Essays on Fiscal Policy and Sovereign Debt Management

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Abstract

An increasing number of countries has adopted fiscal rules in the last 30 years, but little is known why they have any incentives to do so. In Chapter 1, I analyze the role of a fiscal rule, especially a budget rule, on the likelihood of debt repudiation and the welfare of households. Following the Eaton-Gersovitz sovereign default model, I enrich fiscal features in the model by adding a budget rule. The budget rule ensures that spending cannot increase unless tax revenue increases. If more revenue is generated by issuing debt, taxes do not increase much, reducing government spending. The implicit cost of the rule on government spending lowers the government's incentive to borrow, reducing default risks. A budget rule can improve households' welfare if it addresses inefficiencies from the misaligned incentives of the government when the government does not behave in the best interest of the households.

In the second chapter, in joint with Bryn Battersby and Joao Jalles, we empirically examine the effectiveness of announced government fiscal measures in the context of the COVID-19 pandemic. We build a panel data of fiscal announcements by types, such as above-the line, below-the-line, and contingent liabilities. Using this newly constructed data set, we show how various types of fiscal announcements dynamically affect the distinctive proxies of economic activities in different income groups. We also evaluate how the effects change depending on the country's initial conditions. Fiscal announcements influence country spreads, while the results vary by the types of fiscal measures in different income groups. Our findings suggest why it might be critical to evaluate the effect of a fiscal announcement by type rather than the aggregated announcement effect.

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I find myself blessed with finding precious friendships while pursuing a Ph.D. Moonju Cho, who made my Ph.D. life more colorful, was always there for me for emotional support in good times and bad times. We share laughs, memories, inside jokes, and many values. The only silver lining from the Covid pandemic was that I was able to build a good friendship with her by supporting each other and seeing each other regularly. Fiorella Pizzolon, who is adored by everyone who knows her, made me feel so fortunate to be in her cohort. She speaks only words of kindness and sees the good things in people. I can rely on her for anything, not just because we live within 2-minute walking distance. I am lucky to have friends like them who have good hearts. I value our time together. They made me laugh louder and smile brighter. I hope we will be by each other's side as we manage and meet life's varied challenges and triumphs.

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Contents

Chapter 1

How Does a Budget Rule Affect Sovereign Default Incentives and Welfare?

Keywords: Sovereign Debt Management, Fiscal Rule, Fiscal Policy, Quantitative Sovereign Default Model

JEL Classification: :E6, F3, H6

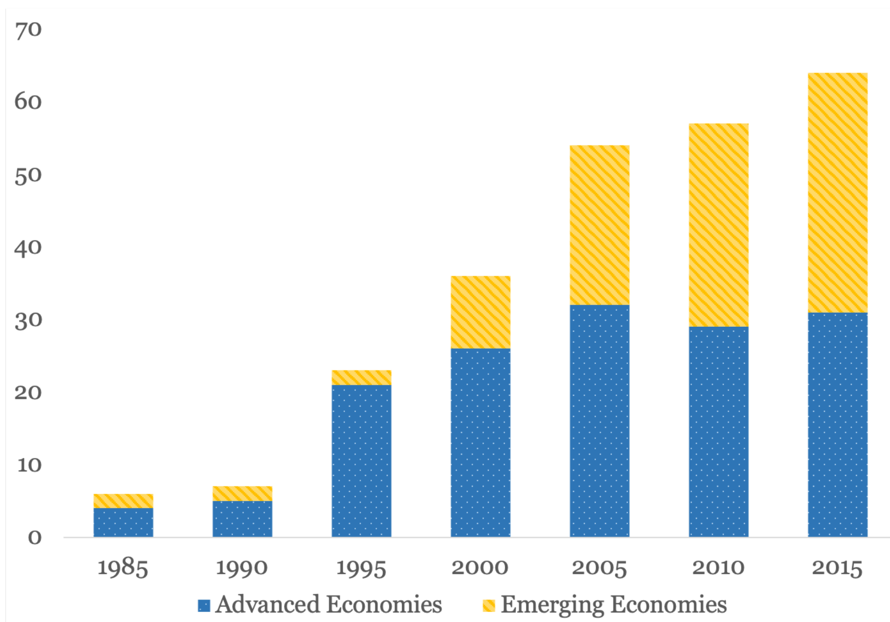
1 Introduction

Over the last 30 years, a steadily increasing number of countries have adopted fiscal rules (Figure 1.1). Fiscal rules "*impose a long-lasting constraint on fiscal policy ... to ensure fiscal responsibility and debt sustainability*" according to the International Monetary Fund (IMF).[1] Among the four types of fiscal rules

[1]Source: Fiscal Rules Dataset (https://www.imf.org/external/datamapper/fiscalrules/map/map.htm)

the IMF dataset covers (debt rule, budget rule, expenditure rule, and revenue rule), the budget rule is the one that is most commonly used in emerging economies (Figure 1.2).[2] Why would countries adopt fiscal rules when the rules restrict governments' fiscal decisions? This paper answers this question by quantitatively examining how a fiscal rule, specifically a budget rule, lowers sovereign default incentives and enhances households' welfare in small open economies with default risks.

Figure 1.1: Number of Countries Adopting Fiscal Rules



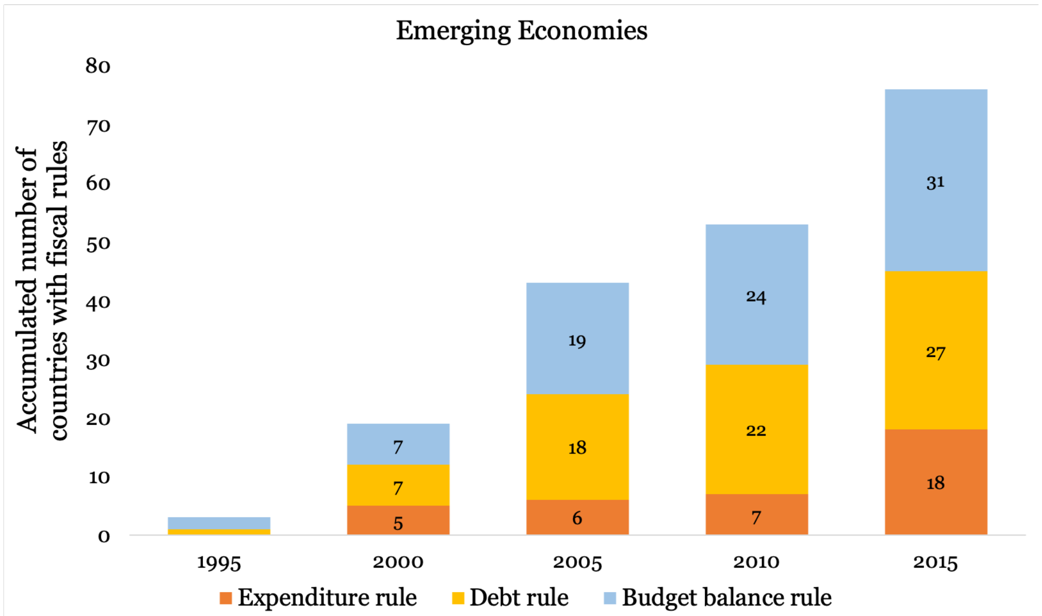
Source: IMF Fiscal Rules Dataset

I calibrate my model to Colombia, which enacted fiscal rules in 2011 under the IMF's intervention.[3] Colombia's structural budget balance rule ensures the

[2]The IMF monitors systematic information on the use and design of fiscal rules in countries around the world from 1985 to 2015. The expenditure rule and Revenue rule are the ones that put a constraint on expenditure and revenue, respectively. The debt rule puts a ceiling on debt. The budget balance rule puts a restriction on a primary surplus or deficit.

[3]Refer to Fiscal rules at a glance (2015, IMF Publication).

Figure 1.2: Composition of fiscal rules in emerging economies



Source: IMF Fiscal Rules Dataset

deviations of spending and taxes from their long-run targets move together. The model reflects this feature of the rule and ties government spending to tax revenue.

Following the Eaton-Gersovitz sovereign default model where the government lacks the commitment to repay and makes endogenous default decisions, I enrich fiscal features by adding a budget rule.[4] My work complements the studies of quantitative sovereign default (**?** and Aguiar and Gopinath (2006)). Multiple studies discuss spending and taxation in sovereign default models. Cuadra et al. (2010) find government spending to be procyclical with the presence of default risk. In recessions, default risk rises, raising sovereign bond

[4]Another approach in the literature is to adopt an exogenous default decision. In Bi (2012)'s study, the default choice is made exogenously from the endogenous debt limit risen from fiscal policy choices

interest rates. Borrowing becomes more costly and the country is able to raise fewer resources for government spending. Taxes are more volatile with default risk since an endogenous credit limit obstructs the country from smoothing borrowing (Pouzo and Presno, 2021). My research paper differs from other work because a simple rule limits the choice of an optimizing government with default risk. **?** study sovereign default risks when a government faces a fiscal constraint of the form of a fixed tax rate. Though an increase in taxes reduces default risk by relaxing the government's budget constraint, low cost borrowing leads the country to increase borrowing, which produces a higher default rate in the long run. A paper by Bianchi et al. (2021) articulates the trade-offs between austerity and stimulus effects of government spending while fixing tax by comparing two economies with and without default risk. According to their paper, whether the country is under default risk results in a different optimal fiscal policy implication. In my study, a budget rule provides behavioral guidance for the government, which affects borrowing incentives rather than constraining fiscal policy choices with a fixed limit.

The first contribution of this paper is to show how a budget rule lowers debt accumulation incentives. There are two ways to raise revenue: borrowing or imposing taxes. If a government relies on borrowing more, it does not need to raise taxes much. The rule requires higher government spending to come from a tax increase. An increase in borrowing reduces taxes, which reduces government spending through the budget rule. Borrowing becomes more costly with the rule since it lowers government spending from which the society derives utility. The rule makes the country choose to borrow less, lowering default risk and sovereign bond spreads. Other studies support this result. Arbeláez et al. (2021) discuss how the enactment of a fiscal rule enabled the Colombian economy to recover the country's investment grading. Similarly, Gomez-Gonzalez et al. (2021) report the data that reveals countries with fiscal rules can reduce their sovereign borrowing cost. Hatchondo et al. (2020) argue the importance of committing to long-term fiscal discipline and its effect on lowering sovereign default risk.

My second contribution shows how the budget rule improves households' welfare measured by a permanent increase in present value consumption. Although the budget rule restricts the government's choice set, it can improve households' welfare if it addresses inefficiencies from the misaligned incentives of the government (agency problem). An agency problem emerges when households' welfare depends on government choices, but the government does not behave in the best interest of the households. An example of misaligned preferences in my model is when the government values government spending more than the households do and allocates more on government spending than the households prefer. According to the rule, to raise government spending the tax must rise, leading to reduced consumption. Increasing government spending becomes more costly with the rule since a rise in government spending crowds out private consumption. The budget rule ties the hand of a self-interested government and improves households' welfare by forcing the government to make choices better aligned with households' preferences. One can find other studies that discuss the inefficiency that fiscal rules can counter to enhance welfare. Hatchondo et al. (2021) study how a debt ceiling rule can improve welfare by addressing inefficiency coming from long-term debt dilution problems. Alfaro and Kanczuk (2017) find that a simple rule can generate a welfare gain as high as the optimal rule in a setting where the government has time-inconsistent preference parameters. My research differs from their work in that my model's fiscal rule offsets the frictions from an institutional problem.

The paper is structured as follows. Section 2 provides the model I use to explain the data. Section 3 compares analytics of how the optimal choice of consumption and government spending change as borrowing changes in an economy with and without the budget rule. Section 4 reports the numerical results from the model with the budget rule. Section 5 derives the welfare implications of the budget rule. Seciton 6 expolores how robust the results are in the main model using alternative model specifications, such as distortionary taxes, substitutability of goods, and long duration bonds. Section 7 describes counterfactual analyses of welfare result using other fiscal rules. Section 8 concludes.

2 Model

This paper studies a small open economy where the government sells one-period non-contingent discount bonds to risk-neutral foreign lenders. The government is a social planner and makes all the decisions for the households which derives utility from private consumption (c) and government spending (g). The government's objective is to maximize the present value of utility by choosing: (1) Whether to default; (2) How much to borrow, and; (3) How to allocate private consumption, government spending and taxes. The economy is endowed with a stochastic output every period. The model is solved under Markov Perfect Equilibrium concept.

I add a fiscal detail to the otherwise standard model: the fiscal rule. The government *without* the rule makes optimal decisions given the lack of commitment to repay issue. Once the optimal borrowing level is determined, the government distributes the resources into private consumption and government spending, using intratemporal optimization method. This economy, without a fiscal rule, is called a *no-rule economy* and used as a benchmark model. When the government introduces a budget rule, government spending is tied to taxes. This economy is called a *rule economy*. The only difference between the two economies is, in the *rule economy*, the government has to satisfy a simple fiscal rule, which adds a constraint to the economy. Other decision processes, such as choosing the optimal borrowing level and making a default decision, are the same in the two economies.

2.1 Value Functions

A government in good financial standing makes repayment or default choices every period. Equation (1.1) describes the decision process:

$$V^G(b,y) \;\; = \;\; \max\{V^C(b,y), V^D(y)\}, \tag{1.1}$$

where b is an outstanding debt and y is an endowment.

V^G is the value when the government starts from good financial standing. If the present value of defaulting on debt, $V^D(y)$, is greater than that of repaying the debt, $V^C(b,y)$, it chooses to default. In a default, the government reneges on 100% of their debt, making outstanding debt, b, no longer relevant.

$\Delta(b,y)$ is a default policy function which is discrete:

$$\Delta(b,y) = \begin{cases} (default) \;\; 1 & \text{if} \quad V^C(b,y) < V^D(y), \\ (repay) \;\; 0 & \text{otherwise.} \end{cases} \tag{1.2}$$

Default is costly in two ways. First, the country gets excluded from the international financial market and enters financial autarky. Following **?**, I assume the country can re-enter the financial market with an exogenous probability, as opposed to staying in a permanent autarky state.[5] When it re-enters, the government does not carry over the previous outstanding debt. Second, the country suffers an output cost. I adopted quadratic output cost in default states as in Chatterjee and Eyigungor (2012) – the higher the output is, the bigger the output cost becomes under default.[6]

Solvency

The government's utility consists of which the households gain utility from: private consumption (c) and government spending (g). The country borrows from risk-neutral foreign lenders. It issues one-period non-contingent discount bonds to smooth consumption of private and government-provided goods. When the government repays the debt, it starts from good financial standing in the next period. Staying in good financial standing means that next period the country returns to the decision that equation (1.1) summarizes.

[5] Eaton and Gersovitz (1981) assume permanent exclusion from the financial market once the country defaults. For endogenous re-entry decision and debt renegotiation, refer to Benjamin and Wright (2009) and Yue (2010).

[6] This is a crucial assumption to produce a countercyclical default outcome. The country suffers from bigger output loss if it defaults in a higher output period, making the government less likely to default in a high output period.

Value function when the country repays the debt is:

$$\begin{aligned} V^C(b,y) &= u(c,g) + \beta\mathbb{E}\left[V^G(b',y')\right], \qquad (1.3) \\ u(c,g) &= \alpha_g \cdot u(c) + (1-\alpha_g)\cdot u(g), \end{aligned}$$

where utility is additively separable.[7] The self-interested government uses its preference over c, α_g, and g, $1-\alpha_g$, when making optimal decisions. Government does not necessarily share the households' preferences over c and g, which is governed by the weight α_h and $1-\alpha_h$.

The utility function follows the constant intertemporal elasticity of substitution form. Intertemporal elasticity of consumption is summarized with a fixed parameter σ.

$$u(c) = \frac{c^{1-\sigma}-1}{1-\sigma} \quad \text{and} \quad u(g) = \frac{g^{1-\sigma}-1}{1-\sigma}.$$

The government's borrowing today will be its outstanding debt in the next period. The optimal borrowing (b'^*) is such that it maximizes the present value of utility. The government also allocates private consumption (c^*), government spending (g^*) and taxes (τ^*) to maximize present value of utility:

$$\{b'^*, c^*, g^*, \tau^*\} = argmax \quad u(c,g) + \beta\mathbb{E}\left[V^G(b',y')\right].$$

When the government repays the outstanding debt, households' private consumption is output (y) net of lump-sum tax (τ) from the households' budget

[7]Here, I do not assume the substitutability between private consumption (c) and government spending (g). In Section 6, I explore how alternative assumptions about the substitutability of consumption and government spending affect outcomes.

constraint:

$$c = y - \tau. \tag{1.4}$$

Following equation shows the government budget constraint:

$$\tau + b' \cdot q(b') = g + b. \tag{1.5}$$

τ denotes lump-sum tax, b' denotes current bond sale, and $q(b')$ denotes the bond price which is a function of the current level of bonds. $b'q(b')$ is the market value of bond sales. The government can raise revenue either by borrowing more or raising taxes. It repays the outstanding debt, b, and spends on public expenditure, g, from the revenue it raises.

Aggregate resource constraint when in good financial standing is derived by combining households' budget constraint in equation (1.4) and the government's budget constraint in equation (1.5):

$$c + g = y + b' \cdot q(b') - b. \tag{1.6}$$

If the government repays the outstanding debt, the total resource it can use in the economy becomes the sum of endowment (y) and net borrowing ($b' \cdot q(b') - b$). Once the government determines the optimal borrowing level, it allocates its resources to c and g.

Output follows a stationary and exogenous process.[8]:

$$\log(y') = \rho \log(y) + \epsilon, \tag{1.7}$$
$$\epsilon \overset{\text{i.i.d.}}{\sim} N(0, \sigma_\epsilon^2).$$

To ensure stationarity, AR(1) coefficient $|\rho|$ needs to be smaller than 1. Error term follows Normal distribution with mean 0 and variance σ_ϵ^2.

Default

In case the government chooses to default, it reneges on its outstanding debt completely ($b = 0$). By repudiating its debt obligation, the country frees up some resources that would have been used to repay the outstanding debt at the cost of (a) exclusion from the international financial market; and (b) output loss. With an exogenous probability μ it can re-enter the market in the following period and starts from good financial standing with zero outstanding debt. With probability $1-\mu$ it will stay in autarky. c^a and g^a represent private consumption and government spending in autarky. Value function of a country when default is:

$$V^D(y) = u(c^a, g^a) + \beta \mathbb{E}\left[\mu V^G(0, y') + (1-\mu)V^D(y')\right]. \tag{1.8}$$

[8]Aguiar and Gopinath (2006) employ a stochastic trend component, showing including a trend component can match the data better. Exogenous output process assumption can be modified as in Mendoza and Yue (2012). They model working capital in sovereign default model showing endogenous feedback between production and default.

Households' budget constraint becomes:

$$c^a = y - L(y) - \tau^a. \tag{1.9}$$

The defaulting country suffers from quadratic output loss as in Chatterjee and Eyigungor (2012), so output losses are greater at high level of output. $L(y)$ is the output loss function ($L(y) = a_1 y + a_2 y^2 > 0$).

In a financial autarky, the government's cannot borrow to smooth consumption, making government spending equals taxes. Government's budget constraint in default period is:

$$g^a = \tau^a, \tag{1.10}$$

where τ^a is lump-sum tax in default period.

The country's resource constraint when defaulting becomes:

$$c^a + g^a = y - L(y). \tag{1.11}$$

When the government reneges on its outstanding debt, households' private consumption and government spending are determined by autarky output.

2.2 Fiscal Rule: Budget Rule

The essence of a budget rule is that taxes and spending move together. Colombia adopted a structural (or cyclically adjusted) budget balance rule in 2011. Equation (1.12) mimics the rule that the Colombian government adopted:

government spending comoves with taxes when $\gamma > 0$.[9] This enforces the notion that spending should be financed by contemporaneous taxes.

In a rule economy model, g and τ satisfy the budget rule[10] :

$$g = \bar{g} + \gamma(\tau - \bar{\tau}). \tag{1.12}$$

The country follows the rule regardless of repayment or default decision. When repaying, $\gamma > 0$. When the country defaults, $\gamma = 0$. I assume government spending does not depend on output and is fixed at its mean level ($g^a = \bar{g}$) in default periods. This assumption is extracted from Argentinean data. One can observe that public spending/GDP had maintained a fixed level around its mean, during the time in between 2001, when Argentina defaulted on its external debt, and 2005, when the country began restructuring its sovereign debt.[11]

I make an assumption that the country cannot commit to the repayment of the debt, but it can commit to obey a fiscal rule, as in Hatchondo et al. (2021). Fiscal rules are often anchored in the Constitution, which provide a long-term fiscal discipline by reducing the chance of discretionary intervention of the government in charge.[12] In 2011, constitutional amendments about the fiscal rule were approved in Congress in Colombia.[13] Once the rule is in Constitution,

[9]The actual behavioral rule implemented is unobservable. Here, I lay the groundwork for a simple behavioral rule to achieve the country's numerical target, usually a medium-term goal.

[10]We can think of this equation as g is a function of τ plus a constant. $\bar{g}$ and $\bar{\tau}$ are calibrated to mean values of spending and taxes.

[11]https://data.worldbank.org/indicator/GC.XPN.TOTL.GD.ZS?locations=AR

[12]According to OECD (2013), "fiscal rules can have different national legal foundations, and may be enshrined in constitutions, ..."

[13]According to Berganza (2012), it included: i) the incorporation of the criterion of fiscal sustainability in the Constitution (articles 334, 339 and 346); ii) a more efficient management

the cost of violating the Constitution is substantial, so assuming the country can commit to follow the fiscal rule is not far-fetched. Another argument for the assumption about the commitment to the rule lies in Deyal et al. (2020) who reveal countries follow fiscal rules due to the ongoing IMF loan programs. When they abandon rules, countries risk losing an opportunity to access IMF loans.

2.3 Foreign Lenders

The country sells a one-period non-contingent discount bonds to risk-neutral foreign lenders. A zero profit condition requires the sovereign bond price to equal its expected return:

$$q(b', y) = \frac{1}{1+r^*}\mathbb{E}[1 - \Delta(b', y')]. \tag{1.13}$$

The bond price $q(b', y)$ depends on tomorrow's default outcome, which depends on today's borrowing. $\Delta(b', y') \in \{0, 1\}$ is the sovereign's default choice in the next period. $\mathbb{E}[1 - \Delta(b', y')]$ can be interpreted as the probability of repayment.[14] r^* is the world interest rate that a government in small open economy takes as given. When the country is likely to repay debt in the next period, lenders charge a lower interest rate, increasing the bond price. The likelihood of repaying the debt depends on two factors: today's borrowing and tomorrow's output.

Today's borrowing (b') becomes tomorrow's outstanding debt. As the

of the royalties,43 and, iii) the adoption of a fiscal rule on central government finances (Ley Nº 1.473).

[14]Since the haircut is 1, $\mathbb{E}[1-\Delta(b', y')] = 1-\mathbb{E}[\Delta(b', y')] = 1-(\mathbb{P}(repay)\cdot 0+\mathbb{P}(default)\cdot 1) = 1-\mathbb{P}(default) = \mathbb{P}(repay)$

country increases the level of borrowing today, it will inherit a higher debt burden in the next period. A higher debt burden chips away the endowment and bond sale revenues in the next period, which costs resources that would otherwise go to consumption and government spending. The country has a higher incentive to renege on the outstanding debt to free up resources, leading to a rise in the probability of default and a decline in bond price.

A lower level of output in the next period increases the likelihood of default in the next period. If a country endowed with low output repays the debt, it has fewer resources to smooth consumption. Default comes with a quadratic output loss: the loss gets bigger when the endowments get higher. Quadratic output loss makes it costly to default in high output state. Thus, the government is more likely to dodge debt repayment obligation in a low output state.

2.4 Equilibrium

Given a set of state variables $s = \{b, y\}$, an equilibrium consists of a set of functions:

1. policy functions $\{c(s),\ g(s),\ \tau(s), b'(s),\ \Delta(s)\}$
2. price $q(b', y)$

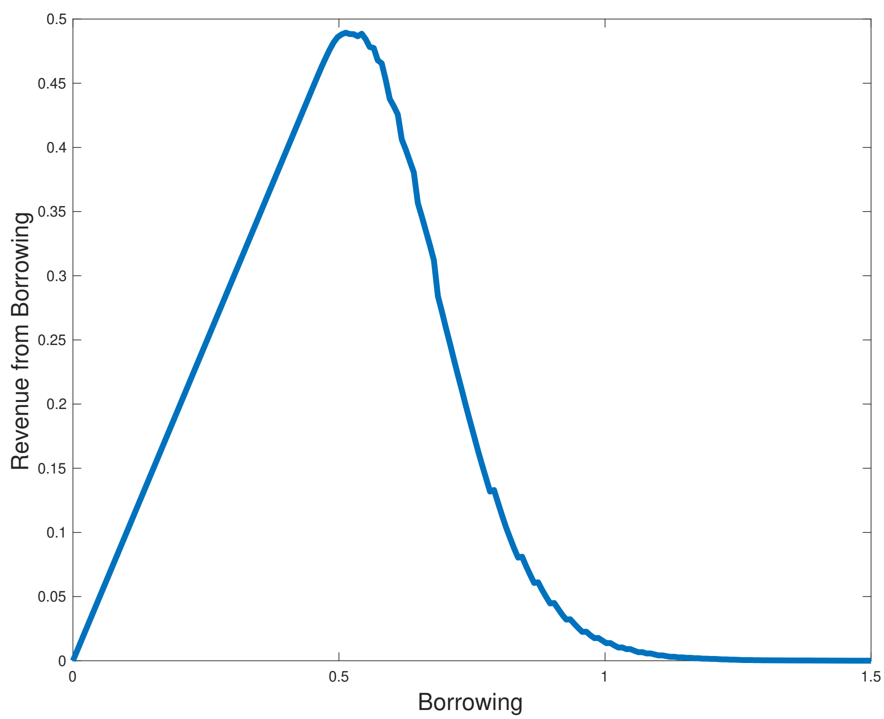
such that equations (1.1)-(1.13) hold.

3 Optimal Allocation

This section obtains and interprets the government's decision rules and debt accumulation incentives in an economy *without* and *with* a fiscal rule. How borrowing affects government spending depends on the presence of fiscal rule.

Revenue from the bond sales generate a debt Laffer curve. Higher borrowing lowers the bond price. When the bond sales are small, additional borrowing raises debt revenue since the drop in bond price is small. As the level of borrowing becomes higher, the bond price drops. Figure 1.3 shows the endogenously risen debt Laffer curve from the no-rule economy when the output is fixed at mean output.[15]

Figure 1.3: Debt Laffer Curve



What the government cares is the amount of revenue it raises from bond sales, not the bond price itself. Lorenzoni and Werning (2019) demonstrate

[15]Rule economy's debt Laffer curve has the same inverted-U shape curve.

two different values of borrowing satisfy the same level of bond sale revenue, causing an indeterminacy of the equilibrium. I do not face this issue in my model: the government chooses the *optimal* level debt, thus the debt level must occur where one unit of borrowing increases the market value of bond sales. In other words, optimal borrowing is on the left-hand side of the debt Laffer curve and the slope is positive.

3.1 No-Rule Economy

By combining the intratemporal Euler equation ($\alpha_g \cdot u_c = (1-\alpha_g) \cdot u_g$, where u_c and u_c are marginal utility from private consumption and government spending, respectively) and resource constraint, we obtain equations (1.14) and (1.15) which show how borrowing affects c and g in no-rule economy.

$$c_{NR} = \underbrace{f_1(\alpha_g, \sigma)}_{\geq 0} \cdot (y + b' \cdot q(b') - b)\,, \tag{1.14}$$

$$g_{NR} = \underbrace{f_2(\alpha_g, \sigma)}_{\geq 0} \cdot (y + b' \cdot q(b') - b)\,. \tag{1.15}$$

Without the fiscal rule, the government chooses the optimal level of debt without an additional constraint on spending or taxes. The intratemporal Euler equation determines how the resources – endowment and net borrowing – will be distributed to c and g. Higher output raises c and g. This algebra shows government spending is optimally procyclical as Cuadra et al. (2010) show.

The coefficients $f_1(\alpha_g, \sigma) = \left(1 + \left(\frac{1-\alpha_g}{\alpha_g}\right)^{\frac{1}{\sigma}}\right)^{-1}$ and $f_2(\alpha_g, \sigma) = \left(\frac{1-\alpha_g}{\alpha_g}\right)^{\frac{1}{\sigma}} f_1(\alpha_g, \sigma)$ are both non-negative since $\alpha_g \in [0, 1]$. Derivations of the following equations can be found in the Appendix.

