of the model.

We focus on the dynamic effects of the following one-standard-deviation positive

[3]GIRF was originally introduced by Koop et al. (1996) and Pesaran and Smith (1998) as a method for analyzing dynamic responses in non-linear models. Later, Pesaran et al. (2004), Pesaran and Smith (2006), and Dess et al. (2007) further developed this methodology, incorporating it into the (GVAR) framework. This advancement enabled the analysis of interdependencies across countries and regions in a globalized setting . The GIRF serves as an alternative to the orthogonalized impulse responses (OIR) proposed by Sims (1980). Unlike the OIR method, which necessitates calculating impulse responses relative to a set of orthogonalized shocks, the GIRF approach focuses on shocks to individual errors and accounts for the influence of other shocks by integrating their effects based on the observed distribution of all shocks, without requiring orthogonalization. Contrary to the OIR, the GIRF is unaffected by the ordering of the countries making it a crucial tool for analysis. While the GIRF may not explain the causes behind changes, it offers valuable insights into the dynamics of shock transmission and how underlying variables respond to those shocks.

$$\Psi_{j,l}^{(h)} = \frac{1}{\sqrt{\sigma_{ii,ll}}} \left(G^{-1}H\right)^h \left(G^{-1}\varepsilon s_j\right), \quad h = 0, 1, \ldots \tag{4.11}$$

This equation measures the effect of one standard error shock to the j-th equation which corresponds to the l-th variable in the i-th country at time t on the expected values of x at time $t+h$. Here S is the selection vector which has 1 at its jth element and zeros otherwise.

[4]For more detailed description on GIRFs see Pesaran and Shin(1998) and Dees et al. (2007)

shocks: [5]

- Real output (GDP),
- Government expenditure,
- Government revenues.

To estimate country-specific and time-dependent responses, we use Structural Generalized Impulse Response Functions (SGIRFs) within the GVAR framework. This method allows the identification of orthogonal structural shocks in China while maintaining flexible, data-driven responses across countries. SGIRFs are particularly suited for analyzing global transmission mechanisms, as they avoid imposing restrictive contemporaneous assumptions across all country blocks.

Following Blanchard and Perotti (2002) structural shocks in the Chinese block are identified through a recursive Cholesky decomposition of the reduced-form error variance-covariance matrix. Two alternative orderings are employed:

$$x_{0t}^{A} = \text{Expenditure}, \text{Revenue}, \text{GDP}, \text{CPI}, \text{Short-term rate}, \text{Equity price}, \text{Exchange rate}'$$
$$x_{0t}^{B} = \text{Revenue}, \text{Expenditure}, \text{GDP}, \text{CPI}, \text{Short-term rate}, \text{Equity price}, \text{Exchange rate}'$$

Ordering A assumes fiscal spending is set contemporaneously ahead of revenue responses and macroeconomic aggregates. Ordering B reflects scenarios where revenues adjust earlier, possibly due to automatic stabilizers or timing of fiscal collections. In both cases, financial variables (e.g., interest rates, equity prices) respond contemporaneously to preceding real-sector changes.

The recursive ordering implies a set of contemporaneous zero restrictions through the lower-triangular structure of the impact matrix. Under Ordering A, government expenditure is placed first and is therefore treated as predetermined within the quarter, implying that expenditure does not respond contemporaneously to innovations in revenues, output, prices, or financial variables. Revenues are ordered second and may react immediately to expenditure shocks but not to contemporaneous output or financial disturbances. GDP is ordered third and may respond contemporaneously to fiscal shocks, while remaining predetermined with respect to price and financial innovations. Under Ordering B, the positions of expenditure and revenues are reversed, so that revenues are treated as predetermined within the quarter, while expenditure is allowed to react contemporaneously to revenue innovations. These identifying restrictions apply only to impact relationships and do not constrain the subsequent dynamic responses captured by the SGIRFs.

[5] Negative shocks (i.e., output contraction and fiscal consolidation) are not reported, as their effects are broadly symmetric to positive shocks and do not alter the qualitative interpretation.

The China block is estimated using a VARX*(1,1) model:

$$P_0 x_{0t} = P_0 \Phi_{01} x_{0,t-1} + P_0 \Lambda_{01} x^*_{0t} + P_0 \Lambda_{02} x^*_{0,t-1} + P_0 u_{0t} \tag{4.12}$$

where:

- x_{0t} is the vector of China's domestic variables,
- x^*_{0t} denotes the trade-weighted foreign variables,
- u_{0t} is the reduced-form innovation,
- $\varepsilon_{0t} = P_0 u_{0t}$ are the orthogonalized structural shocks.

The identification restriction requires that the structural error variance-covariance matrix is diagonal:

$$\Sigma_{\varepsilon_0} = P_0 \Sigma_{u_0} P_0' \tag{4.13}$$

with P_0 being a lower triangular matrix, following Sims (1980).

SGIRFs are then computed to trace the responses of global variables to each identified Chinese shock. At horizon h, the SGIRF for variable x_t with respect to the i-th structural shock is given by:

$$\text{SGIRF}_x(h; \varepsilon_i) = \mathbb{E}[x_{t+h} \mid \varepsilon_t = \sigma_i e_i] - \mathbb{E}[x_{t+h}] \tag{4.14}$$

where e_i is a selection vector, and $\sigma_i = \sqrt{e_i' \Sigma_\varepsilon e_i}$.

Confidence intervals are generated using a bootstrap procedure, allowing us to conduct inference on the dynamic effects of Chinese fiscal and output shocks on domestic and global economies.

4.4 Data

This study uses quarterly data, consistent with previous GVAR literature, covering the period from 2001Q1 to 2023Q4. The use of quarterly statistics is justified as policymakers need time to identify emerging economic trends and make decisions on spending and taxes. Additionally, legislative amendments and implementation take time.

In the GVAR analysis, we include fifteen countries, treating China as the global economy. The remaining countries /regions are ASEAN-5, the rest of Asia and Pacific, Euro area, and South America, as shown in Table 4.1. Together, these countries account for half of the global output.

Following (Pesaran, 2004), the non-fiscal variables included in the GVAR setup, highlighted in Table 4.2, are GDP_{it} (y_{it}), defined as the real gross domestic product of country i during period t in domestic currency; e_{it} (real equity price index); E_{it} (exchange rate in terms of U.S. dollars); CPI_{it} (π_{it}, consumer price index); SR_{it}

Table 4.1: Regions and Countries included in the GVAR Models.

Global Economy	**ASEAN-5**	**Rest of Asia and Pacific**
China	Indonesia	Australia
	Malaysia	India
	Philippines	Japan
	Singapore	South Korea
	Thailand	
South America	**Euro Area**	
Brazil	France	
Chile	Germany	
Mexico	Italy	
Peru	Netherlands	
Argentina	Spain	
	United Kingdom	

(short-term interest rate in percent); and LR_{it} (long-term interest rate in percent).[6] The fiscal variables included in the model are total government expenditure, exp_{it}, and total government revenue, gr_{it}. These variables are expressed in natural logarithms.

To construct the foreign variables, trade weights for each country were obtained, reflecting the average trade flow between countries over the past three years (2021–2023). These variables are represented with stars, i.e., y^*_{it} for foreign GDP, E^*_{it} for foreign exchange rate, π^*_{it} for foreign CPI, e^*_{it} for foreign equity prices, and i^*_{it} for foreign interest rates. Following Dees et al. (2007) methodology, we used purchasing power parity (PPP) GDP to construct regional weights.[7]

Appendix C to the Chapter 4 Table 4.1.1 presents an 8×8 trade share matrix, showing the trade shares of six economies: China, five ASEAN economies (Indonesia, Malaysia, Philippines, Singapore, and Thailand), and regions (Rest of Asia & Pacific, Euro Area,and South America). Each cell in the matrix represents the trade share of a given country or region with others, including itself.

Table 4.2 shows that most countries include y_{it}, e_{it} , E_{it} , π_{it}, i^s_{it} , i^l_{it} exp_{it}, gr_{it} as domestic variables however not all countries contain the same set due to data constraint on some ASEAN economies and other countries included in regions.[8] Following (di Mauro and Smith, 2013) (DdPS) we have not included exchange rate in the China domestic variables and short term and long term interest rates in China foreign variables, see Table 4.2. Further, we excluded foreign exchange rate from rest

[6]For the short-term interest rate, we used the three-month money market rate, and where unavailable, the discount rate or treasury bill rate.

[7]For details on the construction of regional weights, see (Pesaran et al., 2004)(PSW).

[8]For instance, data on real equity prices is missing for Brazil, Mexico, Peru, and Indonesia. Long-term interest rate data is unavailable for Argentina, Brazil, and Chile, while expenditure data is missing for Indonesia.

Table 4.2: Domestic and foreign variables in VARX Models

Non Fiscal Variables	**All countries except China**		**China**	
	Domestic	Foreign	Domestic	Foreign
Output	y_{it}	y^*_{it}	y_{ch_t}	$y^*_{ch_t}$
Inflation / CPI	π_{it}	π^*_{it}	π_{ch_t}	$\pi^*_{ch_t}$
Exchange rate	E_{it}	–	–	$E^*_{ch_t}$
Equity Price Index	e_{it}	e^*_{it}	e_{ch_t}	$e^*_{ch_t}$
Short-term interest rate	i^s_{it}	i^{s*}_{it}	$i^s_{ch_t}$	–
Long-term interest rate	i^l_{it}	i^{l*}_{it}	$i^l_{ch_t}$	–
Fiscal Variables				
Total government expenditure	exp_{it}	exp^*_{it}	exp_{ch_t}	$exp^*_{ch_t}$
Total government revenue	gr_{it}	gr^*_{it}	gr_{ch_t}	$gr^*_{ch_t}$

of the countries models. All the variables used in the GVAR models are seasonally adjusted.[9]Furthermore, small gaps in the data were addressed using linear interpolation, following standard practice in the literature where missing values occurred. [10]

Data on non-fiscal variables, including exchange rates, CPI, and GDP, are sourced from the IMF's International Financial Statistics (IFS). For missing data series, additional data were obtained from DataStream. Furthermore, quarterly data on fiscal variables were acquired from DataStream via Oxford Economics. Data on intra-country trade were sourced from the IMF's Direction of Trade Statistics.

(a) China's Trade with ASEAN-5 (b) China's Trade with Key Regions

Figure 4.1: Composition of China's Average Trade with ASEAN-5 and Other Key Regions (2021–2023)

Note: The charts illustrate average trade flows between China and ASEAN-5 countries (Indonesia, Malaysia, the Philippines, Thailand, and Singapore), and other key regions, over the period 2021–2023. Trade figures include both imports and exports.

[9]Seasonal adjustment was performed using the X12 method in R.

[10]Missing data series were interpolated using linear interpolation for time series in R. For more details, see the function documentation at https://rdrr.io/cran/forecast/man/na.interp.html.

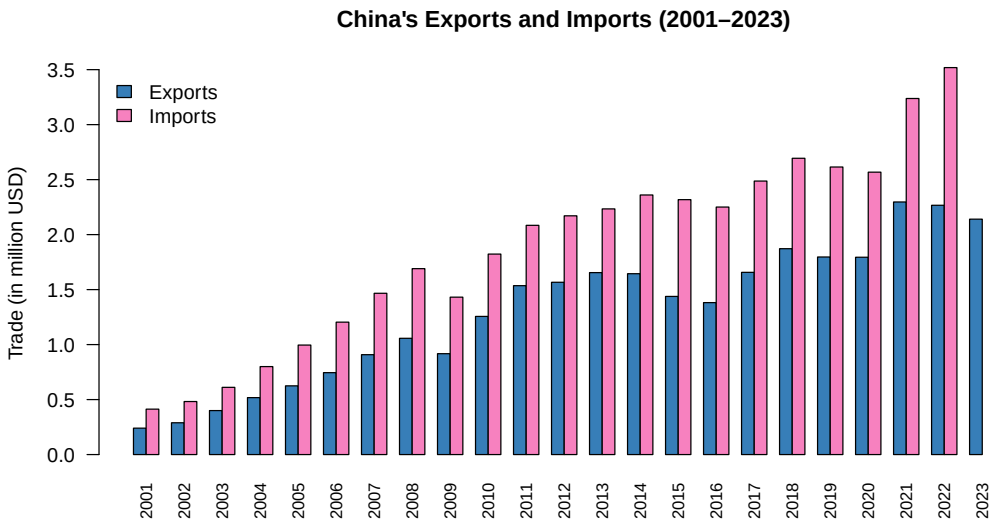


Figure 4.2: China's Total Exports and Imports, 2001–2023

Note: This figure presents China's annual total exports and imports from 2001 to 2023. The blue bars represent China's exports, while the pink bars depict its imports with the rest of the world.

Figures 4.1a and 4.1b present China's total imports and exports with selected countries and regions over the sample period from 2001 to 2023. Figure 4.1a illustrates China's total trade with the ASEAN-5 countries, showing that Indonesia accounts for the largest share at 26.6%, followed by the Philippines at 20.6%. Singapore and Malaysia also exhibit substantial trade shares, exceeding that of Thailand. At the regional level, the ASEAN-5 collectively represent the highest share of China's trade at 49.2%, followed by the Euro Area at 18.6%, then South America, and finally the rest of the Asia-Pacific region.[11] These figures highlight the growing importance of China as a trade partner, particularly for the ASEAN-5, reflecting the increasing exposure of these economies to China's domestic demand, an important channel through which economic shocks may be transmitted.

Figure 4.2 displays China's total trade with the rest of the world from 2001 to 2023, revealing that over this period, imports have consistently exceeded exports, underlining the growing significance of external demand in driving China's trade relations.

4.5 Results

In this section, we first report and discuss the specification test results to ensure that the GVAR model satisfies the necessary assumptions. We then present the GVAR estimation results based on six models corresponding to the shocks outlined earlier.

[11]The figures are based on calculations of overall trade value (exports plus imports) of the respective countries with China.

Consistent with the identification strategy discussed in section 4.3.1, the results reported and discussed in this section are based on Ordering A, which assumes that government expenditure is determined contemporaneously ahead of government revenues and other macroeconomic aggregates. We begin by examining the domestic effects of these shocks, followed by an analysis of their spillover impacts on the ASEAN-5 countries. Finally, we discuss the transmission of these shocks to four regional blocs: the Euro Area, the ASEAN-5 region, the rest of Asia and the Pacific, and South America.

4.5.1 Specification tests

For model specification, we began with the standard Augmented Dickey-Fuller (ADF) test to assess the presence of unit roots. The results, shown in Tables 4.3 and 4.4 in Appendix C, confirm that most of the domestic and foreign variables exhibit non-stationarity at the 5 percent significance level. However, by applying first or second differencing, the variables were rendered stationary.

Next, we determined the optimal lag order for individual VARX models using the Akaike Information Criterion (AIC). For most countries, we adopted a VARX*(2,2) specification, while for China, the Philippines, and South America, the AIC indicated a VARX*(2,1) structure.

To determine the number of long-run cointegrating relationships, we used Johansen's maximum eigenvalue and trace statistics, as adapted by (Pesaran et al., 2000) for models with weakly exogenous I(1) regressors. The number of cointegrating relationships was selected based on the trace test statistics using the 95 percent critical values from (MacKinnon, 2010).

We also examined parameter instability due to structural breaks using the CUSUM test proposed by (Ploberger and Krämer, 1992), along with its mean square variant. The results, presented in Table 4.6 in Appendix C, show that the cumulative sum statistic (PKsup) and its mean square version (PKmsq) indicate overall model stability. Most variables across regions exhibit values well below the critical threshold, except for the Philippines and South America, where the test values are slightly higher. Overall, most countries show stable parameter estimates, supporting the use of the standard GVAR framework.

To ensure robust inference, we rely on sieve-bootstrapped medians and confidence intervals, constructed from 1,000 simulation replications, when assessing the spillover effects from China to ASEAN economies and other regions.

Lastly, based on the cointegration results, estimation of the GVECM model is preferred over the standard GVAR model. Additionally, we employ a fixed trade matrix to construct the foreign variables.

(Chudik and Pesaran, 2016) argue that, in terms of model stability, when the total number of cointegrating relationships is $r = \sum_{i=1}^{N} r_i$, then $k - r$ eigenvalues of the GVAR model lie on the unit circle, while the remaining eigenvalues must

lie within the unit circle for the model to be stable. Our GVECM includes 130 endogenous variables and up to 32 cointegrating relationships, which represent the sum of all cointegrating vectors across individual country-level models. Given this structure, we expect approximately 98 eigenvalues to lie on or within the unit circle. Our results confirm that 29 eigenvalues are exactly equal to one, while all remaining eigenvalues are less than one, indicating that the model is dynamically stable.

4.5.2 Weak Exogenity Test

The main assumption of the GVAR model is that foreign variables are weakly exogenous, meaning there is no feedback from domestic variables to foreign variables.[12] To test this assumption, we follow the approach of (Dees et al., 2007) [13]. Weak exogeneity was tested at the 5 percent significance level, meaning that any F-test value exceeding the critical value at this level would indicate a violation of the weak exogeneity assumption. The empirical findings presented in Appendix C, Table 4.1, indicate that for most countries, the weak exogeneity assumption holds for all foreign variables. Specifically, in the cases of China, Indonesia, Malaysia, the Philippines, Singapore, the rest of Asia-Pacific, and the Euro Area, none of the foreign variables exhibit significant feedback, as their corresponding F-test statistics fall below the critical threshold. This implies that the weak exogeneity condition is satisfied at the 5 percent significance level for these countries and regions. However, exceptions are observed in the cases of Thailand and South America. For Thailand, the variable revenues does not satisfy the weak exogeneity condition, with an F-test value of 3.25 exceeding the critical value of 2.51. Similarly, in South America, government expenditure shows evidence of feedback, with an F-test statistic of 3.72 exceeding the corresponding critical value of 3.12. These results suggest some degree of endogeneity in the specified foreign variables, indicating potential feedback from domestic to foreign variables in these instances. In summary, the weak exogeneity assumption is largely upheld across the countries and regions analyzed, with minor exceptions such as Thailand's revenue variable and South America's expenditure variable. Overall, the foreign variables mostly adhere to the weak exogeneity condition at the 5 percent significance level, which supports the robustness of the GVAR model assumptions.

4.5.3 Domestic Spillovers effects

The structural generalized impulse response functions (SGIRFs) in Figure 4.3 show the responses of GDP, government expenditure, government revenues, inflation, short-term interest rates, long-term interest rates, and equity prices to a one-standard-

[12] In line with Johansen (1992) and Granger and Lin (1995), the weak exogeneity assumption in cointegrating models suggests that there is no long-run feedback from x_{it} to x_{it}^*, but it does not necessarily exclude the possibility of lagged short-run feedback between the two variable sets.

[13] This entails testing the joint significance of the estimated error correction terms in the auxiliary equations for the country-specific foreign variables, x_{it}^*.

deviation GDP shock in China. Under Ordering A, GDP is ordered after government expenditure and revenues and therefore may respond contemporaneously to fiscal innovations while remaining predetermined with respect to price and financial shocks. The results indicate significant and persistent increases in GDP and government revenues. The elevated output level over time reflects mechanisms consistent with output hysteresis, where large shocks can have lasting effects on GDP, as discussed by Ball (2014) and Blanchard and Summers (1986). While these studies mainly emphasize downturns, they provide a rationale that substantial positive shocks might similarly embed into productive capacity.

Government revenues also rise significantly and remain elevated, aligning with standard fiscal logic that a larger tax base from sustained output gains supports higher revenues. This is consistent with findings such as Pappa (2009), who document how output expansions bolster fiscal collections, although typically studied from the opposite causal perspective of fiscal shocks driving output. The absence of a significant expenditure response highlights spending inertia, often due to multi-year budget frameworks and institutional rigidities (Auerbach and Gorodnichenko, 2013).

Inflation exhibits a positive and persistent response, indicating that stronger economic activity generates sustained upward pressure on prices, consistent with New Keynesian models in which demand shocks propagate through nominal rigidities (Galí, 2015). The short-term interest rate and equity prices also respond positively and significantly in the short run, with the effects remaining statistically significant for approximately eight quarters before gradually fading and becoming insignificant thereafter. The increase in short-term interest rates is consistent with a monetary policy response aimed at containing inflationary pressures associated with stronger output growth, while the positive response of equity prices reflects improved growth prospects and expectations of higher corporate earnings. In contrast, long-term interest rates do not exhibit a statistically significant response, suggesting that positive output shocks have limited effects on longer-term financing conditions and inflation expectations.

Taken together, these results suggest that a GDP shock in China generates long-run increases in output, revenues, and inflation, while producing temporary positive effects on short-term interest rates and equity prices and little discernible impact on government expenditure and long-term interest rates. These findings are broadly consistent with established macroeconomic models, although the channel through which positive output shocks translate into sustained revenue gains warrants further empirical investigation.

Figure 4.4 presents the effects of a revenue shock. Under Ordering A, revenues are placed after government expenditure and are therefore allowed to react contemporaneously to expenditure innovations, but not to output or financial disturbances. Consistent with this interpretation, the SGIRFs indicate positive and significant

impacts on GDP and government revenues, but no clear effects on government expenditure. Inflation, short-term interest rates, long-term interest rates, and equity prices also show little evidence of statistically significant responses. This pattern aligns with the fiscal literature suggesting that revenue increases, whether arising from higher taxes or revenue windfalls, are often used to strengthen fiscal positions rather than finance immediate spending increases (Alesina and Ardagna, 2010; Blanchard and Perotti, 2002). Consequently, while output and revenues benefit modestly through improved confidence and stronger public balance sheets, the absence of additional government spending limits demand-side pressures and keeps inflation subdued. Similarly, the muted responses of financial variables suggest that revenue shocks are not perceived by markets as sufficiently large or persistent to alter monetary policy expectations, long-term financing conditions, or equity valuations.

Figure 4.5 illustrates the responses to a government expenditure shock. Since expenditure is ordered first under Ordering A, it is treated as predetermined within the quarter and does not respond contemporaneously to innovations in revenues, output, prices, or financial variables. Accordingly, the SGIRFs show a strong and persistent increase in government expenditure together with moderate positive effects on GDP and revenues. The results show a moderate but consistent positive impact on GDP, with the lower bound of the confidence interval generally above zero, supporting the Keynesian view that government spending stimulates aggregate demand and production (Blanchard and Perotti, 2002). Revenues also rise significantly over the horizon, reflecting higher tax receipts associated with stronger economic activity, in line with the operation of automatic stabilizers documented by Pappa (2009). The expenditure series itself displays a strong and significant increase, between 1 and 2 percent, reflecting the direct nature of the shock. Inflation, by contrast, exhibits a small but significant negative response, suggesting that the economy is able to absorb higher demand without generating inflationary pressures, consistent with studies such as Blanchard and Perotti (2002) and Mountford and Uhlig (2009), which document limited short-run inflationary effects of spending shocks, particularly when spare capacity exists. The responses of short-term interest rates, long-term interest rates, and equity prices are generally insignificant, indicating that government expenditure shocks do not materially affect financial conditions or alter market expectations.

Overall, these findings indicate that positive GDP and revenues shocks in China generate sustained increases in output and government revenues, with expenditure shocks also producing persistent increases in government spending. Inflation responds positively to GDP shocks but exhibits a small negative response to expenditure shocks, while financial variables show only limited and transitory responses. In contrast, revenue shocks primarily support output and fiscal balances without inducing significant changes in government expenditure, inflation, or financial conditions. These results suggest that GDP and spending shocks operate mainly through real

economic channels, whereas revenue shocks have more contained macroeconomic effects.

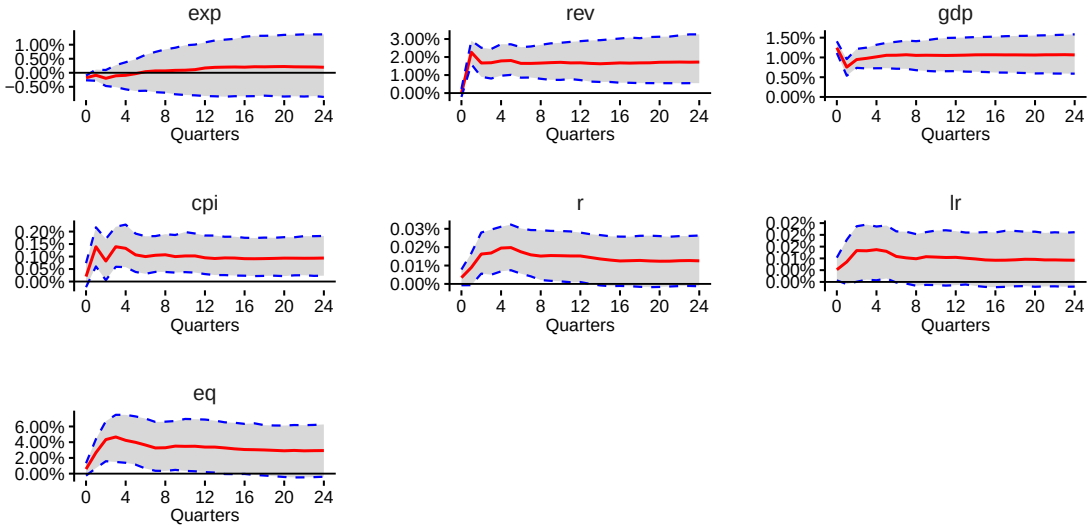


Figure 4.3: Structural General Impulse Responses of a one standard error (+) shock to GDP in China (bootstrap median estimates with 68% bootstrap error bounds).

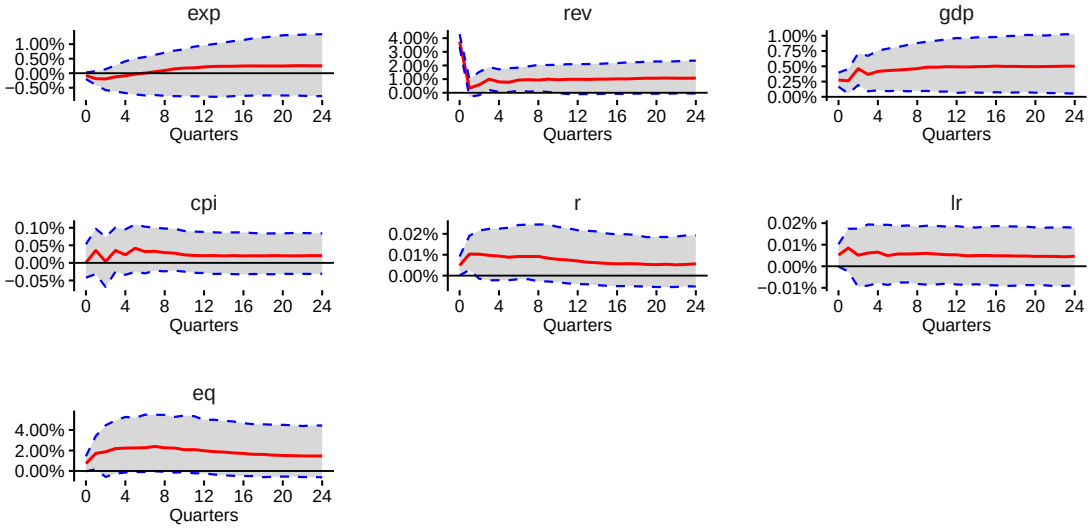


Figure 4.4: Structural General Impulse Responses of a one standard error (+) shock to Revenues in China (bootstrap median estimates with 68% bootstrap error bounds).

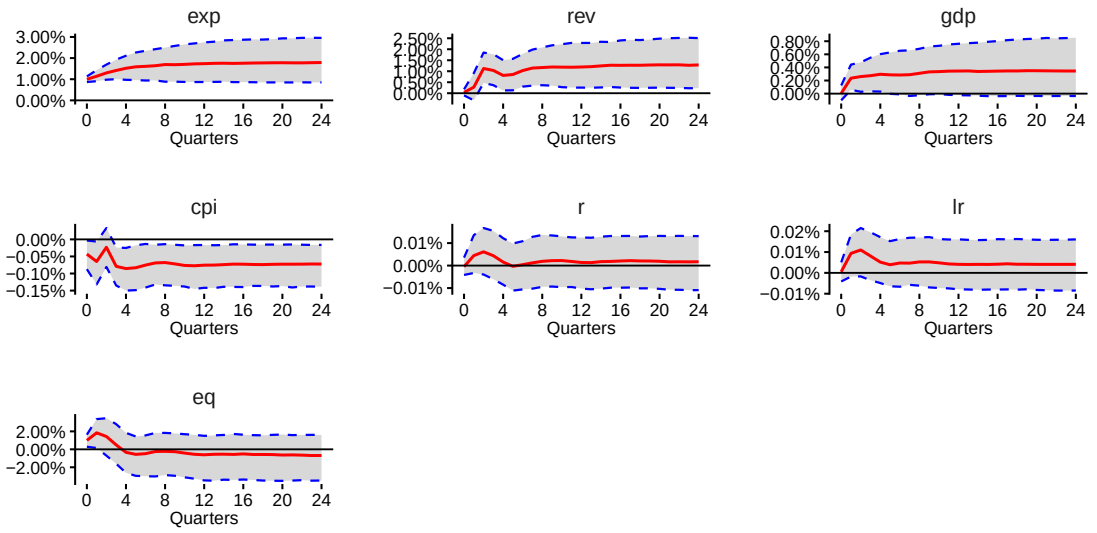


Figure 4.5: Structural General Impulse Responses of a one standard error (+) shock to Expenditures in China (bootstrap median estimates with 68% bootstrap error bounds).

4.5.4 Spillovers to ASEAN

4.5.5 GDP Shock

Figure 4.6–4.7 shows that a one-standard-deviation positive GDP shock in China leads to permanent increases in both output and revenues across all five ASEAN economies (Indonesia, Malaysia, Thailand, the Philippines, and Singapore), with the magnitude of the revenue response generally exceeding that of output. This pattern underscores the strong trade integration of these countries with China, consistent with the view that positive demand shocks in China stimulate ASEAN economies via export channels and supply chain linkages (International Monetary Fund, 2011a,b). Additionally, the GDP shock (Figure 4.8) yields a significant and lasting rise in government expenditures in Malaysia, potentially reflecting procyclical fiscal adjustments or commodity-linked revenues boosting spending capacity, whereas Singapore exhibits an opposite effect on expenditures, possibly due to its countercyclical fiscal framework aimed at stabilizing long-term growth (International Monetary Fund, 2017). Inflation responds positively in Indonesia (Figure 4.11), indicating demand-pull pressures, though impacts are moderate or insignificant in the other ASEAN-5 members, aligning with standard open economy New Keynesian models where trade-driven output gains do not always translate into broad price level increases if capacity slack remains (Galí, 2015).

