Do fiscal rules affect growth?

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30 de novembro de 2022

Abstract

Over the last three decades, countries have widely adopted fiscal rules. This paper studies how fiscal rules affect economic growth. With an overlapping generations model with endogenous growth, in which the government imposes two fiscal rules, a debt rule and a budget balance rule, we analyze the dynamics of public debt, economic growth and welfare in an economy. Empirically, we conduct two exercises to examine the impact of fiscal rules. The first estimates a growth equation derived from the theoretical model for a panel of countries to verify the correlations predicted by the model. The second evaluates the effect of fiscal rules on GDP per capita growth rate. To address the endogeneity problem, we use a cross-country panel with an IV approach. The instrument explores the geographical diffusion of fiscal rules across countries. Results show that fiscal rule adoption positively affects economic growth for developing and low-income countries. For Europe, better fiscal rules also have a positive impact on growth. Well-designed debt rules seem a better recipe for economic growth than budget balance rules, especially in developing and low-income countries.

Key-words: Fiscal rules, Fiscal Policy, Economic growth, Instrumental Variables.

JEL Codes: O47, E61, E62

1 Introduction

In the last few decades, economies all over the globe witnessed the emergence and persistence of large fiscal deficits and public debt. The sustainability of public finances has acquired new importance after the global financial crises in the late 2000s. Many countries

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pursued adjustment with the use of fiscal rules. The International Monetary Fund (FMI) defines fiscal rules as longer-lasting constraints on fiscal policy through numerical limits on budgetary aggregates. The objective of such rules is to pursuit debt sustainability and to ensure fiscal responsibility. They have been widely used to restrain fiscal policy discretion and bolster fiscal discipline.

Since the early 90s, fiscal rules adoption has been increasing in the number of rules per country and in the number of countries that have adopted at least one rule. It has been three decades since the first major fiscal rules implementation. Nowadays, there are over 90 countries with at least one fiscal rule in place.[1] According to Caselli et al. (2018), in the early 90s, the average number of rules per country was less than one. By the year 2015, this average increased to three rules per country, with significant acceleration after the 2008 financial crises.[2] Countries may adopt multiple fiscal rules to achieve multiple objectives. There has been an international trend toward adopting multiple fiscal rules.[3] To better anchor fiscal sustainability, budget balance rules and expenditure rules have progressively been used in combination with debt rules.

There exists some criteria when choosing fiscal rules, such as sustainability, stabilization, simplicity, operational guidance, resilience, ease of monitoring, and enforcement (Kopits and Symansky, 1998). Nevertheless, a single fiscal rule might not achieve all of these criteria simultaneously. Some trade-offs are likely to emerge, such as stabilization versus simplicity: a more flexible rule to accommodate macroeconomic shocks is likely to have a more complex design. For example, rules that correct for the impact of business cycles by targeting cyclically-adjusted balances. Well-designed fiscal structures are generally built over two pillars: (1) a fiscal anchor linked to the final objective of fiscal policy, and (2) one or more operational rules on fiscal aggregates (Andrle et al., 2015). The debt-to-GDP ratio is a natural fiscal anchor. It creates an upper bound for repeated missing the fiscal targets in the country's budget and provides guidance for medium-term fiscal expectations. It can also be calibrated to achieve long-term sustainability of public finances. At the same time, the debt-to-GDP ratio does not provide short-term operational guidance. In this sense, budget balance rules work as a short-term operational rule since they have a close and predictable link to debt dynamics and are under the direct control of the government.

The extensive economic growth literature predicts that fiscal policy can directly affect growth. Public spending can represent a waste of the economy's resources, but public investment or productive public spending can stimulate growth. Concerning fiscal rules, they might improve fiscal behavior and fiscal policy through improving budgetary outcomes, but they can also negatively impact economic growth. Thus, this paper is close to the literature of theoretical models that study fiscal sustainability under the assumption of some fiscal rule within overlapping generations (OLG) model (Bräuninger (2005), Yakita (2008), Arai (2011), Teles and Mussolini (2014) and Agénor and Yilmaz (2017)). These articles either adopt a constant deficit/GDP ratio as a fiscal rule or a spending rule, but they do not include a debt rule or focus on a combination of fiscal rules. Also, they lack an empirical analysis to verify the conclusions of their theory.