Equations (1.16) and (1.17) describe a marginal change in private consumption and government spending from an additional unit of borrowing.

$$\frac{\partial c_{NR}}{\partial b'} = f_1(\alpha_g, \sigma)\left(\frac{\partial b' \cdot q(b')}{\partial b'}\right), \tag{1.16}$$

$$\frac{\partial g_{NR}}{\partial b'} = f_2(\alpha_g, \sigma)\left(\frac{\partial b' \cdot q(b')}{\partial b'}\right). \tag{1.17}$$

$\left(\frac{\partial b' \cdot q(b')}{\partial b'}\right)$ is the slope of the debt Laffer curve, which is positive. Debt-financed revenue ($b'q(b)$) increases both c and g. Once the optimal borrowing level is determined, the preference parameter α_g pins down the distribution of c and g. When $\alpha_g > 0.5$ (when the government puts a higher weight on private consumption over government spending), the increased margin for private consumption is bigger than that of government spending.

3.2 Rule Economy

Equations (1.18) and (1.19) show how private consumption and government spending move as the borrowing and the state of the economy change in a rule economy. They are derived by combining households' budget constraint, government budget constraint, and fiscal rule (equations (1.4), (1.5), and (1.12)).

$$c_R = y + \frac{1}{1-\gamma}\left(b' \cdot q(b') - b\right) - \frac{\tilde{g}}{1-\gamma}, \tag{1.18}$$

$$g_R = \frac{\gamma}{1-\gamma}\left(b - b' \cdot q(b')\right) + \frac{\tilde{g}}{1-\gamma}, \tag{1.19}$$

where $\tilde{g}$ is $\bar{g} - \gamma\bar{\tau}$. Unlike the case in no rule economy, a higher output level only affects private consumption, not government spending. By tying government spending with taxes, the economy eliminates a direct effect of output on public expenditure which lowers procyclicality of government spending.

Equations (1.20) and (1.21) describe how the borrowing affect private consumption and government spending.

$$\frac{\partial c_R}{\partial b'} = \frac{1}{1-\gamma}\left(\frac{\partial b' \cdot q(b')}{\partial b'}\right) \tag{1.20}$$

$$\frac{\partial g_R}{\partial b'} = -\frac{\gamma}{1-\gamma}\left(\frac{\partial b' \cdot q(b')}{\partial b'}\right) \tag{1.21}$$

An increase in borrowing raises private consumption if $0 < \gamma < 1$.[16]

When a country adopts a budget rule as described in equation (1.12), tax is tied to government spending: government spending can only be raised through a rise in taxes. The existence of the rule discourages the government from debt financing their government spending. A rise in taxes increases government spending at the cost of a reduction in private consumption. The more the government generates revenue from bond sales, the less room there is for taxes. Less tax revenue implies the government is facing a lower level of government spending. Debt financing government spending is not viable when the country follows the budget rule. The rule adds an implicit cost of debt accumulation in the form of reduced government spending, lowering borrowing incentives. The social planner's preferences over c and g does not directly affect how she distributes the resources between them, as those preferences do in the no-rule

[16] As γ approaches 1, both net borrowing and net lending explode. In a numerical result, there is a maximum γ that leads the country not to borrow at any states. Thus, I explore parameter space where $0 < \gamma < \gamma^{max} < 1$.

economy.

4 Numerical Results

4.1 Calibration

Table 1.1: Calibration of Colombian economy

Parameter	Description	Value	Source
σ	Risk aversion	2	?
α_g	Weight on private consumption	0.875	World Bank
β	Discount factor	0.865	Calibrated to match Debt/GDP and spreads
$\{a_1, a_2\}$	Output cost of default	(0, -0.245, 0.298)	Calibrated to match Debt/GDP and spreads
r^*	World interest rate	0.0093	U.S. 10 year treasury
(ρ, σ_ϵ)	AR(1) output process	(0.677, 0.128)	World Bank
$\{\bar{g}, \bar{\tau}\}$	Mean gov't expenditure/tax revenue	(0.1448, 0.1466)	World Bank
μ	Re-entry probability	0.0385	Schmitt-Grohé and Uribe (2017)

Period: 1998-2016

Table 1.1 shows the calibration values of the Colombian economy. I use a quarterly model. The risk aversion parameter σ is two, as in many other studies. The government's weight on private consumption, α_g, is calibrated so that the average intratemporal first-order condition satisfies the average data: private consumption is 2.64 times higher than public expenditure. I use households' final consumption expenditure/GDP data for private consumption and public expenses/GDP data for government spending. Both data are from World Bank. (β, a_1) are calibrated to match the debt level (43%), spreads (1.57%) we see in the data before the country adopted the fiscal rule in 2011. a_2 is calibrated to match the output loss in Argentina as in Schmitt-Grohé and Uribe (2017). The quarterly world interest rate is derived from the annual US 10 year Treasury rate (3.79%) in 1998-2016. From Colombian gross domestic output data, I separate the cyclical component from the trend component using the HP filter and estimate its AR parameters, ρ, and σ_ϵ. Mean values are used for government expenditure ($\bar{g}$) and taxes ($\bar{\tau}$). They are from the government expenditure/GDP and tax revenue/GDP data from World Bank. Colombia has no history of sovereign default, so there is no data from which to infer the re-entry probability. I use Argentina's re-entry probability to calibrate μ.[17]

4.2 Empirical Facts

In 2011, the Colombian Congress approved the fiscal rule proposed by the outgoing administration of Àlvaro Uribe that targets the "structural budget balance". The structural budget balance rule targets the fiscal balance excluding the cyclical components of GDP. Arbeláez et al. (2021) explain in detail the history of why the central government of Colombia implemented the fiscal rule.

Table 1.2 prohibits the macroeconomic statistics before and after the adoption of the fiscal rule in 2011.

Table 1.2: Colombian Data

	Avg. debt/GDP	Avg. spreads	$corr(g, y)$
Before 2011 (No rule)	43%	4.08%	0.8391
After 2011 (Rule)	66%	1.57%	0.2668

Period: 1998-2016

The average sovereign spreads decreased from 4% to 1%. after the country adopted the rule. Sovereign spread data is from JP Morgan's EMBI Global stripped spreads. The average central government debt to GDP measured by Central Government Debt in GDP[18] increased from 43% to 66%, at the

[17]Refer to Chapter 13 in Schmitt-Grohé and Uribe (2017) for a calculation of non-zero probability of re-entry.

[18]Data from World Bank

same sample period. The country sustains a higher level of debt with a lower sovereign risk premium after introducing the budget rule. Procyclicality of government spending measured by the correlation between HP-filtered public expenses and GDP has been reduced since 2011.

A budget rule was adopted to prevent the economy from increasing spending from oil boom revenues. This explains a possible reason why the degree of procyclicality of government expenditures fell.[19]

4.3 No Rule Economy

The benchmark economy is where the country does not follow the rule. The government chooses the borrowing level that maximizes its present value of welfare without any constraint on taxes and spending. In this economy, government spending is not a function of lump-sum tax. Optimal level of private consumption and government spending are determined by the government's intratemporal Euler equations (refer to equations (1.14) and (1.15))

Table 1.3: Model Statistics: No-Rule Economy

Average debt/GDP	Average spreads	$corr(g, y)$
44.31%	4.02%	0.94

The no-rule economy model matches the data prior to the adoption of the fiscal rule in 2011 from Table 1.2 by construction. Spreads measure the difference between the sovereign bond yield and the return of risk-free assets

[19] Check the report from Reuters after President Santos' sworn in. "... it would oblige the state to save money and cut debt during boom-times to have the reserves needed to run countercyclical spending policies when the economy slows." (source: https://www.reuters.com/article/colombia-economy/will-colombias-santos-slay-fiscal-deficit-dragon-idUKN0921000520100809)

(r^*). The model shows that government spending is optimally procyclical. This result of procyclical government spending can also be found in Cuadra et al. (2010)'s work.

4.4 Rule Economy

The fiscal rule that ties government spending to taxes affects the government's borrowing incentives. To raise revenue for financial obligation ($b + g$), the government can either raise taxes (τ) and/or raise revenue from bond sales ($b'q(b')$). The country does not need to impose more taxes to finance the same revenue as borrowing increases. When there is no rule (benchmark model), an increase in borrowing raises both private and public expenditure (c and g). However, with the fiscal rule put in place, an increase in borrowing only increases private consumption, not public expenditure (refer to equations (1.18)-(1.15)). To increase government spending (g), the country has to raise taxes which lowers private consumption (equations (1.12) and (1.4)). Unlike the case of a no-rule economy, debt-financed private consumption crowds out government spending. If the government increases borrowing, less revenue comes from increasing taxes, so τ falls. A decline in taxes revenue implies a decline in public spending through the rule. Raising the sovereign debt level with the fiscal rule is more costly compared to the no-rule case. It is because the rule creates an implicit cost of debt-financed government spending. The rule curtails the incentive to increase borrowing to smooth government spending. The government can no longer increase debt to boost its government spending.

Table 1.4 describes the model statistics with different values of fiscal rule coefficient (γ) from simulations.Sovereign spreads are lower than those of the no-rule economy in every fiscal rule coefficient γ. This is because a default cost in a rule economy is substantial (when default, $\gamma = 0$, and g becomes $\bar{g}$). A decrease in default rate increases bond price and reduces spreads. However, due to a more costly borrowing in the rule economy the government chooses to borrow a small amount.

Table 1.4: Model Statistics: Fiscal rule economy

	Average debt/GDP	Average spreads	$corr(g, y)$
$\gamma = 0.1$	34.64%	2.62 %	0.59
$\gamma = 0.2$	34.11%	0.31%	0.80
$\gamma = 0.25$	16.27%	0.01 %	0.75
$\gamma = 0.3$	5.43%	0 %	0.62

A reduction in the spread is more substantial as γ increases. γ implies how much of the taxes convert to government spending. As γ becomes larger, one unit of taxes converts to a larger unit of government spending, implying the opportunity cost of borrowing on government spending is larger. When γ increases, two effects can happen at the same time: (1) raise taxes to raise government spending since higher γ implies more portion of taxes goes to public spending; and (2) do not need to raise taxes to raise spending since the same amount of taxes converts into a higher level of government spending. What we see in the model simulation is that the first effect dominates. The government raises taxes as γ rises. As a result, g gets higher, and c gets lower as γ increases. With a higher γ, the country increases taxes and borrows less, reducing spreads. This leads to lower debt/GDP on average in a rule economy despite of cheaper borrowing cost (lower interest rates).

Figure 1.4 shows the ergodic distribution of the rule economy with different γ values. We see as γ increases, the economy spends more time in the low debt region. Higher γ implies one unit of taxes converts into a higher level of government spending. As γ increases, the same amount of borrowing pushes private consumption and government spending in the opposite direction even further.

The procyclicality of government spending is lower in a rule economy. In a no-rule economy, when output is high, the country borrows more and distributes resources among c and g depending on the preference parameter (α_g). Thus, when output goes high, government spending also increases. With the fiscal rule, g does not get directly influenced by the level of output. This relationship can be found in equations (1.14)-(1.19). Determination of government spending, g, needs to satisfy the fiscal rule, which loses the tie between output and spending.

Figure 1.4: Ergodic Distribution of a Rule Economy

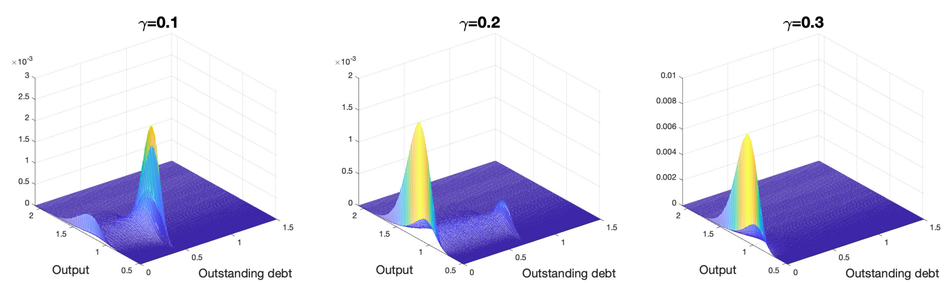


Figure 1.5 characterizes bond price schedules for no-rule economy and for different γs in a rule economy. I fixed the output level to its mean level and show how the bond price changes as the level of borrowing changes. After adopting the fiscal rule, default risk declines. A decrease in probability to default is shown in the outward shifting pricing schedules for the rule economy. Bond pricing schedule shifting to the right means the economy can have a higher level of bond price (a lower level of interest rate) with the same amount

of borrowing due to a drop in default risk. For different output levels, the shape of the figures does not change, but only the threshold where the bond price starts to drop changes. Bond pricing schedules for different levels of output can be found in the Appendix (Figure 1.19). Country defaults less with a higher γ. This is because a default choice with a high γ causes more significant drop in g, making default less desirable. As the policy coefficient γ increases, the pricing schedule shifts further out, explaining lower risk-premium with a higher γ.

Figure 1.5: Bond Price Schedule

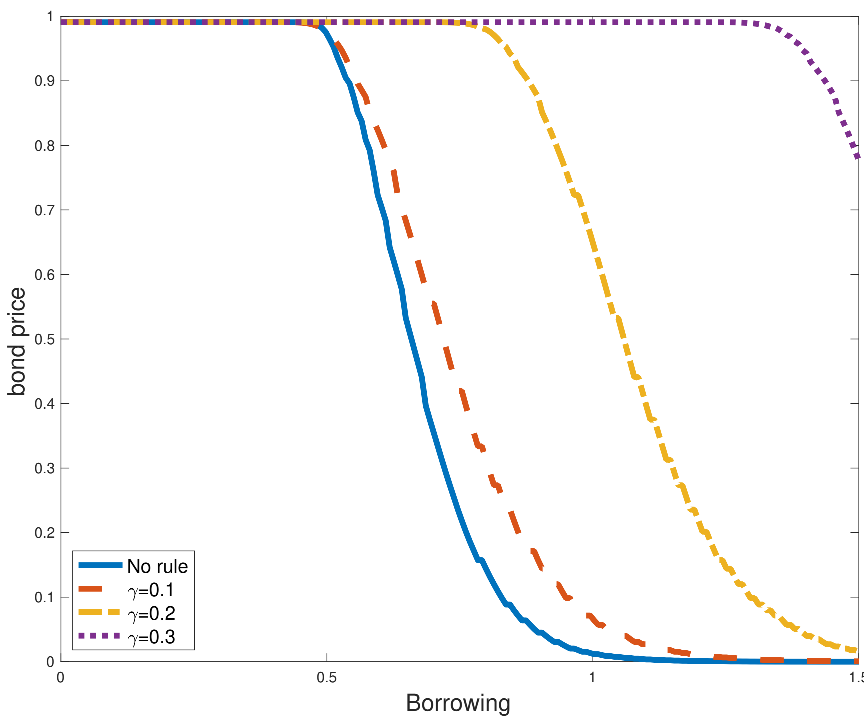
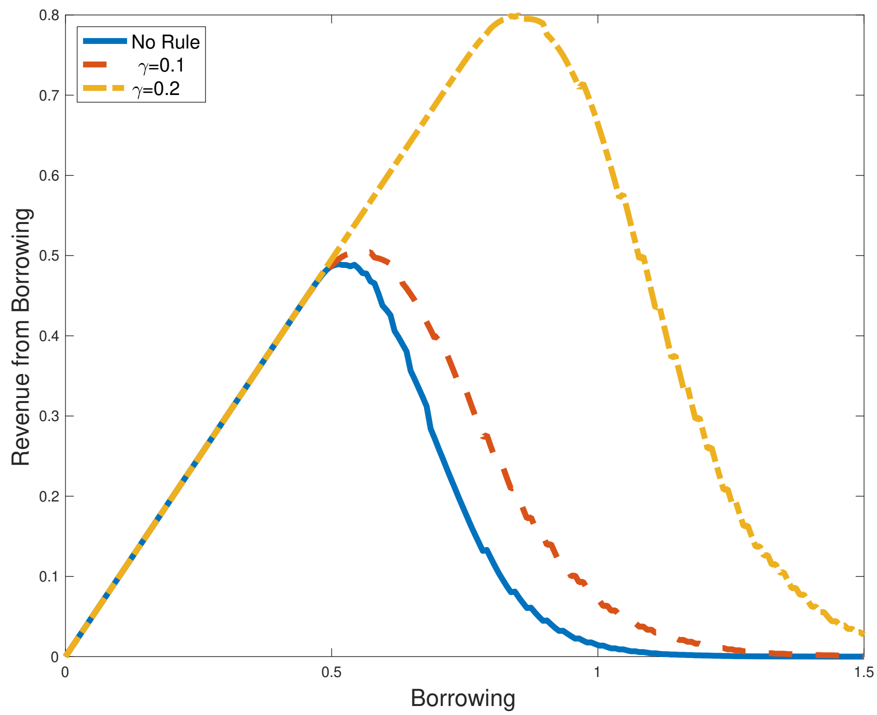


Figure 1.6 compares endogenous debt Laffer curve in a no-rule economy and a rule economy. Bond price is higher in the rule economy, resulting in higher debt revenue for the same amount of borrowing. An implicit cost from

borrowing in the rule economy, however, forces the government to choose a low debt level. As a result, the rule economy chooses to borrow less though the government is able to generate a higher debt revenue than the economy without a rule.

Figure 1.6: Debt Laffer Curve: Rule vs. No Rule



Good Loan Deal from an International Financial Institution

The budget rule itself does not match the empirical finding that the debt to GDP went up after Colombia adopted the rule (Table 1.2). I impose another assumption about unmodelled third party to match the higher debt level in rule economy.

In reality, supranational third party, such as the IMF, provides a loan guarantee with the looming crisis under the condition that the government has a fiscal discipline. Fiscal rules are institutional mechanisms imposed on the government providing a commitment to fiscal discipline. IMF Factsheet states, "When a country borrows from the IMF, its government agrees to adjust its economic policies to overcome the problems that led it to seek financial aid. These policy adjustments are conditions for IMF loans ... ". In other words, to be eligible for IMF financing, a country must meet the preconditions that the IMF imposes. One of the preconditions is "Budget consistent with fiscal framework".[20] Once the preconditions are satisfied, the IMF measures countries macroeconomic variables, such as the ceiling on government's borrowing when evaluating qualification for their financing.

The loan program that is designed to accommodate crisis-preventing or mitigating lending for countries is called Flexible Credit Line (FCL). FCL was a result of their lending reform in the 2009 that was intended "to reduce the perceived stigma of borrowing from the IMF". One of the criteria that the country needs to meet to get low-cost lending is the institutional policy framework. A country implementing a fiscal rule satisfies this condition. Colombia's first FCL was approved on May, 2009.[21]

Bond price function when the country can borrow from the third party is

[20] Refer to: https://www.imf.org/en/About/Factsheets/Sheets/2016/08/02/21/28/IMF-Conditionality

[21] source: IMF Press Release No. 10/186 (https://www.imf.org/en/News/Articles/2015/09/14/01/49/pr10186)

following:

$$q(b', y) = \begin{cases} \frac{1}{1+r^*} & \text{if} \quad b'^* < b_{max}, \\ \frac{1}{1+r^*}\mathbb{E}[1 - \Delta(b', y')] & otherwise. \end{cases} \tag{1.22}$$

Bond pricing equation (1.22) applies in the rule economy only. To get the loan guarantee deal, the country needs to (a) employ a fiscal rule; and (b) borrow under the exogenous debt ceiling, b_{max}.

The countries borrows from foreign lenders. When the country borrows below the debt ceiling, the IMF will guarantee the lenders' losses. Thus, the market does not charge the risk premium, and the bond price is fixed at the risk-free rate, resorting to a higher level of borrowing in equilibrium compared to the rule economy *without* loan guarantee program.

Once the government borrows past the b_{max}, it loses its special right to get the loan guarantee from the international institution and faces the borrowing cost that the market charges for the entire debt it accumulated. There is no partial loan guarantee.

There are studies demonstrate third party's role in sovereign default. Aguiar and Gopinath (2006) model third party bailout as a transfer. A pure transfer subsidizes default since it raises resources in default states. The third party provides resources as a form of loan in my study. Bolton and Jeanne (2009) studies sovereign debt model where sovereign can issue different types of debt. Their model has seniority in debt repayment. Lenders are aware of the existence of the preferential treatment resulting in higher sovereign spreads. I assume the lenders are homogenous, including the international institutions, and there is no differential treatment of sovereign debt repayment. This assumption can be interpreted that there is only one type of debt. In Fink and Scholl (2016)'s study, they assume the government which endogenously determines whether to request IMF supported program cannot default on the IMF loans. I presume the country can get a loan from the international financial institution at a risk-free rate so long as the country agrees to fiscal adjustments by adopting fiscal rules.

Table 1.5: Model Statistics: Fiscal rule economy with a low-cost loan opportunity

$\gamma = 0.1$

	Average debt/GDP	Average spreads	$corr(g, y)$
$b_{max} = 60\%$	51.3136%	1.0503%	0.6034
$b_{max} = 70\%$	60.2213%	0.9940%	0.6109

Table 1.5 reports the model statistics in the rule economy with different numerical borrowing limits (b_{max}). I fix the fiscal rule coefficient to be 0.1 in both cases. A cheaper loan opportunity provided by the IMF serves as insurance for the lender, raising the bond price in the market. Higher bond prices raise the country's utility to stay in repaying regime resulting in a lower default rate. We see for both debt limits 60% and 70% average spreads are lower than before.

The country borrows more as the debt limit becomes more lenient since it can enjoy fixed-price loans in more states. Borrowing more at a cheaper cost raises resources that can be distributed to private consumption and government spending. Defaulting on debt indicates the government will be excluded from the borrowing market, leading it to have less incentive to default. A low incentive to default reduces bond spreads.

5 Welfare Analysis

A simple fiscal rule in a model subject to a lack commitment to repayment issue can only improve welfare when there is an inefficiency that the rule can counteract. This section introduces an environment where a simple budget rule which moves taxes and spending in the same direction can improve welfare.

5.1 Agency Problem

The budget rule can improve households welfare when it addresses inefficiencies from the misaligned incentives of the government (agency problem). An agency problem arises when the households' welfare depends on the government, which has different objectives than the households and does not behave in the best interest of the households.

An example from my model is when the government values private consumption and government spending differently than the households do. This misaligned incentives results in the government not delivering the optimal outcome for the households. The budget rule, in this situation, can alleviate the externality coming from the agency problem.

The following represents how the government's preference is different from that of the households':

$$\begin{aligned} \text{HH utility} \quad & \alpha_h u(c) + (1-\alpha_h)u(g), \\ \text{Gov't utility} \quad & \alpha_g u(c) + (1-\alpha_g)u(g). \end{aligned}$$

I assume that the government values government spending more than the public does ($\alpha_h > \alpha_g$). One can think of "$\alpha_h - \alpha_g$", the discrepancy of the preferences, measures the political distortion. $\alpha_h = 1$ is an extreme case where the public does not value government spending at all. A simple rule, though puts an additional constraint leading to a sub-optimal outcome, has a potential value to the welfare of households when the it induces the government to make the decisions that make households better off.

One can find examples of this kind of agency problem especially in countries with a high rate of corruption. The World Bank's blog states, "It is generally assumed that in developing countries a large portion of public expenditures is lost to fraud, waste, and corruption—as some high-ranking officials have been candid enough to admit.[22]" Izquierdo et al. (2018)'s study indicates that the government spending in Latin American and Caribbean countries (LAC) are consumed wastefully. According to the study, the inefficiency created by wasteful spending is measured as significant as 4.4% of the countries' output on average. They reveal the expenditure for public procurement, which takes almost 30% of GDP in LACs, is a core of corruption and inefficiency. Behar-Villegas (2021) provides the narratives of wasteful and inefficient public spending in Colombia by taking an example of purchases of high-end cars for the government officials.

[22]https://blogs.worldbank.org/governance/waste-in-government-expenditures

5.2 Measuring Welfare

Following is the short description of how I calculate the welfare gain/loss from introducing the rule.

$$
\begin{array}{rcl}
\underline{\text{Benchmark (no-rule)}} & & \underline{\text{Alternative economy (rule)}} \\
V^{nr}(c_{NR}, g_{NR}) & = & V^{r}(c_{R}(1 - W^{*}), g_{R})
\end{array}
$$

I set the economy without the fiscal rule (no-rule economy) as a starting point and measure the welfare gain/loss of moving from the *no-rule* economy to *rule* economy. Welfare gain/loss (W^*) is measured in terms of a permanent increase/decrease of private consumption in present value. A positive W^* tells us up to what percentage of consumption we can take away from the households in rule economy to make them indifferent between the no-rule economy and the rule economy. Positive W^* indicates households would surrender consumption to move to the rule economy, meaning the households in rule economy have higher welfare.

Due to the utility function form I use, there is no simple analytical solution for the welfare gain/loss of adopting the rule. Thus, welfare gain/loss from moving to the economy with a fiscal rule is calculated numerically and is weighted accordingly with the ergodic distribution of no-rule economy. The detailed numerical description of how the welfare is computed can be found in the Appendix.

5.3 Welfare Change in Rule Economy

The government is making the optimal decisions for the households, behaving as if its preference parameter α_g reflects the households' true preference parameter, α_h. I vary α_h and see how the budget rule can improve households' welfare in the presence of a political distortion $(\alpha_h - \alpha_g)$, fixing α_g to the benchmark parameter $(\alpha_g = 0.875)$. I first measure the inefficiency coming from the misalignment of preferences, and see how much of that can be restored by employing a simple budget rule.

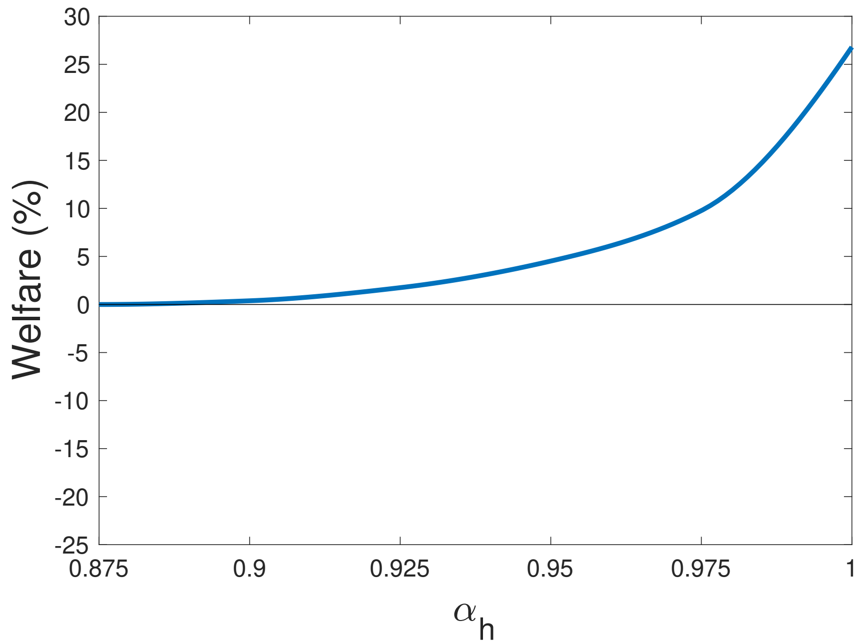
First Best Rule

Due to political distortion $(\alpha_h > \alpha_g)$, the optimal decision that the government makes is not an optimal decision for the households. An obvious first best rule, subject to the lack of commitment issue, is to reflect households' preference on allocation, α_h, when making decision. This rule can remove the distortion from the agency problem. How the spending gets determined when using the first best rule is described in the following equation:

$$g^* = \left(\frac{1-\alpha_h}{\alpha_h}\right)^{\frac{1}{\sigma}} c^*. \tag{1.23}$$

Benchmark economy is where the government decides allocations by discretion using α_g that does not necessarily coincide with α_h. The alternative economy is where the government uses the first best rule, meaning it uses households' preference parameters α_h when making a decision. To put it differently, benchmark economy is where the government satisfies $g^* = \left(\frac{1-\alpha_g}{\alpha_g}\right)^{\frac{1}{\sigma}} c^*$ and the alternative economy where the government satisfies $g^* = \left(\frac{1-\alpha_h}{\alpha_h}\right)^{\frac{1}{\sigma}} c^*$.

Figure 1.7: Welfare comparison: Budget rule vs. First best rule



The government can improve the welfare of the households by reflecting their true preference summarized by α_h. There is no welfare gain when $\alpha_g = \alpha_h = 0.875$ from Figure 1.7, because there is no inefficiency from the social planner having different preferences from the households. The bigger the discrepancies between the government's and households' preference, the bigger the welfare gain from using the first best rule. Welfare gain from using the first best rule can be interpreted as welfare *loss* from not reflecting households' preferences. In other words, it measures the inefficiency from the agency problem. It tells us the potential benefit of the rule when there is political frictions.