Financial variables exhibit heterogeneous responses across countries. (Figure 4.9) shows long-term interest rates increase significantly in Indonesia and display only short-lived effects in the Philippines and Singapore, while remaining largely insignificant in Malaysia and Thailand. (Figure 4.10) shows short-term interest rates respond positively across all ASEAN-5 economies, with the effects remain-

ing significant throughout the horizon in Indonesia, Malaysia, and the Philippines, but becoming insignificant over time in Singapore and Thailand. (Figure 4.12) equity prices generally rise following the GDP shock, with persistent effects in the Philippines and Singapore but more transitory responses in Malaysia and Thailand. Exchange rate responses are also mixed, with Indonesia experiencing a positive and significant response, whereas Malaysia, the Philippines, and Singapore exhibit negative responses see Figure 4.13.

More broadly, these findings highlight how varying domestic economic structures and policy regimes shape the transmission of external shocks. For example, economies with larger commodity sectors or looser fiscal constraints, like Malaysia, may exhibit stronger expenditure responses, whereas countries with explicit fiscal stabilization rules, such as Singapore, deliberately smooth spending over cycles. The muted inflation responses outside Indonesia and the heterogeneous financial responses further emphasize the importance of country-specific characteristics, including monetary frameworks and financial market structures, in shaping the transmission of external demand shocks. Together, these heterogeneous outcomes illustrate that while ASEAN economies are closely tied to China through trade and production networks, the ultimate macroeconomic spillovers depend critically on each country's fiscal stance, structural features, and monetary-policy credibility.

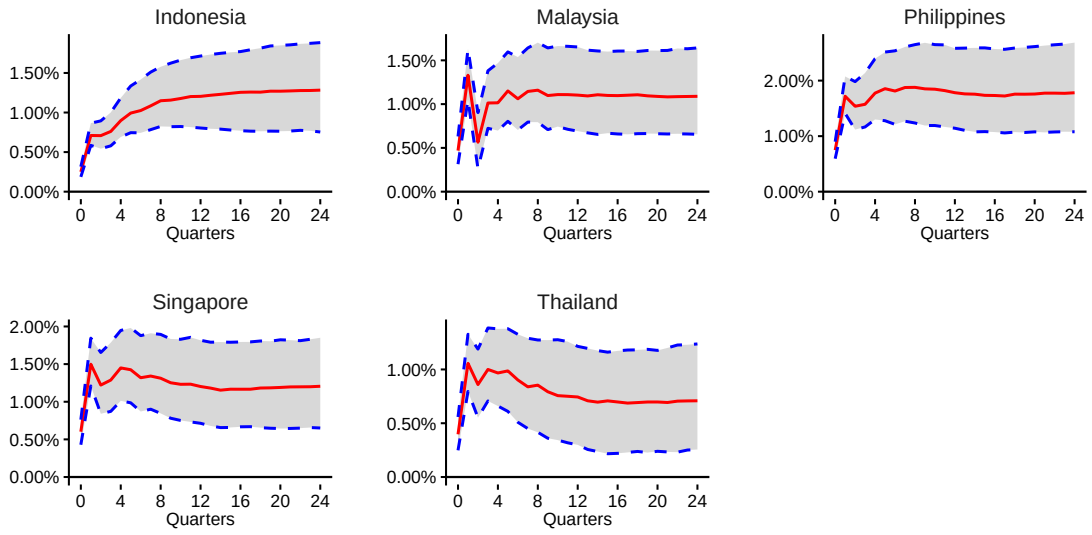


Figure 4.6: Structural Generalized Impulse Responses of a one standard error (+) shock to GDP in China to GDP in ASEAN-5 (bootstrap median estimates with 68% bootstrap error bounds).

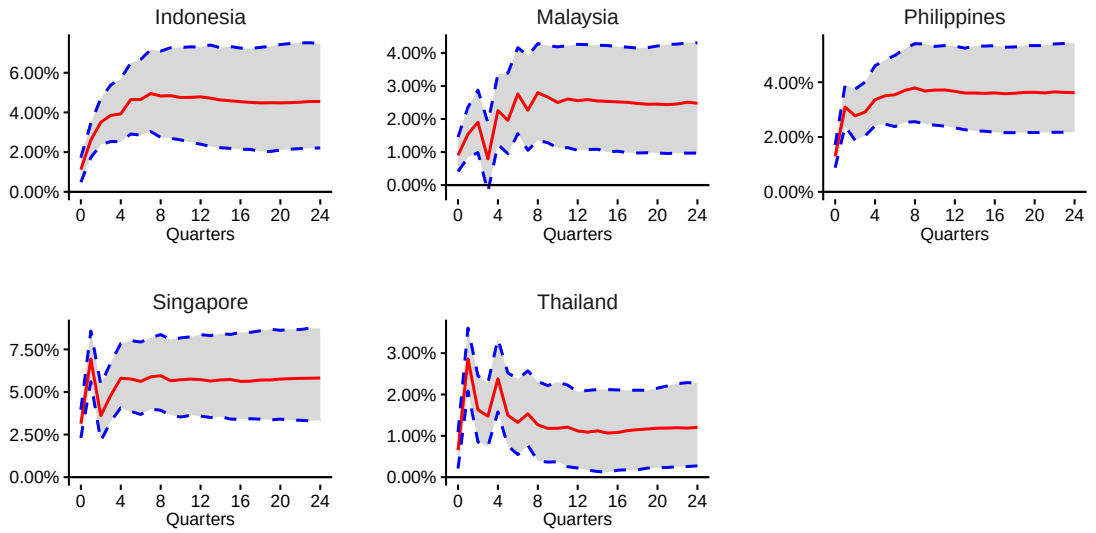


Figure 4.7: Structural Generalized Impulse Responses of a one standard error (+) shock to GDP in China to Revenues in ASEAN-5 (bootstrap median estimates with 68% bootstrap error bounds).

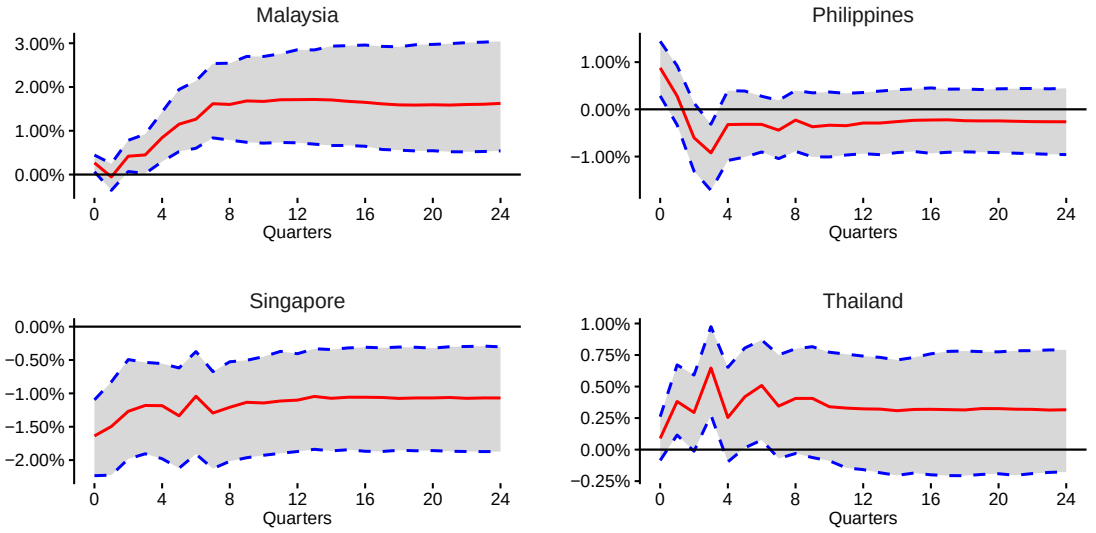


Figure 4.8: Structural Generalized Impulse Responses of a one standard error (+) shock to GDP in China to Expenditures in ASEAN-5 (bootstrap median estimates with 68% bootstrap error bounds).

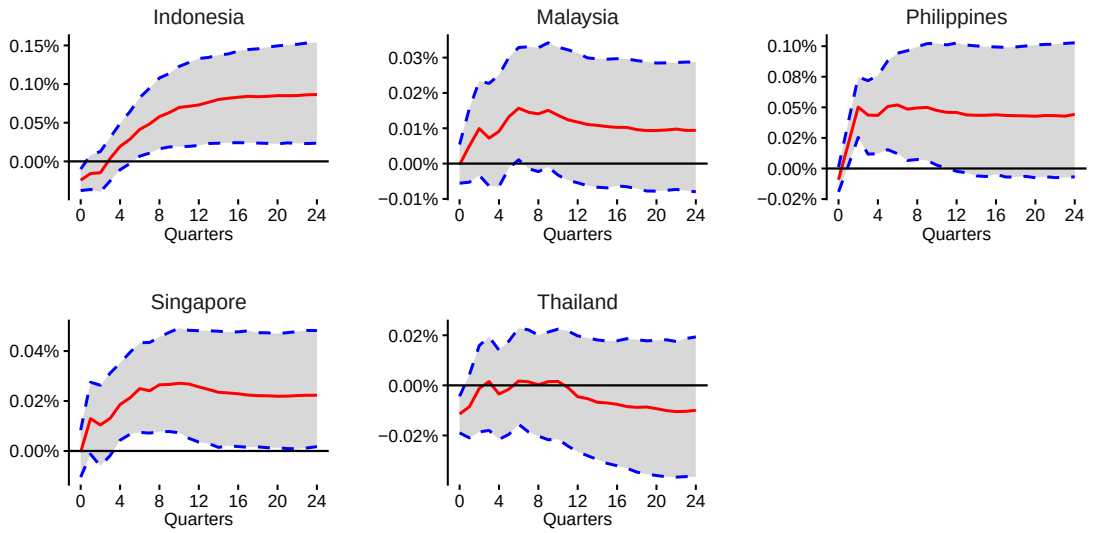


Figure 4.9: Structural Generalized Impulse Responses of a one standard error (+) shock to GDP in China to Long term Interest Rate in ASEAN-5 (bootstrap median estimates with 68% bootstrap error bounds).

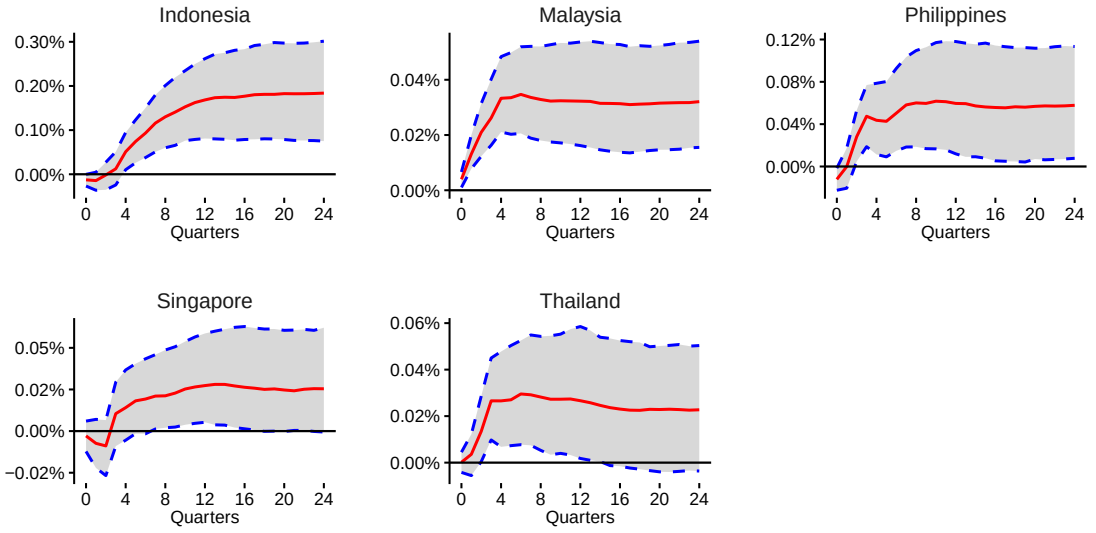


Figure 4.10: Structural Generalized Impulse Responses of a one standard error (+) shock to GDP in China to Short Term Interest Rate in ASEAN-5 (bootstrap median estimates with 68% bootstrap error bounds).

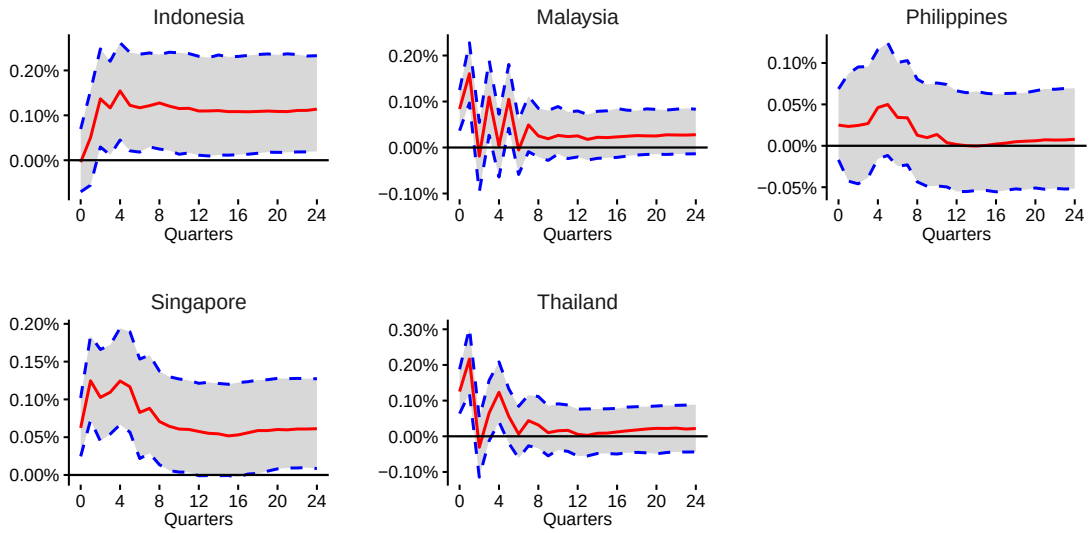


Figure 4.11: Structural Generalized Impulse Responses of a one standard error (+) shock to GDP in China to Inflation in ASEAN-5 (bootstrap median estimates with 68% bootstrap error bounds).

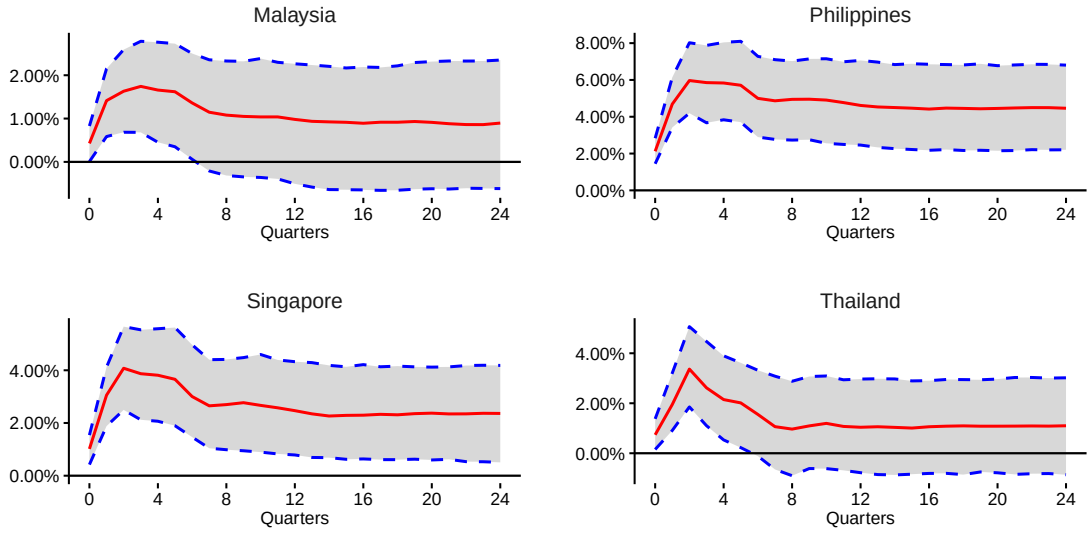


Figure 4.12: Structural Generalized Impulse Responses of a one standard error (+) shock to GDP in China to Equity Prices in ASEAN-5 (bootstrap median estimates with 68% bootstrap error bounds).

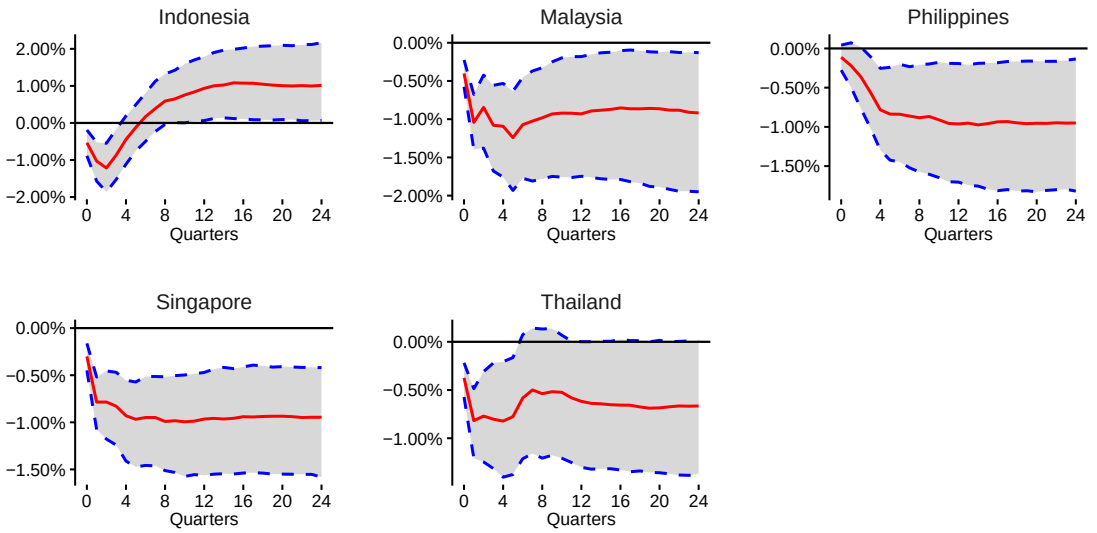


Figure 4.13: Structural Generalized Impulse Responses of a one standard error (+) shock to GDP in China to Exchange Rate in ASEAN-5 (bootstrap median estimates with 68% bootstrap error bounds).

4.5.6 Revenues Shock

Figures 4.14–4.21 display the SGIRFs following a one-standard-deviation positive revenue shock in China and its transmission to the five ASEAN economies. The results indicate that such a shock leads to positive and generally permanent effects on output across all countries except Thailand, where the impact becomes insignificant after around ten quarters. However, the magnitude of these output responses remains modest, reflecting the indirect nature of demand spillovers from fiscal improvements in China. For government revenues, (figure 4.15) the shock produces a sustained positive effect in the Philippines and Singapore, whereas in Indonesia, Malaysia, and Thailand the impacts are positive but taper off over time. This pattern suggests that trade and financial linkages may be more effective in amplifying external fiscal-driven demand in countries with deeper commercial integration or more export exposure to China (International Monetary Fund, 2011a,b).

Notably, the revenue shock does not produce significant effects on government expenditures across the ASEAN-5, with the exception of Malaysia, which shows a brief period of elevated spending (Figure 4.16). This could point to commodity-linked fiscal dynamics that make Malaysia's budget more sensitive to shifts in external revenues. Meanwhile, inflation (Figure 4.19) remains largely unaffected across these economies, consistent with standard small open economy models where external fiscal consolidations or expansions do not necessarily translate into domestic price pressures, especially when credible monetary policy helps anchor inflation expectations (Galí, 2015; Auerbach and Gorodnichenko, 2013). Financial variables also exhibit limited responses. Long-term interest rates are generally insignificant across the ASEAN-5, while short-term interest rates display predominantly positive

but statistically insignificant responses, except for Malaysia, which experiences a brief positive and significant effect (Figures 4.17–4.18). Equity prices remain largely unaffected in Malaysia, Singapore, and Thailand, with only a short-lived positive response observed in the Philippines. Similarly, exchange rate responses are mostly insignificant across countries (Figures 4.20–4.21). Taken together, these results underscore that while improvements in China's fiscal stance can transmit to ASEAN economies by modestly supporting output and revenues, they generally do not trigger broader spending, inflationary, or financial-market responses, highlighting the dampening role of domestic fiscal structures and monetary regimes.

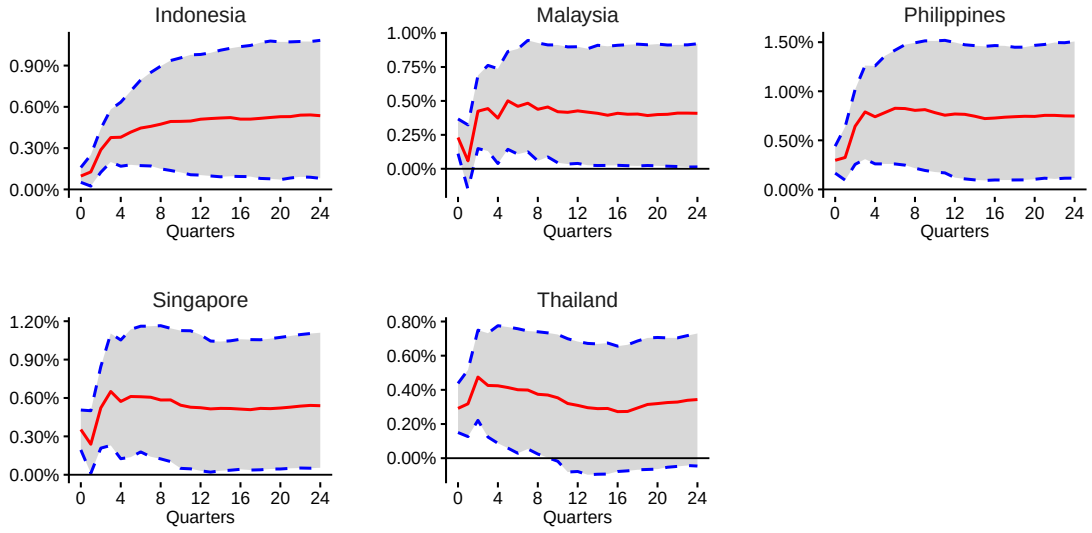


Figure 4.14: Structural Generalized Impulse Responses of a one standard error (+) shock to Revenues in China to GDP in ASEAN-5 (bootstrap median estimates with 68% bootstrap error bounds).

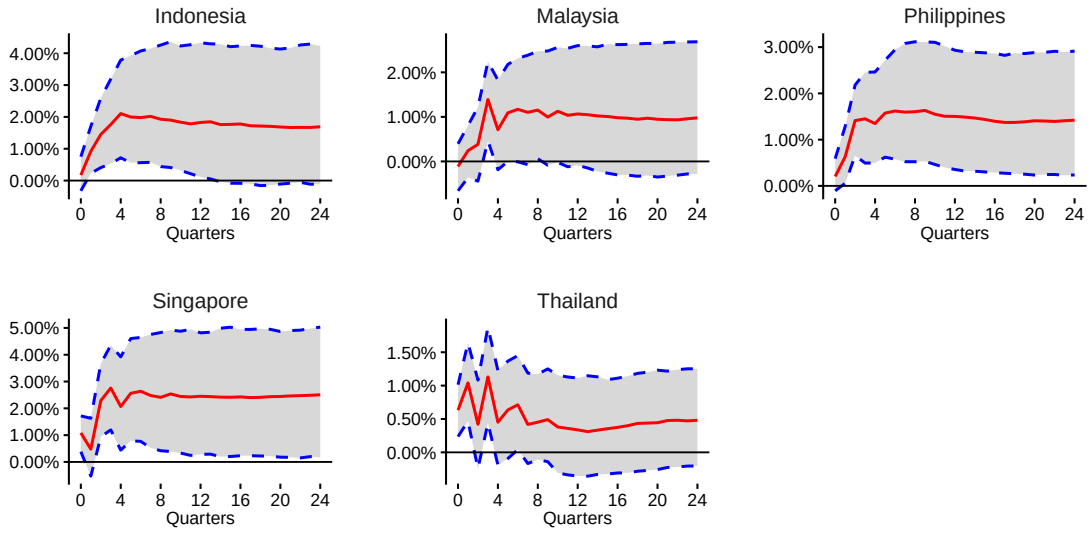


Figure 4.15: Structural Generalized Impulse Responses of a one standard error (+) shock to Revenues in China to Revenues in ASEAN-5 (bootstrap median estimates with 68% bootstrap error bounds).

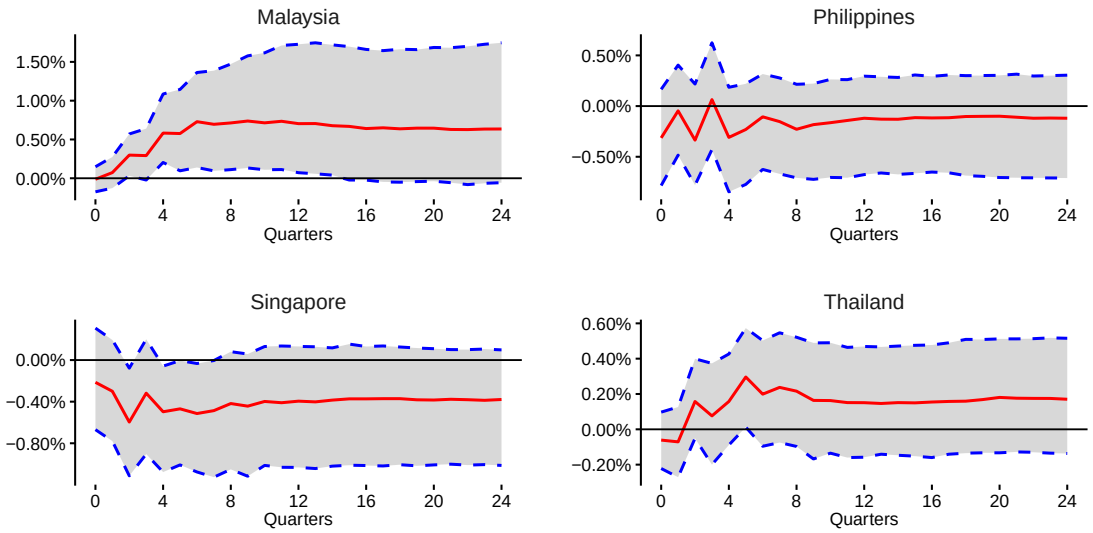


Figure 4.16: Structural Generalized Impulse Responses of a one standard error (+) shock to Revenues in China to Expenditure in ASEAN-5 (bootstrap median estimates with 68% bootstrap error bounds).

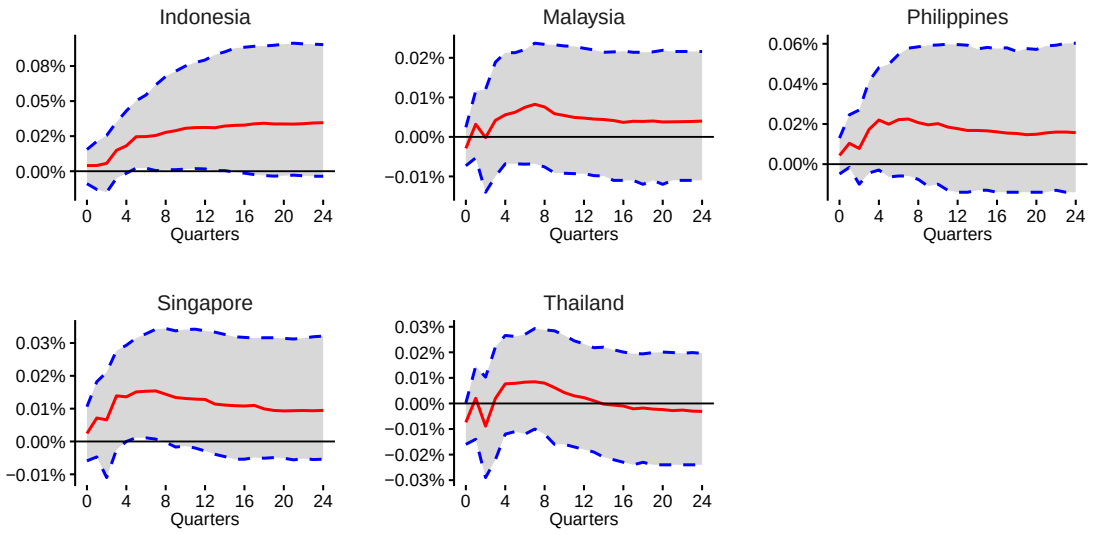


Figure 4.17: Structural Generalized Impulse Responses of a one standard error (+) shock to Revenues in China to Long Term Interest Rate in ASEAN-5 (bootstrap median estimates with 68% bootstrap error bounds).

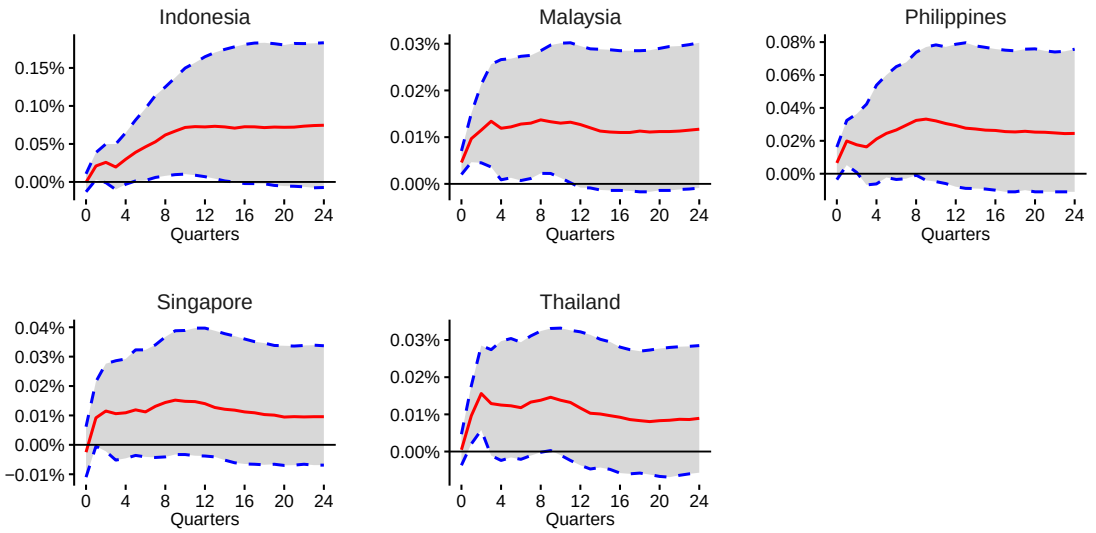


Figure 4.18: Structural Generalized Impulse Responses of a one standard error (+) shock to Revenues in China to Short Term Interest Rate in ASEAN-5 (bootstrap median estimates with 68% bootstrap error bounds).