[1] Eyraud et al. (2018).

[2] In the European Union, this average tripled from 2 to 6 fiscal rules between 2000 and 2015. Among countries outside the EU, the average number of fiscal rules went from zero during the same period.

[3] Another factor that might corroborate this trend includes overlap of supranational and national rules in currency unions, as well as political difficulties in eliminating existing rules when new ones are adopted.

By controlling public aggregates, fiscal rules affect the allocation of resources, economic growth and welfare across generations. This study aims to analyze the dynamics of public debt, economic growth and welfare in an economy under a debt rule and a budget balance rule. We use an overlapping generations model with endogenous growth, in which the government imposes the two fiscal rules. The debt rule sets an upper bound for the public debt. The deficit rule, which works as a budget balance rule, aims to keep budget deficits at a certain percentage of GDP. The tax rate is used to adjust the government budget constraint; thus, it is endogenously chosen. We then explore the effects of those rules on economic growth and equilibrium dynamics. In our model, the long-run growth rate is endogenous, and the engine for boosting productivity is productive public spending. We consider productive public spending as the public expenditure on education, health, and infrastructure, i.e., it is a flow rather than a type of capital that can be accumulated.

Regarding an empirical approach on the impact of fiscal rules, there is a large number of studies of the effects on several fiscal outcomes (Caselli and Reynaud (2019), Bergman et al. (2016), Bergman and Hutchison (2015), Debrun et al. (2008), Tapsoba (2012)). There are far less conclusive answers on the effects of fiscal rules on growth. The few existing studies mainly focus on the European Union (Castro (2011), Afonso and Jalles (2012)). In the second part of this study, we conduct two empirical exercises. In the first one, we estimate a growth equation with a specification derived from the theoretical model for a panel of countries. The idea is to verify the results predicted by the model (the correlations predicted by the model). This analysis controls for country and year fixed effects and has no ambitions regarding the direction of causality or rigorous endogeneity control.

In the second empirical exercise, we take a step further concerning endogeneity control to evaluate the effect of fiscal rules on GDP per capita growth rate. To address the endogeneity problem, we use a cross-country panel with fixed effects and an IV approach following Caselli and Reynaud (2019). The instrument - that has been published recently on other studies[4] - explores the geographical diffusion of fiscal rules across countries. We are the first study to use this kind of instrument to evaluate fiscal rules' effects on economic growth. We explore a larger dataset (178 countries), enabling us to analyze those effects on subsamples such as developing and low-income countries. The results show that fiscal rule adoption positively affects economic growth for developing and low-income countries. For Europe, well-designed fiscal rules also have a positive impact on economic growth. Well-designed debt rules seem a better recipe for economic growth than budget balance rules, especially in developing and low-income countries.

The remainder of the paper is organized as follows. Section 2 sets out our model, and in Section 3, we explore the dynamics of the economy under three scenarios. We also conduct a welfare analysis of the economy with two fiscal rules. Section 4 presents the first empirical exercise, in which we estimate a growth equation derived from the model to analyze the direction of correlations. In section 5, the second empirical exercise aims to evaluate the effect of fiscal rule adoption and enforcement on GDP per capita growth rate. Finally, Section 6 concludes the paper. We also include an appendix with proofs and derivations of the theoretical part and tables with additional estimations of section 5.

[4] See Caselli and Reynaud (2019) and Acemoglu et al. (2019).

2 Model

We consider an overlapping-generation model of endogenous growth, populated by two-period-lived generations. By assuming a Barro (1990)-type public flow expenditures, productive public spending can increase economic productivity driving economic growth.