Although the first best rule improves the welfare the most, given the lack of commitment problem, it is hard to implement this rule in practice. First, government spending is a function of private consumption, which is difficult to observe in real-time, nor is it easily controllable. The rule that achieves the most welfare improvement is not simple enough for the government to use in practice. Second, when households have heterogeneous utility of c, $u_c(i) \neq u_c(j)$, this rule does not improve welfare.

Welfare Gain from Using A Budget Rule

Figure 1.8: Welfare changes to HHs' preference (α_h) change in a *rule* economy

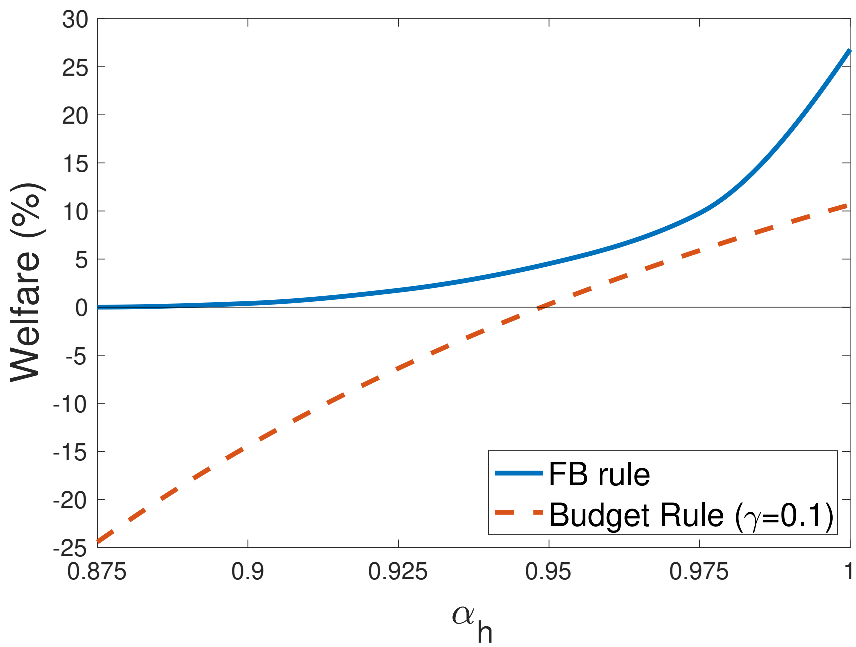


Figure 1.8 illustrates how a budget rule can restore welfare loss from a preference misalignment as the size of misalignment gets larger, fixing γ to 0.1.When there is no preference misalignment between the government and households, $\alpha_h = \alpha_g$, the fiscal rule reduces households' welfare. The fiscal rule serves as another constraint in the economy that prevents the government

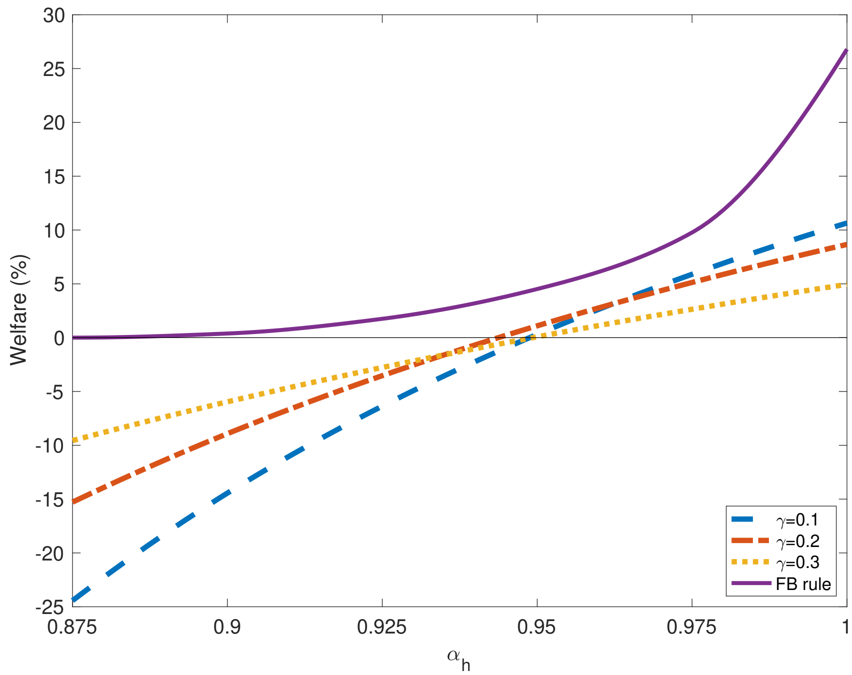
from achieving the best outcome *subject to* a lack of commitment to repay. In this case, the weighted average welfare loss of adopting the rule is 24%.

However, if the government fails to reflect households' preferences on private consumption, α_h, especially when α_h and α_g are sufficiently different, there is a potential welfare gain from the rule for the households. As the preference misalignment between the government and the households gets bigger, households regain more significant welfare. When $\alpha_h = 1$, which is an extreme case where the households do not value public consumption at all, the households gain welfare from the rule that amounts to 11% of permanent consumption when $\gamma = 0.1$.

Possible explanation for this phenomenon is the following: budget rule ties government spending to taxes making government spending more costly. Increasing government spending comes with a direct reduction in private consumption. The fiscal rule dampens the government's incentive to increase government spending. In equilibrium, it is optimal to allocate more to private consumption and less to government spending in the rule economy compared to the no-rule economy. If households do not value public spending as much as the government does ($\alpha_h > \alpha_g$), having a rule increases households' welfare since the rule will effectively reduce government spending. In other words, budget rule enhances households' welfare by rectifying the government's misaligned incentives, so that the government makes choices more in line to what households like to with the rule.

Figure 1.9 describes the variation in weighted welfare in different policy parameters γ. As in $\gamma = 0.1$ case, budget rule restores households' welfare as the preference misalignment gets bigger.

Figure 1.9: Welfare changes to HHs' preference (α_h) change in a *rule* economy



When γ is bigger, we observe a smaller swing in welfare as α_h varies. As γ increases, the same amount of tax revenue turns into a higher level of government spending. In response to that the government raises taxes which decreases borrowing. Government spending increases and private consumption decreases on average. From the households' perspective, when they do not value g as much, increasing γ is not as welfare improving since the government allocates more to government spending which, households do not value. The tipping point where the rule economy is welfare improving varies with γ. The rule improves households' welfare more as the political distortion $\alpha_h - \alpha_g$ gets bigger.

6 Extensions

In the main model, the government imposes lump-sum taxes, substitutability between c and g is not specified, and the government bonds mature in one period. This section explores how robust the results in Section 4 and **??** to alternative model specifications: (1) distortionary tax; (2) substitutability of goods; and (3) long-term debt.

6.1 Distortionary Tax

Think about an economy where the government imposes a consumption taxes. A higher tax rate makes consumption relatively more costly. When the budget rule is in place, the implication of consumption taxes on private consumption and government spending does not change: tax increases reduce consumption but raise government spending through the rule. Households and government budget constraints change as in the following equations:

$$\text{(HH budget constraint)} \qquad c(1+\tau_c) = y, \tag{1.24}$$

$$\text{(Govt budget constraint)} \qquad \tau_c c + b' \cdot q(b') = g + b. \tag{1.25}$$

Fiscal rule with consumption taxes is given in the following equation:

$$g - \bar{g} = \gamma_c(\tau_c c - \bar{T}). \tag{1.26}$$

As in the main model section, set $\gamma_c > 0$ to make government spending and tax revenue move in the same direction. $\bar{g}$ and $\bar{T}$ are parameters of choice. I calibrate them by using mean government spending/GDP and tax revenue/GDP in the data.

I re-calibrate the main model to match the no-rule economy to the data. When $(\beta, a_1, a_2, \theta)$ = (0.875, -0.137, 0.2736, 0.01), benchmark model matches the average debt level and bond spreads from data. Model statistics using consumption taxes is described in Table 1.6.

Table 1.6: No Rule Economy with Consumption Tax

	Average debt/GDP	Average spreads	$corr(g, y)$
Model	42.50	4.88	0.70
Data	43%	4.08%	0.8391

Following equations are derived by combining equations (1.24)-(1.26):

$$\begin{aligned} \text{Tax Revenue} \quad & \tau_c c = \frac{1}{1-\gamma_c}\left(b - b'q - \tilde{g}_c\right), \\ \text{Gov't Spending} \quad & g = \frac{\gamma_c}{1-\gamma_c}\left(b - b'q\right) + \frac{1}{1-\gamma_c}\tilde{g}_c, \\ \text{Consumption} \quad & c = \frac{1}{1-\gamma_c}\left(b'q - b\right) + y - \frac{1}{1-\gamma_c}\tilde{g}_c, \end{aligned}$$

where $\tilde{g}_c = \bar{g} + \gamma_c \bar{T}$. The effect of increasing borrowing on government spending and consumption is similar to the lump-sum tax case. The difference here is now the tax revenue does not increase the same rate as the tax rate increase. In theory, as the tax rate (τ_c) increases, tax revenue first increases and then flattens or even decreases after passing the maximum point. The tax rate is chosen such that it maximizes the current utility that consists of c and g (a detailed explanation of the derivation of the optimal tax rate is in the Appendix).

The model statistics of fiscal rule with consumption taxes are illustrated in

Table 1.7.

Table 1.7: Fiscal Rule Economy with Consumption Tax

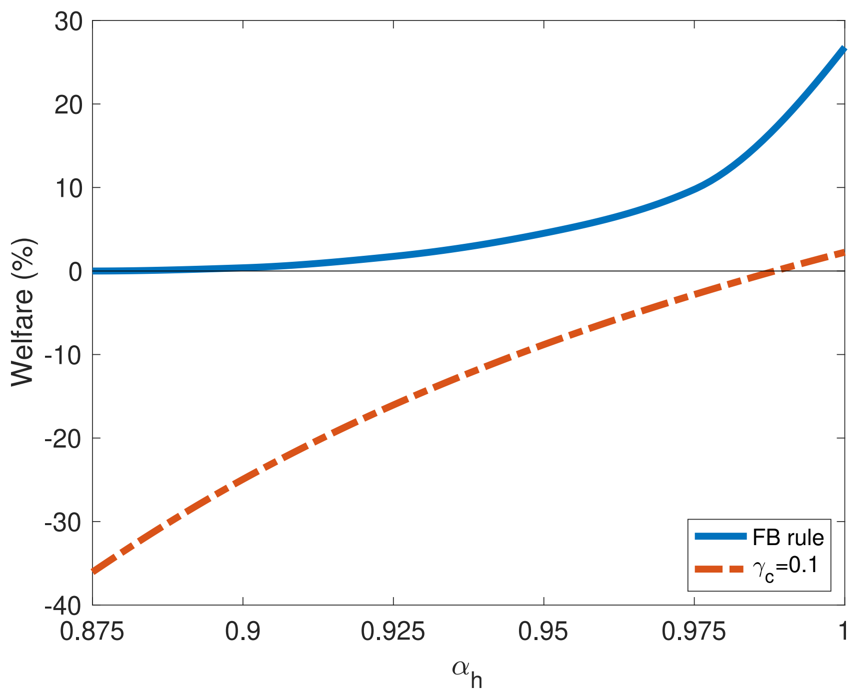
	Average debt/GDP	Average spreads	$corr(g, y)$
$\gamma_c = 0.1$	9.02%	1.25%	0.62
$\gamma_c = 0.125$	6.85%	0.24%	0.60
$\gamma_c = 0.15$	4%	0%	0.53

Sovereign spreads in the rule economy with consumption taxes are lower than that of a no-rule economy. As γ_c increases, average debt decreases, so does sovereign spreads. Procyclicality of spending drops in a rule economy. The economy sustains a lower level of debt, because it spends more time in low debt equilibrium when there is a fiscal rule. The implications of budget rule on debt/GDP, spreads and procyclicality of spending do not change as the taxes become distortionary.

Table 1.17 in the Appendix reports welfare gain/loss of employing fiscal rule with consumption taxes when the agency problem is present. The benchmark model is the no-rule economy with consumption taxes. The alternative economy is the rule economy with a consumption taxes.

As shown in the economy with lump-sum tax, households benefit from adopting the fiscal rule when the government does not reflect their true preferences when making a decision. In other words, with the agency problem, regardless of lump-sum tax or consumption tax, fiscal rules can enhance the welfare of the households. The bigger the distortion from the agency problem is $(\alpha_h - \alpha_g)$, the bigger the gain from the rule. We can also check this result from Figure 1.10 and 1.11. As in lump-sum tax case, as the rule parameter γ_c increases, one unit of tax revenue converts to a higher level of spending, resulting in tax revenue increases followed by spending increases. Thus, with a high α_h, the government does not need to increase tax much to increase government spending when the coefficient γ_c is high resulting in higher consumption. This situation can increase the welfare of the households when the households do not appreciate government spending.

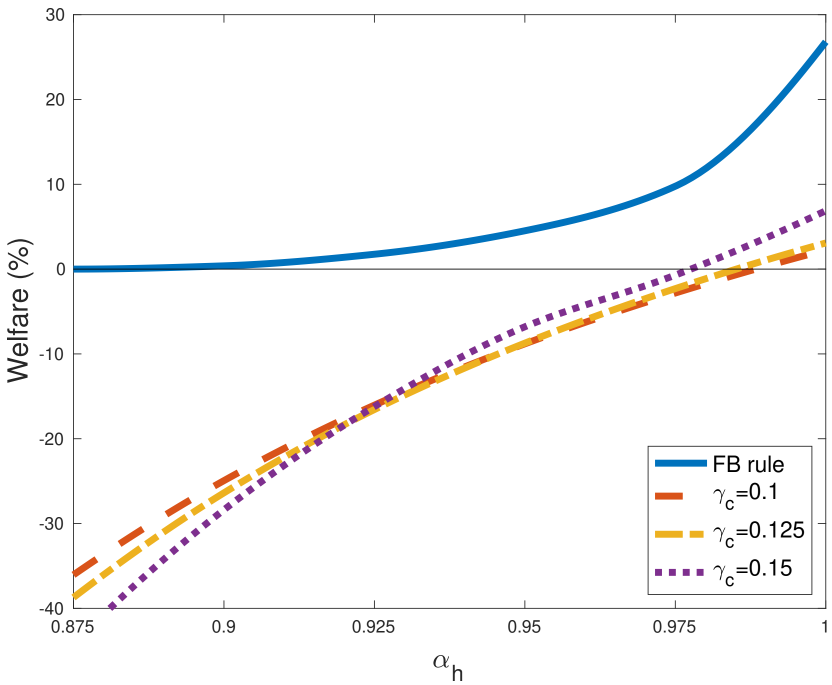
Figure 1.10: Welfare changes in a *rule* economy with consumption tax



6.2 Substitutability of Goods

I check the robustness of welfare results with a more general form of utility function where c and g are not additively separable. Equation (1.27) describes how both households and government derive utility from c and g. Everything else except the utility form is the same as in Section 2, including the rule. In

Figure 1.11: Welfare changes in a *rule* economy with consumption tax



the main model, only the intertemporal elasticity of substitution was constant. Both intratemporal and intertemporal elasticity of substitutions are constant here (equation (1.27)).

$$u(c,g) = \frac{1}{1-\sigma}\left[\alpha_g(c^{1-\epsilon}-1)+(1-\alpha_g)(g^{1-\epsilon}-1)\right]^{\frac{1-\sigma}{1-\epsilon}} \tag{1.27}$$

where

$$\frac{1}{\sigma} = \text{Intertemporal Elasticity of Substitution}$$
$$\frac{1}{\epsilon} = \text{Intratemporal Elasticity of Substitution}$$

Intertemporal elasticity of substitution (inter EIS) is $\frac{1}{\sigma}$. I use the same σ as in the main model ($\sigma = 2$). Intratemporal elasticity of substitution (intra EIS) between c and g is fixed as $\frac{1}{\epsilon}$. When ϵ=2, $\epsilon = \sigma$ and the general utility function collapse down to additively separable utility function used in Section 2.

$$\frac{1}{\epsilon} = \begin{cases} \infty & \text{Two goods are perfect substitutes} \\ 0 & \text{Two goods are perfect complements} \end{cases}$$

When the intra EIS is infinite, two goods are perfect substitutes. When the intra EIS is zero, two goods are perfect substitutes. I pick two different values of ϵ that makes c and g relatively complements or substitutes (Table 1.8). In both no-rule and rule economy, c and g's substitutability/complementarity depend on the parameter ϵ.

Table 1.8: Substitutability between c and g

	ϵ=1.5	ϵ=3
c and g are relatively	Substitutable	Complementable

Substitutes

I re-calibrated the model with the new utility function (equation (1.27)) so that the benchmark no-rule economy can match the average debt and sovereign spreads in data (see Table 1.9). Parameters I changed are following: $(\beta, a_1, a_2, \theta)$ = (0.865, -0.25, 0.3, 0.031)

I show the average debt and sovereign spreads are lower with the fiscal rule (see Table 1.10), as we see in the main result: fiscal rule lowers the default

Table 1.9: No Rule Economy (c and g are substitutes)

	Average debt/GDP	Average spreads	$corr(g, y)$
Model	44.66%	4.82%	0.99
Data	43%	4.08%	0.8391

probability by affecting the country's borrowing incentives. The procyclicality of government spending in a rule economy is not different from that of a no-rule economy.

Table 1.10: Sovereign bond spreads and spending cyclicality: substitutes

γ	Average debt/GDP	Average spreads	$corr(g, y)$
$\gamma = 0.1$	37.51%	0.62%	0.98
$\gamma = 0.5$	18.64%	0.02 %	0.98

When two goods are substitutes, adopting fiscal rule can bring a considerable welfare gain for the households. As the discrepancy between α_h and α_g gets bigger, households' welfare gain increases. The size of welfare improvement compared to the main result is higher, fixing γ and α_h. Figure 1.12-(a) illustrates the welfare gain of the rule when two goods are substitutes. When c and g are substitutes, households can achieve a welfare gain with a relatively low α_h. For example, when $\alpha_h = 0.9$, rule causes a welfare loss when $\gamma = 0.1$ in Section 5 (Figure 1.9). With the same $\alpha_h = 0.9$, households yield welfare from the budget rule, with two goods being substitutes. When two goods are substitutes, the rule can be good for the households even with a smaller political distortion.

The fiscal rule makes government spending come from taxes which lowers consumption. It is more costly to raise government spending since it directly crowds out consumption. In equilibrium with the budget rule, as a result, the government chooses to have less government spending. The budget rule pushes two goods in the opposite direction, promoting further welfare when two goods are substitutes.

Complements

Parameters are re-set to match the benchmark no-rule model when two goods are complements: $(\beta, a_1, a_2, \theta)$ = (0.88, -0.255, 0.3020, 0.03). Following table shows the model statistics from no-rule economy when consumption and government spending are complements:

Table 1.11: No Rule Economy (c and g are complements)

Average debt/GDP	Average spreads	$corr(g, y)$	
Model	45.96 %	4.54 %	0.98
Data	43%	4.08%	0.8391

If the two goods are complements, the budget rule lowers the average debt and spreads (Table 1.12). Procyclicality of government spending is not reduced significantly as in Section 4.

Table 1.12: Sovereign bond spreads and spending cyclicality: complements (ϵ=3)

γ	Average debt/GDP	Average spreads	$corr(g, y)$
$\gamma = 0.05$	20.12%	0.03%	0.92
$\gamma = 0.1$	3.54%	0%	0.97
$\gamma = 0.15$	1 %	0%	0.98

The welfare result is described in Figure 1.12-(b). Unlike in the main result, when the two goods are complements, the rule does not help mitigate the agency problem. Even in an extreme case when the households' do not value government spending at all ($\alpha_h = 1$), when the two goods are complements, the rule does not enhance their welfare.When two goods are complements, they generate a utility when consumed together. The rule does precisely the opposite: the budget rule pushes two goods in the opposite direction, reducing welfare.

6.3 Long Duration Debt

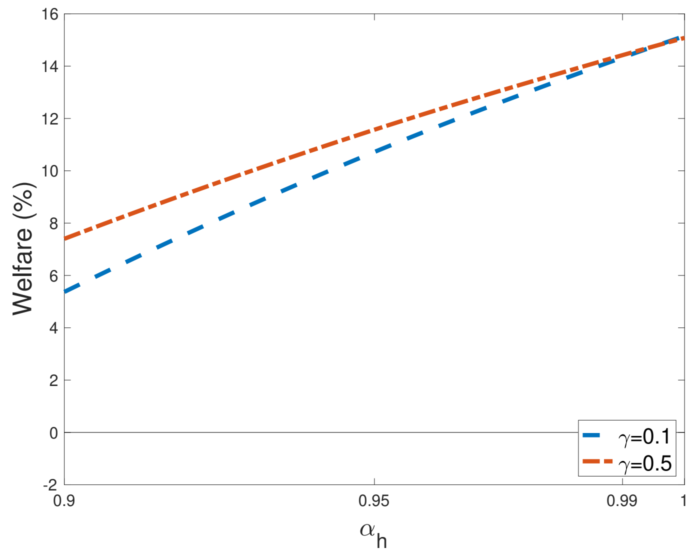
The government in Section 2 sells a one-period discount bond to the foreign lenders. In this subsection, I expand the maturity to multi-period to see if the budget rule's implications on sovereign default rate and households' welfare vary with a longer maturity bonds.

To simplify the computation, I solve a three-period model. A graphical illustration of the types of debts regarding their maturity is in Figure 1.13. As in **?**, at each period, the government makes default decisions only on the bonds that are due and does not default on debts that are not yet due.

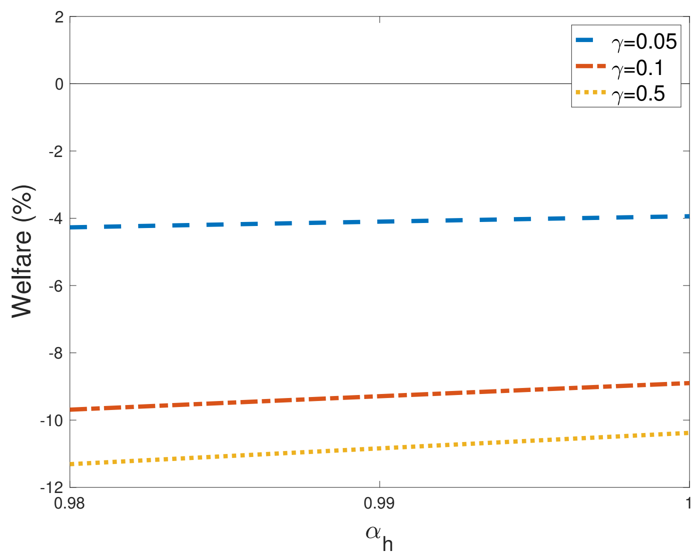
The government starts in period 1 with no existing debt. It sells two types of bonds: a long-term bond that matures in two periods (b_1^L) and a short-term bond that matures in the following period (b_1^S). In period 2, the government makes a default/repay decision for b_1^S. It sells one-period bond (b_2^S) in period 2. In period 3, both the b_1^L and b_2^S are due, and the government chooses to default or not on their debts. It does not issue any bond in period 3. One can find how I solve the model backward in detail in the Appendix.

When the government arrives in period 2, it has an incentive to borrow more (debt dilution), which increases default probability in the future period. A higher default probability in the future reduces the value of existing debt. Thus, how much it borrows in period 2 ($=b_2^S$) affects default decision in period

Figure 1.12: Welfare changes when two goods are



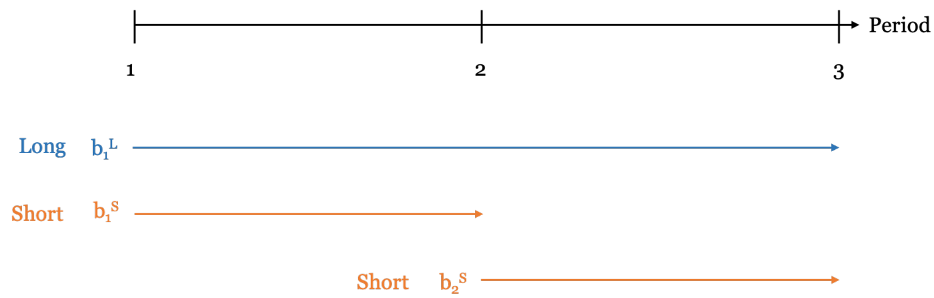
(a) Substitutes



(b) Complements

3, which then feeds back to the price of long duration bond ($=b_1^L$) in period 1. Since b_2^S is unknown when the price of b_1^L gets determined, the inefficiency

Figure 1.13: Long-Term Bond with a Three-Period Model



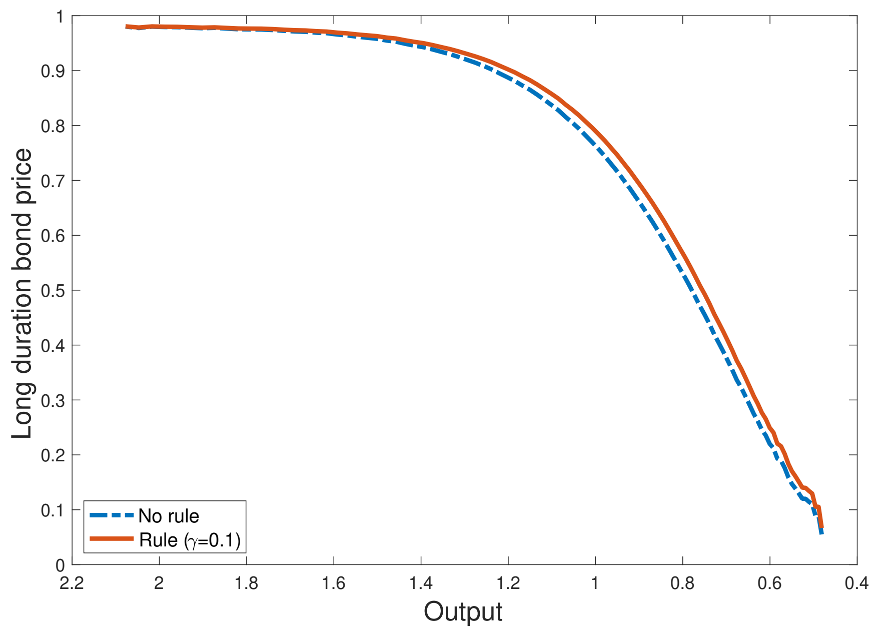
emerges. Due to the debt diluting incentives, a sovereign bond is not priced appropriately.

The government's incentive to overborrow in period 2 is reflected in the bond price in period 1, leading to a high sovereign risk premium. Hatchondo et al. (2016) find debt dilution accounts for a substantial part of the default risk. Because the future government's choices are not controlled, the current government faces a higher interest rate reflecting a high default risk.

Adopting the budget rule could address the friction from debt dilution with long-term debt. By pledging to follow the fiscal rule, it ties the hands of the future government from borrowing excessively by lowering the borrowing incentives in every period. Numerical results in Figure 1.14 and 1.15 show that the main result from adopting the rule (default risk falls and a potential welfare gain from re-distributing goods) remains the same with longer maturity bonds.

One can see how adopting a rule can push the long maturity bond price schedule out, enabling the country to borrow at a lower price, from Figure 1.14. In other words, engaging in a fiscal rule reduces the default risk, hence the sovereign risk premium in the presence of the inefficiency stemming from debt dilution incentives gets lower.