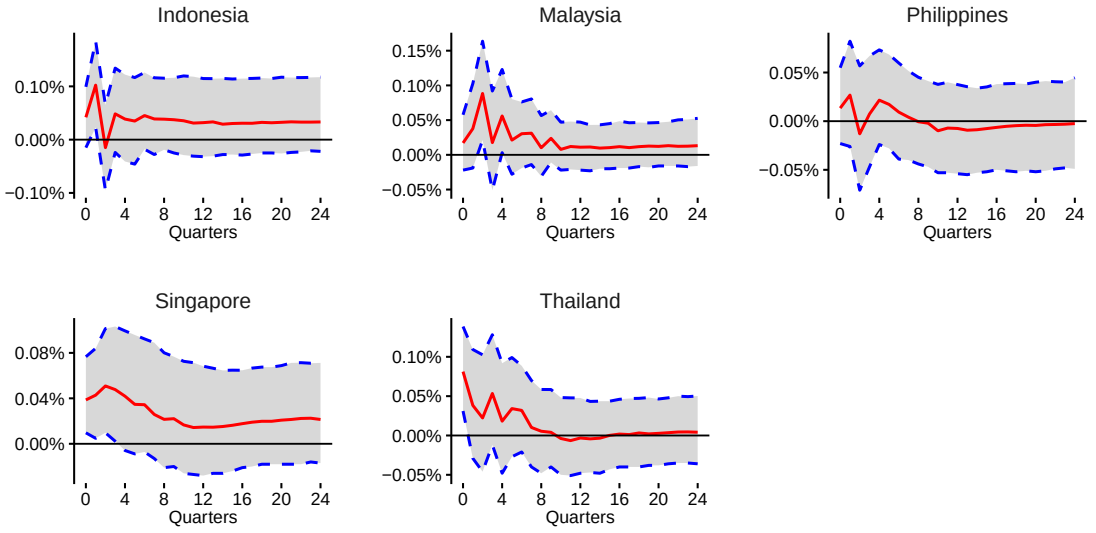


Figure 4.19: Structural Generalized Impulse Responses of a one standard error (+) shock to Revenues in China to Inflation in ASEAN-5 (bootstrap median estimates with 68% bootstrap error bounds).

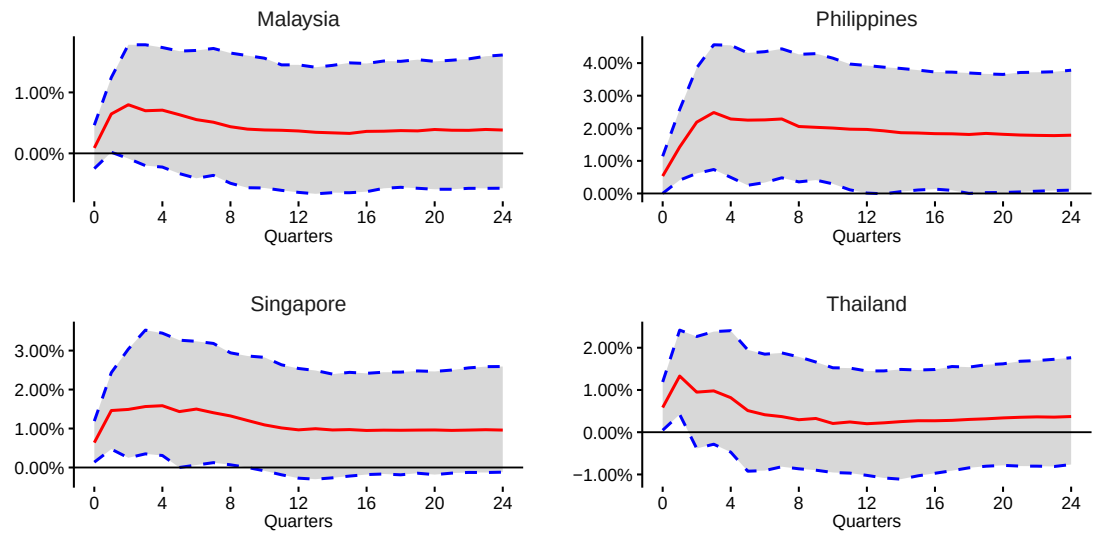


Figure 4.20: Structural Generalized Impulse Responses of a one standard error (+) shock to Revenues in China to Equity Prices in ASEAN-5 (bootstrap median estimates with 68% bootstrap error bounds).

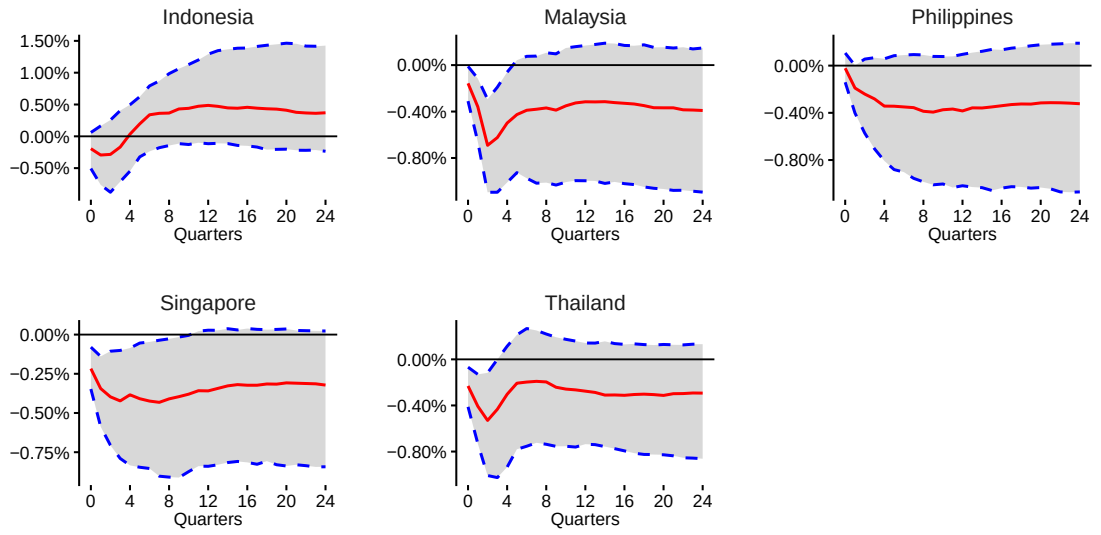


Figure 4.21: Structural Generalized Impulse Responses of a one standard error (+) shock to Revenues in China to Exhange Rate in ASEAN-5 (bootstrap median estimates with 68% bootstrap error bounds).

4.5.7 Expenditures Shock

Figures C.1–C.8 Appenidx C section 4.2 present the SGIRFs for a one-standard-deviation positive expenditure shock in China and its effects on the ASEAN-5 economies. The results indicate that this spending shock does not lead to significant changes in output, government revenues, expenditures, or inflation and financial variables Long term interest rate, short term interest rate and equity prices in any of these countries. This muted transmission is consistent with findings in the international spillover literature, which often shows that fiscal expansions tend to have

limited cross-border effects unless trade or financial linkages are exceptionally strong (Beetsma and Giuliodori, 2010; Auerbach and Gorodnichenko, 2013). Theoretically, standard open economy models also predict that domestic fiscal shocks primarily affect the local economy, with external impacts dampened by exchange rate adjustments or offsetting capital flows (Galí, 2015). Overall, these results suggest that China's expenditure-driven fiscal policies do not substantially spill over to ASEAN-5 macroeconomic variables, underscoring the importance of domestic channels and structural integration in propagating fiscal shocks internationally.

4.6 Regional Analysis

Figures 4.22–4.29 presents the regional impulse responses to a one-standard-deviation positive GDP shock, focusing on ASEAN, the Euro Area, the rest of Asia and Pacific, and South America.

The results reveal that GDP shock (figures 4.22–4.23) has a broadly positive effect on output and government revenues across most regions, though the persistence of these effects differs markedly. Specifically, ASEAN and the Euro Area experience an immediate rise in GDP and revenues following the shock; however, these effects are transitory and dissipate after the initial quarters, indicating only short-lived adjustments, see figure 4.22. This pattern aligns with standard business cycle models where temporary demand or productivity shocks yield short-run deviations from trend output before returning to equilibrium (Blanchard and Quah, 1988).

In contrast, the rest of Asia and the Pacific displays a more persistent response: both GDP and revenues remain elevated throughout the horizon, suggesting that the shock may embed more permanently into the economic trajectory of this region. Such lasting effects resonate with hysteresis-type mechanisms proposed by (Ball, 2014), where initial shocks can leave enduring imprints on output levels, particularly in economies with structural flexibility or underutilized resources that allow shocks to translate into long-run capacity improvements.

For South America, the GDP shock does not produce a significant effect on output itself, but it does generate a small, transitory positive impact on revenues. This could reflect automatic fiscal responses where even modest output increases temporarily expand the tax base, consistent with findings by (Pappa, 2009) on how output fluctuations can influence revenue streams.

Importantly, across all four regions, there is no statistically significant response of government expenditures or inflation to the GDP shock (Figures 4.24 and 4.27). The absence of expenditure adjustments may point to institutional or budgetary rigidities that prevent spending from reacting immediately to cyclical changes, in line with evidence from Auerbach and Gorodnichenko (2013). Likewise, the muted inflation responses suggest that the scale of the shock is insufficient to generate persistent price pressures, or that monetary policy frameworks in these regions successfully

anchor inflation expectations, as theorized in New Keynesian models (Galí, 2015). Financial variables also display relatively limited responses. Long-term interest rates do not exhibit statistically significant effects across the four regions, while short-term interest rates respond positively but only temporarily in the ASEAN region, the Euro Area, and the Rest of Asia and the Pacific, with the effects dissipating after approximately six to eight quarters see (Figures 4.25 and 4.26). Exchange rates likewise show no significant responses (Figure 4.29). Equity prices, however, increase significantly in the Euro Area, while the positive responses observed in the ASEAN region and the Rest of Asia and the Pacific are short-lived and disappear after around four quarters (Figure 4.28). No significant equity price response is found for South America.

Overall, these findings underscore heterogeneous regional dynamics following a GDP shock in China. While positive effects on output and revenues are observed across all regions, these gains appear to be more persistent in parts of Asia. In contrast, there is little evidence of spillovers to government expenditures, inflation, or long-term interest rates, and the responses of other financial variables are generally weak and transitory. Overall, the transmission of China's GDP shocks to the broader regions appears to operate primarily through real economic and trade channels rather than through sustained financial or price effects.

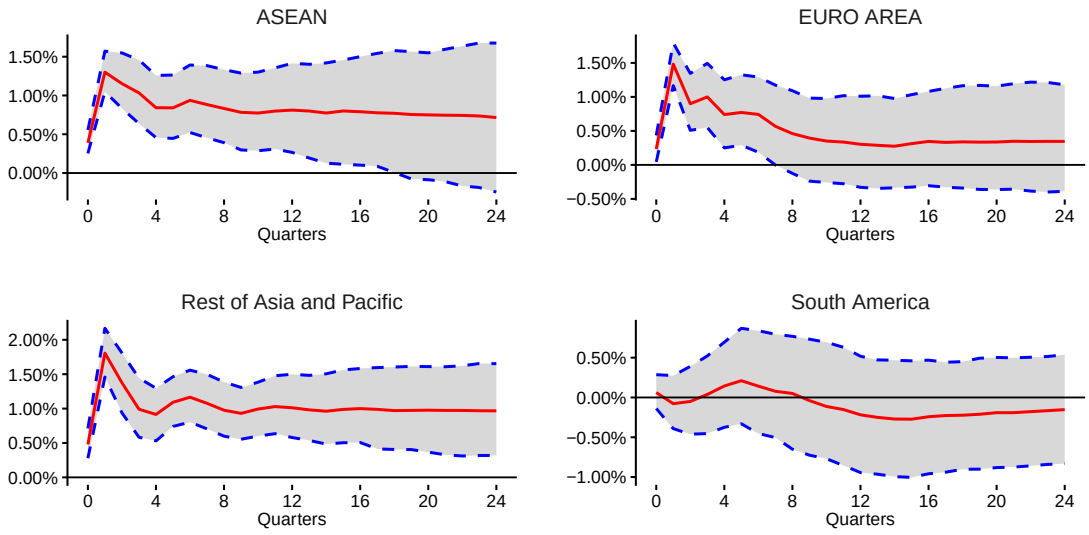


Figure 4.22: Structural Generalized Impulse Responses of a one standard error (+) shock to GDP in China to GDP in Four Regions (bootstrap median estimates with 68% bootstrap error bounds).

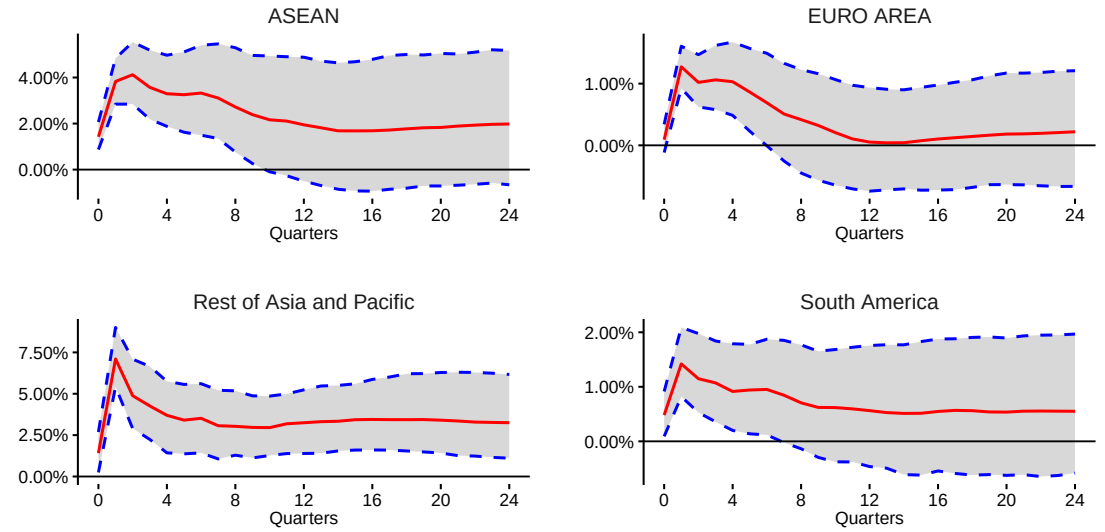


Figure 4.23: Structural Generalized Impulse Responses of a one standard error (+) shock to GDP in China to Revenues in Four Regions (bootstrap median estimates with 68% bootstrap error bounds).

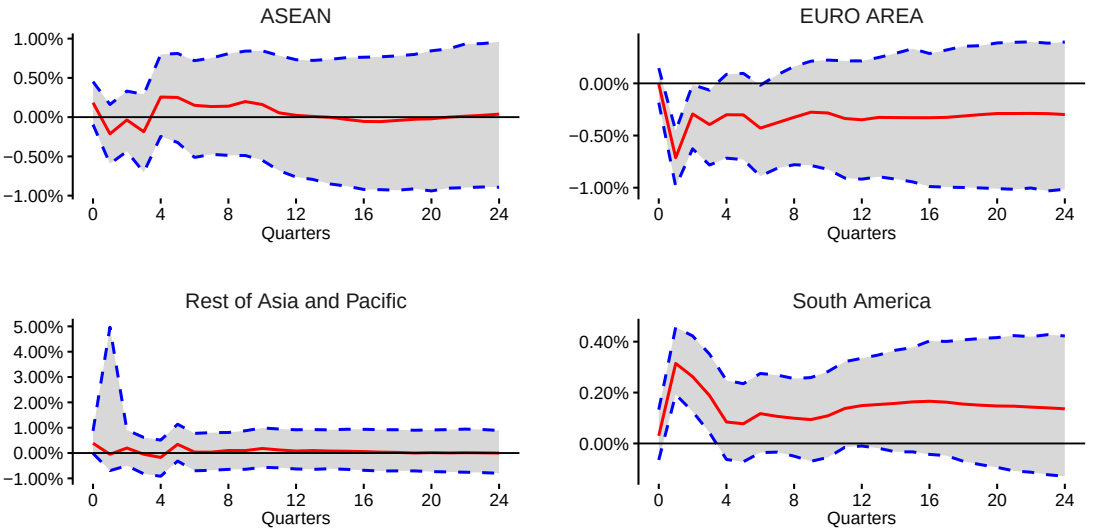


Figure 4.24: Structural Generalized Impulse Responses of a one standard error (+) shock to GDP in China to Expenditures in Four Regions (bootstrap median estimates with 68% bootstrap error bounds).

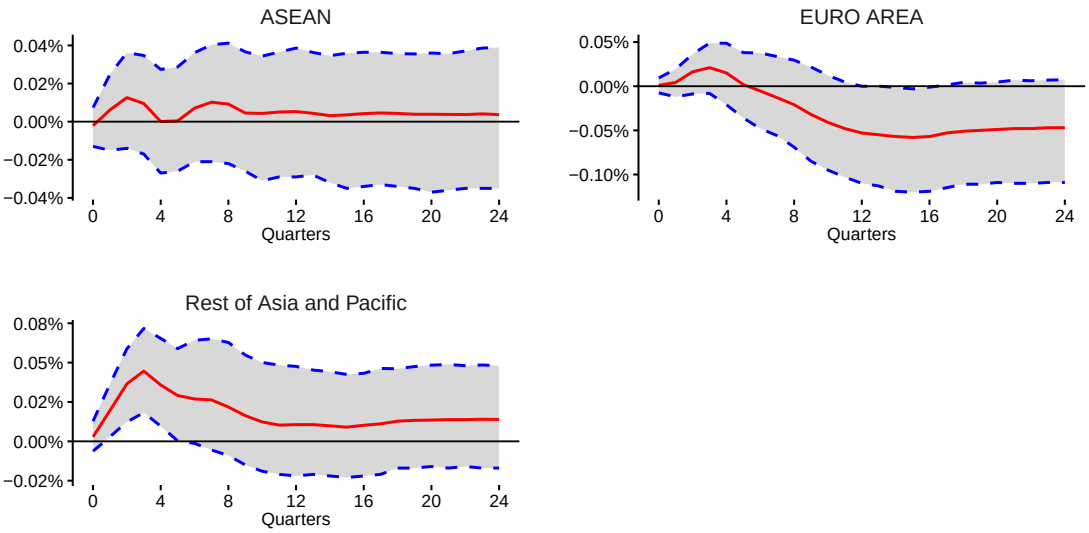


Figure 4.25: Structural Generalized Impulse Responses of a one standard error (+) shock to GDP in China to Long Term Interest Rate in Four Regions (bootstrap median estimates with 68% bootstrap error bounds).

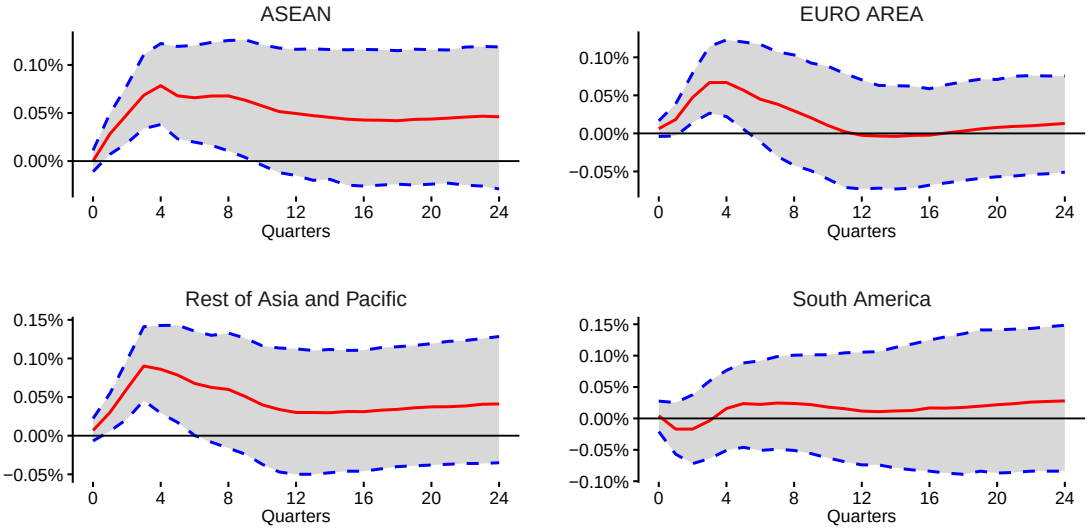


Figure 4.26: Structural Generalized Impulse Responses of a one standard error (+) shock to GDP in China to Short Term Interest Rate in Four Regions (bootstrap median estimates with 68% bootstrap error bounds).

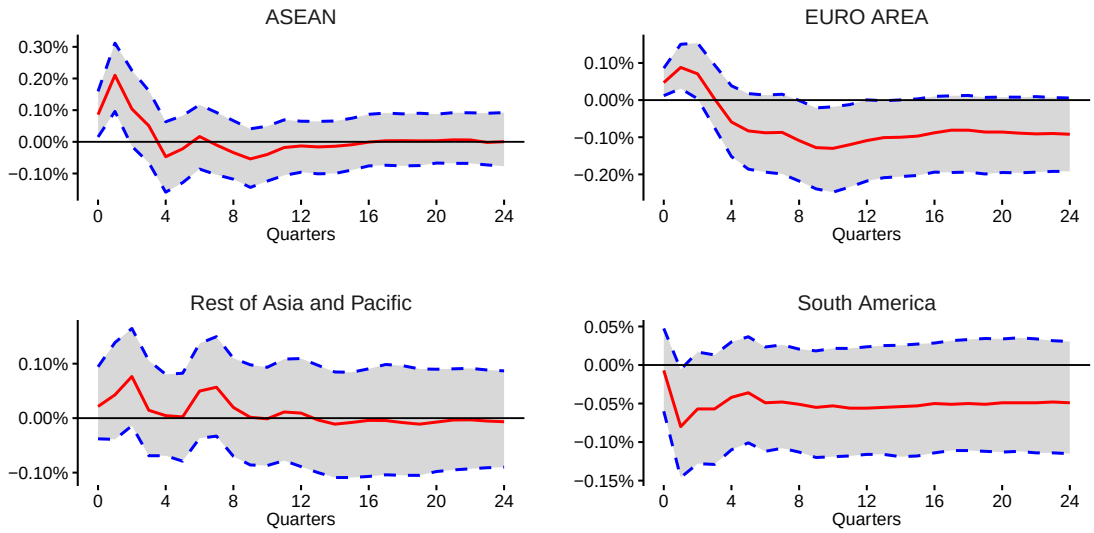


Figure 4.27: Structural Generalized Impulse Responses of a one standard error (+) shock to GDP in China to Inflation in Four Regions (bootstrap median estimates with 68% bootstrap error bounds).

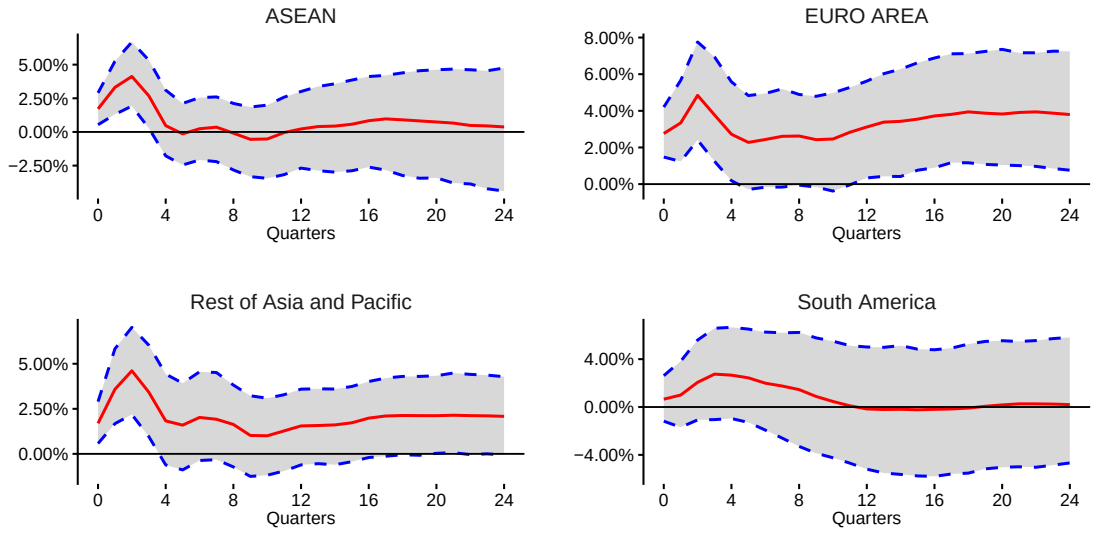


Figure 4.28: Structural Generalized Impulse Responses of a one standard error (+) shock to GDP in China to Equity Prices in Four Regions (bootstrap median estimates with 68% bootstrap error bounds).

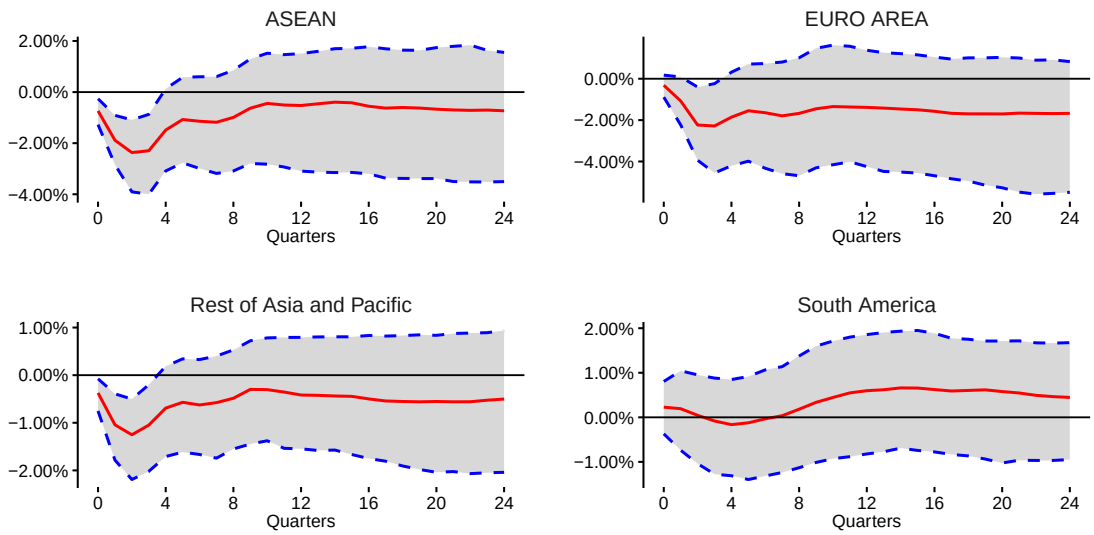


Figure 4.29: Structural Generalized Impulse Responses of a one standard error (+) shock to GDP in China to Exchange Rate in Four Regions (bootstrap median estimates with 68% bootstrap error bounds).

Figures 4.30–4.37 shows the regional effects of a one-standard-deviation positive revenue shock in China on output, revenues, expenditures, and inflation across ASEAN, the Euro Area, the rest of Asia and Pacific, and South America.

The results indicate that higher revenues lead to short-lived boosts in both GDP and government revenues over the initial 2–3 quarters in ASEAN, the Euro Area, and the rest of Asia and Pacific, reflecting typical fiscal channel linkages where increased revenues may support confidence and spending, indirectly stimulating activity, see figures 4.30–4.31. However, for South America, output remains insignificant throughout, with only modest transitory gains in revenues.

Furthermore, this revenue shock does not produce significant responses in government expenditures, long-term interest rates, inflation, equity prices, or exchange rates in any of the four regions, pointing to limited immediate fiscal expansions or price effects (Figures 4.32–4.33 and 4.35–4.37). However, the revenue shock generates a transitory positive response in short-term interest rates in the ASEAN region, the Euro Area, and the Rest of Asia and the Pacific, with no significant effect observed in South America (Figure 4.34). These patterns are broadly consistent with the regional dynamics observed under the GDP shock, underscoring that while improvements in fiscal capacity can support short-run output and revenue gains, they do not automatically translate into higher spending, inflationary pressures, or sustained financial market responses. This aligns with empirical evidence on the often muted macroeconomic pass-through from tax-side fiscal changes (Blanchard and Perotti, 2002; Pappa, 2009) and with the view that expenditure adjustments and inflation typically respond more strongly to demand-side impulses than to fluctuations in revenues alone (Mountford and Uhlig, 2009).

Appendix C Section 4.2.1 figures C9–C16 illustrates the regional impulse responses to a one-standard-deviation positive expenditure shock in China across ASEAN, the Euro Area, the rest of Asia and Pacific, and South America.

The results show that this spending shock does not produce statistically significant effects on GDP, government revenues, expenditures, inflation or financial variables in any of the four regions over the examined horizon. This absence of measurable transmission suggests that the fiscal shock either remains largely contained within China's domestic economy or that any external spillovers are too modest to influence macroeconomic aggregates in these regions within the analyzed period. Such muted cross-regional impacts are consistent with studies like (Auerbach and Gorodnichenko, 2013) and (Perotti, 2005), which note that fiscal spillovers often require strong trade or financial linkages and may be dampened by offsetting adjustments in external balances or monetary conditions. Moreover, standard open economy models indicate that unless foreign economies are tightly integrated, domestic fiscal expansions may have limited direct effects on external output and prices.

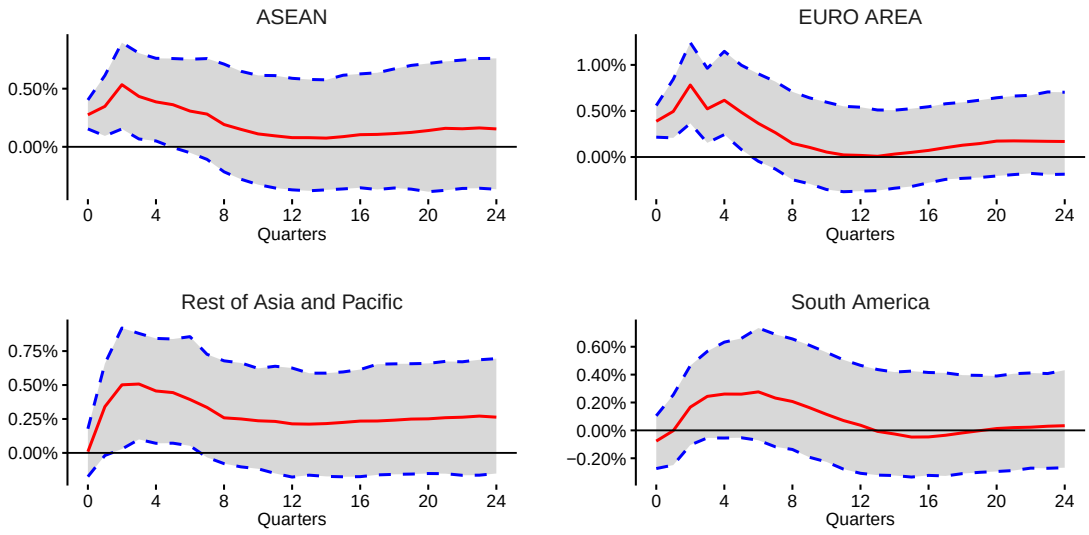


Figure 4.30: Structural Generalized Impulse Responses of a one standard error (+) shock to Revenues in China to GDP in Four Regions (bootstrap median estimates with 68% bootstrap error bounds).