2.1 Individuals

Consider an OLG model of a one-sector economy populated by two-period-lived generations. Each generation consists of a continuum of identical individuals with unit mass. The discrete-time, infinite-horizon economy starts from period t=0. The utility function of an agent is:

$$U_t = \ln c_t^y + \beta \ln c_{t+1}^o \quad \text{with} \quad 0 < \beta < 1 \tag{1}$$

where c_t^y is the young-agent consumption of some generation and c_{t+1}^o is the consumption when old-aged.

Lifetime budget constraint of an agent:

$$\begin{aligned} c_t^y + s_t &\leqslant (1-\tau)w_t \\ c_{t+1}^o &\leqslant (1 + r_{t+1}(1-\tau_{t+1}))s_t \\ (c_t^y, c_{t+1}^o) &> 0 \end{aligned} \tag{2}$$

Moreover, young agents savings is given by:

$$s_t = k_{t+1} + d_{t+1} \tag{3}$$

where k_{t+1} is private capital and d_{t+1} are government bonds owned by private agents. Individuals take w_t (wage rate), r_{t+1} (interest rate) and τ (tax rate) as give.

There is an initial old generation endowed with k_0 units of capital. Generations are endowed with one unit of labor when young. This unit of labor is inelastically supplied in the first period. We assume that the labor supply is the same as the size of the younger generation. Agents consume a part of wage income when young and save the remainder for retirement. Older agents do not save.

2.2 Government

There are two components in government expenditure: z_t and g_t, that represents productive expenditures and consumption, respectively. Both z_t and g_t can be expressed as fraction of output:

$$z_t = \xi y_t \tag{4}$$

$$g_t = \theta y_t \tag{5}$$

We assume that g_t does not affect the utility of the private agent, θ is a fixed fraction and it is exogenously given. The fraction of production assigned for productive expenditure is ξ. The government also levies a tax rate (τ) on agents income (wage and savings), and borrows from the private sector by issuing one-period risk-free domestic bonds (d_t) that pay interests $(1 + r_{t+1})$. Assume $d_0 = 0$ and $0 < \xi + \theta < 1$.

The inter-temporal government budget constraint is:

$$d_{t+1} - d_t = z_t + g_t - \tau(w_t + r_t s_{t-1}) + r_t d_t \tag{6}$$

There is a debt rule aimed at controlling government bond issues:

$$d_t = \mu y_t \quad \text{with} \quad \mu \in (0, 1) \tag{7}$$

Also, there is a budget balance rule that restrain the size of the deficit:

$$\frac{d_{t+1} - d_t}{y_t} = \gamma \tag{8}$$

2.3 Firms

Consider a representative firm which maximizes profits in a perfect competitive market with production technology given by:

$$y_t = A\, k_t^{\alpha} (z_t\, l_t)^{1-\alpha} \quad \text{with} \quad 0 < \alpha < 1 \tag{9}$$

where y_t is the output, l_t and k_t are labor force and capital stock used in production, respectively, z_t are productive government expenditures. Capital law of motion is $k_{t+1} = (1 - \delta)k_t + i_t$. For simplicity, we assume $\delta = 1$.

Using equation (4) and since $l_t = 1$, we rewrite the production function:

$$y_t = A^{1/\alpha} \xi^{\frac{1-\alpha}{\alpha}} k_t = \tilde{A} k_t \tag{10}$$

where $\tilde{A} := A^{1/\alpha} \xi^{\frac{1-\alpha}{\alpha}}$

From equation (10), we get an AK-type technology. As a result, an increase in the rate of productive spending will increase productivity, which permanently raises the marginal product of capital and, consequently, its growth rate. Following Barro (1990), the productive public expenditure is a spending flow rather than public capital accumulation. Teles and Mussolini (2014) detail the implications of considering public expenditures as investments that increase the stock of public capital. There is a risk that a balanced growth path will not exist if we consider public spending as an investment that increases the growth rate of the public capital stock. The productivity growth rate could increase without limitation because of the nature of the AK model. As a result, investment in physical capital and economic growth takes an explosive path.