Figure 1.14: Long maturity bond price



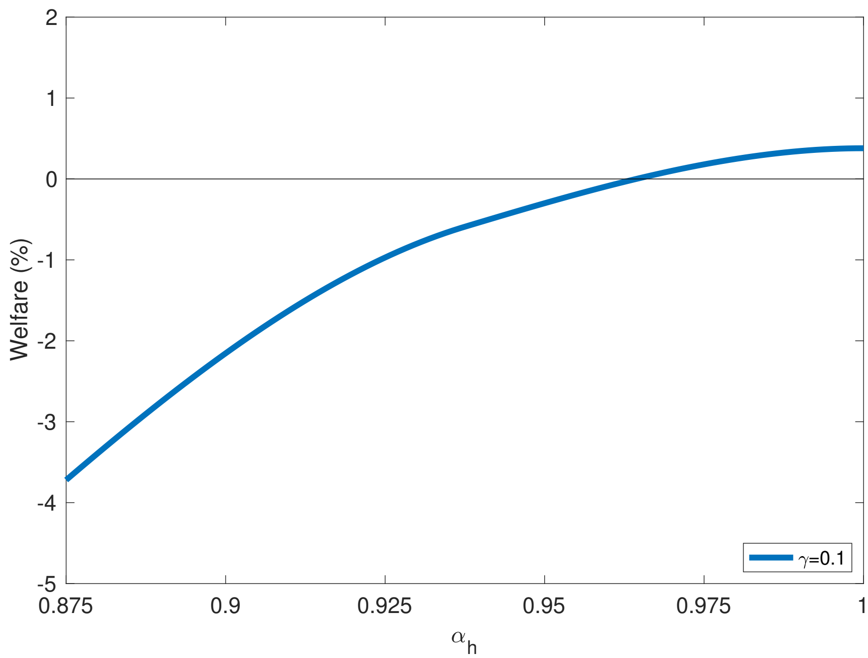
As I show in the main result with the one-period bond, as the preference misalignment gets larger, the potential welfare increase from adopting the fiscal rule gets bigger (Figure 1.15).

7 Spending Limit Rule

The type of agency problem I assume, where the government allocates a hefty amount on g, more than the households would prefer to, can also be countered effectively with other rules, such as spending limit rule.

$$g^* = \begin{cases} \left(\frac{1-\alpha_g}{\alpha_g}\right)^{\frac{1}{\sigma}} c^* & \text{if } \ g^* < g^{max} \\ g^{max} = \varphi \bar{y} & \text{if } \ g^* \geq g^{max} \end{cases} \tag{1.28}$$

Figure 1.15: Welfare: long maturity bond



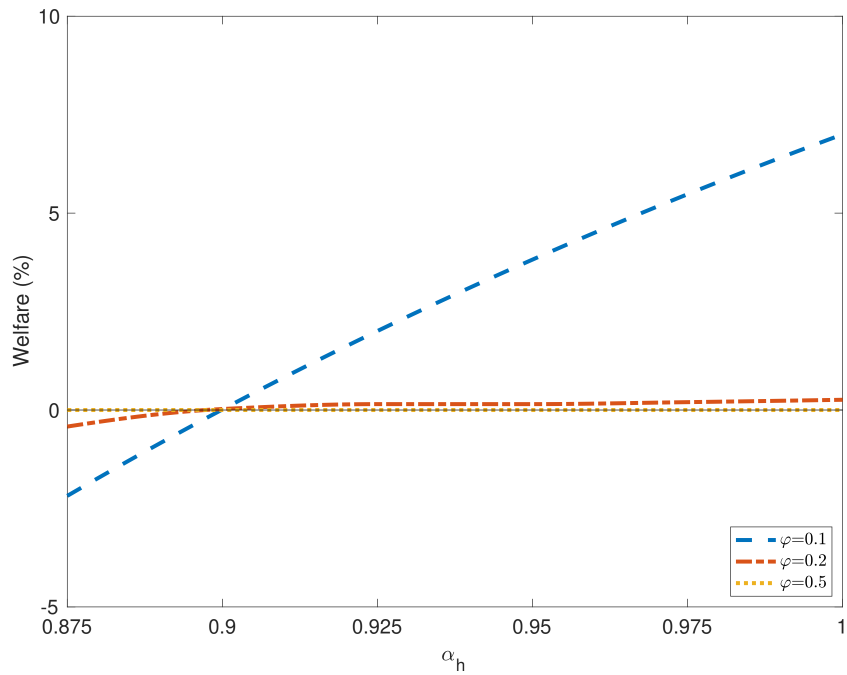
I explore a rule that puts a limit on government spending to see whether. Equation (1.28) describes how the spending limit rule works. If the optimally determined spending is below the spending limit (g^{max}), the equilibrium spending does not get affected. If the optimal spending exceeds the spending limit, the limit is binding: equilibrium spending is determined at the spending limit. I set the spending limit as some percentage of a mean output. φ is in between 0 and 1.

When measuring the welfare, the benchmark model is where everything is optimally determined without any limit rule. The alternative economy is where the government spending follows the equation (1.28). I vary φ and see if there is any welfare gain from the spending limit rule.

Figure 1.16 illustrates spending rule improves welfare as the inefficiency

$(\alpha_h - \alpha_g)$ gets bigger.

Figure 1.16: Welfare comparison: Spending Rule



When the limit φ is tighter (low φ), the bigger the distortion $(\alpha_h - \alpha_g)$, the higher the welfare gain from the spending limit rule. When the limit is set generously ($\varphi = 0.5$), the government's behavior in allocating public spending more than the households want it to is not affected. The spending limit rule becomes useless in enhancing the welfare of the households with a higher limit (φ), because the limit is not binding, thus not changing any allocation on spending.

The spending limit rule only affects the spending levels in certain states where the spending limit binds. In other states where the limit does not bind, the government's "optimal" decision using α_g is not ideal from the households' perspective when the political distortion is considerable. This is the reason why the level of welfare improvement is smaller than the economy with the budget rule (equation (1.12) in some parameter regions.

8 Conclusion

This paper quantitatively shows the effect of a budget rule on sovereign default incentives and welfare, focusing on the case of small open economies with default risk. The budget rule requires government spending to move together with a tax raise. Enriching fiscal aspects in the standard sovereign default model leads to practical policy implications. My contributions are twofold.

First, I show that the budget rule lowers the country's default incentives by influencing the implicit cost of borrowing. Suppose the government relies on revenues from bond sales more. In that case, taxes do not need to increase much, leading to a decrease in government spending: raising borrowing is more costly because it reduces government spending. The rule curbs the government's incentive to frontload resources through borrowing, resulting in a lower default probability and lower sovereign spreads.

Second, the fiscal rule can improve households' welfare if it rectifies the government's misaligned incentives. When the rule counters the inefficiency that stems from the government not acting in the best interest of the households, the rule can increase households' welfare. According to the rule, taxes must rise to raise government spending, forcing the government to surrender private consumption to increase government spending. The budget rule increases the cost of government spending, inducing the government to make the households better off by choosing a lower level of public expenditure that households do not value.

Results hold up with more general model specifications, such as distortionary taxes, different utility specifications, and longer duration bonds.

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10 Appendix

10.1 Analytics

1. No rule economy

    - Intratemporal Euler equation: $\alpha_g u_c = (1-\alpha_g)u_g$

$$\alpha_g c^{-\sigma} = (1-\alpha_g)g^{-\sigma}$$
$$g = \left(\frac{1-\alpha_g}{\alpha_g}\right)^{\frac{1}{\sigma}} c$$

    - Put the intratemporal Euler into Resource constraint

$$c + g = y + b'q - b$$
$$\left(1 + \left(\frac{1-\alpha_g}{\alpha_g}\right)^{\frac{1}{\sigma}}\right) c = y + b'q - b$$

$$\Rightarrow c = \left(1 + \left(\frac{1-\alpha_g}{\alpha_g}\right)^{\frac{1}{\sigma}}\right)^{-1} (y + b'q - b)$$
$$g = \left(\frac{1-\alpha_g}{\alpha_g}\right)^{\frac{1}{\sigma}} \left(1 + \left(\frac{1-\alpha_g}{\alpha_g}\right)^{\frac{1}{\sigma}}\right)^{-1} (y + b'q - b)$$

2. Rule economy

- Rewrite the fiscal rule (equation (1.12))

$$
\begin{aligned}
g &= \bar{g} + \gamma(\tau - \bar{\tau}) \\
&= \gamma\tau + \underbrace{(\bar{g} - \gamma\bar{\tau})}_{\equiv \tilde{g}}
\end{aligned}
$$

- Combining fiscal rule with the government budget constraint (equation (1.5))

$$
\begin{aligned}
\tau - g &= b - b'q \\
(1-\gamma)\tau - \tilde{g} &= b - b'q \\
\tau &= \frac{1}{1-\gamma}(b - b'q) + \frac{1}{1-\gamma}\tilde{g}
\end{aligned}
$$

$$
\begin{aligned}
\Rightarrow \quad g &= \gamma\tau + \tilde{g} \\
&= \frac{\gamma}{1-\gamma}(b - b'q) + \frac{\gamma}{1-\gamma}\tilde{g} + \tilde{g} \\
&= \frac{\gamma}{1-\gamma}(b - b'q) + \frac{1}{1-\gamma}\tilde{g}
\end{aligned}
$$

- Combining the above result with households' budget constraint (equation (1.4))

$$
\begin{aligned}
c &= y - \tau \\
&= y - \frac{1}{1-\gamma}(b - b'q) - \frac{1}{1-\gamma}\tilde{g} \\
&= y + \frac{1}{1-\gamma}(b'q - b) - \frac{\tilde{g}}{1-\gamma}
\end{aligned}
$$

10.2 Figures

Figure 1.17: Composition of fiscal rules in advanced economies

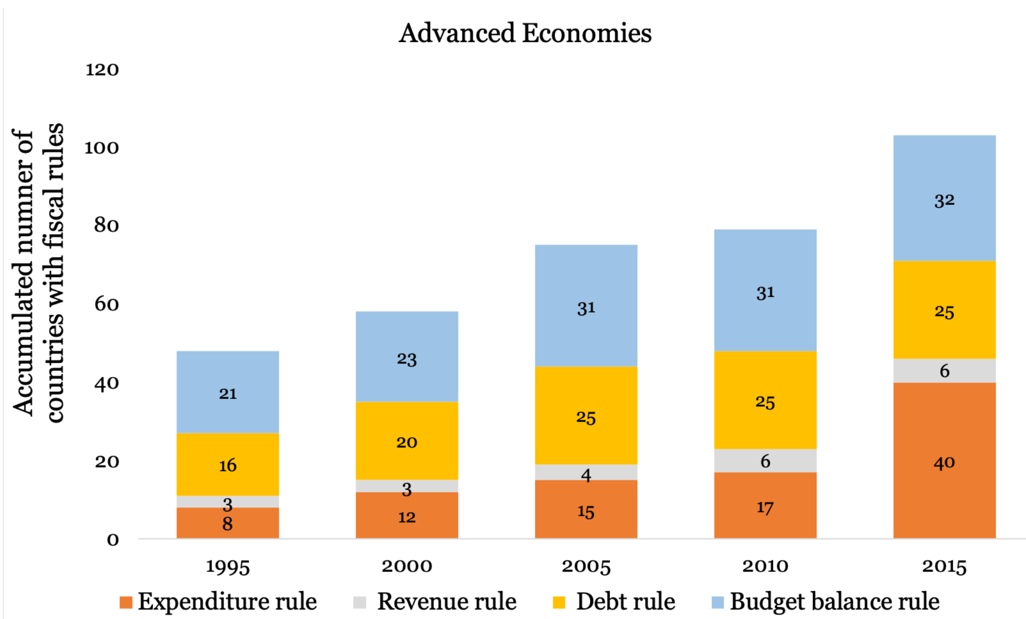


Figure 1.18: Structural balance change

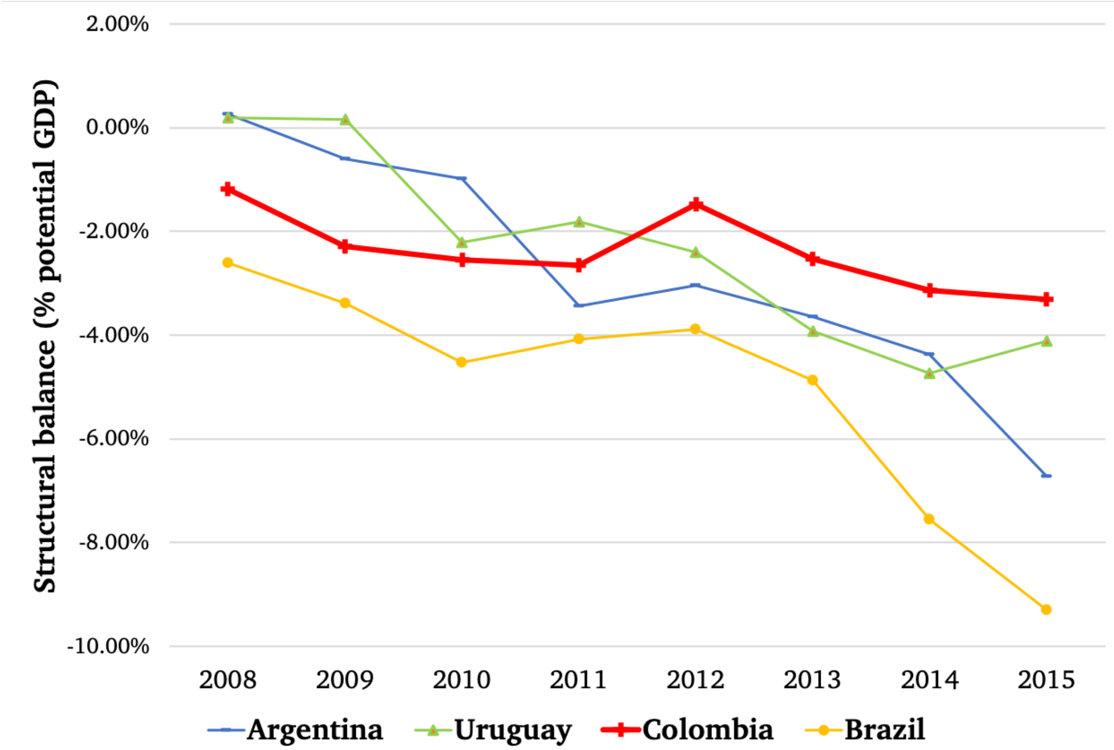
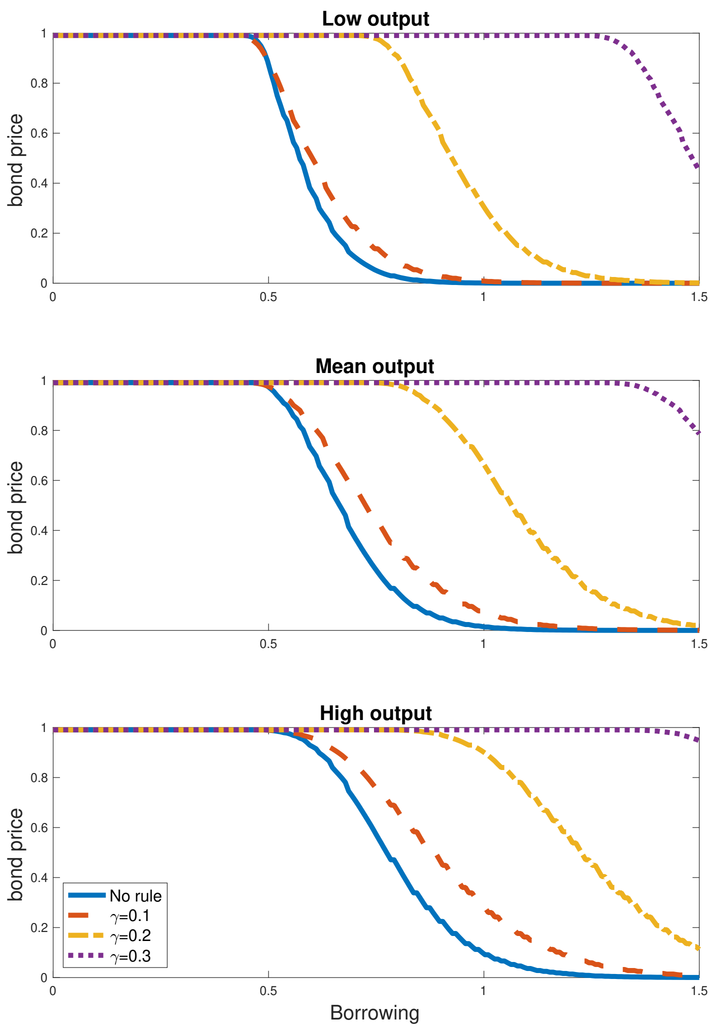


Figure 1.19: Borrowing Schedule



Low output = one standard deviation below the mean output
High output = one standard deviation above the mean output

Figure 1.20: Borrowing Schedule (fix the output)

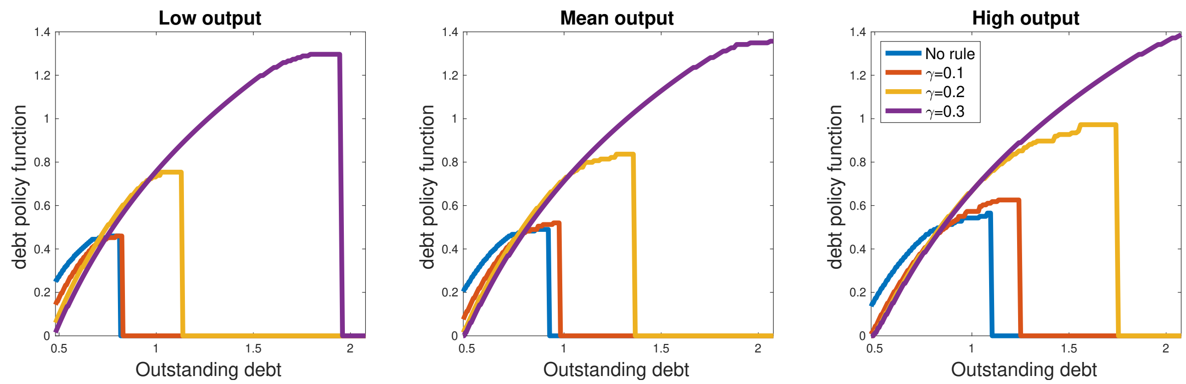


Figure 1.21: Borrowing Schedule (fix the outstanding debt)

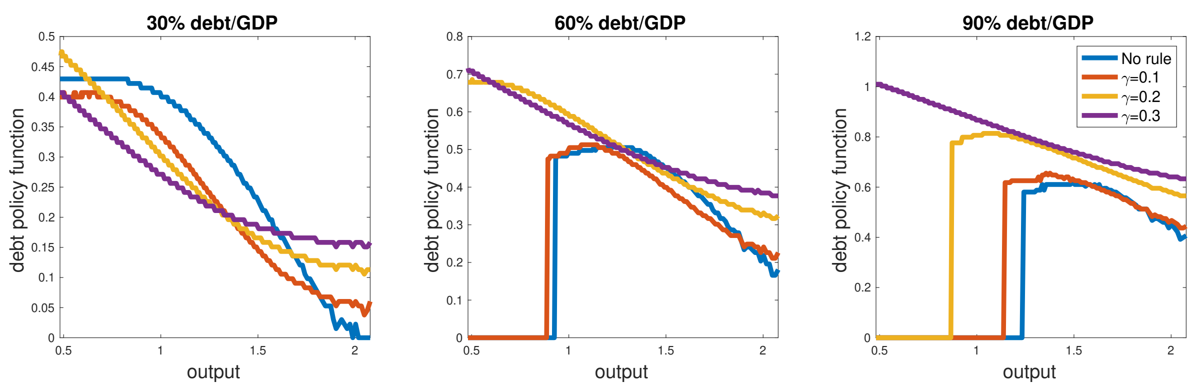
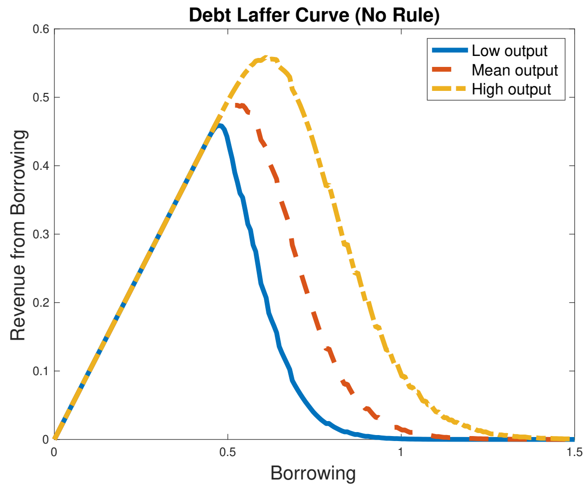
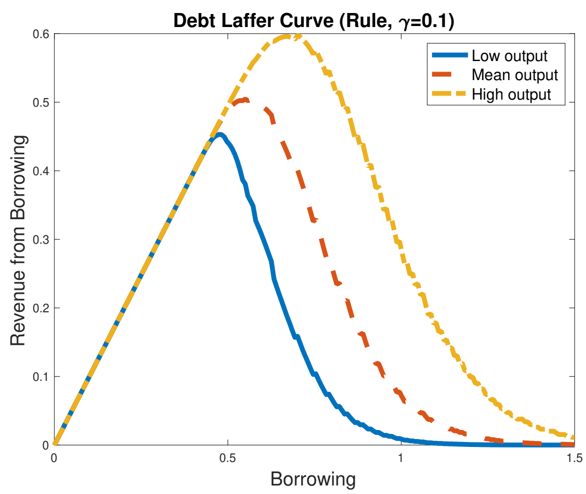


Figure 1.22: Debt Laffer Curve: No Rule



Low output = one standard deviation below the mean output
High output = one standard deviation above the mean output

Figure 1.23: Debt Laffer Curve: Rule



Low output = one standard deviation below the mean output
High output = one standard deviation above the mean output

Set bmax = 60% of GDP. Borrow more yet with a lower cost.

Table 1.13: Model Statistics: Fiscal rule economy with a low-cost loan opportunity

debt limit = 60% of GDP

	Average debt/GDP	Average spreads	$corr(g, y)$	$corr(\tau, y)$
$\gamma = 0.1$	51.3136	1.0503	0.6034	0.6172
$\gamma = 0.2$	34.1131	0.3153	0.8035	0.8056
$\gamma = 0.25$	16.2773	0.0145	0.7545	0.7546
$\gamma = 0.3$	5.4332	2.09e-06	0.6267	0.6267

Table 1.14: Model Statistics: Fiscal rule economy with a low-cost loan opportunity

debt limit = 70% of GDP

	Average debt/GDP	Average spreads	$corr(g, y)$	$corr(\tau, y)$
$\gamma = 0.1$	60.2213	0.9940	0.6109	0.6235
$\gamma = 0.2$	34.7952	0.3203	0.8056	0.8078
$\gamma = 0.25$	16.2773	0.0145	0.7545	0.7546
$\gamma = 0.3$	5.4332	2.09e-06	0.6267	0.6267

10.3 Measuring Welfare Gain/Loss

Welfare gain is measured as a compensation amount in a new economy in terms of private consumption to make benchmark and new economy equally good.

$$v_{bench}(b, y; 0) = v_{new}(b, y; W)$$

where

$$\begin{aligned} v_{new}(b, y; W) &= (1 - f^*)(u((1 - W)c^*, g^*) + \beta \mathbb{E} v_{new}(b'y'; W)) \\ &\quad + f(u((1 - W)c^{a*}, g^{a*}) + \beta \mathbb{E} v^d_{new}(y'; W)) \\ v^d_{new}(y; W) &= u((1 - W)c^{a*}, g^{a*}) + \beta \left[\mu v_{new}(0, y; W) + (1 - \mu) v^d_{new}(y'; W) \right] \end{aligned}$$

$\{c^*, g^*, c^{a*}, g^{a*}, f^*\}$ are obtained from government's maximization problem.

10.4 Consumption Tax

No Rule Economy

I follow the method Cuadra et al. (2010) used to obtain optimal consumption tax in a sovereign default model.

1. Find tax rate for every (b, y, b') that maximizes current utility consists of c and g for a given price (q).

$$\begin{aligned} \tau_c^* = \arg\max \quad & \alpha_g u(c) + (1-\alpha_g)u(g) \\ s.t. \qquad & c = \tfrac{1}{1+\tau_c} y \\ & g = \tau_c c + b'q - b \end{aligned}$$

2. Using obtained optimal tax rate (τ_c^*), derive optimal debt level

$$\begin{aligned} b' = argmax \quad & \alpha_g u(c) + (1-\alpha_g)u(g) + \beta \mathbb{E} V(b', y') \\ s.t. \qquad & c = \tfrac{1}{1+\tau_c^*} y \\ & g = \tau_c^* c + b'q - b \end{aligned}$$

Rule economy

1. Obtain optimal debt given the rule

$$
\begin{aligned}
& b' = argmax \;\; \alpha_g u(c) + (1-\alpha_g)u(g) + \beta \mathbb{E} V(b', y') \\
s.t. \quad & c = \tfrac{1}{1-\gamma_c}\left(b'q - b\right) + y - \tfrac{1}{1-\gamma_c}\tilde{g}_c \\
& g = \tfrac{\gamma_c}{1-\gamma_c}\left(b - b'q\right) + \tfrac{1}{1-\gamma_c}\tilde{g}_c
\end{aligned}
$$

2. Once b' and q are determined, optimal tax/spending/consumption subject to the rule can be derived.

$$
\begin{aligned}
c^* &= \tfrac{1}{1-\gamma_c}\left(b'q - b\right) + y - \tfrac{1}{1-\gamma_c}\tilde{g}_c \\
g^* &= \tfrac{\gamma_c}{1-\gamma_c}\left(b - b'q\right) + \tfrac{1}{1-\gamma_c}\tilde{g}_c \\
\tau_c^* &= \left[\tfrac{1}{1-\gamma_c}\left(b - b'q\right) + \tfrac{1}{1-\gamma_c}\tilde{g}_c\right] \times \tfrac{1}{c^*}
\end{aligned}
$$

10.5 Tables

Table 1.15: Welfare Analysis: First Best Rule

W^*	FB rule
$\alpha_h = 0.875$	0 %
$\alpha_h = 0.95$	4.52 %
$\alpha_h = 0.975$	9.77 %
$\alpha_h = 1$	26.80 %

Table 1.16: Welfare Analysis: rule economy vs. no rule

W^*	$\gamma = 0.1$	$\gamma = 0.2$	$\gamma = 0.3$
$\alpha_h = \alpha_g$	-24.43 %	-15.28 %	-9.56 %
$\alpha_h = 0.95$	0.30 %	1.10 %	0.07 %
$\alpha_h = 0.975$	5.89 %	5.13 %	2.64 %
$\alpha_h = 1$	10.65 %	8.66 %	4.95 %

$W^* > 0$ means budget rule enhances welfare

Table 1.17: Welfare Analysis: Consumption Tax

W^*	$\gamma_c = 0.1$	$\gamma_c = 0.125$	$\gamma_c = 0.15$
$\alpha_h = 0.875$	-36.05%	-38.72 %	-44.16%
$\alpha_h = 0.9$	-24.94%	-26.38%	-28.38%
$\alpha_h = 0.925$	-16.04%	-16.56%	-16.21%
$\alpha_h = 0.95$	-8.81%	-8.73%	-6.80%
$\alpha_h = 0.975$	-2.82%	-2.30%	-0.71%
$\alpha_h = 1$	2.25%	3.08%	6.88%

Table 1.18: Welfare Analysis: $\epsilon = 1.5$ (two goods are *substitutes*)

W^*	$\gamma = 0.1$	$\gamma = 0.5$
$\alpha_h = 0.9$	-5.37 %	-7.40 %
$\alpha_h = 0.95$	10.72 %	11.57 %
$\alpha_h = 0.99$	14.33 %	14.42 %
$\alpha_h = 1$	15.15 %	15.08 %

Table 1.19: Welfare Analysis: $\epsilon = 3$ (two goods are *complements*)

W^*	$\gamma = 0.05$	$\gamma = 0.1$	$\gamma = 0.15$
$\alpha_h = 0.98$	-4.27%	-9.69%	-11.31%
$\alpha_h = 0.99$	-4.10%	-9.29%	-10.84%
$\alpha_h = 1$	-3.94%	-8.90%	-10.38%

Table 1.20: Welfare Analysis: Spending Limit Rule

W^*	$\varphi = 0.2$	$\varphi = 0.5$
$\alpha_h = 0.875$	-2.18 %	0 %
$\alpha_h = 0.95$	3.82 %	0 %
$\alpha_h = 0.975$	5.48 %	0 %
$\alpha_h = 1$	7.00 %	0 %

10.6 Welfare Change with Loan Guarantee from International Institution

Welfare gain/loss from the fiscal rule when the country can take advantage of a lower-cost loan option is in Table 1.21.

Table 1.21: Welfare Analysis: loan guarantee in rule economy ($\gamma = 0.1$) + vs. no-rule

W^*	$b_{max} = 60\%$	$b_{max} = 70\%$
$\alpha_h = 0.875$	-19.80 %	-18.69 %
$\alpha_h = 0.95$	5.89 %	7.44 %
$\alpha_h = 0.975$	11.56 %	13.16 %
$\alpha_h = 1$	16.35 %	17.97 %

$W^* > 0$ means budget rule enhances welfare

As I have shown in Table 1.16, when there is an agency problem, households could yield welfare from the fiscal rule. What is noticeable is that the low-cost loan opportunity enhances the welfare gain from adopting the rule. When $\alpha = 1$, the welfare gain from fiscal rule and the cheaper loan opportunity measures up to 16% increase in consumption when the debt ceiling is 60%. As the debt ceiling goes up to 70%, welfare gain becomes even more significant (17% of permanent consumption increase).