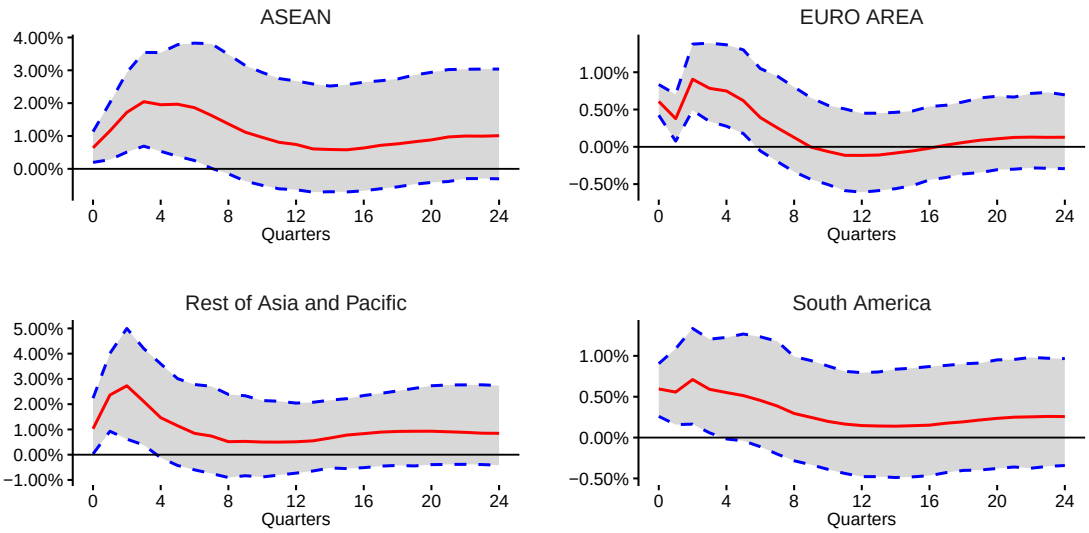


Figure 4.31: Structural Generalized Impulse Responses of a one standard error (+) shock to Revenues in China to Revenues in Four Regions (bootstrap median estimates with 68% bootstrap error bounds).

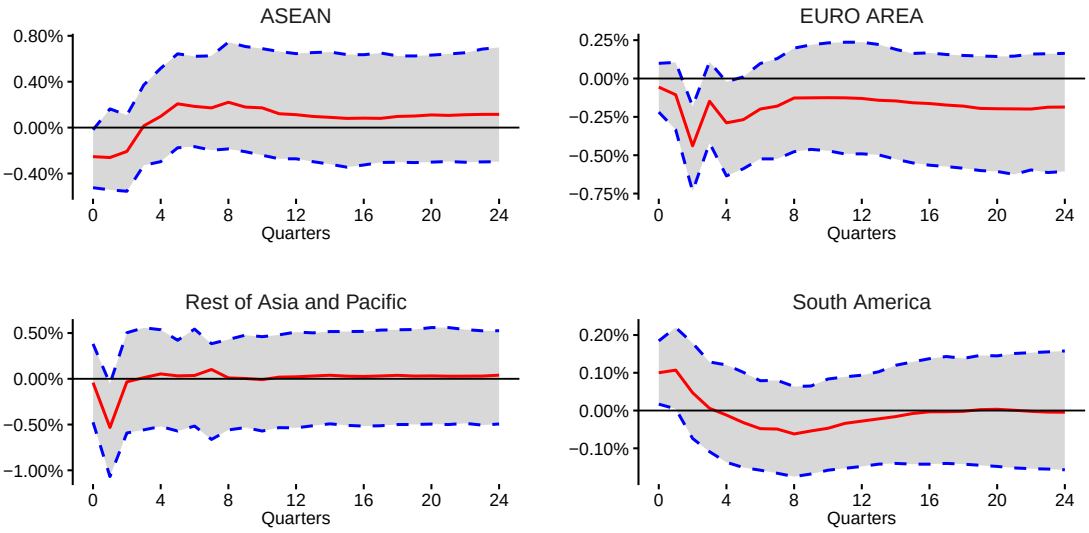


Figure 4.32: Structural Generalized Impulse Responses of a one standard error (+) shock to Revenues in China to Expenditures in Four Regions (bootstrap median estimates with 68% bootstrap error bounds).

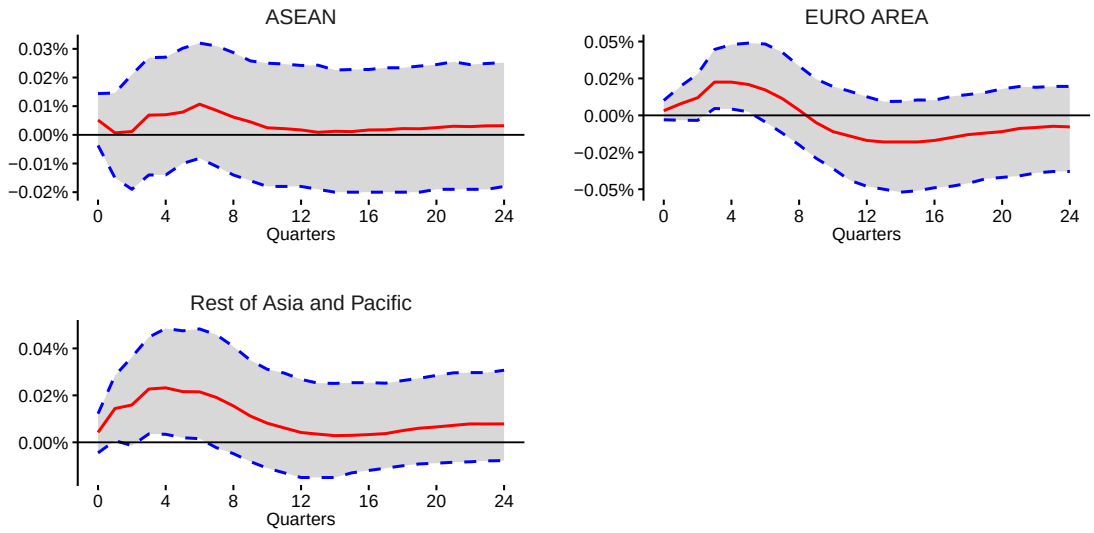


Figure 4.33: Structural Generalized Impulse Responses of a one standard error (+) shock to Revenues in China to Long Term Interest Rate in Four Regions (bootstrap median estimates with 68% bootstrap error bounds).

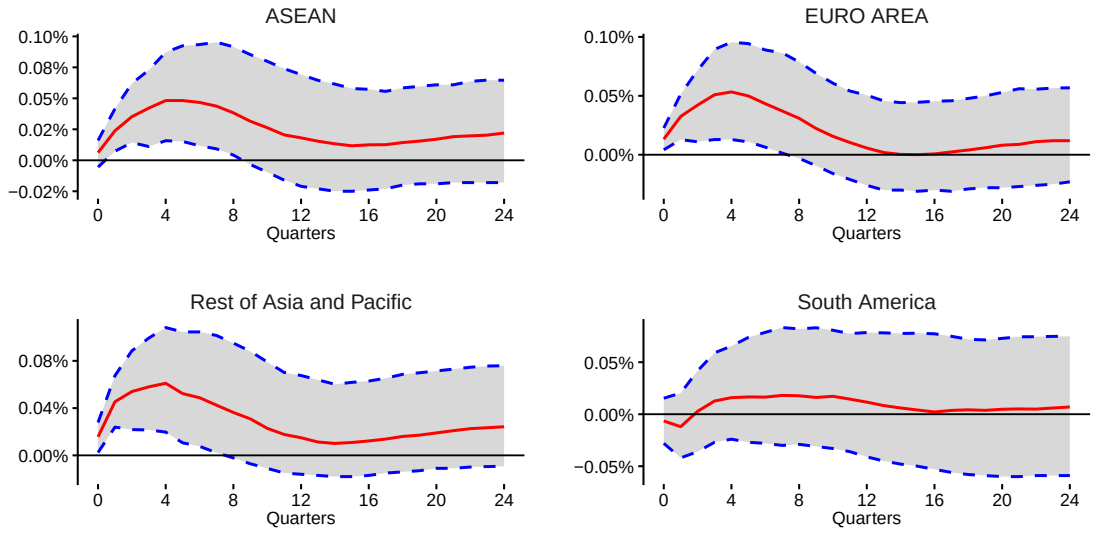


Figure 4.34: Structural Generalized Impulse Responses of a one standard error (+) shock to Revenues in China to Short Term Interest Rate in Four Regions (bootstrap median estimates with 68% bootstrap error bounds).

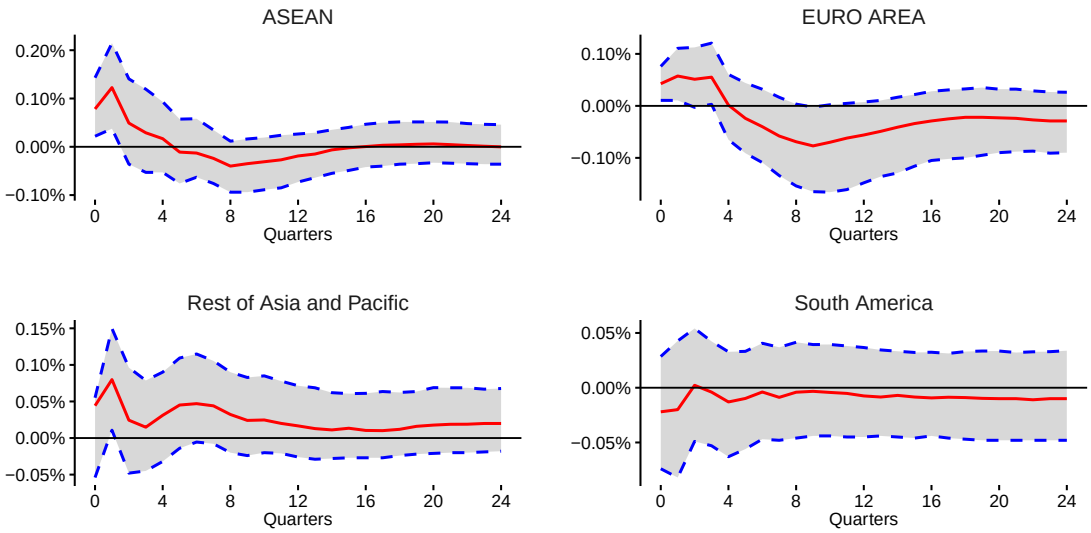


Figure 4.35: Structural Generalized Impulse Responses of a one standard error (+) shock to Revenues in China to Inflation in Four Regions (bootstrap median estimates with 68% bootstrap error bounds).

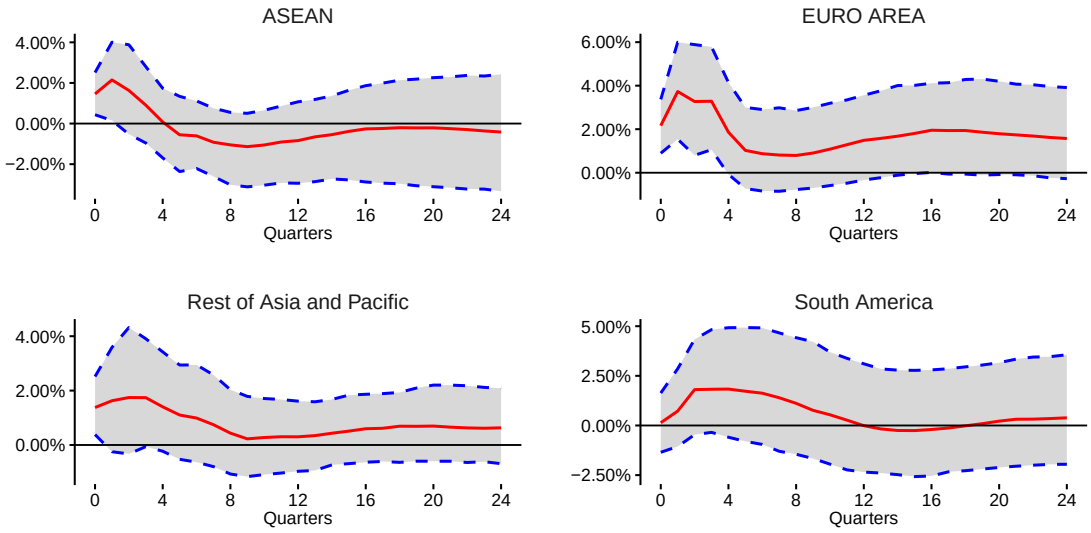


Figure 4.36: Structural Generalized Impulse Responses of a one standard error (+) shock to Revenues in China to Equity Price in Four Regions (bootstrap median estimates with 68% bootstrap error bounds).

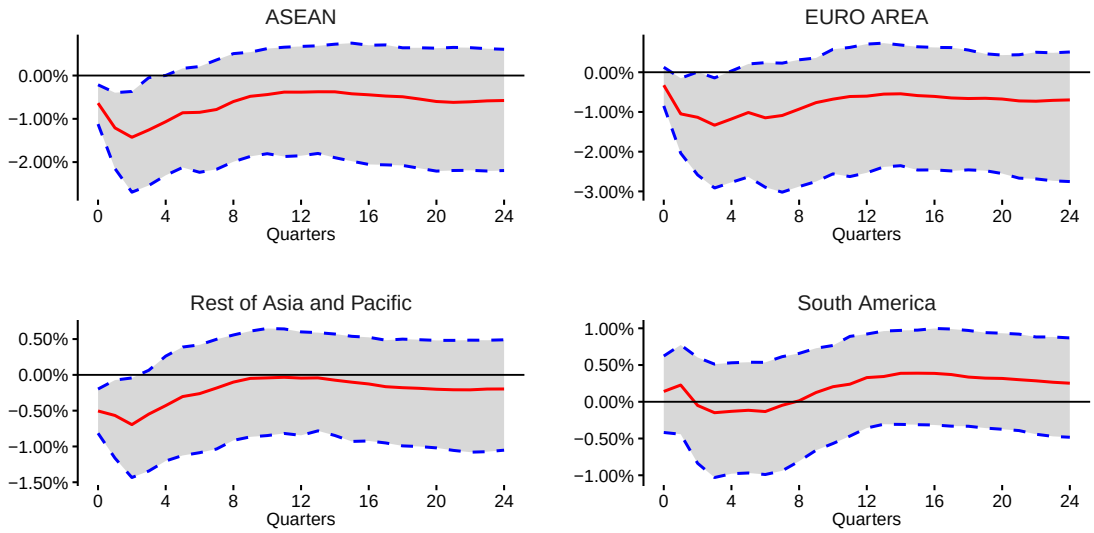


Figure 4.37: Structural Generalized Impulse Responses of a one standard error (+) shock to Revenues in China to Exchange Rate in Four Regions (bootstrap median estimates with 68% bootstrap error bounds).

4.7 Results Robustness

To assess the robustness of the results obtained from the GVAR model, several alternative specifications were considered. First, different identification strategies were employed. In the baseline specification, following (Blanchard and Perotti, 2002), government spending was ordered before revenue, while an alternative specification reversed this ordering. For the majority of countries, the impulse response functions remained qualitatively similar across the two identification schemes, indicating that the main findings are not driven by the particular recursive ordering adopted. For China, however, some differences in the magnitude and timing of the responses were observed. This is not unexpected, as the ordering directly affects the identification of the fiscal shock in the shock-originating country. Nevertheless, the overall economic interpretation of the results and the estimated international spillover effects remained broadly unchanged.

Second, given the structural shifts in global trade dynamics following the COVID-19 pandemic, a fixed trade-weight matrix based on both the pre and post pandemic period was employed. The results remained qualitatively similar under this alternative weighting scheme. Finally, while the Akaike Information Criterion (AIC) suggested that two lags were optimal for the model, additional estimations using alternative lag lengths were conducted, and the principal findings remained largely unchanged. Overall, these robustness checks provide support for the stability of the empirical results presented in this chapter.

4.8 Conclusion

This study analyzes the fiscal spillover effects from China to its domestic economy and its neighboring ASEAN-5 countries, as well as to four broader regions: ASEAN-5, the Euro Area, the Rest of Asia and Pacific, and South America. To achieve this, we employ a Global VAR (GVAR) framework using quarterly data from Q1 2001 to Q4 2023. Our analysis quantifies the impact of China's output and fiscal expansion on both domestic real and fiscal variables. We find that increases in output and fiscal balances in China lead to significant economic gains in other countries primarily through trade channels.

China's output and fiscal expansions have positive significant effects across the ASEAN-5 countries, with the exception of Singapore, where output expansion in China negatively impacts government expenditures. These effects are particularly pronounced due to strong trade linkages, with spillovers estimated at approximately 1 to 2 percentage points for every 1 percentage point increase in China's GDP or fiscal variables. Among the ASEAN-5, fiscal spillovers vary, but tend to have a greater impact on output and government revenues than on expenditures or inflation, consistent with (Poghosyan, 2020).

In both the ASEAN-5 and the Rest of Asia & Pacific regions closely tied to China through commodity exports, China's expansions lead to notable increases in output and government revenues. These spillover effects are largely driven by geographic proximity and robust trade integration. However, while the impacts in the ASEAN region taper off after 15–20 quarters, they remain persistent in the Rest of Asia & Pacific. In contrast, the Euro area experiences initially significant effects that dissipate over time, and South America sees either negligible or short-lived impacts.

Across all four regions, GDP and revenue shocks from China exert modest influence on output and fiscal revenues, with minimal evidence of spillovers to government expenditures or inflation. Notably, Chinese spending shocks do not produce significant spillover effects in any region examined.

From a policy perspective, we suggest that fiscal expansions and consolidations in China can indirectly support growth and fiscal discipline among its key trading partners, ultimately stimulating investment and consumption. Furthermore, neighboring economies such as the ASEAN-5 and the Rest of Asia and Pacific, which maintain close economic and geographic ties with China, could strategically adjust their fiscal policies to better harness the benefits arising from China's output and fiscal dynamics.

This study also points to several avenues for future research. First, enhancing the statistical databases on emerging and developing economies would allow for richer, more detailed analysis of government revenues and expenditures, enabling a deeper exploration of heterogeneous responses. Second, future work should investigate how exchange rate policies, especially in ASEAN-5 countries, might influ-

ence these spillover effects. Understanding how currency adjustments can amplify or dampen the benefits from China's fiscal expansion would offer a more nuanced policy toolkit for ASEAN and other significant trading partners. Third, although this study employs fixed trade-weight matrices for the periods before and after the COVID-19 pandemic, trade patterns and production networks have evolved considerably over the past two decades. As countries relative trade exposures and economic linkages have changed over time, trade interdependencies are inherently dynamic. Future research could therefore incorporate time-varying trade weights and evolving interdependencies within the GVAR framework to better capture these changing relationships and provide a more accurate assessment of the transmission of fiscal shocks over time.

Additionally, although this study uses a Blanchard-Perotti style structural ordering in the GVAR model which assumes that government spending and tax decisions respond only with a delay to changes in output, this approach might be too restrictive for our multi-country analysis. China and the US, for instance, have very different fiscal institutions and policy implementation speeds. China's government can often roll out fiscal measures much more quickly than the US, where budgetary decisions can be slowed by congressional processes. This discrepancy means that applying the same timing assumptions across both countries may not fully capture how fiscal policies actually react, potentially limiting the accuracy of our spillover estimates. An important avenue for future research would be to explore alternative identification schemes that better accommodate country-specific fiscal institutions.

Chapter 5

Conclusion

This thesis has addressed critical questions surrounding fiscal policy by examining fiscal rules, the time-varying nature of fiscal responses to debt, and the international spillover effects of fiscal decisions. Across three chapters, it demonstrates the importance of applying advanced econometric and macroeconomic techniques to understand how fiscal policies shape debt sustainability and transmit across borders, with implications for both (AEs) and emerging and developing countries.

The first chapter analysed the impact of fiscal rules using a dynamic panel model across advanced and emerging economies. The findings suggest that well-designed fiscal rules can discipline spending and support debt sustainability, but their effects vary by institutional and economic context. A key limitation, however, lies in the potential endogeneity inherent in the methodological approach. Future research could address this concern by expanding the set of control variables, adopting alternative estimation strategies with stronger instruments, or employing quasi-experimental approaches such as difference-in-differences to improve causal identification.

The second chapter employed a novel time-varying model to forecast public debt trajectories in high-debt countries. The results underscore that fiscal responses to debt are not constant but evolve in response to changing macroeconomic conditions and domestic institutional settings. Nonetheless, the analysis faced data limitations, particularly for emerging economies where high-frequency and long-span fiscal data are often unavailable. Future extensions could incorporate quarterly fiscal data where possible, broaden the sample to include euro area high-debt countries and African economies, and apply Bayesian time-varying methods that permit the use of informative priors in data-sparse environments.

The third chapter investigated fiscal spillovers using a Global VAR framework, adopting a Blanchard-Perotti-style ordering of fiscal variables within the China block. The findings highlight that fiscal shocks from large economies, such as the US and China, generate meaningful spillovers across regions, although their magnitude and persistence differ. A limitation arises from the structural identification strategy: while recursive identification is a useful benchmark, it may not fully capture the institutional and structural differences between economies such as China

and the US. Future work should experiment with alternative identification schemes, including sign restrictions, narrative approaches, or proxy-SVAR methods, to test the robustness of the spillover effects.

Beyond the individual chapters, the thesis makes three broader contributions to the literature on fiscal policy. First, it brings together analyses of fiscal rules, fiscal reactions, and fiscal spillovers within a single framework, thereby linking institutional design, domestic policy behaviour, and international transmission channels. This integrated perspective is rare in the existing literature, which often treats these themes in isolation. Second, the thesis extends the methodological frontier by applying advanced econometric techniques including dynamic panels, time-varying parameter models, and Global VARs not only to (AEs) but also to emerging and developing countries, where such approaches have been underutilised. Finally, the thesis generates policy-relevant insights: it shows that fiscal discipline is context-dependent, fiscal responses evolve with economic conditions, and large-economy fiscal shocks propagate across borders in ways that can constrain policy space in more vulnerable economies.

In conclusion, this thesis contributes to a deeper understanding of fiscal policy dynamics by bridging methodological innovation with policy application. It highlights that safeguarding debt sustainability and mitigating cross-border risks requires not only well-designed domestic fiscal frameworks but also recognition of the global interdependence of fiscal decisions.

Appendix A

Appendix to Chapter 2

2.1 Tables

Table 2.1: Summary Statistics: Emerging and Developing Countries Sample

Variables	**Observations**	**Mean**	**Std.dev**	**Min**	**Max**
Total Spending	856	0.0510	0.2333	-1.2966	4.2993
Social Spending	685	0.0390	0.3927	-3.4586	2.8391
Education Spending	718	0.0539	0.2303	-1.6687	2.4946
Health Spending	709	0.0651	0.3694	-2.4493	3.0519
Revenue	779	0.0079	0.3050	-1.8396	2.1067
Population	1,155	0.0125	0.0511	-0.0953	1.164
Unemployment rate	811	0.0071	0.2291	-2.4977	1.8763
Total GDP	1,054	-0.6366	1.9731	-3.609	3.6243
GDP Per Capita	1,110	0.5034	1.0657	-0.6037	1.972
Trade openness	1,048	0.0689	0.1225	-0.9004	1.4777
Public debt	748	0.0720	0.1673	-1.0200	1.9527
Control of Corruption	823	0.0149	0.7436	-1.8158	1.7422
Government effectiveness	823	0.1113	0.6125	-1.7172	1.4843
Political Stability	818	-0.0459	0.8760	-2.0180	1.5944
Regularity Quality	823	0.0209	0.6428	-1.6767	1.5427
Rule of Law	820	-0.0070	0.7016	-1.5548	1.6269
Voice and Accountability	825	0.2518	0.6897	-2.0002	1.3727

Note: This table reports the summary statistics (mean, standard deviation, minimum, and maximum) for all variables used in the Fiscal Rule model for emerging and developing countries. The data cover the period from 1985 to 2020 and are measured at annual frequency.

Table 2.2: Summary Statistics: Advanced Countries Sample

Variables	**Observations**	**Mean**	**Std.dev**	**Min**	**Max**
Total Spending	980	0.0228	0.0962	-1.7370	0.8977
Social Spending	962	0.0334	0.1871	-1.9287	1.5640
Education Spending	968	0.0327	0.1374	-0.6431	0.6491
Health Spending	948	0.0492	0.2645	-0.2482	2.9839
Revenue	975	0.0009	0.0523	-0.6053	0.5302
Total Population	1,190	0.0120	0.0149	-0.0235	0.0951
Unemployment rate	1,118	0.0021	0.1835	-0.4886	1.2383
Total GDP	1,106	0.0252	0.8071	-1.9274	2.4649
GDP Per Capita	1,106	0.0187	0.0334	-0.1652	0.2151
Trade openness	1,130	0.0088	0.0676	-0.3359	0.3325
Public Debt	978	0.0192	0.1456	-0.2706	1.6434
Control of Corruption	748	1.4341	0.6847	0.2033	2.4699
Government Effectiveness	748	1.4284	0.5729	0.1445	2.4399
Political Stability	748	0.8497	0.5302	-1.6262	1.7601
Regulatory Quality	748	1.3757	0.4189	0.1483	2.1265
Rule of Law	748	1.3871	0.4934	0.0749	2.1796
Voice and Accountability	748	1.1798	0.3776	-0.3871	1.8009

Note: This table reports the summary statistics (mean, standard deviation, minimum, and maximum) for all variables used in the Fiscal Rule model for advanced countries. The data cover the period from 1985 to 2020 and are measured at annual frequency.

2.1.1 Unit Root Test: (AEs) and (EMDEs)

Table 2.3: Unit Root Test:
Advanced Countries Sample

Im–Pesaran–Shin Unit-Root Tests		
Variables	**P value**	**Z values**
Total Spending	1.000	8.831
Social Spending	1.000	11.12
Education Spending	0.346	-0.393
Health Spending	1.000	7.259
Population	1.000	5.279
GDP Per Capita	0.992	2.441
Unemployment rate	0.462	-0.093
Trade openness	0.951	1.654
GDP	0.756	0.693
Output Gap	1.000	7.815
Inflation rate	0.983	2.895
Revenue % of GDP	1.000	8.369
Debt % of GDP	1.000	4.692

H0: All Panels contain unit root

Table 2.4: Unit Root Test:
Emerging and Developing Countries Sample

Im–Pesaran–Shin Unit-Root Tests		
Variables	**P value**	**Z values**
Total Spending	1.000	5.985
Social Spending	1.000	4.232
Education Spending	1.000	6.065
Health Spending	1.000	5.659
Population	1.000	6.000
GDP Per Capita	1.000	7.782
Unemployment rate	0.784	0.787
Trade openness	0.999	3.48
GDP	0.673	0.450
Output Gap	1.000	3.879
Inflation rate	0.983	2.895
Revenue % of GDP	1.000	6.204
Debt % of GDP	1.000	12.217

H0: All Panels contain unit root

2.1.2 Variables Description and Sample Countries

Table 2.5: Data for fiscal analysis

Variable	**Description / Transformation**	**Data source**
Total Spending	Total public expenditures in constant 2010 US$	SPEED dataset (2019), IFPRI
Social Spending	Social protection expenditures in constant 2010 US$	SPEED dataset (2019), IFPRI
Education Spending	Education expenditure in constant 2010 US$	SPEED dataset (2019), IFPRI
Health Spending	Health expenditure in constant 2010 US$	SPEED dataset (2019), IFPRI
Balanced Budget Rule	Dummy = 1 if country has a balanced budget rule	Fiscal Rules Dataset (2015), IMF
Expenditure Rule	Dummy = 1 if country has an expenditure rule	Fiscal Rules Dataset (2015), IMF
Revenue Rule	Dummy = 1 if country has a revenue rule	Fiscal Rules Dataset (2015), IMF
Debt Rule	Dummy = 1 if country has a debt rule	Fiscal Rules Dataset (2015), IMF
Left Government	Dummy = 1 if left-leaning government	World Bank Political Database
Election Year	Dummy = 1 if election year	World Bank Political Database
Democracy	Dummy = 1 if democratic	World Bank Political Database
Parliamentary System	Dummy = 1 if parliamentary system	World Bank Political Database
Log Revenue	Revenue excluding grants (% of GDP)	World Bank, WDI
Log Population	Total population (Age 65+ plus Age <14)	World Bank, WDI
Log Unemployment Rate	Percentage of labor force not working	World Bank, WDI
Log Output Gap	Output gap (HP filter)	Author's calculation
Log GDP	Real GDP in constant 2015 US$	World Bank, WDI
Log Total Debt	General government debt to GDP ratio	IMF WEO (2021)
Log Inflation	Consumer Price Index	IMF WEO (2021)
Log Per Capita GDP	GDP per capita in constant 2015 US$	World Bank, WDI
Log Trade Openness	Exports + imports as % of GDP	IMF WEO (2021)
Global Financial Crisis	Dummy = 1 during global crisis years	Caselli and Reynaud (2020)
Control of Corruption	Governance score (range: -2.5 to 2.5)	Worldwide Governance Indicators
Government Effectiveness	Governance indicator (range: -2.5 to 2.5)	Worldwide Governance Indicators
Political Stability	Governance indicator (range: -2.5 to 2.5)	Worldwide Governance Indicators
Regulatory Quality	Governance indicator (range: -2.5 to 2.5)	Worldwide Governance Indicators
Rule of Law	Governance indicator (range: -2.5 to 2.5)	Worldwide Governance Indicators
Voice and Accountability	Governance indicator (range: -2.5 to 2.5)	Worldwide Governance Indicators
Economic Union	Dummy = 1 if part of an economic union	Caselli and Reynaud (2020)
IMF Program	Dummy = 1 if under IMF fund program	Polain and Reynaud (2017)

Note: This table presents the variable descriptions for the spending categories, fiscal rule types, and control variables related to the economic, demographic, and governance indicators used in the empirical analysis.