The AK production function displays, simultaneously, constant marginal returns for capital and decreasing returns for firms. This is a result of positive externalities of productive public spending. The firms do not realize that increasing their capital stock (which, in turn, increases output) will also increase productive public spending, leading to a rise in the marginal product of labor and capital. Thereby, the government's productive spending influences the level of aggregate productivity.

2.4 Competitive equilibrium

A competitive equilibrium for this economy consists of a sequence of allocations, $\{k_{t+1}, d_{t+1}, y_t, c_t^y, c_{t+1}^o, s_t^y\}$ and prices $\{w_t, r_{t+1}\}$, such that, given the initial conditions, k_0 and d_0, given fiscal variables, τ, θ, ξ, and fiscal rules, μ, γ, the following conditions hold:

1. Given prices $\{w_t, r_{t+1}\}$, the allocation $(c_t^y, c_{t+1}^o, s_t^y)$ solves the young agents maximization problem of each generation;
2. Given prices $\{w_t, r_t\}$, the allocation (y_t, k_t) solves the representative firm problem of profits maximization;
3. There is equilibrium in capital markets: $s_t = k_{t+1} + d_{t+1}$;
4. The resources restriction holds: $y_t = c_t + i_t + z_t + g_t$;
5. The government adopts the fiscal rules: $d_t = \mu y_t$ and $\frac{d_{t+1-d_t}}{y_t} = \gamma$

Individual agent solution consists of maximize equation (1) subject to equation (2), which yields:

$$s_t = \frac{\beta(1-\tau)w_t}{(1+\beta)} \tag{11}$$

Representative firm solution consists of profits maximization, resulting:

$$r_t = \alpha A^{1/\alpha} \xi^{\frac{1-\alpha}{\alpha}} = \alpha \tilde{A} \tag{12}$$

$$w_t = (1-\alpha) A^{1/\alpha} \xi^{\frac{1-\alpha}{\alpha}} k_t = (1-\alpha)\tilde{A} k_t \tag{13}$$

Since public productive expenditures affect the economy's productivity, they also affect interest rates and wages. The impact on interest rate means an increase in the marginal return of capital, which stimulate investment. From equation (11), we have that positive shocks on wages, due to increasing productive government expenditures, will increase savings. The AK model implies that savings affect growth in the long run. However, equation (11) also shows that the tax rate has a negative impact on savings. Thus, if the government needs to increase the tax rate to adjust its budget, the net gain in productive expenditures will decrease.

3 Dynamics and long-term equilibrium

Now we look at the dynamics of the economy. The first case presented is set with both fiscal rules combined (debt and balanced budget rule). In the second one, we modify the economy with the government adopting only the deficit rule and, the third, with only the debt rule.

3.1 Economy with combined fiscal rules

Assuming that the government adopts the deficit and the debt rules and adjusts its tax rate to meet the budget constraint. Inserting (7) in (3) and using it, along with (8), we can rewrite the government budget constraint as:

$$\gamma y_t = \xi y_t + \theta y_t - \tau(w_t + r_t(k_t + \mu y_t)) + r_t d_t$$

Working the equation above, using (12), (13) and (10) we express the tax rate as:

$$(1-\tau) = \frac{1+(\gamma-\xi-\theta)}{1+\alpha\mu\tilde{A}} \tag{14}$$

Equation (14) demonstrates that a positive shock to both productive and unproductive expenditure must be accompanied by an increase in the tax rate (keeping fiscal rules unchanged). If the government decides to change the fiscal rules, both an increase in the deficit rule and an increase in the debt rule will decrease the tax rate (keeping expenses constant). On the one hand, raising the parameter γ means increasing the threshold for the government deficit. As a result, this may reduce the burden of adjustment on the tax rate. On the other hand, raising the parameter μ, which means increasing the threshold for the public debt, may augment the adjustment needed on the tax rate. However, we must also consider the effects of changing fiscal rules on the growth rate of public debt and private capital, as these parameters are strongly related to the existence of a balanced growth path. To see this, we derive one expression for the capital growth rate and one for the debt growth rate. Using equations (13), (10) and (14) in (11), the capital growth rate is written as:

$$\frac{k_{t+1}-k_t}{k_t} = \frac{\beta}{(1+\beta)}\left[\frac{1+(\gamma-\xi-\theta)}{1+\alpha\mu\tilde{A}}\right](1-\alpha)\tilde{A} - \gamma\tilde{A} - \frac{d_t}{k_t} - 1 \tag{15}$$