Figure 1.24 illustrates the welfare gain in the rule economy when the country can access a low-cost loan opportunity. As the debt ceiling relaxes, the country can have a higher welfare gain/lower welfare loss at the same level of α_h. When $\alpha_g = \alpha_h$, the rule is not welfare improving, even with the third party intervention. With the help of an international financial institution, the welfare loss decreases but does not flip the sign of the welfare.

The third-party intervention guarantees the interest rate to be risk-free so long as the country abides by the fiscal rule and does not go over the debt ceiling. This allows the government to borrow at a higher level. Under the rule economy, the fund raised from the external borrowing is mostly used to finance private consumption, not government spending. Thus, enabling the country to borrow at a higher level can increase the households' welfare further.

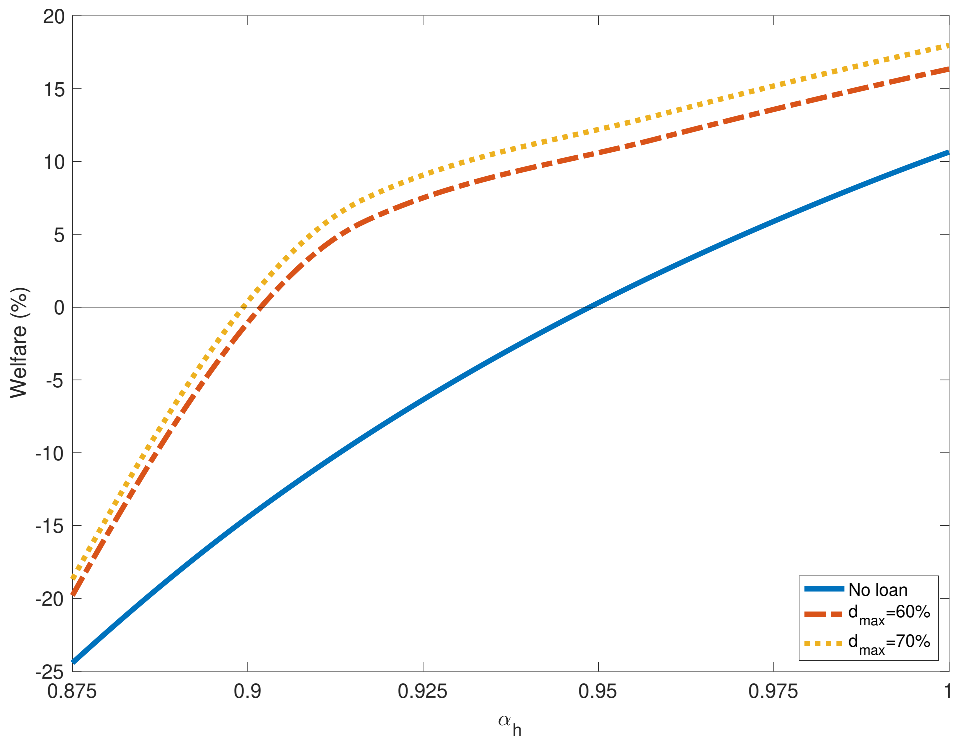
IMF lending itself does not increase welfare as much without the budget rule. Table 1.22 shows the welfare result of IMF loan when the government does not have a fiscal rule. Benchmark economy is where there is no third party intervention. The alternative economy is where there is a third party intervention.

Table 1.22: Welfare Analysis: loan guarantee in no-rule economy

W^*	$b_{max} = 60\%$	$b_{max} = 70\%$
$\alpha_h = 0.875$	6.72 %	11.34 %
$\alpha_h = 0.95$	5.67 %	9.60 %
$\alpha_h = 0.975$	5.35 %	9.06 %
$\alpha_h = 1$	5.04 %	8.55 %

In the absence of a fiscal rule, we see that cheaper loan opportunity improves welfare the most if households and the government agree. Low cost borrowing opportunity broadens the borrowing set, enabling the government to secure more resources. Welfare improves regardless of the discrepancy between the

Figure 1.24: Welfare changes to HHs' preference (α_h) change in a *rule* economy with loan guarantee



government's preference (α_g) and the households' preference (α_h). As the political distortion grows (α_h increases), the welfare gain from the third party intervention declines. When the political distortion gets larger, the government is getting farther from choosing the allocation as households' wish. A loan support program itself does not change the incentives to allocate less for the government spending. Thus, the bigger the distortion, the smaller the welfare gain. This shows cheaper funding opportunity, without the budget rule, does not improve welfare as much in an economy with a high political distortion.

10.7 Consumption Tax Revenues

Figure 1.25: No-Rule Economy

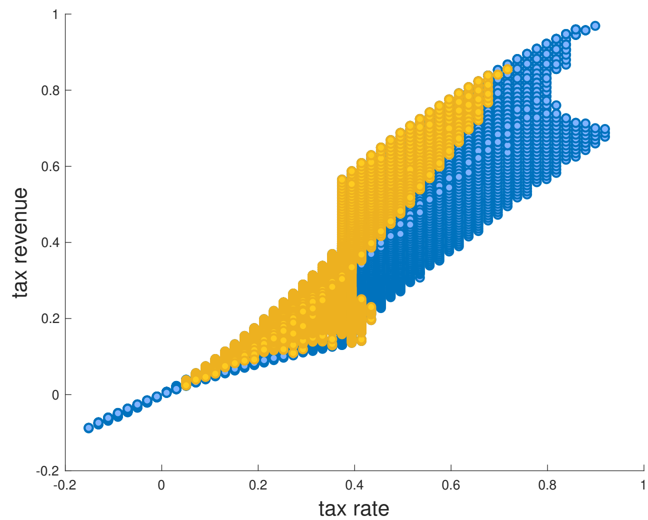
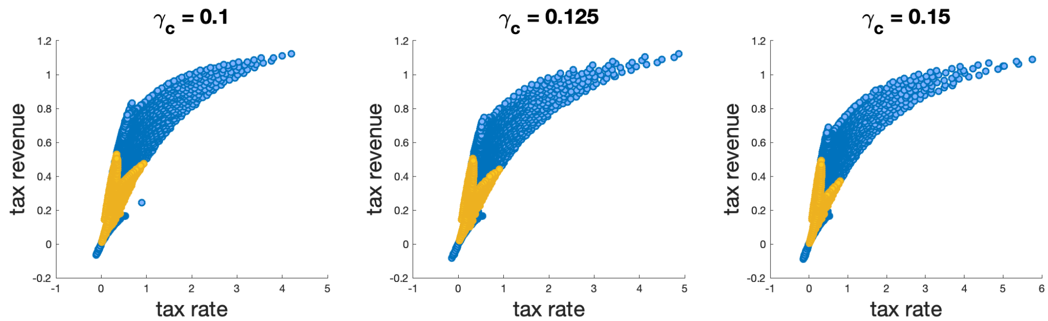


Figure 1.25 illustrates the relationship between equilibrium tax revenue and tax rate in a no-rule economy. Tax revenue increases as the tax rate increases in equilibrium. Yellow points indicate the states the economy visits in simulation.

As in the no-rule economy, the tax rate and the tax revenue has a positive relationship in the rule economy (Figure 1.26). Yellow region indicates the states the economy stays in simulation.

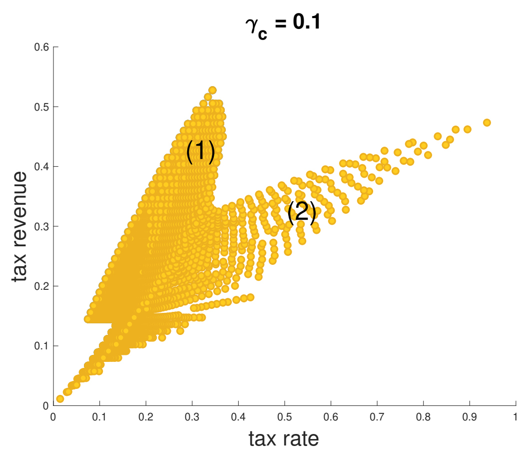
As the tax rate increases, tax revenue can take two different paths. Figure 1.27 describes how tax revenue and tax rate are related in a rule economy when $\gamma_c = 0.1$. Tax revenue is greater in (1) than (2), though (2) has a higher tax rate (τ_c). The difference comes from the states they are in. Region (1) consists of lower debt states than those of region (2). The economy has a higher consumption when it has less outstanding debt. A higher tax base (consumption) leads to a big increase in tax revenue when the tax rate increases.

Figure 1.26: Rule Economy



This explains why tax revenue can be higher in (1). This interpretation applies to economies with any γ_c.

Figure 1.27: Rule economy: Different Path of Revenue



10.8 Solving a Model with Long Duration Bond

We solve the model backward. In period 3:

$$\begin{aligned}
&(\textit{Govt BC}) & \tau_3 &= (1-\Delta_3)(b_1^L + b_2^S) + g_3 && (1.29)\\
&(\textit{Res Const}\ ) & c_3 + g_3 &= y_3 - \Delta_3 L(y_3) - (1-\Delta_3)(b_1^L + b_2^S) && (1.30)\\
&(\textit{Def Choice}) & \Delta_3 &= \begin{cases} 1 & \text{if } V^C(b_1^L, b_2^S, y_3) < V^D(y_3) \\ 0 & \text{otherwise} \end{cases} && (1.31)
\end{aligned}$$

$L(y)$ is a quadratic default cost as in the main model. Once we get the default decision in the last period (Δ_3), we can obtain the bond price in the second period.

$$q_2^S(b_1^L, b_2^S, y_2) = \mathbb{E}\left[\frac{1-\Delta_3}{1+r^*}\right] \tag{1.32}$$

In period 2:

$$\begin{aligned}
&(\textit{Govt BC}) & \tau_2 + b_2^S \cdot q_2^S(b_1^L, b_2^S, y_2) &= (1-\Delta_2)b_1^S + g_2 && (1.33)\\
&(\textit{Res Const}\ ) & c_2 + g_2 &= y_2 - \Delta_2 L(y_2) + b_2^S \cdot q_2^S(b_1^L, b_2^S, y_2) - (1-\Delta_2)b_1^S && (1.34)\\
&(\textit{Def Choice}) & \Delta_2 &= \begin{cases} 1 & \text{if } V^C(b_1^L, b_2^S, y_2) < V^D(y_2) \\ 0 & \text{otherwise} \end{cases} && (1.35)
\end{aligned}$$

Given the short-term bond price in period 2 (q_2^S), we can determine all the other optimal allocations (τ_2, c_2, g_2). Based on the allocations, I construct the value function for default and repay and derive default decision in period 2 (Δ_2). Repeat the same procedure and get the bond price in the first period, using the default decision in period 2.

$$q_1^L = \mathbb{E}\left[\mathbb{E}\left(\frac{1-\Delta_3}{1+r^*}\right)\right] \tag{1.36}$$

$$q_1^S = \mathbb{E}\left[\frac{1-\Delta_2}{1+r^*}\right] \tag{1.37}$$

In period 1:

$$(Govt\ BC) \qquad \tau_1 + b_1^S \cdot q_1^S(b_1^L, b_1^S, y_1) + b_1^L \cdot q_1^L(b_1^L, b_1^S, y_1) = g_1 \tag{1.38}$$

$$(Res\ Const\ ) \quad c_1 + g_1 = y_1 + +b_1^S \cdot q_1^S(b_1^L, b_1^S, y_1) + b_1^L \cdot q_1^L(b_1^L, b_1^S, y_1) \tag{1.39}$$

$$\tag{1.40}$$

Chapter 2

Credibility and Effectiveness of Announced Fiscal Measures: Early Evidence from Covid-19

Keywords: Governments' Responses to Covid-19; Fiscal Announcements; Government Expenditure, Local Projections

JEL Classification: : E6, H3, H8

1 Introduction

The COVID-19 pandemic has cost lives and disrupted economic activity worldwide. Higher rates of illness and death have tested the capacities of health systems. Confinement measures to control the spread of the virus have disrupted trade between and within countries. The closure of schools and childcare services has affected the ability of parents to work. Production and employment are consequently falling in most countries. To prevent the spread of virus, governments have imposed lockdowns with varying degrees of stringency. The general population has also sought to reduce exposure to virus through voluntary social distancing. The result has been a dramatic contraction in economic activity in 2020 with global GDP estimated to have declined by 3.5 percent (IMF, 2021). The rebound in 2021 did not restore the pre-crisis GDP in 2019 in many advanced, emerging and developing economies. At the same time, debt levels, both private and public, were already at record highs before the Covid-19 pandemic, and surged further in 2020. According to IMF (2021) global public debt is projected to have risen by about 19 percentage points of GDP in 2020 among advanced economies. The increase reflects both the rise in deficits due to the automatic stabilizers as economic growth collapsed and the discretionary policy measures undertaken by governments to respond to the health crisis.

In an environment where most countries face very low interest rates (so monetary policy lacks effectiveness, at least for now), fiscal policy retains a crucial role in mitigating the pandemic's overall economic impact and promoting a quick recovery as it can help save lives and shield the most-affected segments of the population. That said, the pressures on government finances were immediate and large as revenue was falling as tax bases contract and there was an increased need for expenditure to expand the capacity of public health services and to adapt other public services, such as education and aged care, to the need for social distancing. Governments implemented (and some of them still do) measures to mitigate the impact of the pandemic on private sector economic activity. To counter income losses arising from the pandemic, countries took bold steps to help households and firms by implementing discretionary revenue and spending measures. In addition, many governments used below the line fiscal measures and contingent liabilities as part of their response to the pandemic, that is, they have been providing liquidity support to the economy in the form of equity injections, asset purchases, loans, and credit guarantees. All modalities of fiscal policy will likely see greater use as the size and scope of fiscal interventions increase. In addition, governments may see specific benefits in using below the line measures and contingent liabilities in these circumstances. Constraints on the ability to increase spending or accumulate liabilities, for example, may result in recourse to below the line measures and contingent liabilities. Or there may be characteristics of below the line measures and contingent liabilities that make them better suited to respond to the challenges of the pandemic. Together with lower projected output growth, these measures would reduce revenues in relation to GDP in 2020 and possibly beyond with important implications for public spending at a time when the overall spending has been scaled up. These developments are likely to result in larger budget deficits and rising debt-to-GDP ratios in the foreseeable future. Understanding empirically the economic effects of fiscal measures is therefore important for policy makers notably once the unwinding of economic support measures begin and the "new-normal" is attained.

This paper empirically examines the economic impact and trade-offs associated with announced government fiscal measures in the context of the COVID-19 pandemic. A key challenge to examine the effect of fiscal measures is to identify fiscal shocks in the data given the limited time sample.[1] We

[1]Some have relied on narrative approaches to identify exogenous fiscal innovations but

address this by using daily data on announced fiscal stimulus measures then converted to weekly observations. More specifically, this paper has three goals. First, we quantify the size of government fiscal announcements by income group of countries and by country individually as the pandemic effects unfold. We split these by type differentiating above and below-the-line fiscal operations, and contingent liabilities, in particular. Secondly, the paper relies on both static and dynamic empirical panel data analyses to assess how fiscal announcements directly shape the impact of the COVID-19 pandemic alternative proxies for economic activity. We find that the dynamic effect of fiscal announcements varies by the types of fiscal measures and on different income groups. We also evaluate whether the effect varies across countries depending on their initial conditions, such as income level and the degree of fiscal indebtedness (which proxies availability of fiscal space or fiscal room for maneuver to battle the COVID-19-led-crisis). The results show that countries with a larger fiscal space tend to boost economic activities more than those who do not have enough fiscal space. Lastly, we analyze to what extent financial markets react to fiscal announcements by seeing how the pricing of country spreads changes. The findings suggest that in developing economies, the impact of fiscal announcement on country spreads is bigger when it involves more direct fiscal support than the supports that require a high level of financial and institutional maturity.

Policy-wise this paper aims to provide guidance on the criteria against which policymakers can assess the appropriateness of fiscal measures as interventions and the circumstances in which one intervention might be preferred to another or to other budget policy interventions.

have done so using lower-frequency indicators (Romer and Romer, 2010; Alesina et al., 2014).

The remainder of this paper is organized as follows. Section 2 reviews the relevant literature. Section 3 develops the empirical framework. Section 4 discusses the data and presents some stylized facts. Section 5 discusses the results. The last section concludes and highlights some policy implications.

2 Literature Review

This paper relates to three main strands of literature. The first is the literature on the economic effects of pandemics. The second strand of the literature relates crises and recessions and fiscal variables. The third strand relates to the credibility effect of fiscal policy on economic and financial outcomes. The first is the literature on the economic effects of pandemics. Studies of the macroeconomic impact of past pandemics and of other major diseases (such as SARS and HIV/AIDs) have typically quantified the resulting short-term loss in output and growth. However, there is little consensus on economic consequences of pandemics. Results critically depend on the models used and on the availability of data (Bell and Lewis, 2004). A study by Brainerd and Siegler (2003), one of the few on the economic effects of the Spanish flu, suggested that the 1918/19 pandemic in the US actually increased growth in the 1920s. In contrast, Almond and Mazumber (2005) argued that the Spanish flu had long-term negative effects through its impact on fetal health. Using a theoretical model, Young (2004) argued that the AIDS epidemic in South Africa would increase net future per capita consumption, while Bell and Gersbach (2004) found strong negative effects. Jonung and Roeger (2006) estimated the macroeconomic effects of a pandemic using a quarterly macro-model constructed and calibrated for the EU-25 as a single economic entity. The recent literature on this topic, motivated by the Covid-19 pandemic, provides evidence of large and persistent effects on economic activity (see e.g. Atkeson, 2020; Barro et al., 2020; Eichenbaum et al., 2020). In fact, Ma et al. (2020) in an empirical analysis of the economic effects of past pandemics, found that real GDP is 2.6 percent lower on average across 210 countries in the year the outbreak is officially declared and remains 3 percent below pre-shock level five years later. Moreover, according to a et al. (2020), significant macroeconomic after-effects of pandemics persist for decades, with real rates of return substantially depressed. Pandemics induce relative labor scarcity in some areas and/or a shift to greater precautionary savings.

The second strand of the literature relates crises and recessions and fiscal variables (see e.g. European Commission, 2009a). Financial crises have induced governments around the globe to take decisive action in terms of sustaining economic activity and preventing the meltdown of the financial sector. These actions had direct and indirect fiscal costs. Direct fiscal costs from actions from financial system rescue packages (such as capital injections, purchases of toxic assets, subsidies, payments of called upon guarantees) resulted in permanent decreases in government´s net worth (such interventions result in higher public debt, which either show up as an increase in stock flow debt-deficit adjustments or as higher deficits (Attinasi et al., 2010; European Commission, 2009b). There also are indirect fiscal costs, i.e., due to the feedback loop from the crisis to economic activity. These involve lower revenues due to falling profits and asset prices, higher expenditure to counter the impact of the crisis, as well as interest rate and exchange rate effects due to market reactions (European Commission, 2009b). European Commission (2009b) building on fiscal reaction functions in the spirit of Gali and Perotti (2003) found that the bulk of the effect of crises on debt changes takes place during the first 2 years. Moreover, the impact of financial crises on debt was larger in emerging market economies than for the EU or other OECD countries. Building on a banking crises dataset by Laeven and Valencia (2008), several empirical studies have investigated the effect of crises on the debt-to-GDP ratio and GDP growth (Furceri and Zdzienicka, 2010, 2012; Reinhart and Rogoff, 2008, 2009, 2011). Furceri and Zdzienicka (2010) using a panel of 154 countries from 1980-2006 showed that banking crises are associated with a significant and long-lasting increase in government debt and that such increase is a positive function of higher initial indebtedness levels – so initial conditions matter. Employing different modelling techniques, Tagkalakis (2013) found significant econometric evidence that fiscal positions deteriorated during financial crises in 20 OECD countries over the 1990-2010 period. Several other studies investigated the direct fiscal implications of past banking system support schemes (Honoghan and Klingebiel, 2003), the determinants of fiscal recovery rates (European Commission, 2009b), as well as whether costly fiscal interventions reduced output loss (Claessens et al., 2005; Detragiache and Ho, 2010).

The third strand relates to the credibility effect of fiscal policy on economic and financial outcomes. Credibility of fiscal announcement is an important factor to ensure the announcement to be effective. The notion of "credibility" refers to the degree of confidence that the public has in the government authorities. In practice, a government announcement on fiscal measure often does not get taken by its face value. Figure 2.1 from a recent IMF Fiscal

Monitor (IMF, 2021, Figure 1.b) illustrates that private sector forecasts heavily discount official projections for fiscal adjustments. Private sectors discount more heavily on the announcements of larger adjustments leading to a conclusion that a large fiscal announcement do not necessarily help budget credibility.[2] End and Hong (forthcoming) develop fiscal credibility measures that quantify the degree to which policy announcements anchor expectations. They analyze why private forecasts for the deficit differ from official projections and shows how strong fiscal frameworks can improve credibility of the announcement. Credible projection of future budget process can reduce the borrowing cost as shown in Figure 2.2 (Figure 2.13, IMF, 2021).[3] Credibility of the government announcement is closely related to the "time inconsistency" problem it is facing. A government being "time inconsistent" is describing an attitude that may be desirable under the immediate circumstances, but was not perceived as optimal in previous period. To mitigate a time consistency problem and restore credibility of policy announcement, it is necessary to build policy framework, such as long-term targets and policy rules (IMF, 2021).

[2]The literature on the political bias in government forecasts is abundant. The persistence of overly optimistic forecasts led to the perception that, as budget forecasts came to occupy a more central role in the political process, the pressure on forecasters to help policy makers avoid hard choices led to forecasting bias. A great deal of literature has analyzed the potential bias the political and institutional process might have on revenue and spending forecasts (Plesko, 1988; Feenberg et al., 1989; Auerbach, 1995 and 1996; Bruck and Stephan, 2006), and the nature and properties of forecast errors within national states (Gentry, 1989; Baguestani and McNown, 1992; Campbell and Ghysels, 1995; Auerbach, 1999; Mühleisen et al., 2005).

[3]Relatedly Gupta et al. (2018) analyzed the causes and consequences of fiscal consolidation promise gaps, defined as the distance between planned fiscal adjustments and actual consolidations. They found that governments that delivered on their fiscal consolidation plans were rewarded by financial markets and not penalized by voters.

Figure 2.1: Credibility of Fiscal Adjustment

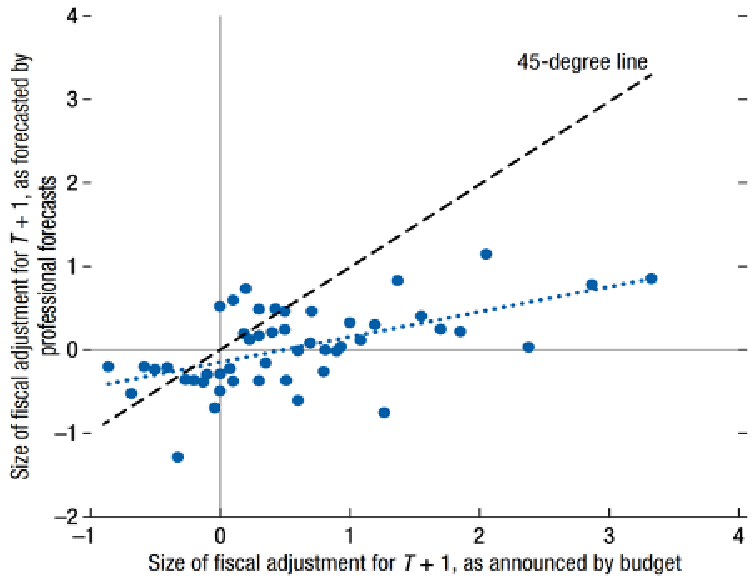
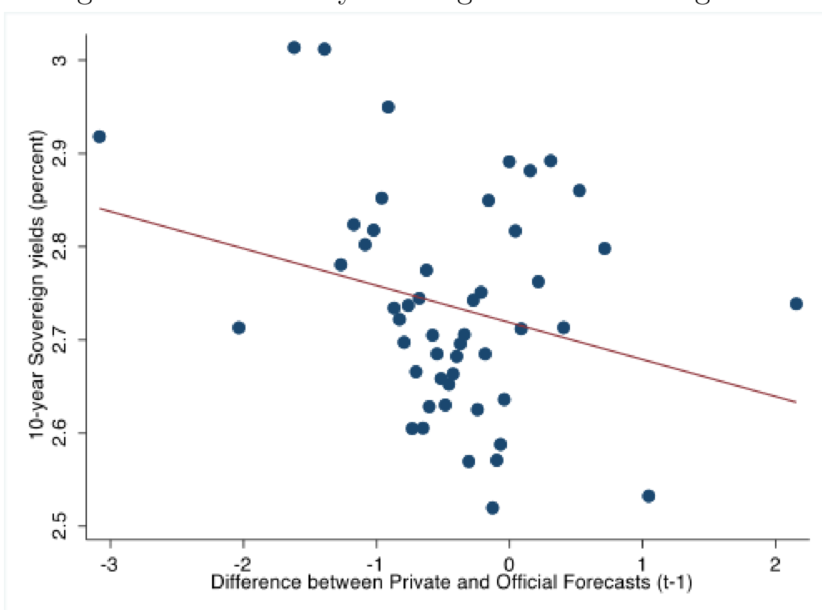


Figure 2.2: Credibility of Budget and Borrowing Rates



Source: IMF Fiscal Monitor (Oct 2021)

While the macroeconomic effects of past pandemics have been studied, a deeper and more disaggregated assessment of the degree of fiscal policy relevance in the context of the COVID-19 pandemic, particularly conditioned on the typology of fiscal announcement, is lacking. This paper aims to bridge this gap.

3 Data and Stylized Facts

3.1 Data

Independent Variables

We assemble a comprehensive database of announced fiscal stimulus measures, economic activity indicators, financial variables, COVID-19 infections and deaths and degrees of stringency in containment measures. The database is of weekly frequency and covers 136 countries between January 2020 and May 2021.

We use fiscal announcements for various types of fiscal measures as our main independent variables. The crude data originally comes from Oxford Stringency data. We then create a new data by classifying each fiscal announcement from Oxford Stringency data into 4 categories: "Above-the-line" (ATL) measures, "Below-the-line" (BTL) measures, Contingent Liabilities (CL), and Unknown. For the data classifications of ATL, BTL, and CL, we follow the definitions from the IMF Glossary – see Appendix. Anything else that does not fall into those three categories is classified as Unknown (UKN). When the announcement is mixed with different types of measures, we separate them into different categories. We cross-checked out classifications with IMF Fiscal Monitor and Yale COVID-19 financial response tracker to increase the accuracy. Yale published a similar data set on fiscal announcement during the Covid pandemic. The difference between Oxford Stringency data and Yale COVID-19 financial response tracker is that Oxford data documented a list of fiscal announcements and each fiscal announcement's size. In the Oxford Stringency data set, the amount of fiscal statement is converted to USD using the exchange rate of the day that the announcement was made.

Typical examples of ATL include unemployment benefits, subsidies, grants, and tax cuts to households and firms. BTL measures include equity injection and loans to the firms. When the government guarantees loans taken out from the banks, this is counted as CL. The obligation does not occur unless a particular event happens. Examples of each measure from Oxford Stringency data can be found in Appendix.

Dependent Variables

A set of high frequency proxies for economic activity are used as a basis for the short-run path of each economy in our database. These variables include measures of travel (such as the number of flights, hotel stays, and mobile phone mobility indicators) and industrial activity measures (such as NO_2 emissions).[4]

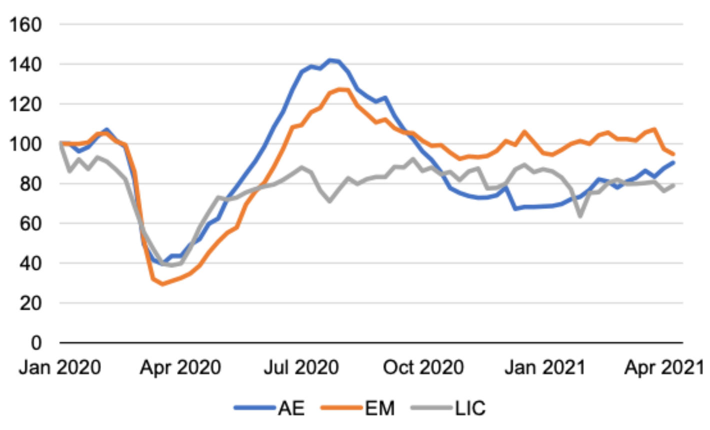
1. Mobility

    Data derived from smartphones on movement and mapping requests are increasingly being used as high frequency measures to nowcast economic activity (e.g., Dong, et al., 2017, Sampi Bravo and Jooste,

[4] Other higher frequency economic indicators (such as the number of job advertisements and indicators of purchasing manager sentiment) were also attempted but due to the more unbalanced and incomplete nature of the data, associated results were omitted.