Table 2.6: List of the Countries

Advanced Countries	**(EMDEs)**
Australia	Argentina
Austria	Armenia
Belgium	Barbados
Canada	Botswana
Cyprus	Brazil
Czech Republic	Bulgaria
Denmark	Chile
Estonia	Colombia
Finland	Costa Rica
France	Croatia
Germany	Ecuador
Greece	Equatorial Guinea
Hong Kong SAR, China	Hungary
Iceland	Georgia
Ireland	India
Israel	Indonesia
Italy	Jamaica
Japan	Malaysia
Latvia	Malta
Lithuania	Mauritius
Luxembourg	Mexico
Netherlands	Namibia
New Zealand	Pakistan
Norway	Panama
Portugal	Paraguay
Singapore	Peru
Slovak Republic	Poland
Slovenia	Romania
Spain	Russian Federation
Sweden	Serbia
Switzerland	Sri Lanka
United Kingdom	Uruguay
United States	St. Kitts and Nevis

Note: This table lists the advanced and emerging and developing countries included in the analysis.

2.2 Fiscal Rule Index

Table 2.7: Construction of the Fiscal Rules Index

Component	Definition	Dataset Variables	Coding	Normalization	Aggregation
Flexibility	Captures the ability of fiscal rules to allow temporary deviations under exceptional circumstances	ER escape clause	Binary: 1 = escape clause present, 0 otherwise	Already bounded in [0,1]	Used directly
Legal Basis	Reflects the statutory strength of fiscal rules (credibility and binding nature)	FR legal base	Ordinal scale (e.g., 1 = political commitment, ..., 4 = constitutional)	Min–max normalization to [0,1]	Used directly
Coverage	Measures the scope of fiscal rules across levels of government	FR (cover), ER(cov), BBR(cov), DR(cov)	Ordinal (e.g., central vs general government)	Min–max normalization to [0,1]	Used directly or averaged across rule types
Enforcement	Captures the existence of mechanisms ensuring compliance with fiscal rules	Formal enforcement procedure; Monitoring of compliance outside government (ER, RR, BBR, DR)	Binary indicators (0/1)	Averaged to [0,1]	Mean of enforcement indicators
Supporting Procedures	Captures institutional arrangements supporting implementation of fiscal rules	Multi-year expenditure ceilings (aggregate, ministry, line item); Independent body (budget assumptions, monitoring); Fiscal responsibility law (FRL)	Binary indicators (0/1)	Averaged to [0,1]	Mean of all supporting variables
Overall Index	Composite measure of fiscal rule strength and design	All above components	—	Each component $\in [0,1]$	Sum $\rightarrow$ range [0,5]

2.3 Generalized Method of Moments

The data-generating process of the model in Section 4 is specified as:

$$y_{it} = \alpha y_{i,t-1} + \boldsymbol{\beta} x_{it} + \varepsilon_{it} \tag{1}$$

where

$$\varepsilon_{it} = \mu_i + v_{it}$$

$$E(\mu_i) = E(v_{it}) = E(\mu_i v_{it}) = 0$$

Here, μ_i represents unobserved individual fixed effects, and v_{it} captures idiosyncratic shocks.

Differencing the equation to eliminate fixed effects, we get:

$$\Delta y_{it} = (\alpha - 1) y_{i,t-1} + \boldsymbol{\beta} x_{it} + \Delta \varepsilon_{it}$$

The issue of applying OLS to equation (1) is that $y_{i,t-1}$ is correlated with the fixed effects in the error term, which results in dynamic panel bias (Nickell, 1981). The correlation between the error term and the regressor violates the assumptions necessary for consistency of OLS.

Nickell bias might inflate the coefficient estimates for lagged spending by attributing predictive power to it which is attributed to the country's fixed effect. If

T is large enough, then Nickell bias and endogeneity problems disappear. However, we have unbalanced panel data, so we transformed the data into log differences (to resolve stationarity issues), which results in loss of N degrees of freedom.

Applying fixed effects also does not eliminate the Nickell bias problem. Under fixed effect transformation, the lagged dependent variable turns to:

$$\tilde{y}_{i,t-1} = y_{i,t-1} - \frac{1}{(T-1)}(y_{i2} + \cdots + y_{iT})$$

while the error term becomes:

$$\tilde{v}_{it} = v_{it} - \frac{1}{(T-1)}(v_{i2} + \cdots + v_{iT})$$

The $y_{i,t-1}$ terms in $\tilde{y}_{i,t-1}$ negatively correlate with $-\frac{1}{(T-1)}v_{i,t-1}$ in $\tilde{v}_{it}$, and both y_{it} and v_{it} also move together. So the error term and regressor are still correlated after transformation.

The endogeneity cannot be resolved by instrumenting $\tilde{y}_{i,t-1}$ with lags of the dependent variable $y_{i,t-1}$ because they are too embedded in the transformed error $\tilde{v}_{it}$. The problem would disappear if T is large, as the terms $-\frac{1}{(T-1)}y_{it}$ and $-\frac{1}{(T-1)}y_{i,t-1}$ would become insignificant. Judson and Owen (1999) reported a bias equal to 20% in the coefficient with $T = 30$. Kiviet (1995) suggests that dynamic panel bias can be handled using LSDV and correcting results for bias. However, this approach is well suited for balanced panels and does not handle endogeneity problems arising from other regressors.

To address endogeneity and dynamic panel bias, two transformations are commonly used. The first is named as Difference GMM — it is the first difference transformation. First difference transformation is effected by $I_N \otimes M_L$, where I_N is the identity matrix of order N and M is a diagonal matrix of -1s with a subdiagonal of 1s on the right. Applying the transformation to equation (1) results in:

$$\Delta y_{it} = \alpha \Delta y_{i,t-1} + \beta \Delta x_{it} + \Delta v_{it} \tag{2}$$

In the difference transformation, fixed effects are removed. The lagged dependent variable is still potentially endogenous, as the $y_{i,t-1}$ term in $\Delta y_{it} = y_{it} - y_{i,t-1}$ is correlated with $\Delta v_{it} = v_{it} - v_{i,t-1}$. Similarly, predetermined variables in X, which are not strictly endogenous, become endogenous as they relate to $v_{i,t-1}$.

Opposite to mean deviation, longer lags of regressors are orthogonal to the error term and used as instruments. The problem with first differencing is magnified in unbalanced panels, which leads to short sample bias.

The second type of transformation is called orthogonal deviations or forward orthogonal deviations, proposed by Arellano and Bover (1995). Instead of subtracting the previous observation from the contemporaneous one, it subtracts the mean of all future available observations of the variable. This technique minimizes data loss. Lagged observations do not enter the formula and can still be used as instruments.

For instance, if the variable is w, the transformation is:

$$w_{i,t+1} \equiv c_{it} \left(w_{it} - \frac{1}{T_{it}} \sum_{s>t} w_{is} \right)$$

The sum is taken over all future available observations of variable w, where T_{it} is the number of observations. The scale factor c_{it} is:

$$c_{it} = \sqrt{\frac{T_{it}}{T_{it}+1}}$$

In the balanced panel setup, the transformation is defined as $I_N \otimes M_L$, where M_L is:

$$M_L = \begin{bmatrix} \sqrt{\frac{T-1}{T}} & -\frac{1}{\sqrt{T(T-1)}} & -\frac{1}{\sqrt{T(T-1)}} & \cdots \\ & \sqrt{\frac{T-2}{T-1}} & -\frac{1}{\sqrt{(T-1)(T-2)}} & \cdots \\ & & \sqrt{\frac{T-3}{T-2}} & \cdots \\ & & & \ddots \end{bmatrix}$$

The rows of M_L are orthogonal to each other. If w_{it} is independently distributed before the transformation, this property will persist after transformation. If w_{it} is independent and identically distributed, it will remain so afterward. That is, $M_L M_L^{-1} = I$.

However, in the case of first differencing, the successive error terms tend to correlate even if they were uncorrelated before transformation. For example:

$$\Delta v_{it} = v_{it} - v_{i,t-1}, \quad \Delta v_{i,t-1} = v_{i,t-1} - v_{i,t-2}$$

Arellano and Bover (1995) also suggest that in a balanced panel, two transformations of full row rank will yield the same estimator. However, in the unbalanced panel case, first differencing leads to increased gaps in the data, reducing efficiency.

Appendix B

Appendix to Chapter 3

3.1 Debt to GDP Projections under Fixed and Time Varying Parameters Models-(AEs) and (EMDEs)

Table 3.1: Projected Debt Summary (AEs) Over a 5-Year Horizon (Fixed Parameter Model)

Country	Year	Min	1st Quartile	Median	Mean	3rd Quartile	Max
UK	1	95.87	105.57	107.97	108.09	110.41	123.73
	2	98.81	110.97	113.80	113.92	116.72	130.00
	3	97.47	108.29	111.18	111.30	114.12	129.45
	4	94.03	109.49	112.77	112.92	116.16	133.78
	5	94.02	109.85	113.34	113.56	117.12	137.56
Canada	1	90.87	104.86	108.50	108.75	112.40	131.78
	2	85.86	105.82	110.55	110.90	115.62	144.85
	3	82.95	106.72	112.39	112.83	118.40	152.35
	4	86.79	107.64	114.22	114.64	121.05	162.19
	5	82.60	108.50	115.50	116.20	123.30	162.90
Japan	1	220.2	249.3	257.1	257.8	265.5	314.3
	2	205.0	251.6	262.1	263.0	273.3	345.1
	3	198.4	255.0	268.0	268.9	281.8	377.7
	4	200.9	257.9	273.4	274.4	289.3	378.0
	5	205.3	261.6	278.4	280.2	296.8	418.9

Note: This table presents the projected government debt-to-GDP ratios over a 5-year horizon for the UK, Canada, and Japan using a fixed-parameter model. For each year, summary statistics from the simulated distribution are shown, including the minimum, maximum, mean, median, and interquartile range (1st and 3rd quartiles), capturing the uncertainty in the projections.

Table 3.2: Projected Debt Summary (AEs) Over a 5-Year Horizon (Time-Varying Parameter Model)

Country	Year	Min	1st Quartile	Median	Mean	3rd Quartile	Max
UK	1	93.35	99.72	101.63	101.83	103.93	110.50
	2	87.15	96.72	100.24	100.29	103.73	119.04
	3	80.37	93.40	97.41	97.76	101.72	131.53
	4	71.79	89.22	94.46	94.79	99.67	132.33
	5	55.85	84.42	91.30	91.96	99.22	139.93
Canada	1	90.54	102.55	106.08	106.43	109.91	137.12
	2	84.77	102.16	107.27	107.88	113.03	147.30
	3	77.90	101.60	108.00	108.60	114.70	155.90
	4	74.20	100.50	108.20	109.00	116.60	178.10
	5	70.34	99.61	108.30	109.36	117.80	185.04
Japan	1	219.9	241.2	249.3	249.9	257.9	286.0
	2	199.2	238.0	250.2	250.8	262.7	325.6
	3	146.8	233.0	248.9	249.1	264.9	349.3
	4	14.92	226.58	246.68	247.99	268.50	351.03
	5	67.5	216.7	247.9	249.6	280.3	365.7

Note: This table presents the projected government debt-to-GDP ratios over a 5-year horizon for the UK, Canada, and Japan using a time-varying parameter model. For each year, summary statistics from the simulated distribution are shown, including the minimum, maximum, mean, median, and interquartile range (1st and 3rd quartiles), capturing the uncertainty associated with the projections.

Table 3.3: Projected Debt Summary (EMDEs) Over a 5-Year Horizon (Fixed Parameter Model)

Country	Year	Min	1st Quartile	Median	Mean	3rd Quartile	Max
Brazil	1	83.72	87.96	88.65	88.65	89.34	92.68
	2	86.30	91.86	93.14	93.16	94.48	100.81
	3	74.63	86.95	89.57	89.64	92.30	104.64
	4	54.56	66.80	69.30	69.35	71.85	83.92
	5	22.80	35.36	38.51	38.58	41.70	56.13
Argentina	1	58.45	74.14	77.79	77.89	81.46	100.93
	2	69.52	96.69	102.70	103.05	109.07	138.58
	3	96.15	123.17	135.72	132.95	141.72	154.59
	4	70.76	98.06	101.08	101.99	114.55	125.24
	5	26.42	74.41	86.36	87.66	99.64	207.31
Pakistan	1	66.63	73.88	75.38	75.39	76.90	84.75
	2	55.33	69.80	72.42	72.42	75.05	87.40
	3	37.59	60.92	65.56	65.53	70.15	91.00
	4	22.92	55.61	63.78	64.39	72.46	124.66
	5	14.98	54.11	65.91	67.45	78.86	157.50

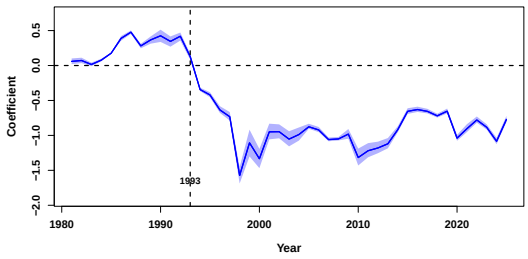
Note: This table presents the projected government debt-to-GDP ratios over a 5-year horizon for Brazil, Argentina, and Pakistan using a fixed-parameter model. For each year, summary statistics from the simulated distribution are shown, including the minimum, maximum, mean, median, and interquartile range (1st and 3rd quartiles), capturing the uncertainty in the projections.

Table 3.4: Projected Debt Summary (EMDEs) Over a 5-Year Horizon (Time-Varying Parameter Model)

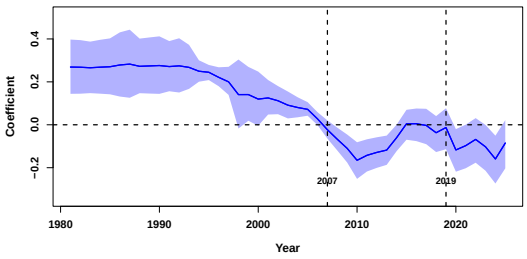
Country	**Year**	**Min**	**1st Quartile**	**Median**	**Mean**	**3rd Quartile**	**Max**
Brazil	1	77.37	84.21	85.97	85.06	87.76	100.29
	2	66.05	83.44	86.63	86.67	89.76	116.36
	3	64.50	86.80	91.11	91.30	95.74	125.27
	4	10.21	79.57	87.80	87.97	95.89	182.07
	5	158.19	55.46	82.03	78.14	86.87	253.13
Pakistan	1	63.87	70.59	72.08	72.09	73.55	80.63
	2	43.93	67.64	73.67	74.36	80.18	128.12
	3	36.68	58.26	68.49	93.08	95.08	166.74
	4	29.32	52.01	65.31	100.30	112.90	179.90
	5	22.71	48.50	66.90	82.40	93.80	160.50
Argentina	1	31.43	67.40	74.60	74.88	81.61	133.04
	2	27.60	58.54	78.88	65.49	71.78	112.79
	3	35.01	71.86	81.51	83.88	93.29	173.15
	4	54.05	85.52	85.84	110.87	122.19	201.70
	5	68.68	65.94	78.56	85.55	94.17	119.52

Note: This table presents the projected government debt-to-GDP ratios over a 5-year horizon for Brazil, Argentina, and Pakistan using a time-varying parameter (TVP) model. For each year, summary statistics from the simulated distribution are shown, including the minimum, maximum, mean, median, and interquartile range (1st and 3rd quartiles), capturing the uncertainty around the forecast paths.

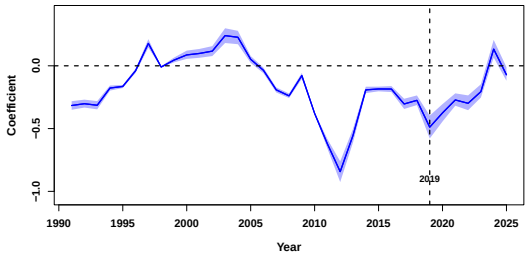
3.2 Time Varying Fiscal Reaction Function (TVP-FRF) Figures



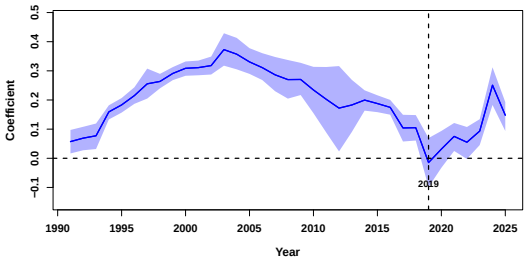
(a) Debt-to-GDP Coefficient, Japan



(b) Threshold Debt Coefficient, Japan



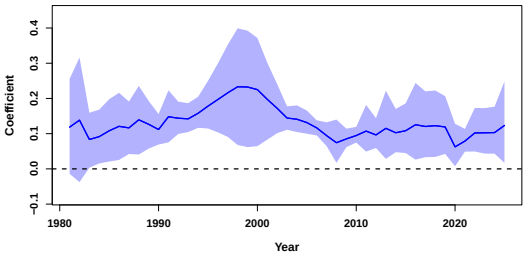
(c) Debt-to-GDP Coefficient, Pakistan



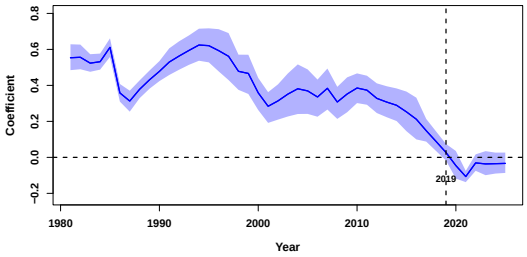
(d) Threshold Debt Coefficient, Pakistan

Figure B.1: Time-Varying Fiscal Response Estimates: Japan and Pakistan

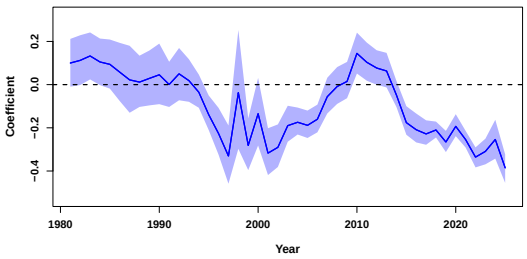
Note: The figures present time-varying parameter estimates from fiscal reaction functions. The solid line represents the posterior median of the fiscal response to the respective debt metric, while the shaded areas are 90% confidence bands. All models are estimated using Bayesian methods with time-varying coefficients. Sample periods differ across countries and models. Japan's estimates are based on Quaternary data , while Pakistan's estimates are based on annual data for lagged debt and threshold debt.



(a) Primary Balance Coefficient, UK



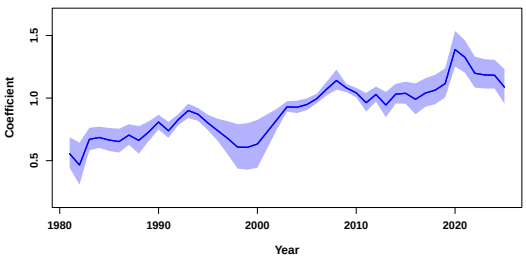
(b) Primary Balance Coefficient, Canada



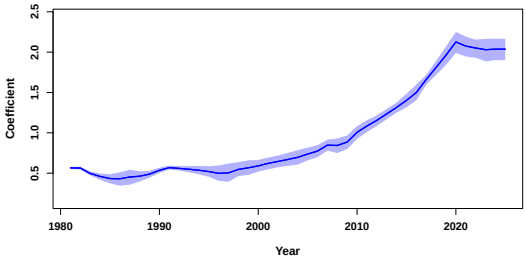
(c) Primary Balance Coefficient, Japan

Figure B.2: Time-Varying Fiscal Response Estimates: Primary Balance Coefficients for UK, Canada, and Japan

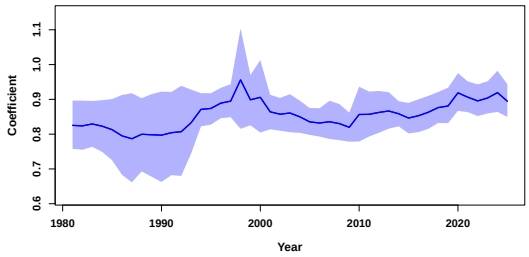
Note: The panels depict time-varying parameter estimates of fiscal responses to lagged primary balance for (AEs). Solid lines show posterior medians of the primary balance coefficient, with shaded areas indicating 90% credible intervals. All estimates derive from time-varying parameter models.



(a) Output Gap Coefficient, UK



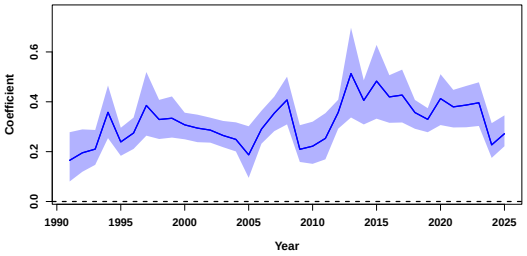
(b) Output Gap Coefficient, Canada



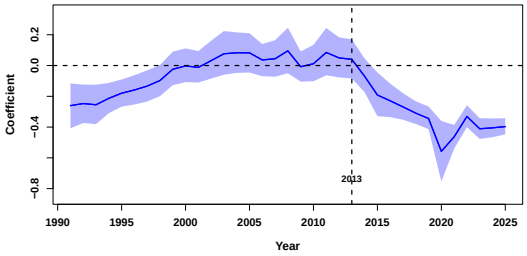
(c) Output Gap Coefficient, Japan

Figure B.3: Time-Varying Fiscal Response Estimates: Output Gap Coefficients for UK, Canada, and Japan

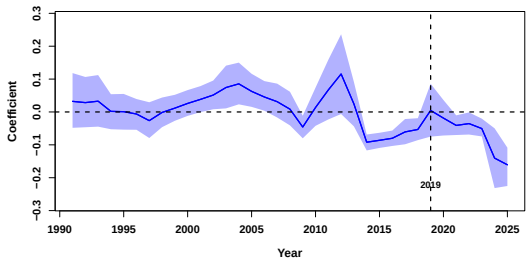
Note: The figures show time-varying estimates of fiscal responses to the output gap for (AEs). Solid lines represent posterior medians of the output gap coefficients, while shaded bands denote 90% credible intervals. All models are estimated using Bayesian techniques with time-varying parameters. Country sample periods vary according to data availability.



(a) Primary Balance Coefficient, Argentina



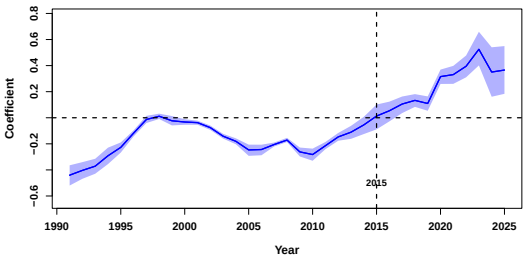
(b) Primary Balance Coefficient, Brazil



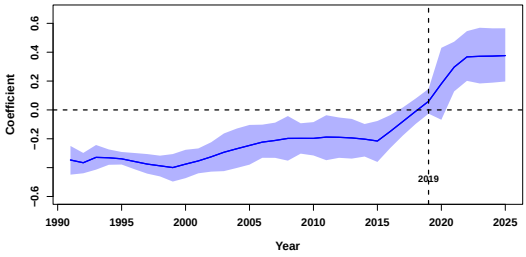
(c) Primary Balance Coefficient, Pakistan

Figure B.4: Time-Varying Fiscal Response Estimates: Primary Balance Coefficients for Argentina, Brazil, and Pakistan

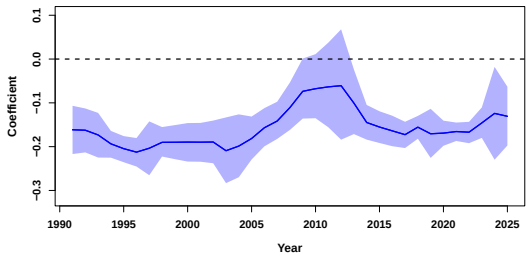
Note: The panels present time-varying estimates of fiscal responses to lagged primary balance for emerging and developing economies (EMDEs). Solid Lines denote posterior medians, while shaded regions indicate 90% credible intervals. All models are estimated with time-varying parameters.



(a) Output Gap Coefficient, Argentina



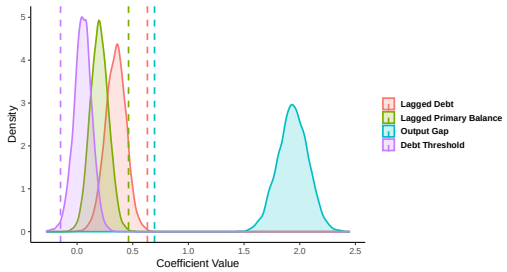
(b) Output Gap Coefficient, Brazil



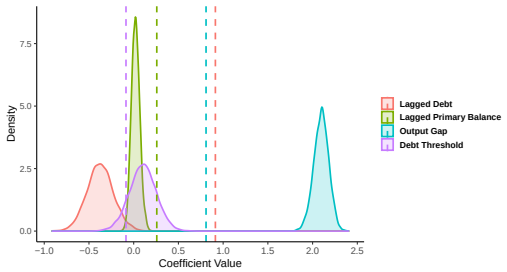
(c) Output Gap Coefficient, Pakistan

Figure B.5: Time-Varying Fiscal Response Estimates: Output Gap Coefficients for Argentina, Brazil, and Pakistan

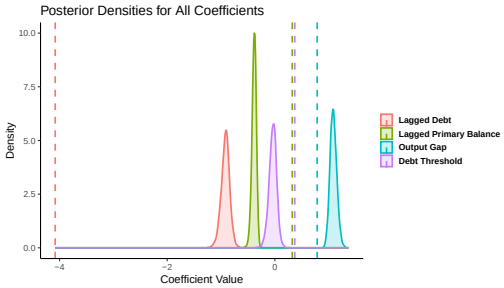
Note: The panels show time-varying parameter estimates of fiscal responses to the output gap for emerging and developing economies (EMDEs). Solid lines indicate posterior medians of the output gap coefficients, while shaded areas represent 90% credible intervals. All estimates are obtained from time-varying parameter models.



(a) United Kingdom



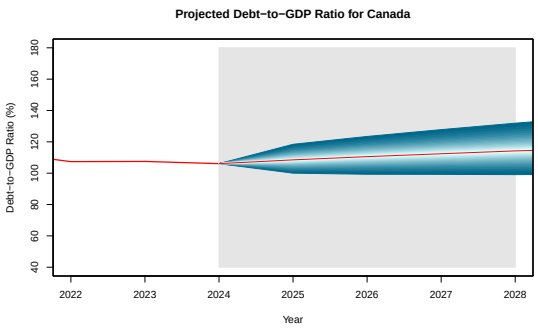
(b) Canada



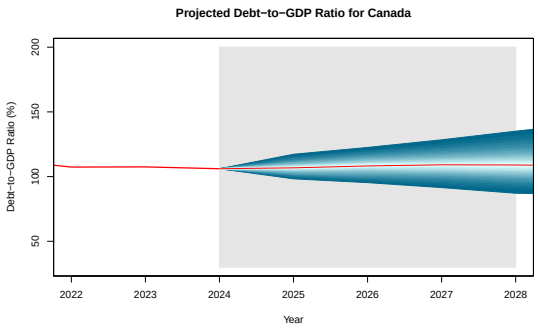
(c) Japan

Figure B.6: Density Plots for (AEs): United Kingdom, Canada, and Japan

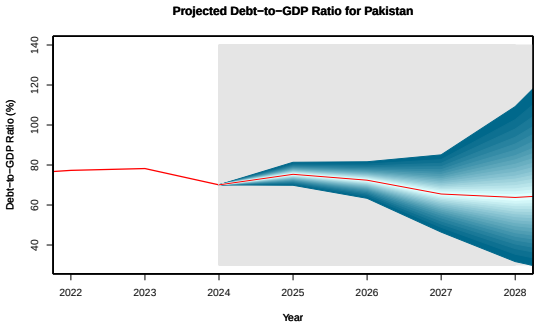
Note: The panels display kernel density estimates for four fiscal coefficients in the time-varying fiscal reaction function: Lagged Debt, Lagged Primary Balance, Output Gap, and Debt Threshold. Vertical lines represent benchmark coefficients from the fixed-parameter fiscal rule. Estimates are based on time varying fiscal reaction function models.



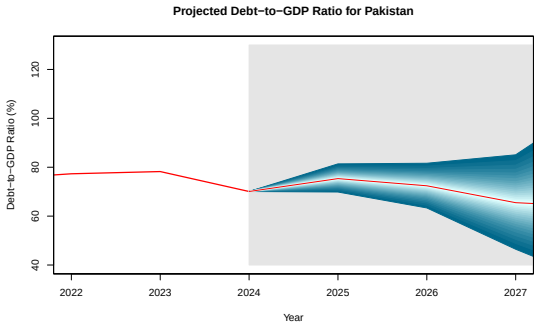
(a) Fixed Parameters – Canada



(b) Time-Varying Parameters – Canada



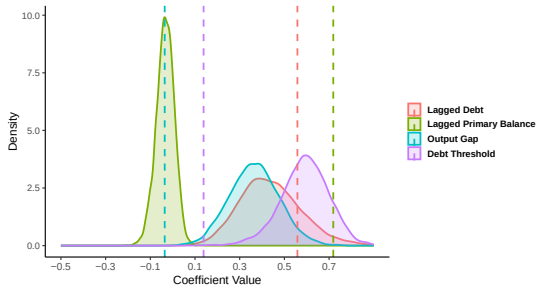
(c) Fixed Parameters – Pakistan



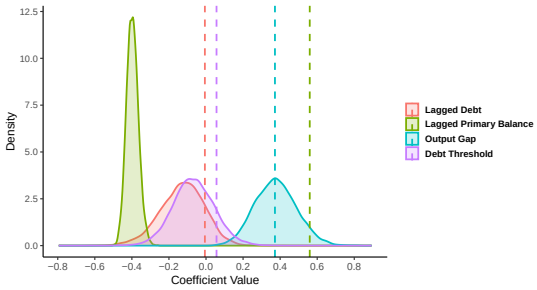
(d) Time-Varying Parameters – Pakistan

Note: Each panel presents fan-chart projections of the public debt-to-GDP ratio. Fixed parameter models assume constant fiscal behavior and macroeconomic conditions, while time-varying models incorporate evolving fiscal responses and economic dynamics.