Using the deficit rule and the production function, the debt growth rate is:

$$\frac{d_{t+1}-d_t}{d_t} = \gamma\tilde{A}\frac{k_t}{d_t} \tag{16}$$

The system dynamics can be represented by the capital growth rate (equation 15) and debt growth rate (equation 16), where d_{t+1} and k_{t+1} are state variables. A balanced growth path is defined as a trajectory in which the state variables growth at the same rate, i.e, for an equilibrium to exist, $\frac{d_t}{k_t}$ must be constant, such that $\frac{k_{t+1}}{k_t} = \frac{d_{t+1}}{d_t}$. Thus, we set (15) equal to (16) and obtain a quadratic equation with solution given by:

$$\frac{d}{k} = \frac{J \pm \sqrt{J^2 - 4\gamma\tilde{A}}}{2} \quad \text{where} \quad J \equiv \frac{\beta}{1+\beta}\left(\frac{1+(\gamma-\xi-\theta)}{1+\alpha\tilde{A}\mu}\right)(1-\alpha)\tilde{A} - \gamma\tilde{A} - 1$$

If there exists at least one positive root, there will exist one steady-state equilibrium.

Proposition 1. *There exists a critical value γ': if $\gamma < \gamma'$, then there are two steady states, x_1 and x_2. In these steady states, d_t and k_t growth at the same rate, thus d/k is constant. If $\gamma > \gamma'$ there is no steady state and if $\gamma = \gamma'$ there is a unique steady state.*

Proof. See Appendix A.1. □

For a better understanding, we present the first steps of the proof of Proposition 1. First, we set equation (15) equal to (16):

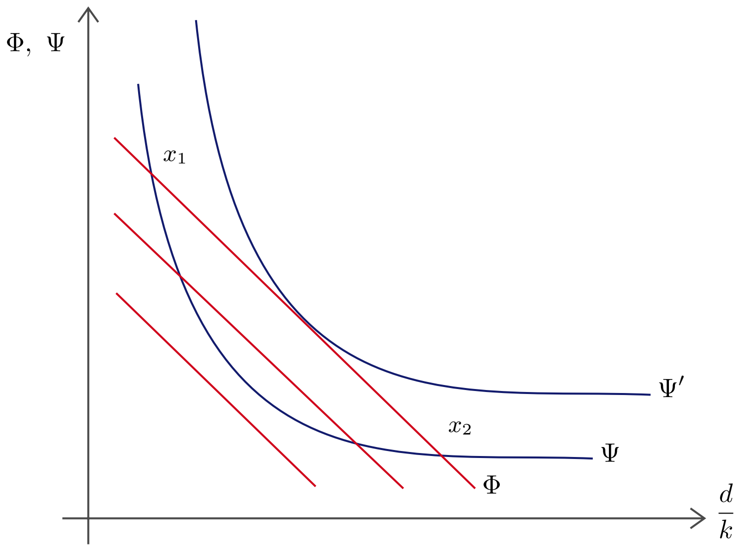
$$\frac{\gamma\tilde{A}}{d/k} = \frac{\beta}{(1+\beta)}\left[\frac{1+(\gamma-\xi-\theta)}{1+\alpha\mu\tilde{A}}\right](1-\alpha)\tilde{A} - \gamma\tilde{A} - \frac{d_t}{k_t} - 1$$

Then, we define x, Ψ and Φ.