Figure 2.3: Apple Map Requests during COVID-19 by Income Grouping

Jan 2020 = 100



Source: Apple and author calculations

2020). We draw on data provided by Apple that counts the number of map requests in any given week as an estimate of mobility and economic activity in a country. Weekly data on these requests are available for 62 of the 163 countries in our dataset of fiscal measures (Figure 2.3).

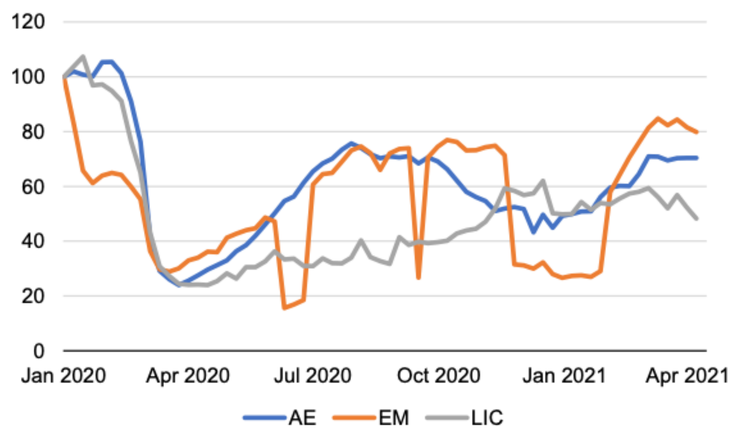
2. Hotel bookings

The number of hotel room nights demanded in any given week provides an indication of output in the accommodation sector specifically, and the travel sectors more generally. Our hotel data are drawn from STR Hospitality Data and cover 66 countries of the 163 countries in our dataset of fiscal measures (Figure 2.4).

3. Flights

Figure 2.4: Hotel Bookings during COVID-19 by Income Grouping

Jan 2020 = 100



Source: STR Hotel Data and author calculations

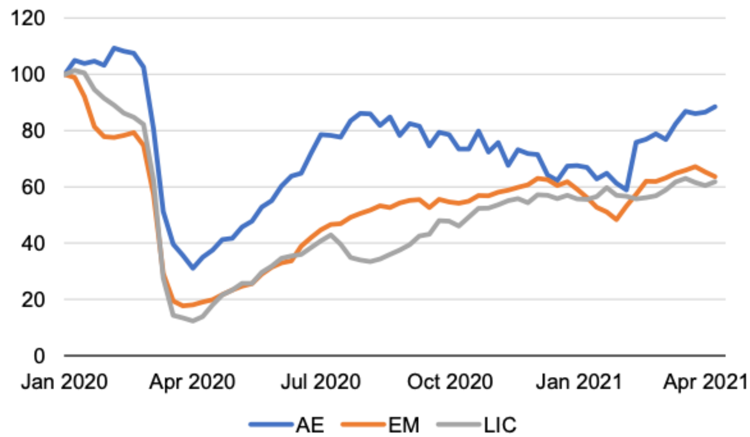
Our flights data are drawn from the FlightRadar24.com website as the average number of daily domestic flights, international departures, and arrivals by country for each week in our dataset. The number of flights in a country in each week provides an approximation for the combined passenger and cargo air capacity available in that week. Data are available for 160 of the 163 countries in our dataset of fiscal measures (Figure 2.5).

4. Nitrogen Dioxide emissions

Nitrogen Dioxide (NO_2) has been identified as a correlate with economic activity (Lin and McElroy, 2011) and industrial production (Pallara and Hosny, 2021). NO_2 is mainly emitted from the burning of fossil fuels for transportation and electricity generation and is particularly well-suited to high frequency economic analysis because

Figure 2.5: Flights during COVID-19 by Income Group

Jan 2020 = 100



Source: FlightRadar24 and author calculations

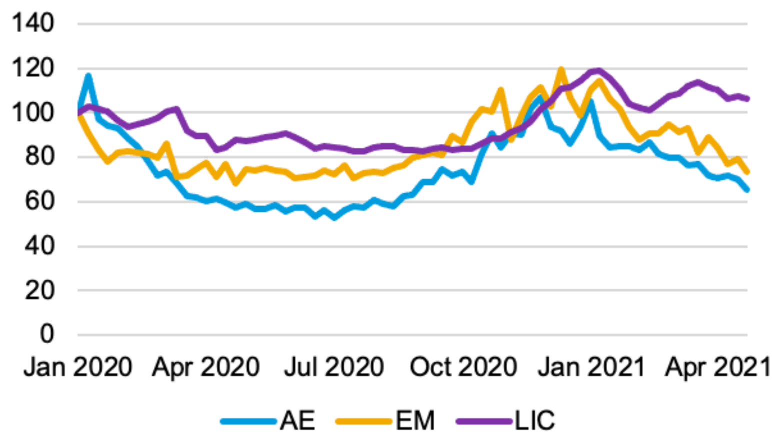
it has a short lifetime. Data on NO_2 emissions are sourced from the Air Quality Open Data Platform of the World Air Quality Index (WAQI) and from the European Space Agency's Senitnel-5P Precursor satellite. The combination of these datasets covers emissions in 120 of the 163 countries in our dataset of fiscal measures. Figure 2.6 presents the aggregate emissions for AE, EME and LICs indexed to 100 at the beginning of the dataset.

Other Variables

Our key regression analysis will also include as key control variables a proxy for the COVID-19 shock given by either the number of deaths or cases in each country and time period (week) and the containment stringency index from the Oxford Coronavirus Government Response Tracker, which is a composite

Figure 2.6: Nitrogen Dioxide emissions during COVID-19 by Income Grouping

Jan 2020 = 100



Source: Sentinel-5P (European Commission/ESA/Copernicus) and the Air Quality Open Data Platform of the World Air Quality Index.

measure based on nine response indicators including school closures, workplace closures, and travel bans, rescaled to a value from 0 to 100 (100=strictest).[5] The same indicator was recently employed by Furceri et al. (2021).

Furthermore, to assess how a country's or income-group characteristics before the pandemic played a role in the effectiveness of the announcement of fiscal measures, we add in some instances some interactive variables based on prevailing macroeconomic and fiscal conditions prior to the COVID-19 shock, namely: (1) the degree of public indebtedness; (2) economic stance proxied by real GDP growth. We select data is for the year 2019 which can be found in World Economic Outlook.

[5]The Oxford Coronavirus Government Response Tracker collects information on government policy responses across several dimensions. The database scores the stringency of each measure ordinally, for example, depending on whether the measure is a recommendation or a requirement and whether it is targeted or nationwide. We normalize each measure to range between 0 and 100 to make them comparable.

Table 2.1: Cumulative Fiscal Measures by type and income group (% in GDP)

	Advanced (AE)			Emerging (EM)			Low-income (LIC)		
	Obs	Mean	Std.dev	Obs	Mean	Std.dev	Obs	Mean	Std.dev.
Total/GDP	37	13.47 %	10.36	60	3.01 %	3.51	39	1.77 %	3.63
ATL/GDP		7.72 %	6.11		2.53 %	3.40		1.69 %	3.65
BTL/GDP		0.60 %	1.70		0.13 %	0.30		0.05 %	0.19
CL/GDP		5.08 %	8.16		0.33 %	0.61		0.01 %	0.06

Note: Numbers are cumulative measure in the last week of May 2021

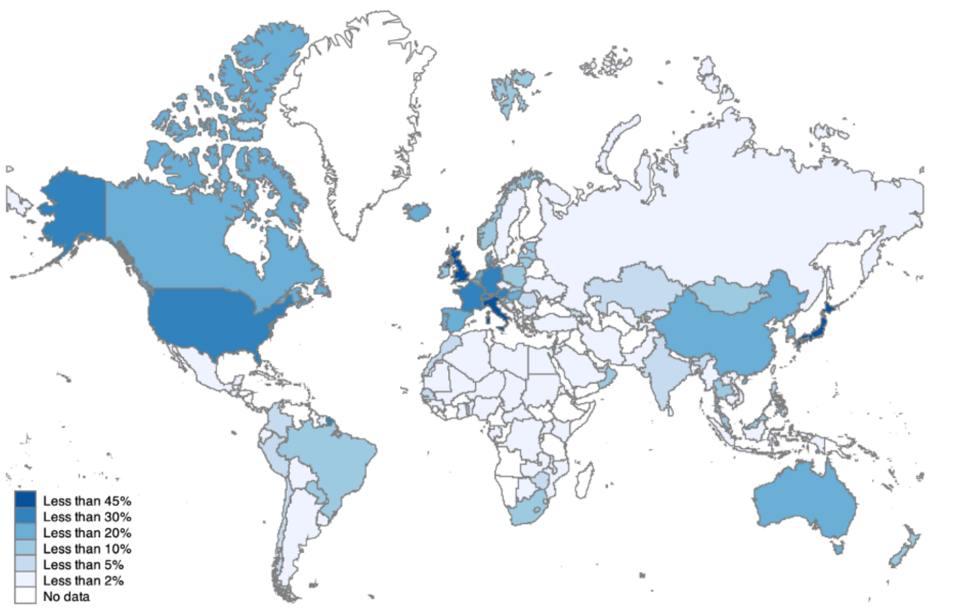
3.2 Stylized Facts

Table 2.1 describes the statistics of cumulative fiscal measures during our sample period (January 2020-May 2021) by income group. Total/GDP is a sum of ATL, BTL, CL and Unknown from our data. Fiscal measures classified as "unknown" are not included in our analysis. AE has the highest numbers for accumulated total fiscal measures/GDP, followed by EM and LIC. This ordering holds for all the fiscal measures (ATL, BTL and CL).

The World map displayed in Figure 2.7 displays regional differences in total accumulated fiscal measures (sum of ATL, BTL and CL) between January 2020 and May 2021. Total accumulated fiscal measures are in percentage of GDP. The bigger the size of total accumulated fiscal measures, the darker the color of the region. Countries are divided into six groups according to their size of accumulated total fiscal measures. High income countries, such as Japan and United Kingdom, fall into the top group, whereas most of the low-income countries in African continent correspond to the lowest group.

Figure 2.8 shows the box-whisker plots of cumulative amounts of fiscal announcements over time between January 2020 and May 2021 for our entire sample of countries. Corresponding figures by income group are available in Appendix Figures 2.19-2.21. Each figure displays three components – ATL,

Figure 2.7: World Map of Total Accumulated Fiscal Measures (% GDP)



Note: Numbers are cumulative measure in the last week of May 2021

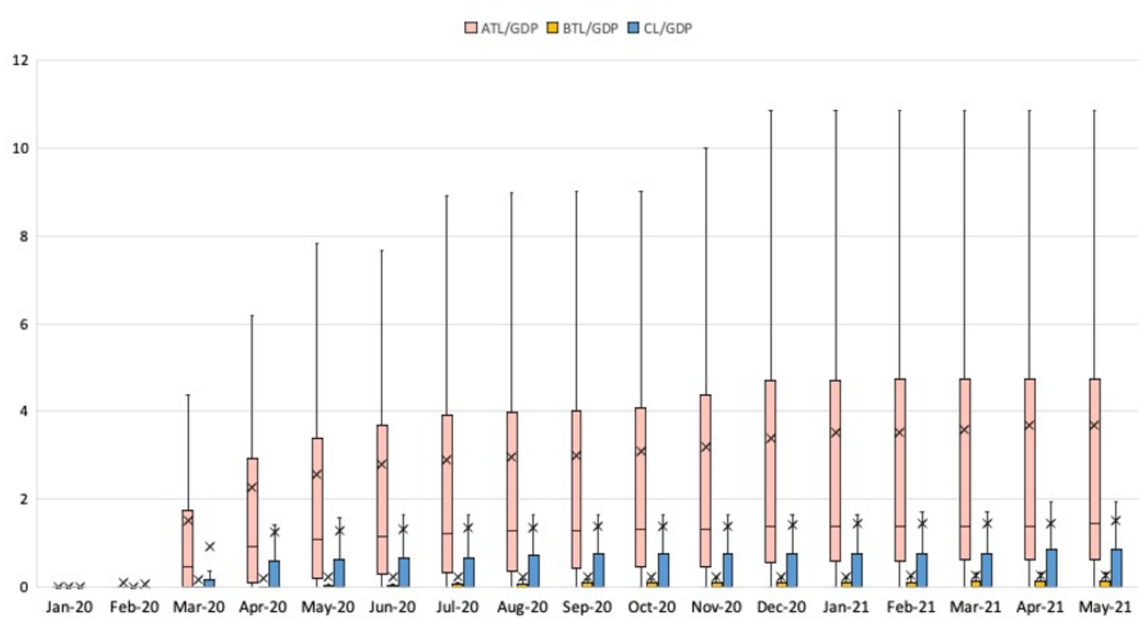
BTL and CL. Lower and upper line of the box represents 25th and 75th percentile, respectively, while the middle line shows the median value. X marks show mean value of each fiscal measure. Below is the stylized facts about the fiscal announcement packages in our sample period:

1. AE dominates in terms of the size of fiscal measures for all types (ATL, BTL and CL).

2. In all income groups (AE, EM and LICs), ATL is the one that is the most frequently used.

3. In AE and EM, CL is the second mostly frequently used measure, whereas in LIC, BTL is takes that place.

Figure 2.8: Distribution of Fiscal Measures by Type Over Time, All Countries

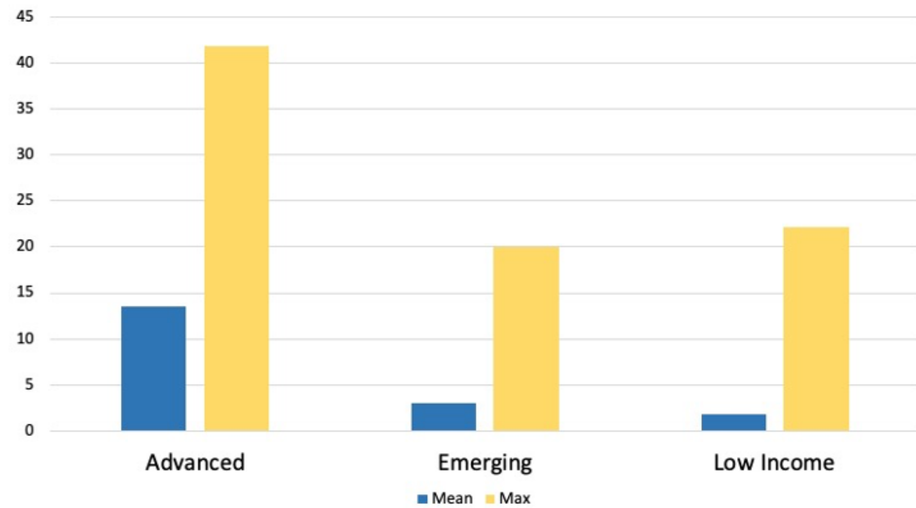


4. BTL and CL are used in AE, but the usage of BTL and CL in EM and LICs is insignificant (less than 1 percent of GDP at the best).

5. Mean of BTL and CL in EM and LICs are driven by outliers.

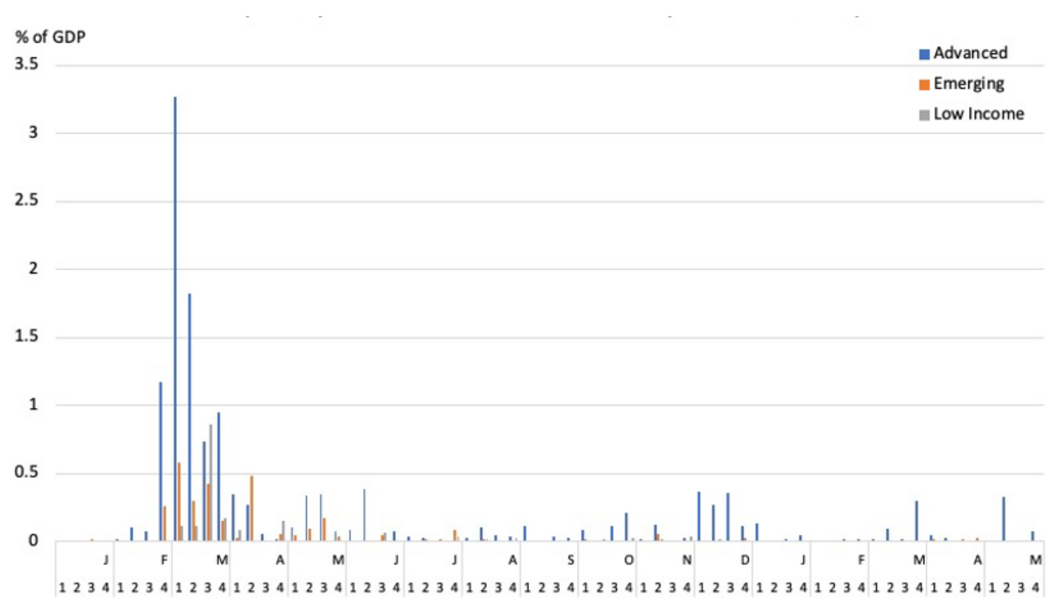
Figures 2.9 and 2.10 report results that are comparable to Deb et al. (forthcoming). As in their paper, mean of total accumulated fiscal measures are the biggest in AE, followed by EM and LIC, in that order (Figure 2.9). The size of fiscal announcement spiked up in March 2020 for al income groups. Additional fiscal support was announced throughout the 2020, but the size is limited in EM and LICs (Figure 2.10).

Figure 2.9: Total Accumulated Fiscal Measures by Income Group (% GDP)



Note: Numbers are cumulative measure in the last week of May 2021

Figure 2.10: Absolute Frequency of Fiscal Measures by Income Group Over Time (% GDP)



Note: Mean values of total fiscal measures for every week

4 Methodology

4.1 Static Approach

We begin by estimating, in a static manner, the unconditional effect of fiscal shocks on weekly economic indicators. We use an unbalanced sample of 59 countries from January 2020 to May 2021. The first reduced-form regression takes the form:

$$\Delta y_{i,t} = \alpha_i + \pi_t + \gamma Covid_{i,t} + \delta TOT_{i,t} + \sigma \Delta string_{i,t} + \vartheta X_{i,t-1} + \epsilon_{i,t} \quad (2.1)$$

where $\Delta y_{i,t}$ is the indicator of economic activity—mobility, hotel stays, energy consumption, flights, NO_2 emissions. $TOT_{i,t}$ denotes the overall size of the total fiscal announcement. α_i are country fixed effects to account for time-invariant specific characteristics. π_t are time effects. $Covid_{i,t}$ is a proxy for COVID-19 health outcomes, namely new cases per million inhabitants. $\Delta string_{i,t}$ is the Oxford stringency index, rescaled to a value from 0 to 100 (100=strictest). $X_{i,t-1}$ is a vector of control variables including real GDP per capita, population density, number of hospital beds, median population age and the human development index. $\epsilon_{i,t}$ is an i.i.d error term satisfying standard assumptions.

We extent the baseline specification to evaluate whether the impact of announced fiscal measures varies by typology of measure:

$$\Delta y_{i,t} = \alpha_i + \pi_t + \gamma Covid_{i,t} + \delta ATL_{i,t} + \sigma \Delta string_{i,t} + \vartheta X_{i,t-1} + \epsilon_{i,t} \quad (2.2)$$

$$\Delta y_{i,t} = \alpha_i + \pi_t + \gamma Covid_{i,t} + \delta BTL_{i,t} + \sigma \Delta string_{i,t} + \vartheta X_{i,t-1} + \epsilon_{i,t} \quad (2.3)$$

$$\Delta y_{i,t} = \alpha_i + \pi_t + \gamma Covid_{i,t} + \delta CL_{i,t} + \sigma \Delta string_{i,t} + \vartheta X_{i,t-1} + \epsilon_{i,t} \quad (2.4)$$

where $ATL_{i,t}$, $BTL_{i,t}$ and $CL_{i,t}$ denote above-the-line, below-the-line and contingent liabilities, respectively. All other variables are as in equation (2.1).

Finally, we analyze if the impact of COVID-19 on the different dependent variables varies with the size of the fiscal announcement by augmenting the previous regressions with an interaction term, as follows:

$$\begin{aligned} \Delta y_{i,t} &= \alpha_i + \pi_t + \gamma Covid_{i,t} + \delta TOT_{i,t} + \rho(TOT_{i,t} \times Covid_{i,t}) \\ &\quad + \sigma \Delta string_{i,t} + \vartheta X_{i,t-1} + \epsilon_{i,t} \end{aligned} \quad (2.5)$$

Equation (2.5) is estimated for the overall fiscal announcement shock and for each category individually. Equations (2.1)-(2.5) are estimated with OLS with robust standard errors clustered at the country level.

4.2 Dynamic Approach

To assess the dynamic response of COVID-19 and fiscal announcement shocks on several high frequency dependent variables identified in the previous section, we follow the local projection method proposed by Jordà (2005) to estimate impulse-response functions (IRFs). The first exercise is to dynamically look at the separate effect of the pandemic and fiscal shocks. The second will condition the effect of the pandemic on the amount of the fiscal announcement in a interacting-type regression. This local projection method was advocated by Auerbach and Gorodnichenko (2013) and Romer and Romer (2019) as a flexible alternative to vector autoregression (autoregressive distributed lag) specifications since it does not impose dynamic restrictions.[6] It is also better suited to estimating nonlinearities in the dynamic response—such as, in our case, interactions between debt surge episodes and the degree of initial indebtedness.

The baseline unconditional specification for the COVID-19 shock takes the following form:

$$y_{i,t+k} - y_{i,t-1} = \alpha_i + \pi_t + \beta_k Covidshock_{i,t} + \theta K_{i,t} + \tau P_{i,t-1} + \vartheta X_{i,t-1} + \epsilon_{i,t} \quad (2.6)$$

in which y is the dependent variable of interest; β_k denotes the (cumulative) response of the variable of interest in each k weeks after the COVID-19 shock; α_i, γ_t are country and time fixed effects, respectively; $Covidshock_{i,t}$ denotes the COVID-19 shock (the log of the number of cases). $K_{i,t}$ is a set a of control variables including two lags of the shock and two lags of the dependent variable. $P_{i,t-1}$ is an additional vector of controls akin vector X in equation (2.1).

The baseline unconditional specification for the fiscal announcement shock takes the following form:

$$y_{i,t+k} - y_{t-1,i} = \alpha_i + \pi_t + \beta_k Fshock_{i,t} + \theta L_{i,t} + \tau P_{i,t-1} + \vartheta X_{i,t-1} + \epsilon_{i,t} \quad (2.7)$$

in which y is the dependent variable of interest; β_k denotes the (cumulative)

[6] This method has been used to study the dynamic impact of macroeconomic shocks such as financial crises (Romer and Romer, 2017) or fiscal shocks (Jordà and Taylor, 2016).

response of the variable of interest in each k week after the fiscal announcement shock;$Fshock_{i,t}$ denotes the fiscal announcement shock (size of fiscal announcement in percent of GDP). $L_{i,t}$ is a set a of control variables including two lags of the shock, two lags of the dependent variable and two lag of the number of COVID-19 cases (in logs). All other variables are as in equation (2.6).

Equations (2.7-2.8) are estimated using Ordinary Least Squares (OLS). IRFs are then obtained by plotting the estimated β_k for k= 0,1,..12 (in weeks) with 90 (68) percent confidence bands computed using the standard deviations associated with the estimated coefficients β_k - based on robust standard errors clustered at the country level.[7] According to Sims and Zha (1999) "the conventional pointwise bands common in the literature should be supplemented with measures of shape uncertainty." Hence, for characterizing likelihood shape, bands that correspond to 68 percent posterior probability, or one standard deviation shock, provide a more precise estimate of the true coverage probability.[8]

To explore the role of the size of fiscal announcements at the time of COVID-19 shock on several high frequency variables proxying different aspects of economic activity, the dynamic response is now allowed to vary, as follows:

$$\begin{aligned} y_{i,t+k} - y_{i,t-1} &= \alpha_i + \pi_t + \beta_k^L F(z_{i,t}) Covidshock_{i,t} + \\ &\quad \beta_k^H (1 - F(z_{i,t})) Covidshock_{i,t} + \theta K_{i,t} + \tau P_{i,t-1} + \epsilon_{i,t} \end{aligned} \quad (2.8)$$

[7]Another advantage of the local projection method compared to vector autoregression (autoregressive distributed lag) specifications is that the computation of confidence bands does not require Monte Carlo simulations or asymptotic approximations. One limitation, however, is that confidence bands at longer horizons tend to be wider than those estimated in vector autoregression specifications.

[8]Other papers that have employed one standard deviation bands include e.g. Giordano et al. (2007), Romer and Romer (2010), Bachmann and Sims (2012).

with $F(z_{i,t}) = \frac{exp(-\gamma z_{i,t})}{1+exp(-\gamma z_{i,t})}$, $\gamma > 0$.

in which $z_{i,t}$ is an indicator of the size of the fiscal announcement, normalized to have zero mean and unit variance. The weights assigned to each regime vary between 0 and 1 according to the weighting function $F(.)$, so that $F(z_{i,t})$ can be interpreted as the probability of being in a given state (high fiscal announcement or low fiscal announcement). The coefficients β_k^L and β_k^H capture the impact of COVID-19 shocks at each horizon k.

As discussed in Auerbach and Gorodnichenko (2012, 2013), the local projection approach to estimating non-linear effects is equivalent to the smooth transition autoregressive (STAR) model developed by Granger and Teräsvirta (1993). Here, $\delta = 1$ is used.[9] The use of the STAR function an indicator of fiscal policy is not new. Auerbach and Gorodnichenko (2012, 2013) and Abiad et al. (2016) employed similar approaches.

A variant of equation (2.8) is to explore the role of prevailing economic and fiscal space conditions at the time of the fiscal announcement on several high frequency variables proxying different aspects of economic activity, the dynamic response is now allowed to vary, as follows:

$$\begin{aligned} y_{i,t+k} - y_{i,t-1} &= \alpha_i + \pi_t + \beta_k^L I(g_{i,t}) Fshock_{i,t} + \\ &\quad \beta_k^H (1 - I(g_{i,t})) Fshock_{i,t} + \theta L_{i,t} + \tau P_{i,t-1} + \epsilon_{i,t} \end{aligned} \tag{2.9}$$

in which $g_{i,t}$ is an indicator of the phase of the economy (proxied by real GDP growth) or the fiscal space (proxied by government debt in percent of GDP) in the year prior to the COVID-19 started (i.e, 2019). $I(g_{i,t})$ is defined in the

[9]The results do not qualitatively change for different values of $\delta > 0$.

high (low) state as having country average growth above (below) the sample median growth. For the fiscal space exercise, the high (low) state is one where the country average debt to GDP ratio is below (above) the sample median debt. In this latter case, we have high and low fiscal space respectively. The coefficients β_k^L and β_k^H capture the impact of fiscal announcement shocks at each horizon k for each state.

5 Results

5.1 Baseline Unconditional

We begin with the estimation of the unconditional regressions depicted by equations (2.1-2.6) above. Results excluding and including control variables are displayed in Table 2.2. We observe that fiscal announcement measures seem to have a positive and significant effect on the number of flights (but the effect lowers in magnitude and significance once other controls are added). As expected, the effect of COVID-19 is generally negative and significant on several alternative proxies of economic activity and so is the degree of stringency (the higher the degree of lockdown imposed, the larger the negative impact on the economy). These generally results are in line with previous papers (see e.g. Furceri et al., 2021).