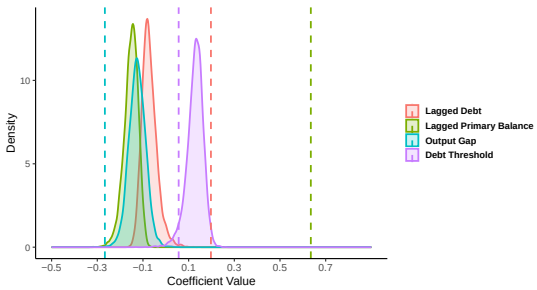
Figure B.7: Fan charts of debt projections under fixed and time-varying parameters



(a) Argentina



(b) Brazil



(c) Pakistan

Figure B.8: Density Plots for Emerging and Developing Economies: Argentina, Brazil, and Pakistan

Note: The panels display kernel density estimates for four fiscal coefficients in the time-varying fiscal reaction function: Lagged Debt, Lagged Primary Balance, Output Gap, and Debt Threshold. Vertical lines represent benchmark coefficients from the fixed-parameter fiscal rule. All estimates are from Bayesian models; country-specific sample periods vary.

3.3 Primary Balance Forecasting Framework

To project the medium-term path of the primary balance, we employed a Time-Varying Parameter Fiscal Reaction Function (TVP-FRF) framework. This model captures evolving fiscal behavior by allowing response coefficients to change over time. The primary balance is modeled as:

$$pb_t = \phi_{1,t} \cdot debt_{t-1} + \phi_{2,t} \cdot pb_{t-1} + \phi_{3,t} \cdot og_{t-1} + \phi_{4,t} \cdot imf_{t-1} + \phi_{5,t} \cdot ey_{t-1} + \phi_{6,t} \cdot tdebt_{t-1} + \varepsilon_t \tag{B.1}$$

where:

- $\phi_{j,t}$ are time-varying coefficients drawn from the posterior,
- *debt* is lagged debt-to-GDP,
- *pb* is the lagged primary balance,
- *og* is the output gap,
- imf and ey are control dummies (IMF program and election year),
- *tdebt* indicates whether debt exceeds a risk threshold (e.g. 60% of GDP),
- $\varepsilon_t \sim \mathcal{N}(0, R)$ is the error term.

We conducted stochastic simulations over a five-year horizon, drawing from the posterior distribution of the time-varying coefficients and shock variances

3.4 Standard DSA Methodology with Fixed Parameters

This Stochastic Debt Sustainability Analysis (SDSA), based on the frameworks of Celasun et al. (2006) and Medeiros (2012), follows these steps:

1. Estimate a fiscal reaction function (FRF) and a VAR model to obtain reduced-form coefficients and the distributions of shocks to fiscal and macroeconomic variables.
2. Draw shocks from the estimated distribution and use them in the VAR to forecast macroeconomic variables. Feed these forecasts into the FRF to simulate the primary balance.
3. Use the simulated primary balance to project the debt-to-GDP ratio using the debt accumulation identity.

4. If applicable, repeat steps 2 and 3 to extend the forecast for horizons $h = 2, 3, \ldots, H$.

5. Repeat the entire process R times to generate a distribution of future paths for the primary balance and debt ratios, where R is a sufficiently large number (e.g., 1,000 or 10,000).

3.5 Variable Description

Table 3.5: Variable Description for the VAR Model

Variable	**Description**
Real Gross Domestic Product (GDP)	Gross Domestic Product at market prices; total economic output measured in real terms.
Long-term Interest Rate	10-year government bond yield, used as a proxy for long-term borrowing cost.
Short-term Interest Rate	Three-month money market rate (MMR); Treasury bill used where MMR is unavailable.
Inflation	GDP deflator based on market prices; represents overall price level changes.

Note: This table shows the variables used in the VAR analysis for both advanced and emerging and developing countries samples.

Appendix C

Appendix to Chapter 4

4.1 Tables

Table 4.1: Test for Weak Exogeneity at the 5% Significance Level

Country / Region	**F test**	**F crit**	**ys**	**cpis**	**eqs**	**rs**	**lrs**	**exps**	**revs**
China	F(3,73)	2.73	2.36	1.62				1.26	0.60
Indonesia	F(4,70)	2.50	0.76	2.30	1.46	2.41	0.94	0.82	1.11
Malaysia	F(4,68)	2.51	0.70	1.88	2.44	2.29	1.54	0.47	1.11
Philippines	F(4,68)	2.51	0.14	0.87	1.66	1.09	0.70	1.79	0.30
Singapore	F(4,68)	2.51	0.14	0.80	0.66	0.47	1.24	1.51	0.87
Thailand	F(4,68)	2.51	1.55	1.04	0.63	0.62	1.41	1.59	3.25
Asia and Pacific	F(4,68)	2.51	1.06	1.11	0.73	1.17	2.06	0.45	2.02
ASEAN	F(4,68)	2.51	1.20	1.71	0.69	1.54	1.90	1.13	1.79
Euro Area	F(5,67)	2.35	1.28	2.04	0.32	0.53	0.90	0.91	0.34
South America	F(2,72)	3.12	1.81	0.15	1.25	0.75	0.24	3.72	0.62

Note: This table reports F-statistics from the weak exogeneity tests for each country at the 5% significance level. The null hypothesis is that the foreign variables are weakly exogenous. If the F-statistic for a given variable exceeds the critical value (Fcrit), the null is rejected and weak exogeneity does not hold for that variable.

4.1.1 Weight Matrix

Table 4.2: Weight Matrix (based on Fixed Weights)

Country	**Asia/Pacific**	**China**	**EU**	**Indo.**	**Malay.**	**Phil.**	**S. America**	**Sing.**	**Thai.**
Asia/Pacific	0	0.386	0.238	0.291	0.254	0.307	0.188	0.252	0.221
China	0.460	0	0.509	0.358	0.273	0.278	0.497	0.230	0.209
EU	0.177	0.240	0	0.072	0.092	0.083	0.225	0.123	0.398
Indo.	0.116	0.050	0.021	0	0.069	0.088	0.014	0.093	0.038
Malay.	0.049	0.070	0.030	0.072	0	0.058	0.030	0.189	0.051
Phil.	0.021	0.030	0.011	0.036	0.022	0	0.009	0.033	0.022
S. America	0.067	0.138	0.129	0.030	0.028	0.025	0	0.025	0.026
Sing.	0.057	0.039	0.035	0.089	0.195	0.086	0.015	0	0.035
Thai.	0.052	0.048	0.026	0.051	0.067	0.076	0.022	0.054	0

Note: This table reports the trade of each country with the rest of the countries in the sample.

4.1.2 Unit Root Test

Table 4.3: Unit Root Tests for the Domestic Variables at the 5% Significance Level

Domestic Variables	Crit. Value	Asia/Pacific	China	EU	Indo.	Malay.	Phil.	S. America	Sing.	Thai.
y (trend)	-3.45	-1.2381	-0.1678	-3.2638	-0.8139	-2.8133	-2.7892	-1.2938	-1.6050	-2.2845
y (no trend)	-2.89	-1.4623	-4.4411	-1.4670	-1.4370	-0.9130	-0.4849	-1.3797	-1.9889	-2.1385
Dy	-2.89	-9.4929	-6.4247	-8.5961	-6.9632	-7.0256	-8.0345	-7.3480	-7.2712	-7.3784
DDy	-2.89	-8.2914	-8.1431	-7.0981	-8.9178	-8.7301	-10.7770	-7.8423	-7.2136	-8.4820
cpi (trend)	-3.45	-1.7963	-3.7822	-3.1255	-5.8229	-6.5364	-4.9462	-3.2316	-3.4133	-5.3854
cpi (no trend)	-2.89	-1.8069	-3.7809	-2.9644	-4.5361	-6.5670	-4.9352	-2.4205	-3.3724	-5.3098
Dcpi	-2.89	-9.0420	-7.6227	-8.0228	-7.0030	-7.6175	-7.0988	-5.7391	-8.8665	-7.8264
DDcpi	-2.89	-10.1670	-8.1029	-7.7368	-9.7457	-9.2674	-8.5806	-7.7174	-8.2841	-9.5306
eq (trend)	-3.45	-2.1082	-3.8772	-3.4811		-1.3212	-1.4948	-1.0877	-2.4430	-2.7186
eq (no trend)	-2.89	-1.8551	-2.5951	-3.4354		-2.0451	-2.0640	0.0795	-2.6001	-2.6350
Deq	-2.89	-7.6092	-5.7172	-6.3257		-5.5191	-4.5197	-5.8670	-7.0437	-5.5789
DDeq	-2.89	-7.9905	-7.3651	-7.9201		-8.0367	-7.2328	-9.0275	-7.6361	-7.8498
reer (trend)	-3.45	-1.1220		-3.2919	-3.1935	-1.4421	-1.2426	-1.8016	-1.5456	-1.1169
reer (no trend)	-2.89	-1.9539		-2.5887	-3.8400	-1.9137	-1.5827	-1.7187	-1.5520	-2.3721
Dreer	-2.89	-5.5375		-6.0358	-4.8879	-6.2932	-5.6185	-6.2358	-5.1796	-7.6205
DDreer	-2.89	-10.5918		-8.7914	-9.0906	-9.2864	-7.6173	-7.1589	-7.8704	-7.8186
r (trend)	-3.45	-3.2980	-2.3384	-1.4389	-4.1880	-2.8949	-2.5570	-1.9205	-1.7342	-3.3386
r (no trend)	-2.89	-3.0570	-1.8947	-2.1555	-3.7346	-2.5865	-2.9281	-2.5680	-2.1644	-2.5156
Dr	-2.89	-6.0581	-5.2006	-4.0648	-6.0726	-4.7355	-4.6771	-4.7045	-6.1389	-3.8772
DDr	-2.89	-10.5475	-10.1266	-7.4204	-7.1148	-10.1637	-9.0742	-6.1672	-9.8032	-8.5978
lr (trend)	-3.45	-2.9490	-4.3946	-0.7988	-3.3330	-3.8389	-2.5186		-3.5728	-3.3784
lr (no trend)	-2.89	-3.0061	-3.3520	-1.7104	-2.0112	-2.3017	-3.1061		-3.2280	-1.7177
Dlr	-2.89	-4.5418	-6.3169	-5.4855	-7.1883	-5.8957	-5.6218		-8.2600	-5.8273
DDlr	-2.89	-8.3578	-10.9732	-8.4536	-7.9694	-7.8859	-7.4446		-8.0569	-7.3901
exp (trend)	-3.45	-2.1924	0.6745	-1.6669		-1.5326	-2.0442	-0.4915	-5.5323	0.6111
exp (no trend)	-2.89	-0.3412	-2.7878	0.4036		-0.7552	0.7838	-1.9119	0.0213	-3.9668
Dexp	-2.89	-10.3117	-1.9898	-4.3285		-4.4821	-14.3847	-4.2615	-9.7437	-2.9313
DDexp	-2.89	-8.8194	-8.9871	-11.6151		-6.5555	-9.5629	-8.1442	-8.6525	-10.3633
rev (trend)	-3.45	-4.1868	-0.6699	-2.2045	-1.5505	-2.3306	-2.3585	-2.4716	-4.6936	-1.9586
rev (no trend)	-2.89	-1.0738	-2.8076	0.0818	-1.4919	-1.2270	-0.7077	-0.6958	-0.2049	-2.7368
Drev	-2.89	-8.9577	-7.8930	-7.7847	-5.9067	-8.5538	-10.2081	-6.7825	-7.0790	-12.2466
DDrev	-2.89	-8.7799	-8.7409	-9.9324	-8.4776	-9.6164	-8.2196	-9.3555	-9.0509	-8.0159

Note: The null hypothesis is that the series has a unit root (non-stationary). If the ADF test statistic is less than the critical value, the null is rejected and the series is stationary. The gap in the China variable series indicates that the variable was not included in the analysis. Other gaps across countries reflect missing data in certain series

Table 4.4: Unit Root Tests for the Foreign Variables at the 5% Significance Level

Foreign Variables	Crit. Value	Asia/Pacific	China	EU	Indo.	Malay.	Phil.	S. America	Sing.	Thai.
ys (trend)	-3.45	-0.4447	-1.5633	-0.1634	-0.6496	-0.7683	-0.7644	-0.5821	-1.2493	-1.5617
ys (no trend)	-2.89	-3.7789	-1.4321	-3.5222	-3.1676	-2.9056	-2.8859	-3.6584	-2.6277	-1.9972
Dys	-2.89	-6.9737	-7.9525	-2.3945	-7.6413	-7.4224	-7.6415	-7.5676	-7.8513	-8.0762
DDys	-2.89	-7.5767	-7.7178	-7.8201	-7.6010	-7.3289	-7.5428	-7.5222	-7.7662	-7.5396
cpis (trend)	-3.45	-3.6994	-1.5476	-3.3400	-2.8081	-2.6561	-2.7160	-3.2494	-2.9810	-4.3633
cpis (no trend)	-2.89	-3.6222	-1.4649	-3.3783	-2.8351	-2.6512	-2.6515	-3.2739	-2.8859	-4.3534
Dcpis	-2.89	-8.1208	-9.1870	-8.8229	-8.8865	-8.4779	-9.1968	-8.4906	-9.3820	-8.2319
DDcpis	-2.89	-8.7251	-9.5914	-8.4088	-8.9669	-9.0562	-9.2564	-8.5449	-9.3522	-8.7026
eqs (trend)	-3.45	-3.1473	-1.6975	-2.4936	-3.2088	-3.2153	-3.2260	-3.7555	-3.2056	-3.4153
eqs (no trend)	-2.89	-2.8099	-2.0936	-2.4041	-2.4517	-2.5150	-2.4127	-2.5667	-2.6353	-2.5916
Deqs	-2.89	-5.4884	-7.2222	-5.4178	-5.8720	-6.1860	-6.1287	-5.5157	-6.0789	-6.1104
DDeqs	-2.89	-6.6926	-9.8599	-6.7174	-6.7694	-6.6390	-6.7607	-6.7452	-6.7295	-7.3228
reers (trend)	-3.45	-2.5034	-1.5800	-1.6277	-1.2674	-1.6477	-1.6128	-2.3320	-1.6458	-2.5266
reers (no trend)	-2.89	-3.5341	-2.8889	-2.0701	-2.1247	-2.8200	-2.9421	-3.3583	-2.9772	-3.3590
Dreers	-2.89	-4.6340	-5.1335	-2.9122	-6.1669	-5.2390	-5.1806	-5.9712	-6.5090	-5.8867
DDreers	-2.89	-9.1410	-7.6562	-11.2994	-7.5395	-8.1295	-8.0500	-8.0320	-8.2347	-8.3550
rs (trend)	-3.45	-3.0389	-3.9032	-4.0829	-4.4796	-4.6532	-4.2565	-3.2615	-3.8352	-2.5393
rs (no trend)	-2.89	-2.7345	-2.4775	-2.3287	-2.3791	-2.9073	-2.9897	-2.3349	-3.0675	-2.5015
Drs	-2.89	-4.6645	-4.7034	-5.2389	-4.1333	-4.7407	-4.5790	-4.5836	-4.5770	-4.4189
DDrs	-2.89	-7.7891	-8.1355	-8.3849	-8.6956	-8.1181	-7.9043	-9.3040	-7.6774	-7.4811
lrs (trend)	-3.45	-3.5812	-2.3412	-3.7902	-3.6158	-3.5056	-3.5189	-3.2855	-3.3995	-2.0553
lrs (no trend)	-2.89	-1.8150	-2.4283	-2.5287	-2.4783	-2.2852	-2.2129	-2.1182	-2.2050	-2.0174
Dlrs	-2.89	-7.1405	-6.5682	-6.8969	-6.8803	-7.4011	-7.4030	-6.6316	-7.1702	-6.4988
DDlrs	-2.89	-7.7905	-8.3077	-7.5664	-7.8890	-8.6011	-8.5102	-11.1589	-8.2068	-7.5180
exps (trend)	-3.45	0.5544	-1.4411	0.6560	0.0258	-0.4328	-0.1363	0.3000	-0.6107	-0.9916
exps (no trend)	-2.89	-2.4933	-0.6225	-3.4534	-2.7463	-1.9154	-2.5671	-3.3897	-2.4294	-1.8185
Dexps	-2.89	-2.9511	-9.7713	-4.7248	-6.6590	-8.2278	-7.1572	-3.2478	-4.1902	-4.7945
DDexps	-2.89	-7.8419	-8.4917	-7.9834	-8.0968	-8.6027	-8.2975	-7.9330	-7.6784	-7.2521
revs (trend)	-3.45	-0.9357	-3.1790	-1.3227	-1.7160	-1.9958	-1.8274	-1.2587	-1.6961	-2.1015
revs (no trend)	-2.89	-2.3844	-0.8827	-2.2501	-1.7294	-1.3031	-1.6345	-2.3620	-1.8269	-1.4161
Drevs	-2.89	-7.0770	-8.5012	-7.3882	-8.0818	-8.5054	-8.1944	-7.5697	-7.7271	-7.9423
DDrevs	-2.89	-8.1823	-8.7099	-7.6285	-7.3239	-7.8348	-7.3428	-7.3240	-8.6472	-8.0900

Note: The null hypothesis is that the series has a unit root (non-stationary). If the ADF test statistic is less than the critical value, the null is rejected and the series is stationary.

4.1.3 Serial Correlation Test of the VECMX* Residuals

Table 4.5: F-Statistics for the Serial Correlation Test of the VECMX* Residuals

Country / Region	F Crit	y	cpi	eq	reer	r	lr	exp	rev
Asia/Pacific	F(4,59)	0.1747	0.6397	1.4971	0.7208	3.3910	1.1751	2.7904	1.6783
China	F(4,70)	1.2103	2.5846	0.7667		0.3296	0.3673	3.5629	0.7608
EU	F(4,58)	2.9544	1.3398	1.9023	2.4712	0.7431	2.1925	0.7381	1.9914
Indo.	F(4,61)	0.1096	2.0653		1.8628	3.9928	0.5705		2.2408
Malay.	F(4,59)	1.1631	0.8016	0.9165	1.5171	1.4499	1.5611	2.0527	2.1906
Phil.	F(4,66)	1.0235	1.2225	0.3178	0.7141	0.2772	0.6967	1.4692	2.0150
S. America	F(4,76)	0.4786	0.9213	0.4725	1.6435	2.6572		0.9092	0.9702
Sing.	F(4,74)	1.0174	1.0114	2.9355	1.5708	1.0101	0.9231	1.4578	1.2302
Thai.	F(4,59)	0.9848	1.6680	0.6661	4.7959	0.1096	1.8952	2.7241	0.2718

Note: The null hypothesis is that the there is no serial correlation in the residual of the model up to lag four.

4.1.4 Structural Stability Tests

Table 4.6: Structural Stability Tests: Statistics

Variables	**y**	**cpi**	**eq**	**reer**	**r**	**lr**	**exp**	**rev**
PK sup								
Asia/Pacific	0.6661	0.8053	0.6493	0.4888	0.4857	0.7516	0.3866	0.4583
China	0.9274	0.4734	0.5400		0.4889	0.7218	0.6067	0.6314
EU	0.4709	0.5112	0.3825	0.4381	0.4719	0.3439	0.4024	0.7558
Indo.	0.4860	0.2491		0.4845	0.3781	0.9955		0.4450
Malay.	0.4377	0.3707	0.4060	0.5233	0.3977	0.3648	0.4091	0.3319
Phil.	0.2056	0.4906	0.0257	0.7530	0.6855	0.8576	0.4157	0.4885
S. America	0.8621	0.5614	1.1042	0.8512	0.5570		0.8475	0.9292
Sing.	0.5901	0.7111	0.4536	0.6543	0.7264	0.5158	0.4503	1.1392
Thai.	0.6170	0.8550	1.0083	0.5426	0.4505	0.4634	0.8684	0.8302
PK msq								
Asia/Pacific	0.0960	0.1823	0.0659	0.0361	0.0608	0.1708	0.0333	0.0485
China	0.2150	0.0414	0.0582		0.0416	0.0742	0.0730	0.1108
EU	0.0465	0.0472	0.0210	0.0334	0.0302	0.0152	0.0372	0.0933
Indo.	0.0406	0.0113		0.0343	0.0179	0.1498		0.0237
Malay.	0.0524	0.0198	0.0259	0.0405	0.0325	0.0257	0.0235	0.0207
Phil.	0.1073	0.0427	0.1203	0.0895	0.0216	0.1560	0.0175	0.0516
S. America	0.1929	0.0491	0.4272	0.1729	0.0705		0.1418	0.1213
Sing.	0.0925	0.0702	0.0385	0.0604	0.1545	0.0412	0.0340	0.0650
Thai.	0.0755	0.2360	0.1507	0.0532	0.0397	0.0525	0.1575	0.1578

Note: The null hypothesis is that the parameters of the model are structurally stable over time.

4.2 SGIRFs ASEAN-5 response to Expenditure Shock in China

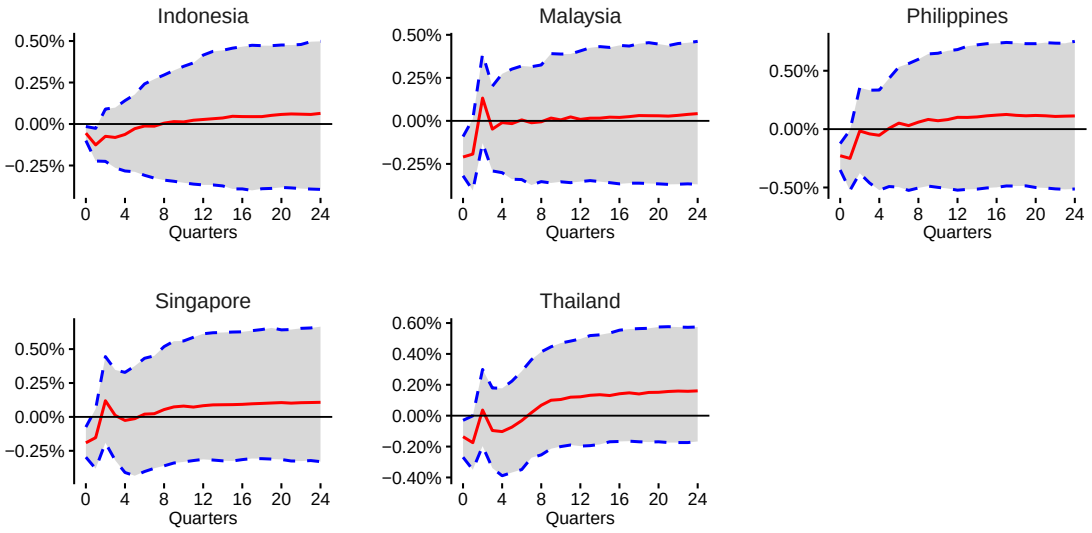


Figure C.1: Structural Generalized Impulse Responses of a one standard error (+) shock to Expenditures in China to GDP in ASEAN-5 (bootstrap median estimates with 68% bootstrap error bounds).

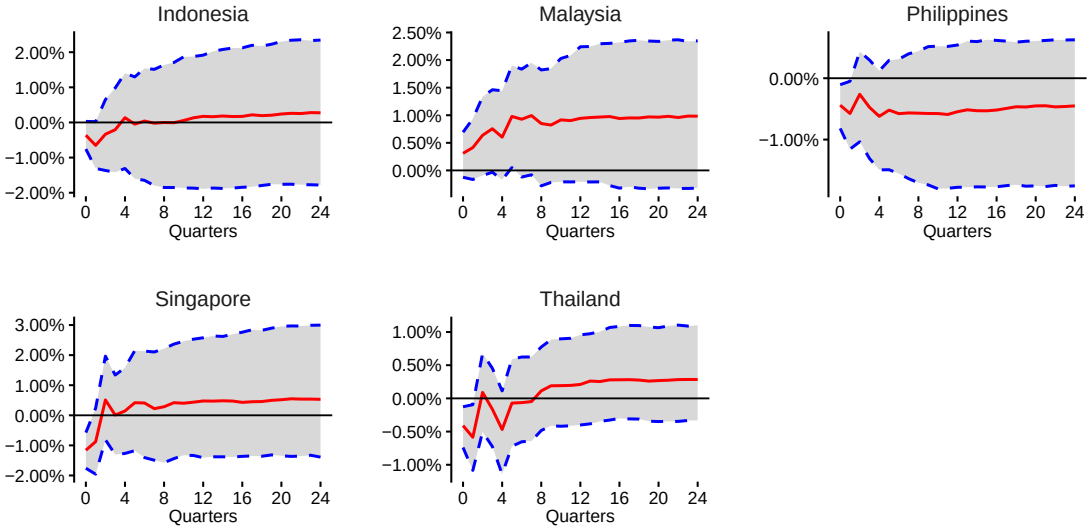


Figure C.2: Structural Generalized Impulse Responses of a one standard error (+) shock to Expenditures in China to Revenues in ASEAN-5 (bootstrap median estimates with 68% bootstrap error bounds).

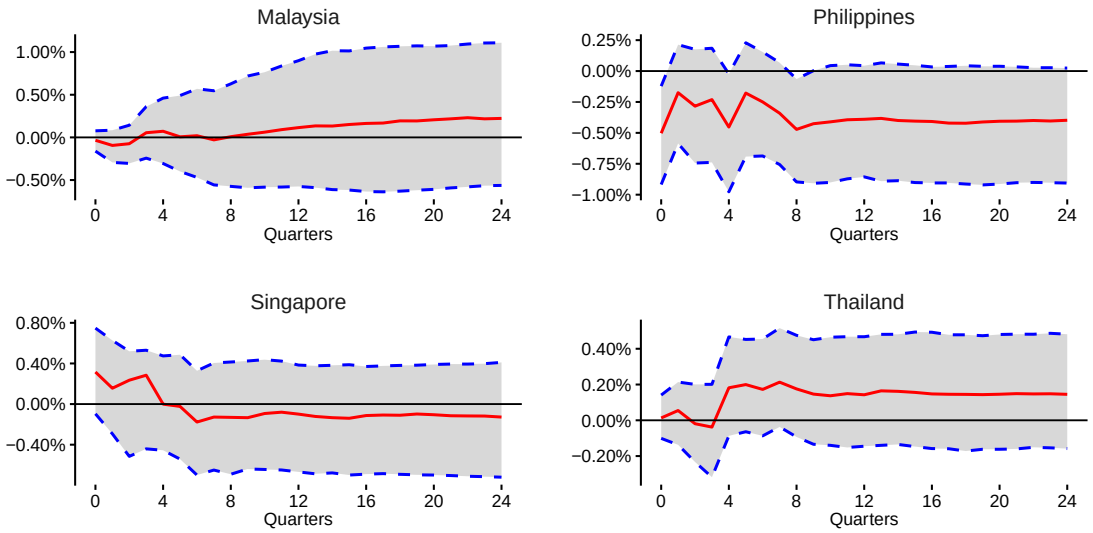


Figure C.3: Structural Generalized Impulse Responses of a one standard error (+) shock to Expenditures in China to Expenditures in ASEAN-5 (bootstrap median estimates with 68% bootstrap error bounds).

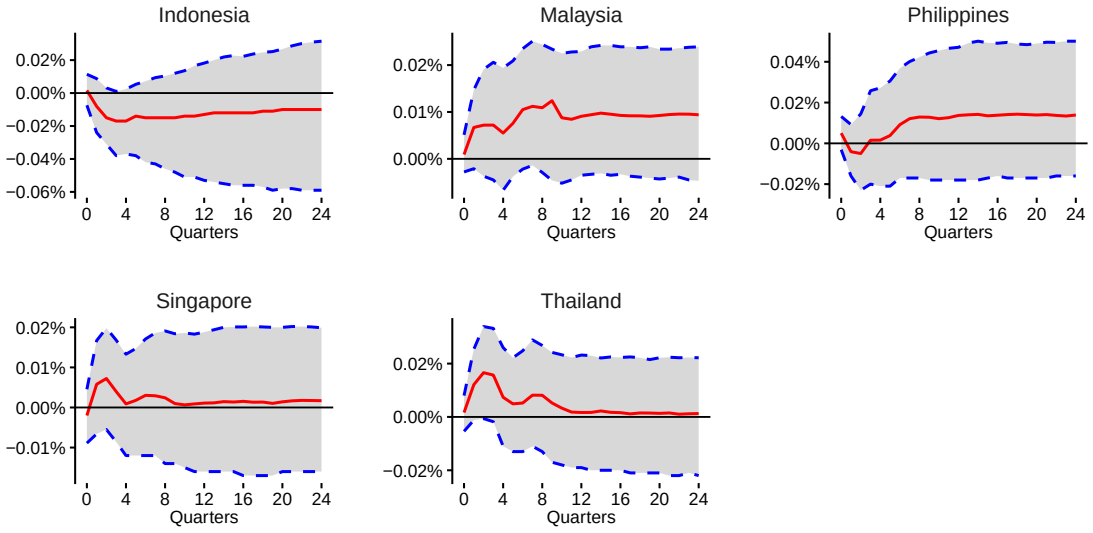


Figure C.4: Structural Generalized Impulse Responses of a one standard error (+) shock to Expenditures in China to Long Term Interest Rate in ASEAN-5 (bootstrap median estimates with 68% bootstrap error bounds).

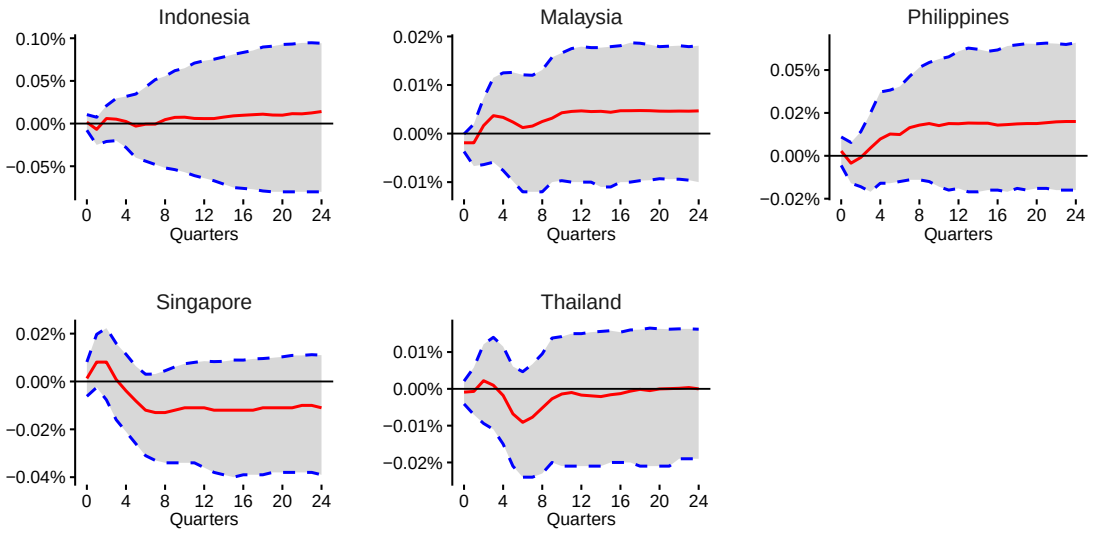


Figure C.5: Structural Generalized Impulse Responses of a one standard error (+) shock to Expenditures in China to Short Term Interest Rate in ASEAN-5 (bootstrap median estimates with 68% bootstrap error bounds).