$$\begin{aligned} x &\equiv \frac{d}{k} \\ \Psi(x,\gamma) &\equiv \frac{\gamma \tilde{A}}{x} + 1 \\ \Phi(x,\gamma) &\equiv \frac{\beta}{(1+\beta)} \left[\frac{1+(\gamma-\xi-\theta)}{1+\alpha\mu\tilde{A}} \right] (1-\alpha)\tilde{A} - \gamma\tilde{A} - x \end{aligned}$$

Figure 1 depicts Proposition 1. Here, we illustrate the situations where there are two equilibrium, x_1 and x_2, ie., for values of γ and μ such that Ψ and Φ intercept. The point where Ψ and Φ' are tangents depicts the unique steady state case. Furthermore, an increase in γ shifts Ψ upwards and Φ downwards. A decrease in μ only shifts Φ upwards. Thereby, for a large γ and/or a sufficiently high μ, there won't exist a steady-state.

Figure 1 – Existence of BGPs



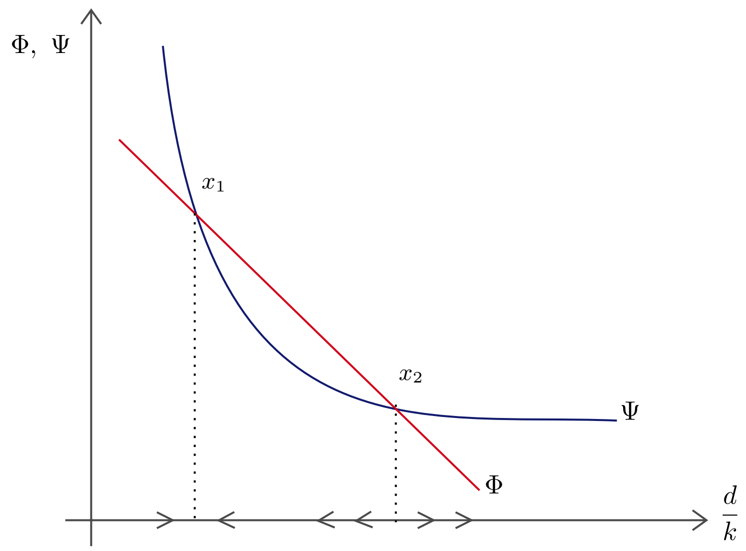
In this economy, a rise in μ means raising the ceiling for the public debt, which leads to a reduction in the capital growth rate, according to equation (15). This is because there is space for the public debt to grow, which can happen via increases in productive and/or unproductive public spending. The same reasoning holds for γ since its increase raises the limit for government deficits and public debt growth hate. Now that we have the conditions for the existence of equilibrium, we explore the conditions for the stability of such equilibrium.

Proposition 2. *The steady state x_1, with low d/k, is locally stable. The steady state x_2, with high d/k, is unstable. Thus, fiscal rules γ and μ can be sustained around x_1, but for an initial d/k sufficiently large, it is not possible to comply with the rules.*

Proof. See Appendix A.2. □

Figure 2 depicts Proposition 2. As stated in the Proposition, in x_1 there is a stable equilibrium, so, for plausible values of γ and μ and a sufficiently low initial d/k, the fiscal framework is sustainable. In the unstable equilibrium in x_2 we have an upper bound for the initial d/k for which d/k converges to a finite level. That is, if the initial d/k is strictly greater than d/k of x_2, then the public-debt/capital ratio diverges. Thus, for a large initial public-debt/capital ratio, there is no equilibrium and the debt rule is pointless.

Figure 2 – Stability of BGP



3.2 Economy with a deficit rule

Assuming that the government adopts only one fiscal rule: a budget balance rule that restrain the size of the deficit. As before, the tax rate is the mechanism used to meet the budget constraint. Inserting (8) in (6) we rewrite the government budget constraint as:

$$\gamma y_t = \xi y_t + \theta y_t - \tau(w_t + r_t(k_t + \mu y_t)) + r_t d_t$$

We work the equation above using (12), (13) and (10) to get the following expression for the tax rate:

$$(1-\tau) = \frac{1 + (\gamma - \xi - \theta)}{1 + \alpha d_t/k_t} \tag{17}$$

The public debt growth rate is the same as in the previous section, given by equation (16). Using equations (13), (10) and (17) in (11), the capital growth rate is written as:

$$\frac{k_{t+1} - k_t}{k_t} = \frac{\beta}{(1+\beta)} \left[\frac{1 + (\gamma - \xi - \theta)}{1 + \alpha d_t/k_t}\right] (1-\alpha)\tilde{A} - \gamma\tilde{A} - \frac{d_t}{k_t} - 1 \tag{18}$$