In Table 2.3, we repeat the estimations of Table 2.2 splitting the sample by income group. The full set of results are available in Appendix Table 2.6 while Table 2.3 below summarizes the key findings in terms of coefficient signs and significance. We observe that the size of announced fiscal measures had negative significant effect in hotel stays in the case of developing countries and then

Table 2.2: Baseline Unconditional Results, all countries

Specification	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dep. Var.	lnmobility		lnhotel		lnflights		NO_2	
TOT	-0.4039	-0.385	-0.4959	-0.5089	0.9730**	0.6912*	0.731	0.7225
	(0.332)	(0.333)	(0.383)	(0.387)	(0.418)	(0.391)	(0.461)	(0.47)
Covid	-0.3835*	-0.4482**	-0.6627*	-0.6266*	-0.2304	-0.261	-0.4472**	-0.5015**
	(0.207)	(0.21)	(0.373)	(0.37)	(0.223)	(0.218)	(0.221)	(0.222)
Δstring	-0.4008***	-0.4001***	-0.5275***	-0.5404***	-0.4873***	-0.5591***	-0.2048**	-0.2428**
	(0.065)	(0.067)	(0.108)	(0.113)	(0.078)	(0.078)	(0.094)	(0.101)
L.lngdppc		-12.3006 **		9.3027		-10.4818		4.8043
		(5.456)		(8.021)		(9.117)		(12.668)
L.lnpopdens		-0.4918		-2.6869		-3.5583		-3.6673**
		(0.971)		(1.693)		(3.097)		(1.502)
L.lnhospbeds		-6.0355		-4.9110		-8.7237		-16.3083**
		(3.871)		(5.008)		(7.400)		(6.349)
L.human_development_index		62.3648**		-66.8211		85.4003		32.3864
		(29.210)		(61.699)		(64.847)		(101.120)
L.median_age		0.0664		0.8409		-0.6201		0.6700
		(0.335)		(0.544)		(0.922)		(1.059)
Observations	3,581	3,522	3,281	3,224	7,420	6,873	2,676	2,617
R-squared	0.4897	0.4969	0.3677	0.3688	0.3384	0.3718	0.0705	0.0751

Note: results reported are based on a maximum sample of 59 countries using weekly data from January 2020 until May 2021. Estimates are based on OLS estimation with robust standard errors in parenthesis clustered at the country level. Country and time fixed effects omitted for reasons of parsimony. Constant term omitted. *, **, *** denote statistical significance at the 10, 5 and 1 percent levels, respectively.

positive and significant in NO_2 emissions group of countries. Economically some of these results are difficult to rationalize and for this reason they should be interpreted with care as these static regressions translate a longer-run analysis and the dynamic exercise that will follow aims to instead look at shorter-run effects. The COVID-19 shock generally comes out negative and significant across different dependent variables and income groups.

In Table 2.4, we repeat the estimations of Table 2.2 splitting the fiscal announcement by one of the three types: ATL, BTL and CL. Overall BTL measures seem to be the most effective ones (leading to a positive and significant longer run effect in mobility, flights and emissions).

Next, we move to the short to-medium term dynamic analysis by means of the local projection method (Figure 2.11). We believe that this part of the analysis is perhaps more informative and closer to the “true” macroeconomic

Table 2.3: Summary of Unconditional Results, by income group

Income Group	(AE)	(DEV)	(AE)	(DEV)	(AE)	(DEV)	(AE)	(DEV)
Dep. Var.	lnmobility		lnhotel		lnflights		NO_2	
TOT	-	-	-	-,*	+	-	+	+,*
Covid	-,*	-	-, *	-	-, *	-	-	-,*

Note: all regressions are akin to those represented in Table 2.2 with all controls but those shown omitted for reasons of parsimony. See Appendix Table 2.6 for full details. + denotes positive coefficient; - denotes negative coefficient; * denotes statistical significance at the 10 percent level of higher.

Table 2.4: Summary of Unconditional Results, by type of fiscal measure

Type of Fiscal Measure	(ATL)	(BTL)	(CL)	(ATL)	(BTL)	(CL)	(ATL)	(BTL)	(CL)	(ATL)	(BTL)	(CL)
Dep. Var.	lnmobility			lnhotel			lnflights			NO_2		
TOT	-	+,*	-	-	-	-	+	+,*	+	+,*	+,*	+
Covid	-,*	-,*	-,*	-,*	-,*	-,*	-	-	-	-,*	-,*	-,*

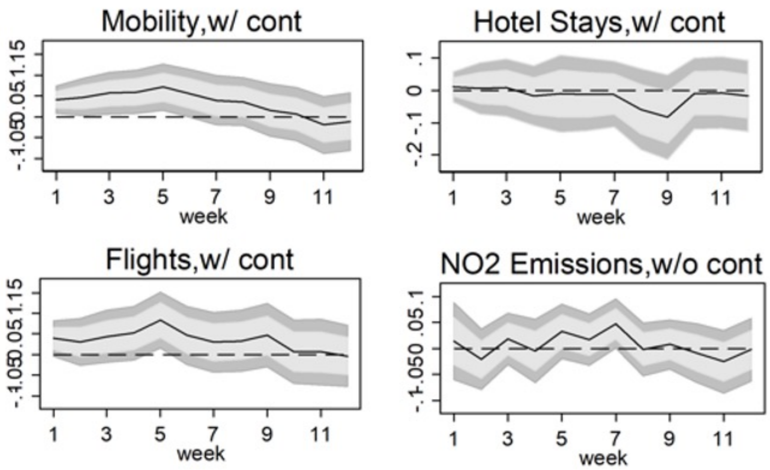
Note: all regressions are akin to those represented in Table 2.2 with all controls but those shown omitted for reasons of parsimony. The variable "TOT" denotes a given type of fiscal measure identified in the first row. See Appendix Tables 2.7-2.9 for full details. + denotes positive coefficient; - denotes negative coefficient; * denotes statistical significance at the 10 percent level of higher.

effects.[10] Following a fiscal announcement, mobility increases and the effect remains statistically different from zero until around 6 weeks after. The effect on hotel stays, flights and NO_2 emissions are more ambiguous (with some tendence for flights to react positively and stay borderline significant). Splitting by income group (AE vs DEV) – Figure 2.12 - we observe that fiscal announcements have the largest positive and significant effects in mobility and to a lesser extent flights for developing countries. In advanced economies the effect of fiscal announcements is negative for hotel stays in the very short run, which dissipates after 5 weeks.

In Figure 2.13 we split the fiscal announcement by type. For mobility, the effectiveness is largest (that is, positive and significant impact) when either

[10]Results for the estimation of equation 5 for COVID-19 shocks is shown in Appendix Figure 2.9. Following the pandemic shock flights and hotel stays go down (and the effect is statistically significant and persistent).

Figure 2.11: Impulse Responses to Fiscal Announcement Shocks, all countries (percent)



Note: estimation of equation 5 over a time horizon of k=12 weeks. Light and dark shaded areas denote confidence bands at the 68 and 90 percent levels. t=0 is the week of the debt surge shock; t=1 is the first week of the fiscal announcement shock. Solid black lines denote the response to a fiscal announcement shock, dark grey area denotes 90 percent confidence bands while light gray area denotes 68 percent confidence bands, based on standard errors clustered at country level.

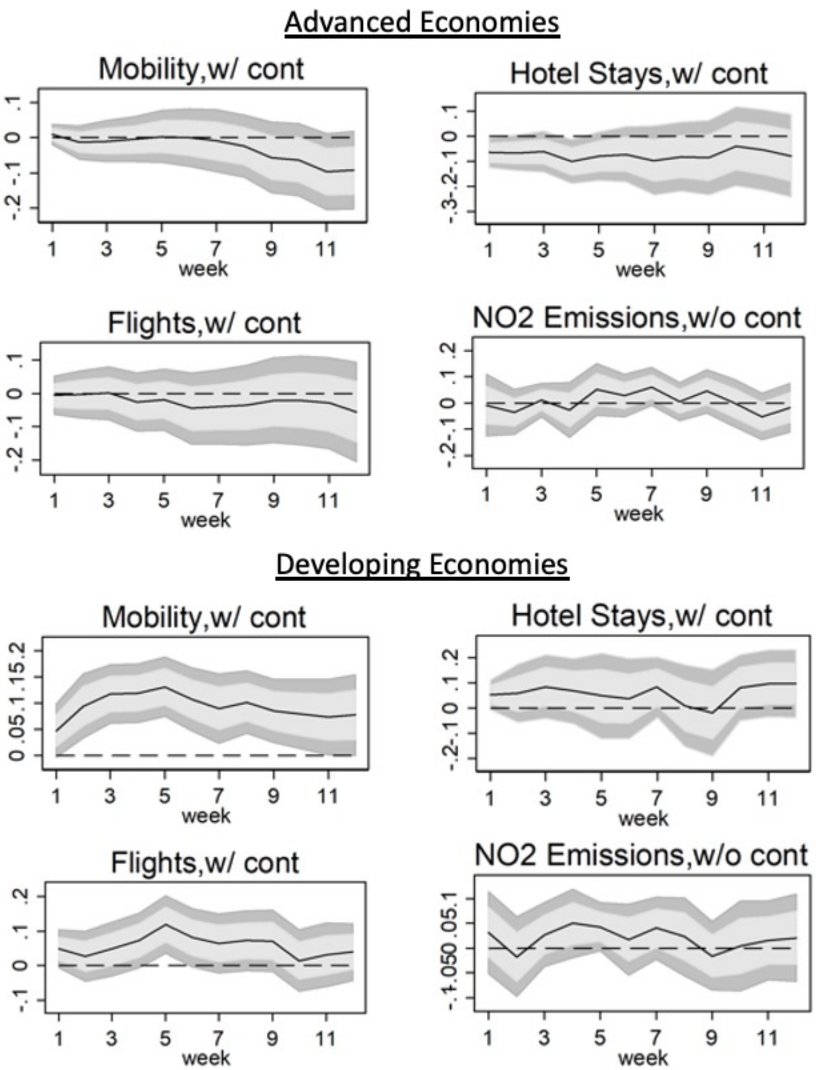
ATL or CL are announced (but the magnitude and degree of significance is larger for CL). CL have positive medium-term effects on hotel stays while other types of measures do not significantly impact this variable. Flights react positively following either BTL or CL fiscal announcement and seem indifferent to ATL measures. Finally, the effect on NO_2 emissions is unclear.

5.2 Conditional

Now we turn to the conditional effects, that is, estimation of equation (2.8).[11] The size of the fiscal announcement package matters for the short-term eco-

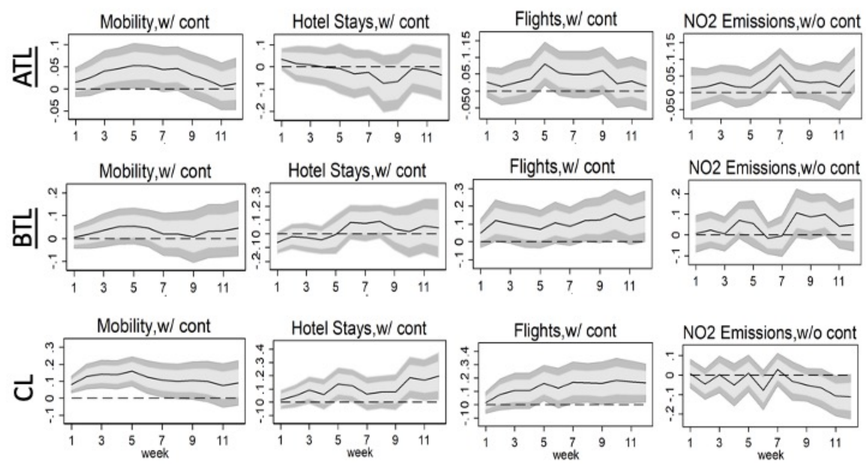
[11] In Appendix Table 2.10 we conduct a static conditional regression exercise by expanding equation 1 with an interaction term of COVID-19 and the fiscal announcement. Results are on average weak and inconclusive with the exception of BTL for the case of NO_2 emissions where the combined result (accounting for the significant interacting coefficient) is a negative effect of fiscal announcements the larger the size of the fiscal announcement package.

Figure 2.12: Impulse Responses to Fiscal Announcement Shocks, AEs vs DEV



Note: estimation of equation 5 over a time horizon of k=12 weeks. Light and dark shaded areas denote confidence bands at the 68 and 90 percent levels. t=0 is the week of the debt surge shock; t=1 is the first week of the fiscal announcement shock. Solid black lines denote the response to a fiscal announcement shock, dark grey area denotes 90 percent confidence bands while light gray area denotes 68 percent confidence bands, based on standard errors clustered at country level.

Figure 2.13: Impulse Responses to Fiscal Announcement Shocks by type, all countries

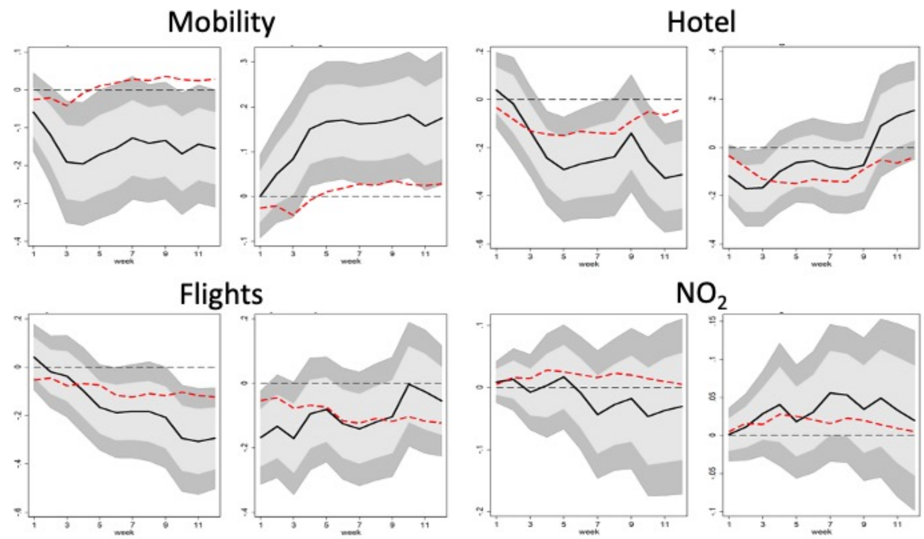


Note: estimation of equation 5 over a time horizon of k=12 weeks. Light and dark shaded areas denote confidence bands at the 68 and 90 percent levels. t=0 is the week of the debt surge shock; t=1 is the first week of the fiscal announcement shock. Solid black lines denote the response to a fiscal announcement shock, dark grey area denotes 90 percent confidence bands while light gray area denotes 68 percent confidence bands, based on standard errors clustered at country level.

nomic response that follows (Figure 2.14). In particular, a large (small) fiscal announcement has a positive (negative) and significant effect on mobility. Moreover, if the size of the fiscal announcement is small, then the effect on hotel stays and number of flights is negative and significant.

Next, we estimate equation (2.9). As discussed, we evaluate two sets of prevailing conditions at the time of the fiscal announcement shock: business cycle conditions; fiscal space. Looking at Figure 2.15, we observe that, in the case of mobility, the prevailing business cycle conditions matter for the effect of the fiscal announcement. If the economy is booming, mobility increases and the effect is statistically different from zero. In the remainder of the variables analyzed the conditional effect is not statistically different from that of the baseline (unconditional) regression. In Figure 2.16, we inspect whether

Figure 2.14: Impulse Responses to Fiscal Announcement Shocks, AEs vs DEV



Note: estimation of equation 2.8 over a time horizon of k=12 weeks. Light and dark shaded areas denote confidence bands at the 68 and 90 percent levels. t=0 is the week of the COVID-19 shock; t=1 is the first week of COVID-19 shock. Solid black lines denote the response to a COVID-19 shock, dark grey area denotes 90 percent confidence bands while light gray area denotes 68 percent confidence bands, based on standard errors clustered at country level. The red line denotes the variable's unconditional result for comparison purposes.

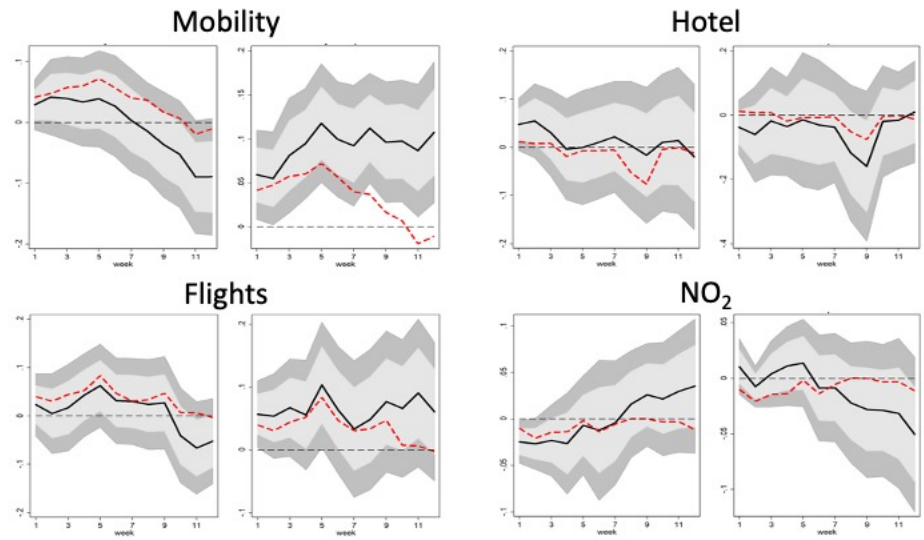
existence of fiscal space matters. If the fiscal room for maneuver is generous, then mobility, hotel stays and flights all increase (at least in the short-run) and above the baseline (unconditional) result.

5.3 Government Credibility Effect

A final exercise is to check to what extent financial markets pricing sovereign bond issuances see the announcement of different types of fiscal measures. The new dependent variable is government bond yields and spreads as measured by 10-year foreign currency-denominated government bond yields and spreads vis-à-vis the U.S. benchmark, which are drawn from Bloomberg.[12] Note that due to

[12]The list includes the following countries: Albania, Argentina, Austria, Azerbaijan, Bahamas, Bahrain, Belgium, Belize, Benin, Bolivia, Brazil, Bulgaria, Canada, Chile, China,

Figure 2.15: Conditional Impulse Responses to Fiscal Announcements, Good Vs Bad Times

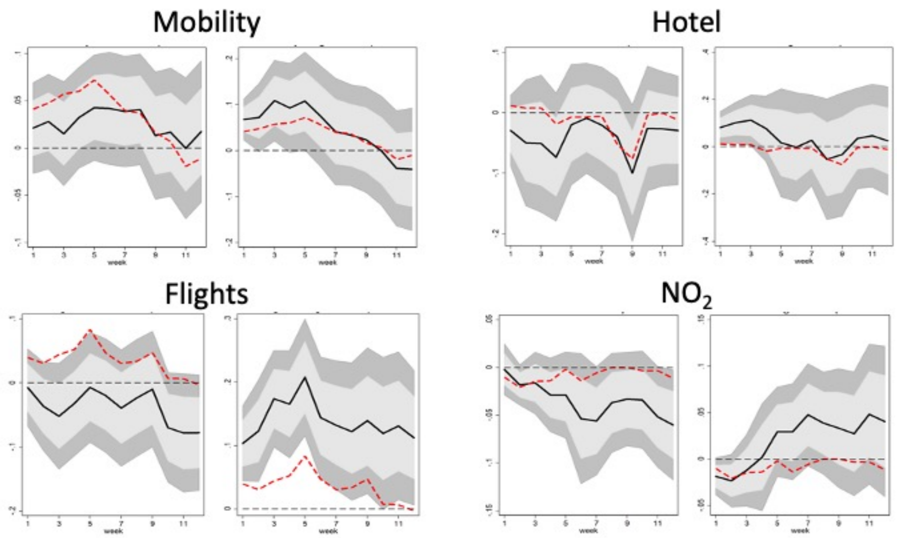


Note: estimation of equation (2.9) over a time horizon of k=12 weeks. Light and dark shaded areas denote confidence bands at the 68 and 90 percent levels. t=0 is the week of the fiscal announcement shock; t=1 is the first week of the fiscal announcement shock. Solid black lines denote the response to a fiscal announcement shock, dark grey area denotes 90 percent confidence bands while light gray area denotes 68 percent confidence bands, based on standard errors clustered at country level. The red line denotes the variable´s unconditional result for comparison purposes.

data availability the empirical analysis that follows does not necessarily match the same sample of countries as before. Table 2.5 shows the unconditional static results of estimating equation (2.1) with the new dependent variable spreads. We observe that the effect on the fiscal announcement is negative and significant, particularly when of the BTL type. This suggests that financial markets reward those announcing big fiscal packages.

Colombia, Costa Rica, Croatia, Cyprus, Czech Republic, Côte d'Ivoire, Dominican Republic, Ecuador, Egypt, El Salvador, Finland, France, Ghana, Greece, Guatemala, Hong Kong, Hungary, Indonesia, Ireland, Israel, Italy, Jamaica, Jordan, Kazakhstan, Kenya ,Korea, Latvia, Lithuania, Luxembourg, Mexico, Mongolia, Morocco, Mozambique, Netherlands, Nigeria, Oman, Pakistan, Panama, Paraguay, Peru, Philippines, Poland, Portugal, Qatar, Romania, Russian Federation, Rwanda, Saudi Arabia, Senegal, Slovak Republic, Slovenia, South Africa, Spain, Sri Lanka, Sweden, Tajikistan, Republic of, Trinidad and Tobago, Turkey, Ukraine, United Arab Emirates, Uruguay, Uzbekistan, Republic of, Vietnam, Zambia.

Figure 2.16: Conditional Impulse Responses to Fiscal Announcements, High vs Low Fiscal Space



Note: estimation of equation (2.9) over a time horizon of k=12 weeks. Light and dark shaded areas denote confidence bands at the 68 and 90 percent levels. t=0 is the week of the fiscal announcement shock; t=1 is the first week of the fiscal announcement shock. Solid black lines denote the response to a fiscal announcement shock, dark grey area denotes 90 percent confidence bands while light gray area denotes 68 percent confidence bands, based on standard errors clustered at country level. The red line denotes the variable´s unconditional result for comparison purposes.

Dynamically, running equation (2.7) on the new dependent variable yields the impulse responses plotted in Figure 2.17. We confirm the static results in the sense that spreads go down in the short run, and more so in the case of developing economies. In Figure 2.18 we split the type of fiscal announcement and we observe that in the case of AEs it is BTL type of measures that lead to the largest (negative) impact on spreads. In the case of DEV, ATL seem to matter more to reduce spreads (but the effect is only on the margin significant – depends on the CI chosen). More interestingly is the fact that financial markets penalize developing countries that announce BTL or CL type of measures. One reason for this result could be the fact that typically these countries are characterized by poorer institutions and weaker public administrations. In

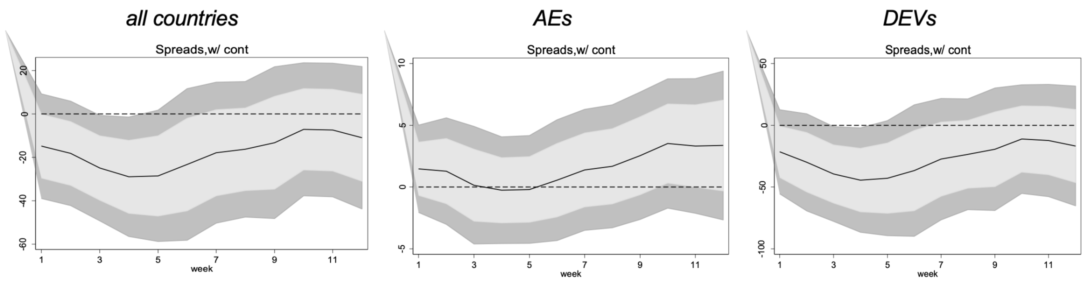
Table 2.5: Unconditional Results on Spreads

Specification Types of Fiscal announcements	(1) TOT	(2) ATL	(3) BTL	(4) CL
Fiscal Announcement	-2.6435*	-3.0893	-23.8493*	-2.0637
	(1.528)	(1.973)	(14.041)	(2.198)
Covid	-1.2770*	-1.3221*	-1.3464*	-1.2880*
	(0.738)	(0.743)	(0.746)	(0.746)
Δstring	0.2154	0.2241	0.2176	0.2145
	(0.280)	(0.283)	(0.281)	(0.282)
L.lngdppc	33.9193	34.3017	35.9530	35.8857
	(44.781)	(44.505)	(45.201)	(45.327)
L.lnpopdens	19.4262	19.4795	19.4581	19.5365
	(20.268)	(20.246)	(20.250)	(20.284)
L.lnhospbeds	18.8791	19.1482	19.3125	19.4233
	(22.609)	(22.603)	(22.453)	(22.468)
L.human_development_index	-280.5438	-281.2073	-284.6956	-286.2401
	(307.437)	(307.243)	(308.748)	(308.915)
L.median_age	2.5241	2.5030	2.3844	2.3972
	(3.207)	(3.203)	(3.170)	(3.170)
Observations	4,355	4,355	4,355	4,355
R-squared	0.1092	0.1090	0.1088	0.1087

Note: Estimates are based on OLS estimation with robust standard errors in parenthesis clustered at the country level. Country and time fixed effects omitted for reasons of parsimony. Constant term omitted. *, **, *** denote statistical significance at the 10, 5 and 1 percent levels, respectively.

the case of DEV, they are rewarded with fiscal announcements that involve more direct support, such as ATL, rather than the announcements that require a high level of financial infrastructure and maturity, such as BTL and CL. Their lower level of financial infrastructure makes it difficult to carry out BTL and CL types of support credibly. Thus, fiscal announcement related to BTL and CL could be seen as “less credible” in DEVs and does not reduce spreads. Also, CL has more uncertainty and exposes the government to fiscal risks that may not be well managed down the line, which could be why spreads are not contracting in response to CL type of fiscal announcements in DEVs.

Figure 2.17: Impulse Responses on Sovereign Bond Spreads to Fiscal Announcement Shocks, all countries vs AE vs DEV



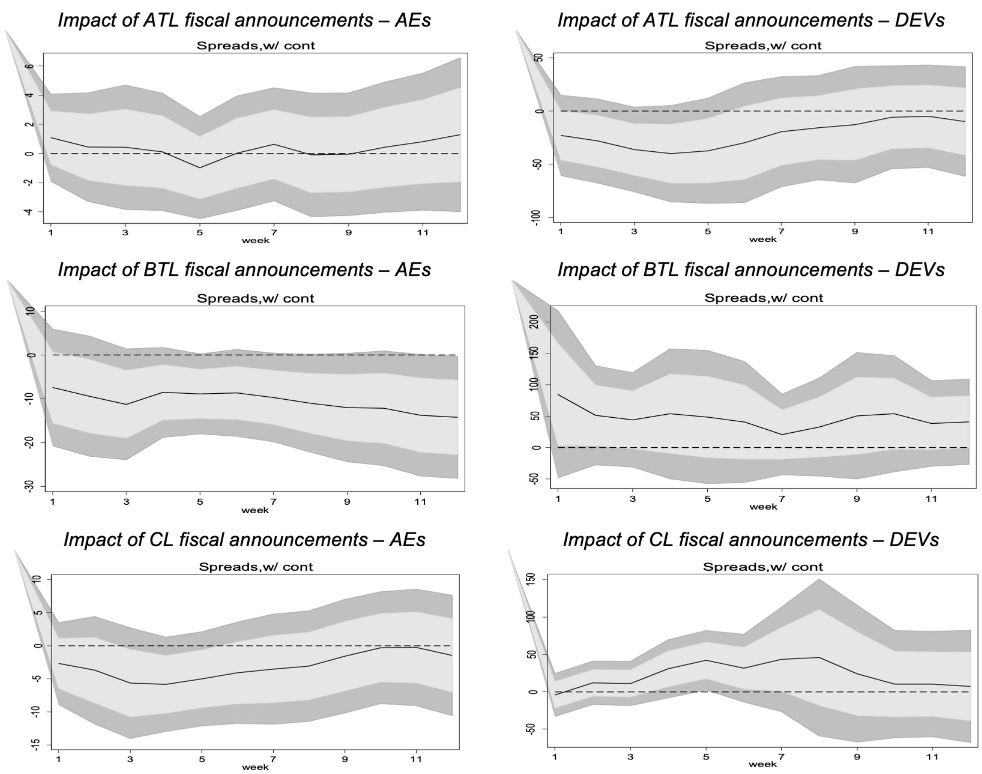
Note: estimation of equation (2.7) over a time horizon of k=12 weeks. Light and dark shaded areas denote confidence bands at the 68 and 90 percent levels. t=0 is the week of the fiscal announcement shock; t=1 is the first week of the fiscal announcement shock. Solid black lines denote the response to a fiscal announcement shock, dark grey area denotes 90 percent confidence bands while light gray area denotes 68 percent confidence bands, based on standard errors clustered at country level. The red line denotes the variable's unconditional result for comparison purposes.