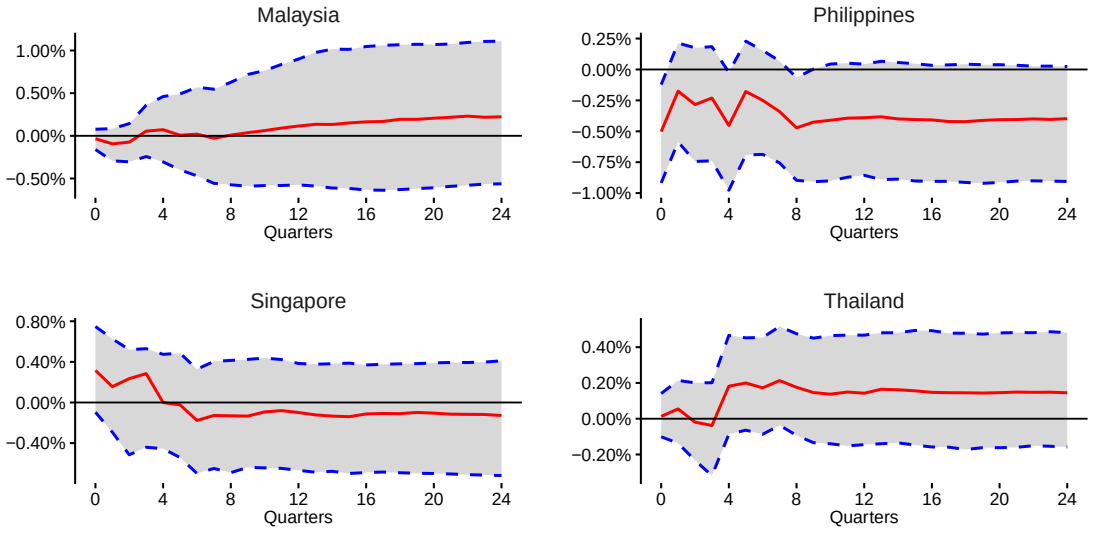


Figure C.6: Structural Generalized Impulse Responses of a one standard error (+) shock to Expenditures in China to Equity Prices in ASEAN-5 (bootstrap median estimates with 68% bootstrap error bounds).

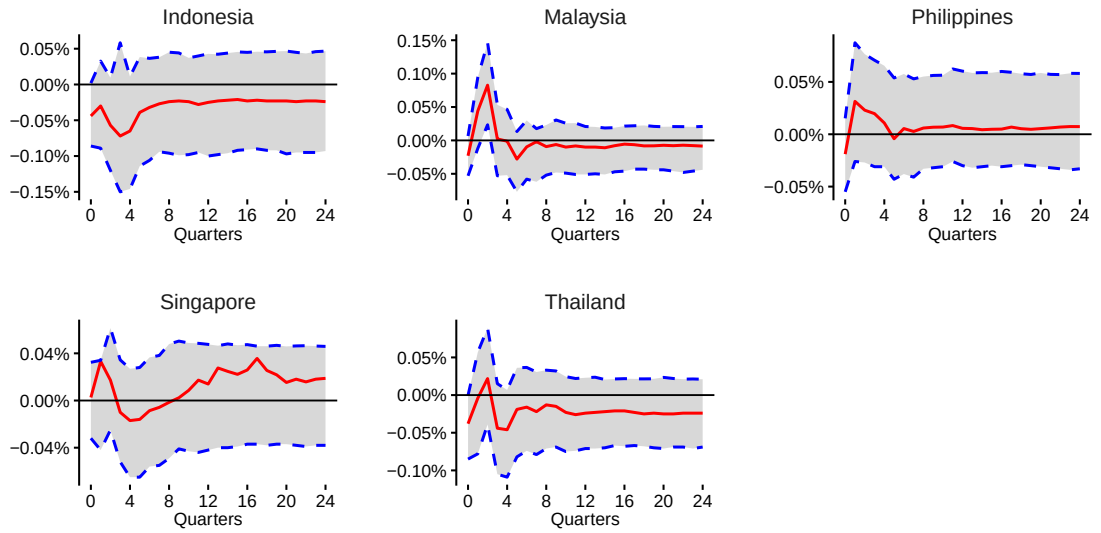


Figure C.7: Structural Generalized Impulse Responses of a one standard error (+) shock to Expenditures in China to Inflation in ASEAN-5 (bootstrap median estimates with 68% bootstrap error bounds).

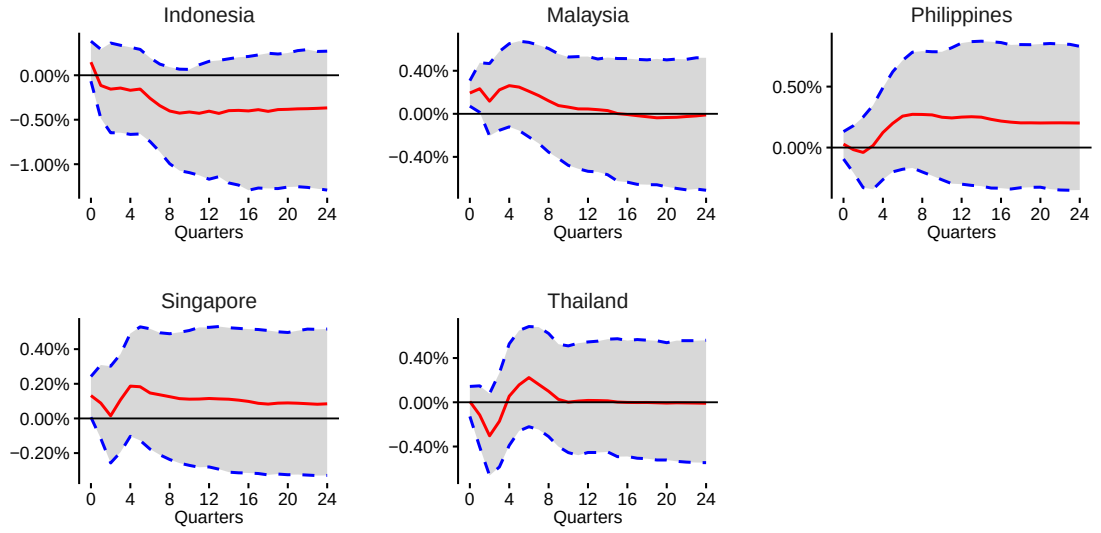


Figure C.8: Structural Generalized Impulse Responses of a one standard error (+) shock to Expenditures in China to Exchange Rate in ASEAN-5 (bootstrap median estimates with 68% bootstrap error bounds).

4.2.1 SGIRF-Regional Response to Expenditure Shock in China

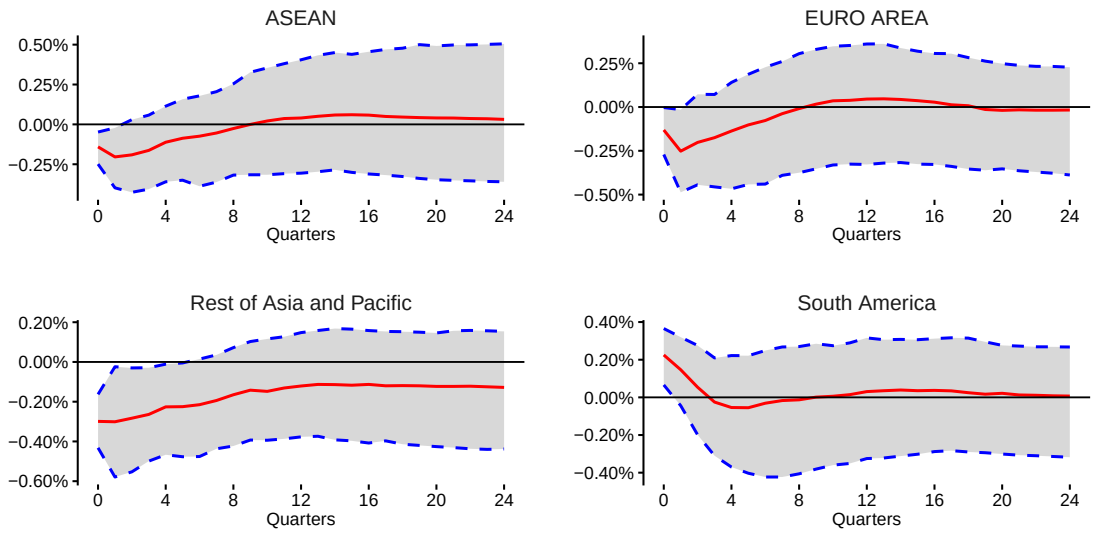


Figure C.9: Structural Generalized Impulse Responses of a one standard error (+) shock to Expenditures in China to GDP in Four Regions (bootstrap median estimates with 68% bootstrap error bounds).

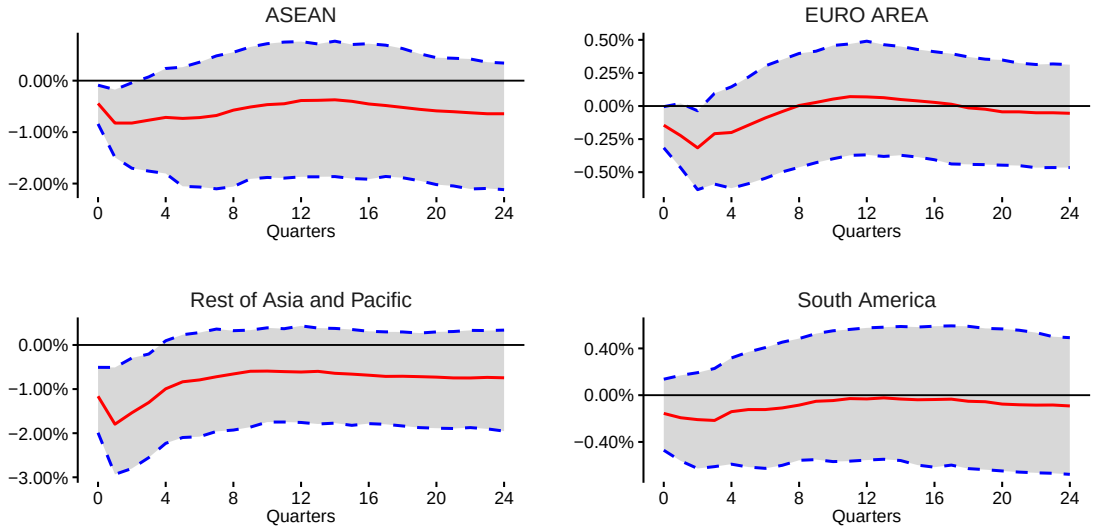


Figure C.10: Structural Generalized Impulse Responses of a one standard error (+) shock to Expenditures in China to Revenues in Four Regions (bootstrap median estimates with 68% bootstrap error bounds).

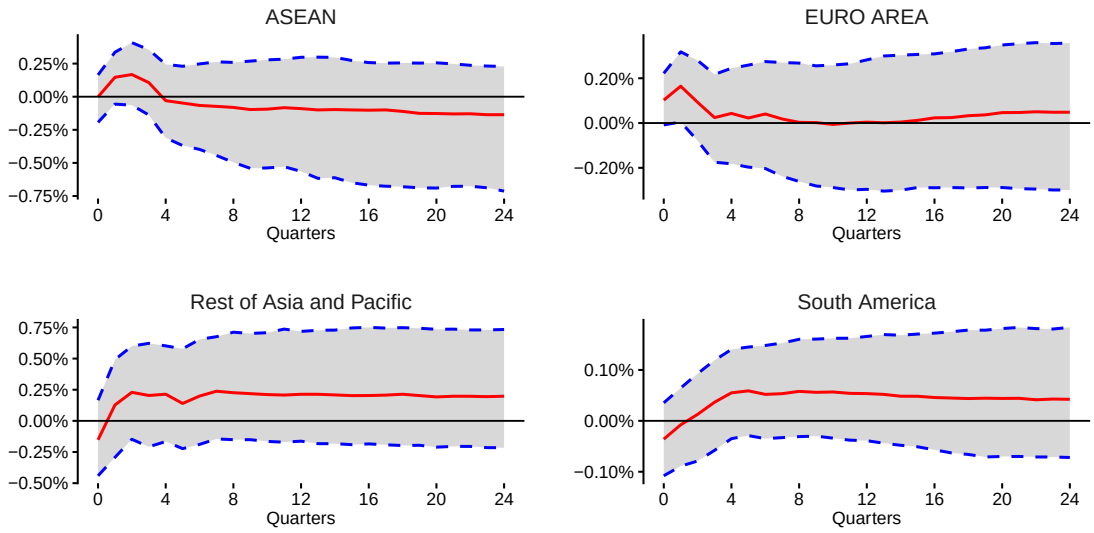


Figure C.11: Structural Generalized Impulse Responses of a one standard error (+) shock to Expenditures in China to Expenditures in Four Regions (bootstrap median estimates with 68% bootstrap error bounds).

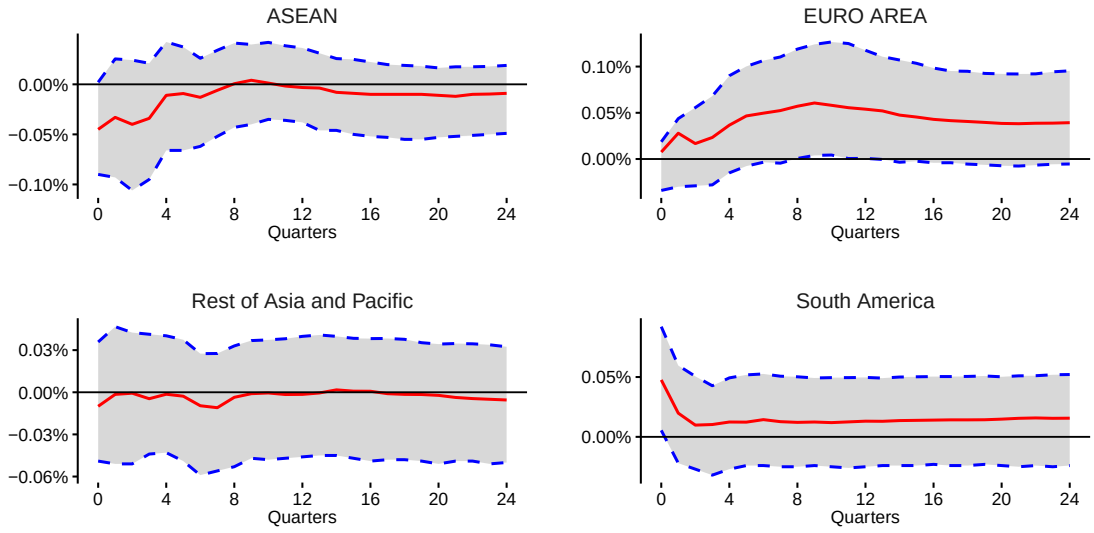


Figure C.12: Structural Generalized Impulse Responses of a one standard error (+) shock to Expenditures in China to Inflation in Four Regions (bootstrap median estimates with 68% bootstrap error bounds).

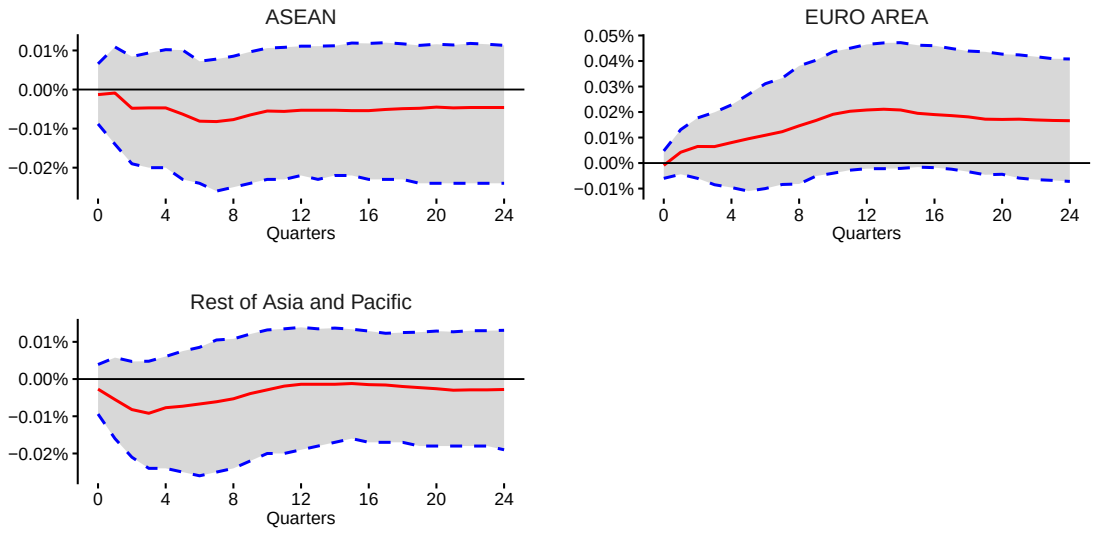


Figure C.13: Structural Generalized Impulse Responses of a one standard error (+) shock to Expenditures in China to Long Term Interest Rate in Four Regions (bootstrap median estimates with 68% bootstrap error bounds).

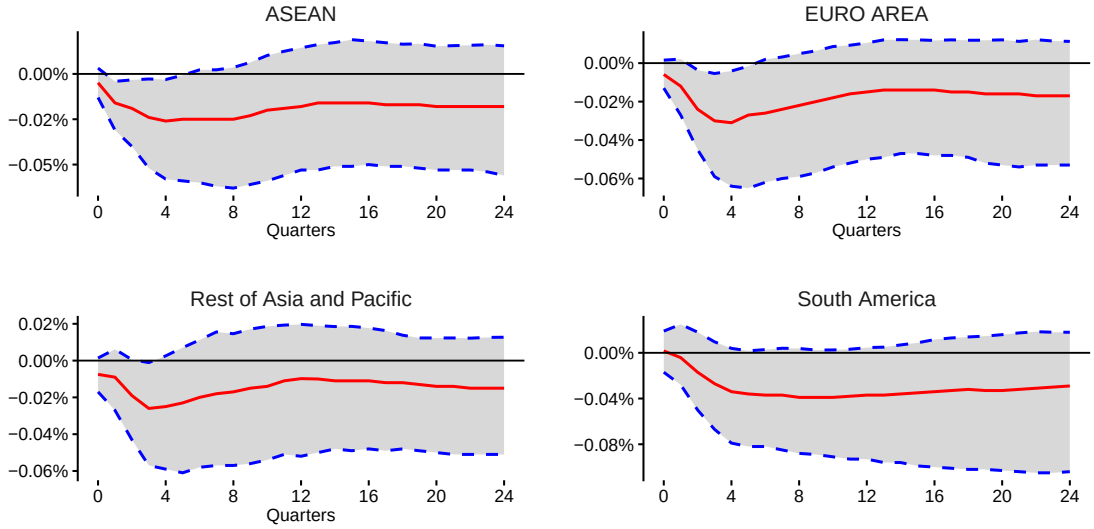


Figure C.14: Structural Generalized Impulse Responses of a one standard error (+) shock to Expenditures in China to Short Term Interest Rate in Four Regions (bootstrap median estimates with 68% bootstrap error bounds).

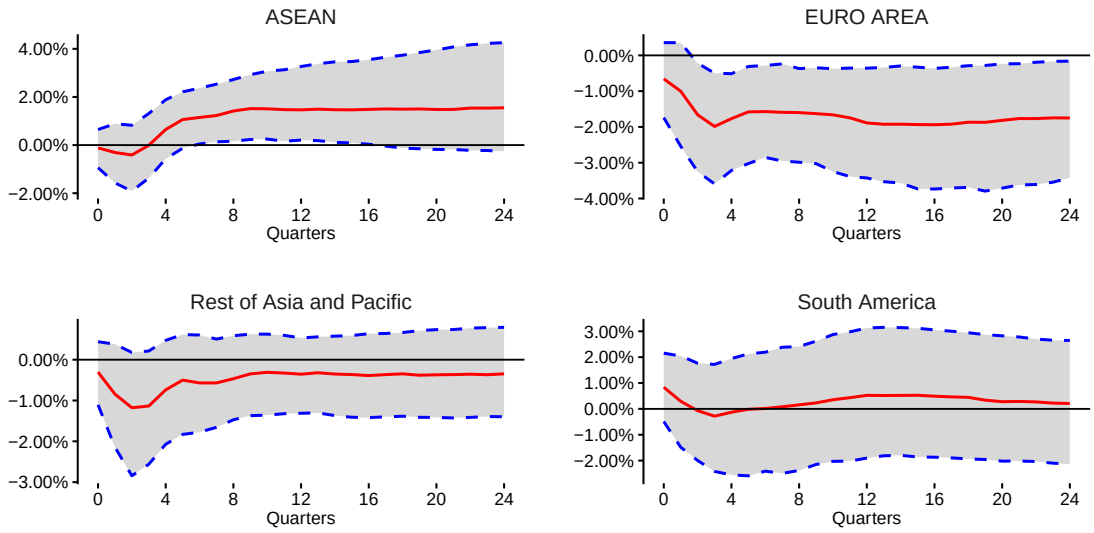


Figure C.15: Structural Generalized Impulse Responses of a one standard error (+) shock to Expenditures in China to Equity Prices in Four Regions (bootstrap median estimates with 68% bootstrap error bounds).

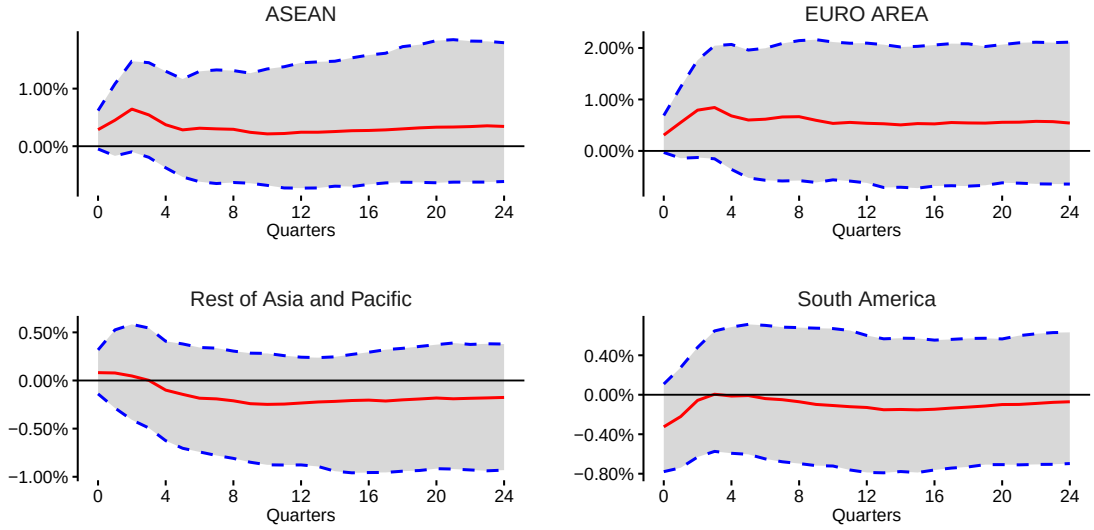


Figure C.16: Structural Generalized Impulse Responses of a one standard error (+) shock to Expenditures in China to Exchange Rate in Four Regions (bootstrap median estimates with 68% bootstrap error bounds).

Bibliography

António Afonso and João Tovar Jalles. Measuring the success of fiscal consolidations. *Applied Financial Economics*, 22(13):1053–1061, 2012.

Antonio Afonso, Jaromir Baxa, and Michal Slavík. Fiscal developments and financial stress: a threshold var analysis. *Empirical Economics*, 54:395–423, 2018.

Abdullahi D Ahmed and Rui Huo. Impacts of china's crash on asia-pacific financial integration: Volatility interdependence, information transmission and market co-movement. *Economic Modelling*, 79:28–46, 2019.

Ashvin Ahuja and Alla Myrvoda. *The spillover effects of a downturn in China's real estate investment*. International Monetary Fund, 2012.

Ashvin Ahuja and Malhar Nabar. *Investment-led growth in China: Global spillovers*. International Monetary Fund, 2012.

Ashvin Ahuja, Nigel Andrew Chalk, Nathan Porter, Papa N'Diaye, and Malhar Nabar. *An end to China's imbalances?* International Monetary Fund, 2012.

Alberto Alesina. Fiscal policy after the great recession. *Atlantic Economic Journal*, 40:429–435, 2012.

Alberto Alesina and Silvia Ardagna. Tales of fiscal adjustment. *Economic policy*, 13(27):488–545, 1998.

Alberto Alesina and Silvia Ardagna. Large changes in fiscal policy: taxes versus spending. *Tax policy and the economy*, 24(1):35–68, 2010.

Alberto Alesina and Roberto Perotti. *Fiscal Expansions and Fiscal Adjustments in OECD Countries*. August 1995a. doi: 10.3386/w5214.

Alberto Alesina and Roberto Perotti. The political economy of budget deficits. *IMF Staff Papers*, 42(1):1–31, 1995b.

Alberto Alesina and Roberto Perotti. Fiscal adjustments in oecd countries: composition and macroeconomic effects. *IMF Staff Papers*, 44(2):209–247, 1996.

Alberto Alesina and Guido Tabellini. A positive theory of fiscal deficits and government debt. *The Review of Economic Studies*, 57(3):403–414, 1990.

Alberto Alesina, Nouriel Roubini, and Gerald D. Cohen. Political cycles and the macroeconomy. *MIT Press*, 1993.

Alberto Alesina, Reza Baqir, and William Easterly. Public goods and ethnic divisions. *The Quarterly journal of economics*, 114(4):1243–1284, 1999.

Alberto Alesina, Francesco Giavazzi, and Carlo Favero. Austerity: When it works and when it doesn't. 2019.

Alberto F Alesina and Tamim Bayoumi. The costs and benefits of fiscal rules: evidence from us states, 1996.

Mario Alloza, Pablo Burriel, and Javier J Pérez. Fiscal policies in the euro area: Revisiting the size of spillovers. *Journal of Macroeconomics*, 61:103132, 2019.

James E. Alt and Robert C. Lowry. Divided government, fiscal institutions, and budget deficits: Evidence from the states. *American Political Science Review*, 88 (4):811–828, 1994. doi: 10.2307/2082719.

Mr Derek Anderson, Mr Jorge Iván Canales Kriljenko, Mr Paulo Drummond, Pedro Espaillat, and Mr Dirk Muir. *Spillovers from China onto Sub-Saharan Africa: Insights from the flexible system of global models (FSGM)*. International Monetary Fund, 2015.

Martin Ardanaz, Eduardo Cavallo, and Alejandro Izquierdo. Growth-friendly fiscal rules? safeguarding public investment from budget cuts through fiscal rule design. Technical report, Inter-American Development Bank, 2020.

Martín Ardanaz, Eduardo Cavallo, Alejandro Izquierdo, and Jorge Puig. Growth-friendly fiscal rules? safeguarding public investment from budget cuts through fiscal rule design. *Journal of International Money and Finance*, 2021.

Manuel Arellano and Stephen Bond. Some tests of specification for panel data: Monte carlo evidence and an application to employment equations. *Review of Economic Studies*, 58(2):275–295, 1991.

Manuel Arellano and Olympia Bover. Another look at the instrumental variable estimation of error-components models. *Journal of Econometrics*, 68(1):29–51, 1995. doi: 10.1016/0304-4076(94)01642-D.

Klaus Armingeon et al. Comparative political data set 1960-2017, 2019. Institute of Political Science, University of Zurich.

Vivek Arora and Athanasios Vamvakidis. China's economic growth: international spillovers. *China & World Economy*, 19(5):31–46, 2011.

Alan J Auerbach and Yuriy Gorodnichenko. Output spillovers from fiscal policy. *American Economic Review*, 103(3):141–146, 2013.

Joaquim Ayuso-i Casals, Diana Gonzalez Hernandez, Laurent Moulin, and Alessandro Turrini. Beyond the sgp: Features and effects of eu national-level fiscal rules. In *Policy Instruments for Sound Fiscal Policies: Fiscal Rules and Institutions*, pages 204–240. Springer, 2009.

Harald Badinger. Fiscal rules, discretionary fiscal policy and macroeconomic stability: an empirical assessment for oecd countries. *Applied Economics*, 41(7): 829–847, 2009.

Harald Badinger and Wolf Heinrich Reuter. The case for fiscal rules. *Economic Modelling*, 60:334–343, 2017.

Benoît Baduel and Robert Price. Strengthening debt sustainability assessments. *OECD Economics Department Working Papers*, (973), 2012.

Laurence Ball. Long-term damage from the great recession in oecd countries. *European Journal of Economics and Economic Policies*, 11(2):149–160, 2014.

Moulaye Bamba, Jean-Louis Combes, and Alexandru Minea. The effects of fiscal consolidations on the composition of government spending. *Applied Economics*, 52(14):1517–1532, 2020.

Pranab Bardhan and Dilip Mookherjee. Capture and governance at local and national levels. *American economic review*, 90(2):135–139, 2000.

Robert J Barro. On the determination of the public debt. *Journal of political Economy*, 87(5, Part 1):940–971, 1979.

Ms Anja Baum, Mr Marcos Poplawski-Ribeiro, and Anke Weber. *Fiscal Multipliers and the State of the Economy*. International Monetary Fund, 2012.

Roel Beetsma and Massimo Giuliodori. The macroeconomic costs and benefits of the emu and other monetary unions: an overview of recent research. *Journal of Economic literature*, 48(3):603–641, 2010.

Roel Beetsma and Massimo Giuliodori. The effects of government purchases shocks: review and estimates for the eu. *The Economic Journal*, 121(550):F4–F32, 2011.

Roel Beetsma, Massimo Giuliodori, and Franc Klaassen. Trade spill-overs of fiscal policy in the european union: a panel analysis. *Economic policy*, 21(48):640–687, 2006.

Ansgar H Belke and Thomas U Osowski. Measuring fiscal spillovers in emu and beyond: A global var approach. *Scottish Journal of Political Economy*, 66(1): 54–93, 2019.

Helge Berger, Teresa Dabán, and Ad van Riet. Fiscal prudence: It's all in the timing – estimating time-varying fiscal policy reaction functions for core eu countries, 2021a. IMF Working Paper WP/21/29.

Tino Berger, Tore Dubbert, and Ruben Schoonackers. Fiscal prudence: It's all in the timing–estimating time-varying fiscal policy reaction functions for core eu countries. *Available at SSRN 3810841*, 2021b.

U Michael Bergman and Michael Hutchison. Fiscal procyclicality in developing economies: The role of fiscal rules, institutions and economic conditions. *Unpublished paper, University of Copenhagen, Copenhagen*, 2018.