6 Conclusion

This paper studies the effectiveness of fiscal announcements on economic activities by looking at Covid-19 related fiscal announcements. Our first contribution is that we build a panel data of fiscal announcements that are Covid-related demand support type. We separate all fiscal announcements between January 2020 and May 2021 into three different categories (ATL, BTL and CL), while keeping track of the date the announcement was made. We also separate each country into different income groups to see the characteristics of fiscal announcements in different income groups.

Secondly, we show how fiscal announcements affect the different proxies of economic activities and sovereign spreads dynamically, conditioning on countries' initial conditions prevailing at the time of the COVID-19 shock. When looking at static results, the effects of fiscal announcements on high-frequency economic activity variables are more or less confusing. As we employ

Figure 2.18: Impulse Responses on Sovereign Bond Spreads to Fiscal Announcement Shocks, AE vs DEV



Note: estimation of equation (2.7) over a time horizon of k=12 weeks. Light and dark shaded areas denote confidence bands at the 68 and 90 percent levels. t=0 is the week of the fiscal announcement shock; t=1 is the first week of the fiscal announcement shock. Solid black lines denote the response to a fiscal announcement shock, dark grey area denotes 90 percent confidence bands while light gray area denotes 68 percent confidence bands, based on standard errors clustered at country level. The red line denotes the variable's unconditional result for comparison purposes.

dynamic analysis, however, we find more interesting results as we classify the types of fiscal announcements and income groups. Fiscal announcements have a large and positive effect on mobility and flights in developing countries. Different types of announcements influence economic activity in various way: ATLs are the most effective on mobility, flights, and NO_2 emissions in the medium-term. CLs are effective on mobility, hotel stays, and flights in short to medium-term, whereas the effects of BTL on economic activity are ambiguous. The impact of fiscal announcement on economic activity in the short term is more significant in countries with a larger fiscal space.

Lastly, we explore how financial markets react to governments' fiscal announcements by examining country spreads. BTL and CL reduce country spreads in advanced economies, but ATL measures do not. This is reversed in developing countries where the effect of ATL is to reduce spreads, whereas BTL and CL do not reduce the spreads. This may reflect the market's concern that country needs a higher level of maturity in the finance and banking sectors to implement BTL and CL successfully. These results suggest why it might be essential to see the effect of a fiscal announcement by types, rather than the aggregated announcement effect.

These results are particularly relevant from a policy perspective. They highlight that the particularly cost-effective role of CL and BTL measures in supporting short-run activity during the pandemic. CL and BTL measures have very low upfront costs and may not lead to any notable increase in public debt in the long run, unlike ATL measures which require immediate spending, often funded through additional borrowing. For AEs, the introduction of CL and BTL measures has a further benefit, as they appear to also reduce sovereign spreads, lowering borrowing costs and supporting confidence. Still, while this combination of low up-front costs, generally positive announcement impact, and lower spreads meant CL and BTL measures were a powerful tool in addressing at least the immediate effects of the pandemic, these measures also carry with them a (sometimes very large) contingent liability that could be realized in the future. Policymakers should be sure to also assess the magnitude and likelihood of risk realization when designing the combination of policy responses to future similar events.

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8 Appendix

8.1 IMF Glossary

- **"Above-the-line"** measures Involve revenue raising and government expenditure, which affects the overall fiscal balance and government debt. In summary fiscal statements, these measures are typically recorded above the line of the overall fiscal balance.

- **"Below-the-line"** measures Generally involve the creation of assets or liabilities without affecting fiscal revenues and spending today. Examples include government provision of loans or equity injection in firms. In summary fiscal statements, these are typically recorded as the net acquisition of financial assets, which is below the line of the overall fiscal balance.

- **Contingent liabilities**: Obligations that are not explicitly recorded on government balance sheets and that arise only in the event of a particular discrete situation, such as a crisis.

8.2 Examples of Fiscal Measures

1. **"Above-the-line"** measures (ATL)

    - Wage subsidy

        - The Australian government provides a wage subsidy to around 6 million workers who will receive a flat payment of $1,500 per fortnight through their employer before tax.

- Education and social welfare
    - Indonesia helps access information for teachers, students, students, and lecturers in carrying out Distance Learning during the pandemic. The government provides subsidized internet quota for students, teachers, and lecturers for four months.
    - On March 19 2020, Ecuador announced further measures to support the population and businesses, such as deferral of payroll contributions, distribution of food baskets, and exceptional cash transfer amounting to US$120 to 400 thousand low-income families.
- Tax cuts/suspensions
    - The Italian government has introduced a series of rules that provide for a total allocation of €2.4 billion, with the effect of suspending taxes and contributions for a total of 10.7 billion euros on March 17, 2020.
    - On July 31, 2020, Cambodia extended tax holidays for airlines, tourism-related businesses to offset the COVID-19 impact. Locally registered airlines are granted an extended minimum tax exemption for two months from August to September 2020.

2. **"Below-the-line"** measures (BTL)
    - Equity purchase
        - Brussels Airlines has asked the federal government for €200 million in aid to cope with the fallout from the COVID-19 epidemic.

  - Dubai government has put AED7.3 billion ($2 billion) into Emirates since March 2020 to help its flagship airline sustain operations during the coronavirus pandemic.

- Loan

  - On September 3 2020, the French government announced a new fiscal package to support the recovery of the French economy ("Plan de Relance"), which focuses on the ecological transformation of the economy.

3. **Contingent liabilities**

- Provision of loans and guarantees

  - The Swiss federal government announced fiscal measures of 15 million CHF for Commercial guarantees and Switzerland Global Enterprise SGE on March 13 2020

  - The Colombian government announced a specific allocation of $2.5 billion through the National Guarantee Fund (FNG) for lines of credit that leverage the payment of payroll for gardens and private schools, and higher education institutions.

  - South Korean government announced emergency measures on April 8 2020, which includes additional stimulus worth KRW 55.9 trillion ($45 billion) to prevent a recession in the domestic market.

8.3 Tables

Table 2.6: Baseline Unconditional Results, with controls, by income group

Income group	AE				DEV			
Specification	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dep. Var.	lnmobility	lnhotel	lnflights	NO_2	lnmobility	lnhotel	lnflights	NO_2
TOT	-0.5064	-0.1797	0.5653	0.3860	-4.5482	-6.9095*	-2.7571	7.8977**
	(0.359)	(0.420)	(0.383)	(0.442)	(2.915)	(3.888)	(3.935)	(3.521)
Covid	-0.6806***	-1.7330***	-1.4020***	-0.0637	-0.4125	-0.0128	-0.0187	-0.5158*
	(0.219)	(0.521)	(0.315)	(0.416)	(0.317)	(0.424)	(0.275)	(0.255)
Δstring	-0.3912***	-0.6235***	-0.5467***	-0.3340*	-0.3208**	-0.4048***	-0.5029***	-0.1762*
	(0.073)	(0.193)	(0.107)	(0.185)	(0.119)	(0.133)	(0.100)	(0.096)
L.lngdppc	-8.7550*	-2.8207	-25.5779**	1.7266	-21.6160**	17.3658	-5.8232	31.5895***
	(4.390)	(9.174)	(11.483)	(21.216)	(9.308)	(16.206)	(10.596)	(10.499)
L.lnpopdens	0.3614	0.4712	-2.3977	-4.4692*	-1.5139	-8.9853***	-2.3745	-7.6295
	(1.136)	(1.514)	(2.041)	(2.418)	(2.590)	(2.732)	(5.616)	(5.645)
L.lnhospbeds	-7.7370**	0.6827	3.6707	-2.5272	-5.5143	-5.4964	-12.7185	-22.3009*
	(3.207)	(4.334)	(5.722)	(13.205)	(7.497)	(9.036)	(10.108)	(11.826)
L.human_development_index	14.2661	-30.2616	130.2313**	121.7275	152.4259***	-157.7330	83.6802	-249.7445**
	(33.918)	(58.335)	(60.894)	(133.940)	(49.950)	(123.451)	(98.082)	(118.537)
L.median_age	0.5273	1.0582**	-0.5739	0.1141	-0.5073	1.0846	-0.6592	3.2053
	(0.374)	(0.457)	(0.484)	(1.457)	(0.727)	(0.785)	(1.547)	(2.195)
Observations	1,956	1,166	1,990	1,405	1,566	2,058	4,883	1,212
R-squared	0.5571	0.5152	0.4733	0.1177	0.5163	0.3400	0.3650	0.1283

Note: results reported are based on a maximum sample of 59 countries using weekly data from January 2020 until May 2021. Estimates are based on OLS estimation with robust standard errors in parenthesis clustered at the country level. Country and time fixed effects omitted for reasons of parsimony. Constant term omitted. *, **, *** denote statistical significance at the 10, 5 and 1 percent levels, respectively.

Table 2.7: Decomposing Fiscal Measures by Type: ATL Results, with controls, all economies

Specification	(1)	(2)	(3)	(4)
Dep. Var.	lnmobility	lnhotel	lnflights	NO_2
ATL	-0.2474	-0.6446	0.8773	1.3545*
	(0.340)	(0.578)	(0.605)	(0.713)
Covid	-0.4619**	-0.6413*	-0.2498	-0.4890**
	(0.210)	(0.372)	(0.218)	(0.223)
Δstring	-0.3975***	-0.5378***	-0.5618***	-0.2466**
	(0.067)	(0.113)	(0.078)	(0.100)
L.lngdppc	-12.0762**	9.2049	-10.5788	4.6800
	(5.382)	(8.012)	(9.122)	(12.588)
L.lnpopdens	-0.4372	-2.6649	-3.5866	-3.7102**
	(0.978)	(1.696)	(3.097)	(1.484)
L.lnhospbeds	-6.0421	-4.8386	-8.7917	-16.3554**
	(3.832)	(5.018)	(7.403)	(6.340)
L.human_development_index	61.4267**	-66.4424	85.7566	32.8612
	(28.934)	(61.510)	(64.947)	(101.103)
L.median_age	0.0596	0.8351	-0.6119	0.6865
	(0.332)	(0.549)	(0.922)	(1.061)
Observations	3,522	3,224	6,873	2,617
R-squared	0.4962	0.3686	0.3717	0.0753

Note: results reported are based on a maximum sample of 59 countries using weekly data from January 2020 until May 2021. Estimates are based on OLS estimation with robust standard errors in parenthesis clustered at the country level. Country and time fixed effects omitted for reasons of parsimony. Constant term omitted. *, **, *** denote statistical significance at the 10, 5 and 1 percent levels, respectively.

Table 2.8: Decomposing Fiscal Measures by Type: BTL Results, with controls, all economies

Specification	(1)	(2)	(3)	(4)
Dep. Var.	lnmobility	lnhotel	lnflights	NO_2
BTL	2.6490**	-13.4850	1.8580*	4.1434***
	(1.148)	(9.608)	(0.963)	(1.382)
Covid	-0.4726**	-0.6446*	-0.2454	-0.4806**
	(0.208)	(0.366)	(0.219)	(0.226)
Δstring	-0.3951***	-0.5385***	-0.5613***	-0.2471**
	(0.067)	(0.113)	(0.078)	(0.099)
L.lngdppc	-11.8518**	9.6053	-10.8730	4.1748
	(5.353)	(8.018)	(9.130)	(12.468)
L.lnpopdens	-0.3746	-2.7079	-3.6439	-3.7880**
	(0.977)	(1.697)	(3.088)	(1.489)
L.lnhospbeds	-6.0107	-5.1086	-8.7860	-16.2504**
	(3.814)	(4.988)	(7.398)	(6.371)
L.human_development_index	59.9884**	-67.0014	86.3018	35.4009
	(29.148)	(61.826)	(65.042)	(101.139)
L.median_age	0.0577	0.8297	-0.5895	0.6687
	(0.329)	(0.545)	(0.924)	(1.069)
Observations	3,522	3,224	6,873	2,617
R-squared	0.4972	0.3699	0.3714	0.0751

Note: results reported are based on a maximum sample of 59 countries using weekly data from January 2020 until May 2021. Estimates are based on OLS estimation with robust standard errors in parenthesis clustered at the country level. Country and time fixed effects omitted for reasons of parsimony. Constant term omitted. *, **, *** denote statistical significance at the 10, 5 and 1 percent levels, respectively.

Table 2.9: Decomposing Fiscal Measures by Type: CL Results, with controls, all economies

Specification Dep. Var.	(1) lnmobility	(2) lnhotel	(3) lnflights	(4) NO_2
CL	-0.7495	-0.3952	0.5642	0.2311
	(0.650)	(0.614)	(0.485)	(0.672)
Covid	-0.4488**	-0.6395*	-0.2519	-0.4810**
	(0.209)	(0.369)	(0.221)	(0.223)
Δstring	-0.4020***	-0.5389***	-0.5600***	-0.2487**
	(0.067)	(0.113)	(0.078)	(0.101)
L.lngdppc	-12.3008**	9.6469	-10.8171	4.1046
	(5.464)	(8.011)	(9.128)	(12.567)
L.lnpopdens	-0.4785	-2.5934	-3.6385	-3.7996**
	(0.971)	(1.671)	(3.086)	(1.521)
L.lnhospbeds	-6.0227	-4.8612	-8.8025	-16.3072**
	(3.891)	(5.009)	(7.405)	(6.348)
L.human_development_index	62.0397**	-67.9222	86.3257	36.4919
	(29.414)	(61.792)	(65.004)	(101.320)
L.median_age	0.0715	0.8179	-0.5950	0.6656
	(0.335)	(0.547)	(0.924)	(1.073)
Observations	3,522	3,224	6,873	2,617
R-squared	0.4976	0.3685	0.3714	0.0740

Note: results reported are based on a maximum sample of 59 countries using weekly data from January 2020 until May 2021. Estimates are based on OLS estimation with robust standard errors in parenthesis clustered at the country level. Country and time fixed effects omitted for reasons of parsimony. Constant term omitted. *, **, *** denote statistical significance at the 10, 5 and 1 percent levels, respectively.

Table 2.10: Static Conditional Results, with controls, all countries

Specification Dep.Var.	(1) lnmobility	(2) lnhotel	(3) lnflights	(4) NO_2
TOT	-0.7078	-0.7723	0.3240	0.2889
	(0.507)	(0.492)	(0.578)	(0.701)
Covid	-0.4597**	-0.6395*	-0.2756	-0.5218**
	(0.209)	(0.373)	(0.218)	(0.226)
Interaction	0.1222	0.1112	0.1641	0.1847
	(0.127)	(0.196)	(0.157)	(0.212)
ATL	-0.3160	-0.5083	0.4606	1.8465*
	(0.683)	(0.855)	(0.857)	(1.062)
Covid	-0.4632**	-0.6368*	-0.2631	-0.4757**
	(0.207)	(0.375)	(0.217)	(0.223)
Interaction	0.0220	-0.0555	0.1960	-0.1926
	(0.143)	(0.214)	(0.219)	(0.329)
BTL	-3.6666	-13.1231	2.9038	-8.3546***
	(3.748)	(10.838)	(6.142)	(2.780)
Covid	-0.4904**	-0.6433*	-0.2441	-0.4948**
	(0.208)	(0.364)	(0.219)	(0.227)
Interaction	2.5718*	-0.4859	-0.4282	4.9906***
	(1.303)	(4.813)	(2.216)	(1.026)
CL	-1.2610	-1.1721	0.2300	-0.8769
	(0.909)	(0.761)	(0.663)	(0.538)
Covid	-0.4544**	-0.6494*	-0.2539	-0.4982**
	(0.210)	(0.369)	(0.221)	(0.223)
Interaction	0.2108	0.3208	0.1381	0.4801***
	(0.280)	(0.293)	(0.173)	(0.153)

Note: results reported are based on a maximum sample of 59 countries using weekly data from January 2020 until May 2021. Estimates are based on OLS estimation with robust standard errors in parenthesis clustered at the country level. Country and time fixed effects omitted for reasons of parsimony. Constant term omitted. *, **, *** denote statistical significance at the 10, 5 and 1 percent levels, respectively.

8.4 Figures

Figure 2.19: Distribution of Fiscal Measures by Type Over Time, Advanced Economies

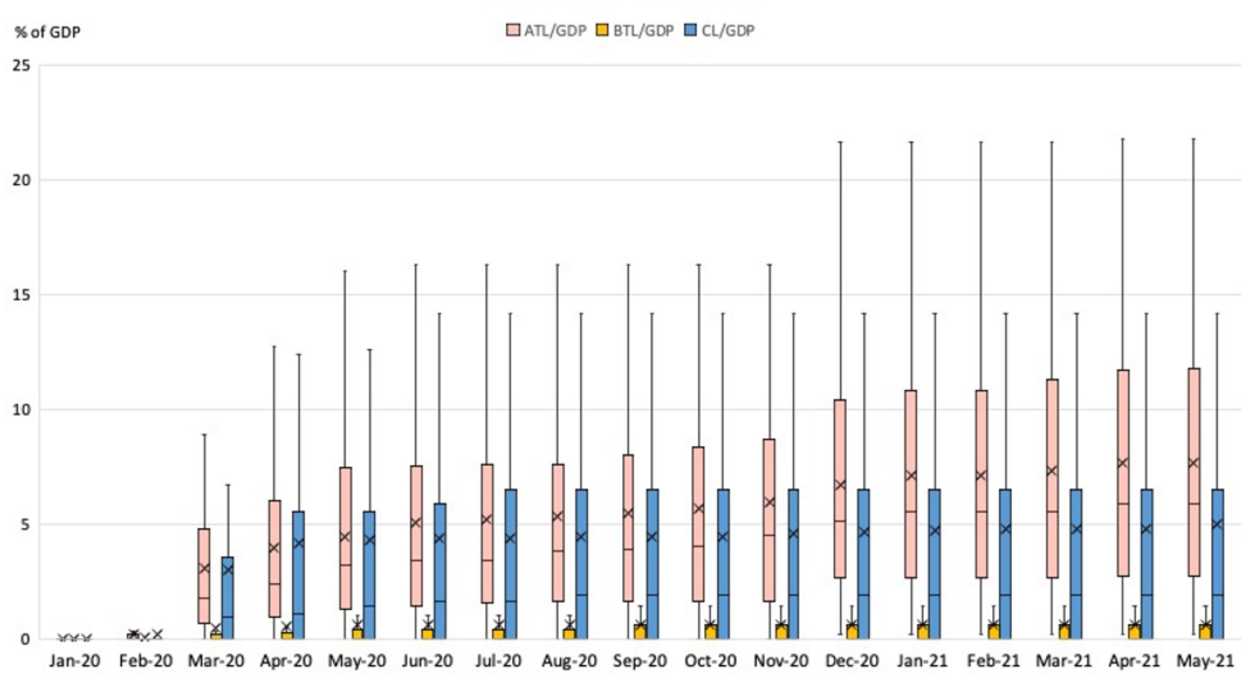


Figure 2.20: Distribution of Fiscal Measures by Type Over Time, Emerging Economies

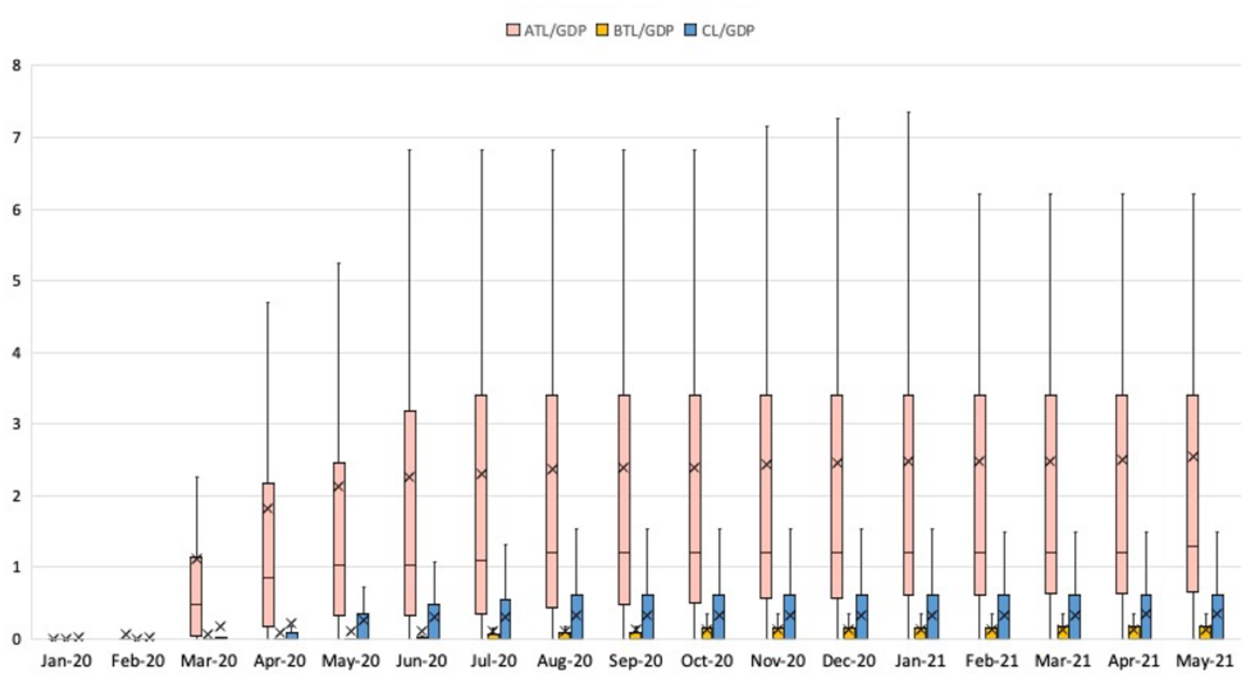


Figure 2.21: Distribution of Fiscal Measures by Type Over Time, Low-Income Economies

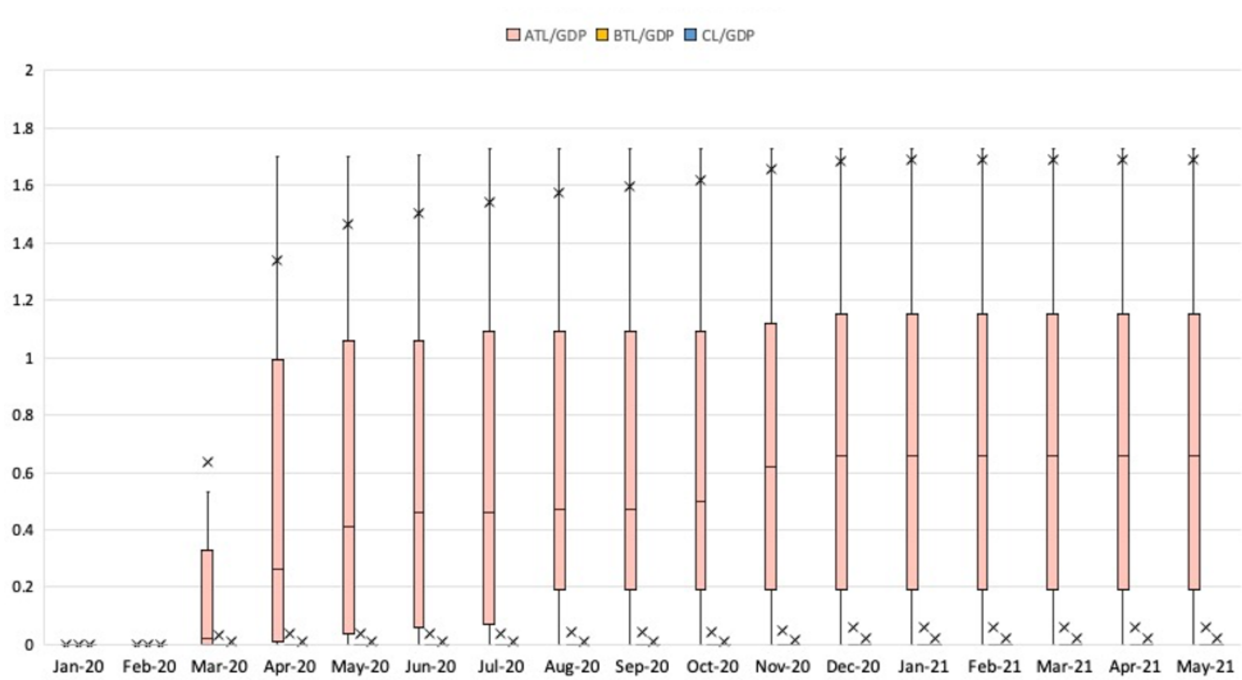
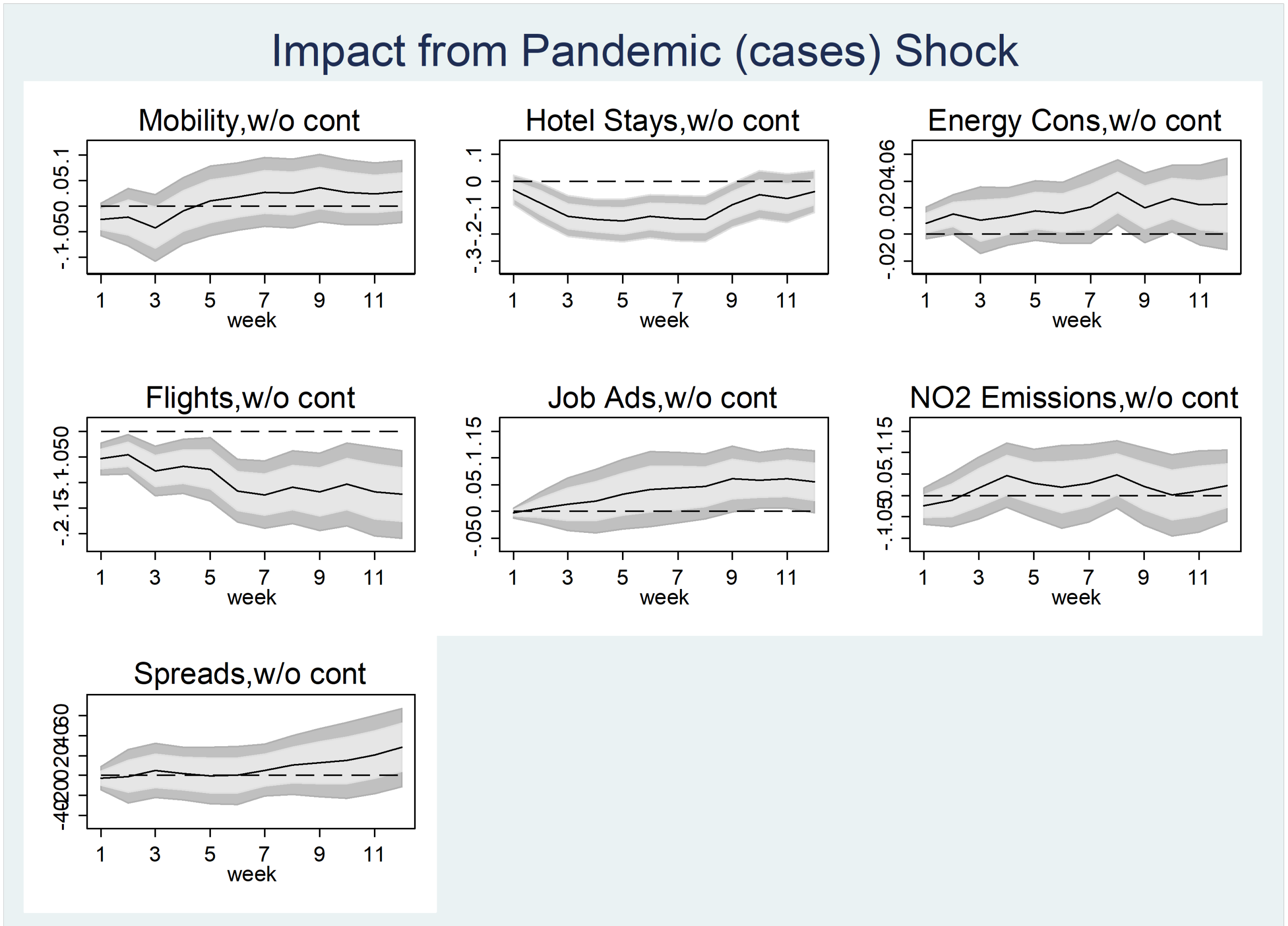


Figure 2.22: Impulse Responses to COVID-19 Shocks, all countries



Note: estimation of equation (2.7) over a time horizon of k=12 weeks. Light and dark shaded areas denote confidence bands at the 68 and 90 percent levels. t=0 is the week of the debt surge shock; t=1 is the first week of a COVID-19 shock. Solid black lines denote the response to a COVID-19 shock, dark grey area denotes 90 percent confidence bands while light gray area denotes 68 percent confidence bands, based on standard errors clustered at country level.