Ben S Bernanke, Jean Boivin, and Piotr Eliasz. Measuring the effects of monetary policy: a factor-augmented vector autoregressive (favar) approach. *The Quarterly journal of economics*, pages 386–423, 2005.

Huixin Bi, Eric M Leeper, and Campbell Leith. Sovereign default risk premia, fiscal limits, and fiscal policy. *Journal of Monetary Economics*, 60(6):709–726, 2013.

AC Bicu and LM Lieb. Cross-border effects of fiscal policy in the eurozone. 2015.

Patrick Blagrave and Esteban Vesperoni. The implications of china's slowdown for international trade. *Journal of Asian Economics*, 56:36–47, 2018.

Patrick Blagrave, Giang Ho, Ksenia Koloskova, and Mr Esteban Vesperoni. *Fiscal spillovers: The importance of macroeconomic and policy conditions in transmission*. International Monetary Fund, 2017.

Andrew Blake and Haroon Mumtaz. Time-varying vars and macroeconomic policy. *Handbook of Macroeconomics*, 2015.

Andrew P Blake and Haroon Mumtaz. Applied bayesian econometrics for central bankers. *Technical Books*, 2012.

Olivier Blanchard and Roberto Perotti. An empirical characterization of the dynamic effects of changes in government spending and taxes on output. *the Quarterly Journal of economics*, 117(4):1329–1368, 2002.

Olivier Blanchard, Christopher J Erceg, and Jesper Lindé. Jump-starting the euro-area recovery: would a rise in core fiscal spending help the periphery? *NBER macroeconomics annual*, 31(1):103–182, 2017.

Olivier J Blanchard and Daniel Leigh. Growth forecast errors and fiscal multipliers. *American Economic Review*, 103(3):117–120, 2013.

Olivier J Blanchard and Danny Quah. The dynamic effects of aggregate demand and supply disturbances, 1988.

Olivier J Blanchard and Lawrence H Summers. Hysteresis and the european unemployment problem. *NBER macroeconomics annual*, 1:15–78, 1986.

Henning Bohn. The sustainability of budget deficits in a stochastic economy. *Journal of Money, credit and banking*, 27(1):257–271, 1995.

Henning Bohn. The behavior of u.s. public debt and deficits. *Quarterly Journal of Economics*, 113(3):949–963, 1998.

Henning Bohn and Robert P. Inman. Balanced-budget rules and public deficits: evidence from the us states. *Carnegie-Rochester Conference Series on Public Policy*, 45:13–76, 1996. doi: 10.1016/S0167-2231(96)00012-7.

Stephen R. Bond. Dynamic panel data models: a guide to micro data methods and practice. *Portuguese Economic Journal*, 1(2):141–162, 2002. doi: 10.1007/s10258-002-0009-9.

M. E. Bontempi and I. Mammi. Implementing a strategy to reduce the instrument count in panel gmm. *The Stata Journal*, 15(4):998–1017, 2015. doi: 10.1177/1536867X1501500408.

Othman Bouabdallah, Cristina D Checherita-Westphal, Thomas Warmedinger, Roberta De Stefani, Francesco Drudi, Ralph Setzer, and Andreas Westphal. Debt sustainability analysis for euro area sovereigns: a methodological framework. *ECB Occasional Paper*, (185), 2017.

Elva Bova, Tidiane Kinda, Priscilla Muthoora, and Frederik Toscani. Fiscal rules at a glance. *International Monetary Fund*, 2015.

Adi Brender and Allan Drazen. Political budget cycles in new versus established democracies. *Journal of Monetary Economics*, 52(7):1271–1295, 2005a.

Adi Brender and Allan Drazen. Political budget cycles in new versus established democracies. *Journal of monetary Economics*, 52(7):1271–1295, 2005b.

James M Buchanan and Richard E Wagner. Democracy in deficit: The political legacy of lord keynes. *(No Title)*, 1977.

Matthieu Bussière, Laurent Ferrara, Michel Juillard, and Daniele Siena. Can fiscal budget-neutral reforms stimulate growth? model-based results. *Model-Based Results (April 2017)*, 2017.

Fabio Canova, Luca Gambetti, et al. Structural changes in the us economy: Bad luck or bad policy? 2006.

GM Caporale and A Girardi. How do us credit supply shocks propagate internationally? a gvar approach. *Journal of International Money and Finance*, (84): e0–85, 2013.

Andrea Carriero, Haroon Mumtaz, and Angeliki Theophilopoulou. Macroeconomic information, structural change, and the prediction of fiscal aggregates. *International Journal of Forecasting*, 32(3):324–349, 2015.

C. K. Carter and R. Kohn. On gibbs sampling for state space models. *Biometrika*, 81(3):541–553, 1994.

Francesca Caselli and Julien Reynaud. Do fiscal rules cause better fiscal balances? a new instrumental variable strategy. *European Journal of Political Economy*, 63: 101873, 2020a.

Francesca Caselli and Philippe Wingender. Bunching at 3 percent: The maastricht fiscal criterion and government deficits. IMF Working Paper 19/93, International Monetary Fund, 2018.

Francesco Caselli and Julien Reynaud. Do fiscal rules cause better fiscal balances? a new instrumental variable strategy. *European Journal of Political Economy*, page 101880, 2020b.

Oya Celasun, Xavier Debrun, and Jonathan D. Ostry. Primary surplus behavior and risks to fiscal sustainability in emerging market countries: A "fan-chart" approach. *IMF Staff Papers*, 53(3):401–425, 2006a.

Oya Celasun, Xavier Debrun, and Jonathan D Ostry. Do debt sustainability analyses help? *IMF Working Paper*, 2006b.

Oya Celasun, Xavier Debrun, and Jonathan D. Ostry. Do debt sustainability analyses help forecast sovereign defaults? IMF Working Paper 07/251, International Monetary Fund, 2007.

Ambrogio Cesa-Bianchi, M Hashem Pesaran, Alessandro Rebucci, TengTeng Xu, and Roberto Chang. China's emergence in the world economy and business cycles in latin america [with comment]. *Economía*, pages 1–76, 2012.

Cristina Checherita-Westphal and Václav Žďárek. Fiscal reaction function and fiscal fatigue: evidence for the euro area. Technical report, European Central Bank Frankfurt, Germany, 2017.

Alexander Chudik and M Hashem Pesaran. Theory and practice of gvar modelling. *Journal of Economic Surveys*, 30(1):165–197, 2016.

Todd E Clark and Francesco Ravazzolo. Macroeconomic forecasting performance under alternative specifications of time-varying volatility. *Journal of Applied Econometrics*, 31(3):552–576, 2015.

Benedict Clements, Sanjeev Gupta, and Masahiro Nozaki. What happens to social spending in imf-supported programmes? *Applied Economics*, 45(28):4022–4033, 2013.

Timothy Cogley and Thomas J Sargent. Drifts and volatilities: monetary policies and outcomes in the post wwii us. *Review of Economic dynamics*, 8(3):261–303, 2005.

Jean-Louis Combes, Andreea Minea, and Mouhamadou Sow. Is fiscal policy always counter-(pro-) cyclical? the role of public debt and fiscal rules. *Economic Modelling*, 65:136–156, 2017.

Till Cordes, Mr Tidiane Kinda, Ms Priscilla S Muthoora, and Anke Weber. *Expenditure rules: Effective tools for sound fiscal policy?* International Monetary Fund, 2015.

Giancarlo Corsetti, André Meier, and Gernot J Müller. Cross-border spillovers from fiscal stimulus. 2009.

Ms Era Dabla-Norris, Pietro Dallari, and Mr Tigran Poghosyan. *Fiscal spillovers in the euro area: Letting the data speak*. International Monetary Fund, 2017.

Momi Dahan and Michel Strawczynski. Fiscal rules and the composition of government expenditures in oecd countries. *Journal of Policy Analysis and Management*, 32(3):484–504, 2013.

Hamid Davoodi, Paul Elger, Alexandra Fotiou, Mr Daniel Garcia-Macia, Xuehui Han, Andresa Lagerborg, and W Raphael Lam. Fiscal rules and fiscal councils: Recent trends and performance during the covid-19 pandemic. 2022.

Xavier Debrun and Lars Jonung. Under threat: Rules-based fiscal policy and how to preserve it. *European Journal of Political Economy*, 57:142–157, 2019.

Xavier Debrun and Manmohan Kumar. Fiscal rules, fiscal councils and all that: commitment devices, signaling tools or smokescreens. In *Proceedings of Banca d'Italia Public Finance Workshop, Rome*. Citeseer, 2007.

Xavier Debrun and Manmohan S. Kumar. *The Discipline-Enhancing Role of Fiscal Institutions: Theory and Empirical Evidence*, pages 51—88. Palgrave Macmillan UK, 2009. ISBN 9780230271791. doi: 10.1057/9780230271791_3.

Xavier Debrun, Laurent Moulin, Alessandro Turrini, Joaquim Ayuso-i Casals, and Manmohan S Kumar. Tied to the mast? national fiscal rules in the european union. *Economic Policy*, 23(54):298–362, 2008.

Stephane Dees, Filippo di Mauro, M Hashem Pesaran, and L Vanessa Smith. Exploring the international linkages of the euro area: a global var analysis. *Journal of applied econometrics*, 22(1):1–38, 2007.

et al. Delgado. Title unknown, 2020. Placeholder for paper on output gap using HP filter.

Maria Carolina Deza Delgado, HX Jara, N Oliva, and J Torres. Financial disincentives to formal employment and tax-benefit systems in latin america. EUROMOD Working Paper EM8/20, Institute for Social and Economic Research, University of Essex, 2020.

Filippo di Mauro and L Vanessa Smith. The basic gvar ddps model. *The GVAR handbook, Structure and applications of a macro model of the global economy for policy analysis*, 12, 2013.

Alistair Dieppe, Georgios Georgiadis, Martino Ricci, Ine Van Robays, and Björn Van Roye. Ecb-global: Introducing the ecb's global macroeconomic model, for spillover analysis. *Economic Modelling,*, 72:75–98, 2018.

Allan Dizioli, Mr Jaime Guajardo, Mr Vladimir Klyuev, Rui Mano, and Mr Mehdi Raissi. *Spillovers from China's growth slowdown and rebalancing to the ASEAN-5 economies*. International Monetary Fund, 2016.

Evsey D Domar. The burden of the debt, and the national income. *The American Economic Review*, 34(5):797–828, 1944.

Catalin Dragomirescu-Gaina and Dionisis Philippas. Strategic interactions of fiscal policies in europe, a global var perspective. *Journal of international Money and Finance*, 59:48–75, 2015.

Axel Dreher. Imf and economic growth, the effects of programs loans, and compliance with conditionality. *World Development*, 33(5):768–789, 2006.

Tore Dubbert. Stochastic debt sustainability analysis using time-varying fiscal reaction functions-an agnostic approach to fiscal forecasting. *Applied Economics*, 56 (8):901–917, 2024.

Mr Romain A Duval, Mr Kevin C Cheng, Kum Hwa Oh, Richa Saraf, and MissDulani Seneviratne. *Trade integration and business cycle synchronization, A reappraisal with focus on Asia.* International Monetary Fund, 2014.

Selim Elekdag and Dirk Muir. Das public kapital: How much would higher german public investment help germany and the euro area? wp 13/227. *International Monetary Fund*, 2014.

Julio Escolano. A practical guide to public debt dynamics, fiscal sustainability, and cyclical adjustment of budgetary aggregates, 2010. Technical notes and nanuals.

European Commission. Reflection paper on the social dimension of europe. EU Communication COM(2017) 206 final, European Commission, 2017.

Gerdie Everaert and Stijn Jansen. On the estimation of panel fiscal reaction functions: Heterogeneity or fiscal fatigue? *Economic Modelling*, 71:86–95, 2018.

Stefania Fabrizio and Ashoka Mody. Can budget institutions counteract political indiscipline? *Economic Policy*, 20(47):691–738, 2006.

Renato Faccini, Haroon Mumtaz, and Paolo Surico. International fiscal spillovers. *Journal of International Economics*, 99:31–45, 2016.

Shenggen Fan and Neetha Rao. Public spending in developing countries: Trends, determination, and impact. Technical report, International Food Policy Research Institute, 2003.

Carlo Favero, Francesco Giavazzi, and Jacopo Perego. Country heterogeneity and the international evidence on the effects of fiscal policy. Technical report, National Bureau of Economic Research, 2011.

Financial Times. Public debt fears resurface amid inflation and interest rate shock, February 2024. Accessed: 2025-08-02.

Organisation for Economic Co-operation and Development. *Fiscal Sustainability of Health Systems: Bridging Health and Finance Perspectives*. OECD Publishing, Paris, 2015.

Jeffrey A Frankel, Carlos A Vegh, and Guillermo Vuletin. On graduation from fiscal procyclicality. *Journal of Development Economics*, 100(1):32–47, 2013.

Jason Furman et al. The new view of fiscal policy and its application. *VoxEU. org*, 2, 2016.

Jordi Galí. *Monetary policy, inflation, and the business cycle: an introduction to the new Keynesian framework and its applications*. Princeton University Press, 2015.

Jordi Galí and Roberto Perotti. Fiscal policy and monetary integration in europe. *Economic policy*, 18(37):533–572, 2003.

Marcos Chamon Garcia and Roberto Rigobon. A framework for debt sustainability analysis under uncertainty. *NBER Working Paper No. 10336*, 2004.

Vitor Gaspar, Mr Maurice Obstfeld, Ms Ratna Sahay, Mr Douglas Laxton, Mr Dennis P Botman, Kevin Clinton, Mr Romain A Duval, Kotaro Ishi, Zoltan Jakab, Laura Jaramillo, et al. *Macroeconomic management when policy space is constrained: A comprehensive, consistent and coordinated approach to economic policy*. International Monetary Fund, 2016.

Vitor Gaspar, Olivier Blanchard, Ceyla Pazarbasioglu, Carmen M Reinhart, Arminio Fraga, Ricardo Reis, Felipe Larrain Bascuñan, Emmanuel Saez, and Alex Cobham. Rethinking fiscal: Public finance and fairness. *IMF Staff Discussion Note*, 2021.

Ludovic Gauvin and Cyril C Rebillard. Towards recoupling? assessing the global impact of a chinese hard landing through trade and commodity price channels. *The world economy*, 40(11):3378–3416, 2018.

Atish R. Ghosh, Jun Il Kim, Enrique G. Mendoza, Jonathan D. Ostry, and Mahvash S. Qureshi. Fiscal fatigue, fiscal space and debt sustainability in advanced economies. *The Economic Journal*, 123(566):F4–F30, 2013a.

Atish R Ghosh, Jun Il Kim, Enrique G Mendoza, Jonathan D Ostry, and Mahvash S Qureshi. Fiscal fatigue, fiscal space and debt sustainability in advanced economies. *The Economic Journal*, 123(566):F4–F30, 2013b.

Atish R Ghosh, Jun Il Kim, Enrique G Mendoza, Jonathan D Ostry, and Mahvash S Qureshi. Fiscal fatigue, fiscal space and debt sustainability in advanced economies. *The Economic Journal*, 123(566):F4–F30, 2013c.

Massimo Giuliodori and Roel Beetsma. What are the spill-overs from fiscal shocks in europe? an empirical analysis. Technical report, ECB Working Paper, 2004.

Massimo Giuliodori and Roel Beetsma. What are the trade spill-overs from fiscal shocks in europe? an empirical analysis. *De economist*, 153(2):167–197, 2005.

Bram Gootjes, Jakob de Haan, and Richard Jong-A-Pin. Do fiscal rules constrain political budget cycles? *Public Choice*, 188(1):1–30, 2021.

Antoine Goujard. Cross-country spillovers from fiscal consolidations. *Fiscal studies*, 38(2):219–267, 2017.

Veronica Grembi, Tommaso Nannicini, and Ugo Troiano. Do fiscal rules matter? *American Economic Journal: Applied Economics*, 8(3):1–30, 2016.

Gene M. Grossman and Elhanan Helpman. Electoral competition and special interest politics. *The Review of Economic Studies*, 63(2):265–286, 1996.

Jaime Guajardo, Daniel Leigh, and Andrea Pescatori. Expansionary austerity? international evidence. *Journal of the European Economic Association*, 12(4): 949–968, 2014.

Martine Guerguil, Pierre Mandon, and Rachid Tapsoba. Flexible fiscal rules and countercyclical fiscal policy. *Journal of Macroeconomics*, 52:189–220, 2017.

Mark Hallerberg, Rolf Strauch, and Jürgen von Hagen. *Fiscal Governance in Europe*. Cambridge University Press, 2009.

Shafik Hebous and Tom Zimmermann. Estimating the effects of coordinated fiscal actions in the euro area. *European Economic Review*, 58:110–121, 2013.

Friedrich Heinemann. Debt sustainability in the european monetary union. *Intereconomics*, 27:230–236, 1992.

Friedrich Heinemann, Marc-Daniel Moessinger, and Mustafa Yeter. Do fiscal rules constrain fiscal policy? a meta-regression-analysis. *European Journal of Political Economy*, 51:69–92, 2018.

Robert J. Hodrick and Edward C. Prescott. Postwar u.s. business cycles: An empirical investigation. *Journal of Money, Credit and Banking*, 29(2):1–17, 1997.

Josef Hollmayr. Fiscal spillovers and monetary policy transmission in the euro area. *Frankfurt am Main: Goethe University Frankfurt am Main*, 2012.

F. Holm-Hadulla, S. Hauptmeier, and P. Rother. The impact of expenditure rules on budgetary discipline over the cycle. *Applied Economics*, 44(25):3287–3296, September 2012. ISSN 1466-4283. doi: 10.1080/00036846.2011.572855.

Angang Hu, Yilong Yan, and Xing Wei. *China 2030*. Springer Science & Business Media, 2014.

Ethan Ilzetzki and Carlos A Végh. Procyclical fiscal policy in developing countries: Truth or fiction? Technical report, National Bureau of Economic Research, 2008.

Robert P. Inman. Do balanced budget rules work? u.s. experience and possible lessons for the emu. Technical Report w5838, National Bureau of Economic Research, 1998.

International Monetary Fund. World economic outlook, 1996. Washington, DC.

International Monetary Fund. Assessing sustainability, 2002. IMF Policy Paper.

International Monetary Fund. Public debt in emerging markets, 2003a. World Economic Outlook, Chapter 3.

International Monetary Fund. Debt sustainability in low-income countries, 2003b. Staff Papers.

International Monetary Fund. Fiscal rules—anchoring expectations for sustainable public finances. Technical report, International Monetary Fund, Fiscal Affairs Department, 2009.

International Monetary Fund. Imf spillover reports, 2011a. Ongoing series since 2011, covering external spillovers from systemic and policy-induced shocks.

International Monetary Fund. *People's Republic of China: Spillover Report-2011 Article IV Consultation*. International Monetary Fund, 2011b.

International Monetary Fund. Debt sustainability analysis for ecuador, 2015. Country Report No. 15/XXX.

International Monetary Fund. Singapore: 2017 article iv consultation - press release; staff report. Country Report 17/240, International Monetary Fund, July 2017. IMF Country Report No. 17/240.

International Monetary Fund. Review of program design and conditionality, 2018a. IMF Policy Paper.

International Monetary Fund. Fiscal rules dataset: Updated october 2018. Imf fiscal affairs department database, International Monetary Fund, 2018b.

International Monetary Fund. Fiscal monitor: Policies to support people during the covid-19 pandemic. Technical report, International Monetary Fund, Washington, DC, October 2020. Accessed: 2025-08-28.

International Monetary Fund. World economic outlook: Navigating global divergences, 2023.

Òscar Jordà. Estimation and inference of impulse responses by local projections. *American economic review*, 96(2):160–183, 2005.

G KAMINSKY, C REINHART, and V VEGH. When it rain, it pours: Procyclical capital flows and macroeconomic policies. 2004.

Philip Keefer. Clientelism, credibility, and the policy choices of young democracies. *American Journal of Political Science*, 51(4):804–821, 2007.

Gary Koop and Dimitris Korobilis. Bayesian multivariate time series methods for empirical macroeconomics. *Foundations and trends in econometrics*, 3(4):267–358, 2010.

George Kopits. Fiscal rules: Useful policy framework or unnecessary ornament? *IMF Working Papers*, 01(145):1, 2001. ISSN 1018-5941. doi: 10.5089/9781451856545.001.

George Kopits and Steven Symansky. Fiscal policy rules. IMF Occasional Paper 162, International Monetary Fund, 1998.

M Ayhan Kose and Franziska Ohnsorge. Emerging and developing economies: Ten years after the global recession. 2020.

Signe Krogstrup and Sébastien Wälti. Do fiscal rules cause budgetary outcomes? *Public Choice*, 136(1–2):123–138, February 2008. ISSN 1573-7101.

Abhishek Kumar, Sushanta Mallick, and Apra Sinha. Fiscal spillover in emerging economies: Real versus financial channels. *Journal of International Money and Finance*, 149:103168, 2024.

Victor Lledó, Sungnam Yoon, Xiangming Fang, Samba Mbaye, and Young Kim. Fiscal rules at a glance. Technical report, International Monetary Fund, Washington, DC, 2017. IMF Background Paper.

Agnello Luca and Ricardo M. Sousa. How does fiscal consolidation impact on income inequality? *SSRN Electronic Journal*, 2012. ISSN 1556-5068. doi: 10.2139/ssrn.2060097.

James G MacKinnon. Critical values for cointegration tests. Technical report, Queen's Economics Department Working Paper, 2010.

Scott Mainwaring and Timothy R. Scully. *Building democratic institutions: Party systems in Latin America*, volume 277. Stanford University Press, Stanford, 1995.

Paolo Mauro, Rafael Romeu, Ariel Binder, and Asad Zaman. A modern history of fiscal prudence and profligacy. *Journal of Monetary Economics*, 76:54–71, 2015.

Carlos I Medeiros. Stochastic debt simulation using var models and a panel fiscal reaction function. *IMF Working Paper*, 2012.

Maximilien Kaffo Melou, Mariusz A Sumlinski, and Chris Geiregat. *An Application of the Fan-Chart Approach to Debt Sustainability in post-HIPC low-income countries*. International Monetary Fund, 2014.

Enrique G Mendoza and Jonathan D Ostry. International evidence on fiscal solvency: Is fiscal policy responsible? *Journal of Monetary Economics*, 55(6):1081–1093, 2008.

Gian Maria Milesi-Ferretti. Good, bad or ugly? on the effects of fiscal rules with creative accounting. IMF Working Paper 03/173, International Monetary Fund, 2003.

Fiscal Monitor. Now is the time fiscal policies for sustainable growth. *IMF World Economic and Financial Surveys*, 2015.

IMF Fiscal Monitor. Capitalizing on good times. *Washington: IMF*, 2018.

Andrew Mountford and Harald Uhlig. What are the effects of fiscal policy shocks? *Journal of applied econometrics*, 23(7):961–993, 2009.

Christiane Nickel and Isabel Vansteenkiste. The international spillover of fiscal spending on financial variables. *The GVAR handbook, structure and applications of a macro model of the global economy for policy analysis*, pages 182–192, 2013.

Jonathan D. Ostry, Atish R. Ghosh, Jun Il Kim, and Mahvash S. Qureshi. Fiscal space. *IMF Staff Position Note*, (SPN/10/11), 2010.

Evi Pappa. The effects of fiscal shocks on employment and the real wage. *International Economic Review*, 50(1):217–244, 2009.

Anne-Charlotte Paret. Debt sustainability in emerging market countries, some policy guidelines from a fan-chart approach. *Economic Modelling*, 63:27–46, 2017.

Roberto Perotti. Estimating the effects of fiscal policy in oecd countries. *Available at SSRN 717562*, 2005.

Torsten Persson and Lars E.O. Svensson. Why a stubborn conservative would run a deficit, policy with time-inconsistent preferences. *Quarterly Journal of Economics*, 105(3):324–346, 1989.

Torsten Persson and Guido Tabellini. *Political economics: explaining economic policy*. MIT press, 2002.

Torsten Persson and Guido Tabellini. Constitutional rules and fiscal policy outcomes. *American Economic Review*, 95(2):25–45, February 2004. ISSN 0002-8282.

M Hashem Pesaran. Stephane dees, filippo di mauro, m. hashem pesaran and l. vanessa smith. 2004.

M Hashem Pesaran, Yongcheol Shin, and Richard J Smith. Structural analysis of vector error correction models with exogenous i (1) variables. *Journal of econometrics*, 97(2):293–343, 2000.

M Hashem Pesaran, Til Schuermann, and Scott M Weiner. Modeling regional interdependencies using a global error-correcting macroeconometric model. *Journal of Business & Economic Statistics*, 22(2):129–162, 2004.

Werner Ploberger and Walter Krämer. The cusum test with ols residuals. *Econometrica: Journal of the Econometric Society*, pages 271–285, 1992.

Tigran Poghosyan. Cross-country spillovers of fiscal consolidations in the euro area. *International Finance*, 23(1):18–46, 2020.

James Poterba. *Budget Institutions and Fiscal Policy in the U.S. States*. February 1996. doi: 10.3386/w5449.

Niklas Potrafke. Does government ideology influence budget composition? empirical evidence from oecd countries. *Economics of Governance*, 11(2):101–134, 2010.

Andrew Powell. 2016 latin american and caribbean macroeconomic report: Time to act. Technical report, Inter-American Development Bank, Washington, DC, 2016. Uses Hodrick-Prescott filter to estimate output gaps.

Giorgio E. Primiceri. Time varying structural vector autoregressions and monetary policy. *Review of Economic Studies*, 72(3):821–852, 2005a.

Giorgio E Primiceri. Time varying structural vector autoregressions and monetary policy. *The Review of economic studies*, 72(3):822–853, 2005b.

Martin Ravallion. Transfers and safety nets in poor countries: Revisiting the trade-offs and policy options. In *Understanding Poverty*, pages 202–232. Oxford University Press, 2006.

Carmen M Reinhart and Kenneth S Rogoff. Growth in a time of debt. *American economic review*, 100(2):573–578, 2010.

Wolfgang H. Reuter. Title unknown, 2015. Placeholder for work on trade openness and output gap.

Reuters. Debt, fiscal challenges facing low-income countries worry imf, April 2024. Accessed: 2025-08-02.

Alejandro Ricci-Risquete and Julián Ramajo-Hernández. Macroeconomic effects of fiscal policy in the european union, a gvar model. *Empirical Economics*, pages 1586–1618, 2015.

Alejandro Ricci-Risquete, Julian Ramajo, and Geoffrey Hewings. Public finance behavior of the spanish regions: An analysis based on fiscal reaction functions. *Available at SSRN 3280242*, 2018.

David Roodman. How to do xtabond2, an introduction to difference and system gmm in stata. *The Stata Journal*, 9(1):85–137, 2009a.

David Roodman. A note on the theme of too many instruments. *Oxford Bulletin of Economics and Statistics*, 71(1):134–159, 2009b.

David Roodman. How to do xtabond2: An introduction to difference and system gmm in stata. *The Stata Journal: Promoting communications on statistics and Stata*, 9(1):86–136, March 2009c. ISSN 1536-8734. doi: 10.1177/1536867x0900900106.

Nouriel Roubini and Jeffrey Sachs. *Political and Economic Determinants of Budget Deficits in the IndustrialDemocracies*. August 1988.

Andrea Schaechter, Tidiane Kinda, Nina Budina, and Anke Weber. Fiscal rules in response to the crisis toward the "next generation" rules: A new dataset. IMF Working Paper 12/187, International Monetary Fund, 2012a. Retrieved from International Monetary Fund website.

Ms Andrea Schaechter, Mr Tidiane Kinda, Mrs Nina Budina, and Anke Weber. *Fiscal Rules in Response to the Crisis, Toward the Next-Generation" Rules, A New Dataset*. International Monetary Fund, 2012b.

Herman Christiaan Schakel, Erilia Hao Wu, and Patrick Jeurissen. Fiscal rules, powerful levers for controlling the health budget? evidence from 32 oecd countries. *BMC Public Health*, 18(1):300, 2018.

A Fair Shot. Fiscal monitor. 2021.

CA Sims. Macroeconomics and reality'econometrica, vol. 48. 1980.

Ron P Smith. The gvar approach to structural modelling. *The GVAR Handbook, Structure and Applications of a Macro Model of the Global Economy for Policy Analysis*, pages 55–70, 2013.

Joseph E. Stiglitz and Jay K. Rosengard. *Economics of the Public Sector: Fourth International Student Edition*. W. W. Norton & Company, 2015.

Anna Sznajderska and Mariusz Kapuściński. The spillover effects of chinese economy on southeast asia and oceania. Technical report, Narodowy Bank Polski, 2019.

Teresa Ter-Minassian. Preconditions for a successful introduction of structural fiscal balance-based rules in latin america and the caribbean: a framework paper. IDB Technical Note IDB-TN-195, Inter-American Development Bank, 2010.

Alessandro Turrini. Fiscal policy and the cycle in the euro area, the role of government revenue and expenditure. Technical report, Directorate General Economic and Financial Affairs, European, 2008.

Subhan Ullah, Pervaiz Akhtar, and Ghasem Zaefarian. Dealing with endogeneity bias, the generalized method of moments (gmm) for panel data. *Industrial Marketing Management*, 70:68—-79, May 2018.

Camila Vammalle. Fiscal sustainability of health systems–why is it an issue, what can be done? OECD Economics Department Paper 1273, Organisation for Economic Co-operation and Development, 2015.

Cezara Vinturis. How do fiscal rules shape governments' spending behavior? *Economic Inquiry*, 61(2):322–341, 2023.

Jurgen Von Hagen. Fiscal rules, fiscal institutions, and fiscal performance. *Vol. XX, No. XX, Issue, Year*, 2002.

Jürgen Von Hagen. Fiscal rules and fiscal performance in the eu and japan. 2005.

Jürgen von Hagen and Barry Eichengreen. Federalism, fiscal restraints, and european monetary union. *The American Economic Review*, 86(2):134–138, 1996.

Jürgen von Hagen. Budgeting procedures and fiscal performance in the european communities. European Economy - Economic Papers 96, European Commission, Directorate-General for Economic and Financial Affairs, 1992.

Jürgen von Hagen and Ian J. Harden. Budget processes and commitment to fiscal discipline. *European Economic Review*, 39(3–4):771–779, April 1995. ISSN 0014-2921. doi: 10.1016/0014-2921(94)00084-d.

Robert F. Westcott and C. John McDermott. An empirical analysis of fiscal adjustments. *IMF Working Papers*, 96(59):1, 1996. ISSN 1018-5941. doi: 10.5089/9781451965957.001.

Charles Wyplosz. Debt sustainability assessment: The imf approach and alternatives. 2007.

Charles Wyplosz. Fiscal rules: Theoretical issues and historical experiences. In Alberto Alesina and Francesco Giavazzi, editors, *Fiscal Policy after the Financial Crisis*. University of Chicago Press, 2012.