Same as before, in the balanced growth path, the debt-to-capital ratio is constant. To find such solution, we set (16) equal to (18), which yields the following cubic equation:

$$\alpha x^3 + x^2(\alpha\gamma\tilde{A} + \alpha + 1) - x\left[\frac{\beta}{1+\beta}(1 + \gamma - \xi - \theta)(1-\alpha)\tilde{A} - \gamma\tilde{A}(1+\alpha) - 1\right] + \gamma\tilde{A} = 0 \tag{19}$$

Proposition 3. *Since equation (19) is cubic, it has at least one real root. Given that the condition* $\frac{\beta}{1+\beta}(1-\alpha)(1+\gamma-\xi-\theta) > \frac{1}{\tilde{A}} + \gamma(1+\alpha)$ *is satisfied, then, it has two (or none) positive real roots.*

Proof. See Appendix A.3. □

In case equation (19) has two positive real roots, the rule γ will have the same behavior as in Proposition 1, and the proof is similar. However, in the current case, we do not have an instrument to limit the size of public debt. Therefore, the government has no mechanism to control debt growth rate.

3.3 Economy with a debt rule

Now we assume that the government adopts only a debt rule, i.e, a rule aimed at controlling government bond issue. Again, the tax rate is the mechanism used to meet the budget constraint. Inserting (7) in 6) we rewrite the government budget constraint as:

$$\mu y_{t+1} - \mu y_t = \xi y_t + \theta y_t - \tau(w_t + r_t(k_t + \mu y_t)) + r_t d_t$$

We work the equation above using (12), (13) and (10) and define $\pi \equiv k_{t+1}/k_t$ to get the following expression for the tax rate:

$$(1 - \tau_t) = \frac{1 + \mu\pi - (\mu\xi + \theta)}{1 + \mu\alpha\tilde{A}} \tag{20}$$

On one hand, the capital growth rate is computed the same way using equations (13), (10) and (20) in (11):

$$\frac{k_{t+1}}{k_t} = \frac{\beta(1-\alpha)\tilde{A}[1 - (\mu + \xi + \theta)]}{(1 + \mu\tilde{A})(1 + \beta)(1 + \alpha\tilde{A}\mu) - \beta(1 - \alpha\tilde{A})\mu} \tag{21}$$

On the other hand, now we compute the debt growth rate using the government budget since we do not have a mechanism acting directly on the deficit. We divide equation (6) by d_t, we use equations (13), (10) and (20) to get:

$$\frac{d_{t+1}}{d_t} = 1 + \alpha\tilde{A} \tag{22}$$

Note that in this case the solution is indeterminate. Equation (20) defines the tax rate as a function of capital growth. Thus, the BGP will depend on the initial conditions k_0 and d_0 if the economy converges to the steady-state in period t=1. In case this happens in some period s, the BGP will depend on the levels k_{t-s} and d_{t-s}.

3.4 Welfare Analysis

In this section, we assume an economy as the one in Section 3.1, with combined fiscal rules and investigate the effects of changes such rules on welfare of households. More specifically, we consider an unanticipated and permanent decrease in μ and γ. Such policy is aimed at tightening fiscal discipline, since it imposes a smaller target for fiscal debt and deficit. The objective is to compute the impact on the indirect utility of agents.

We assume that the government fixes ξ. Thus, changes in μ and γ do not change the interest rate, but do alter the tax rate and debt-capital ratio. An agent born at t_1 has indirect utility given by the following equation[5], where k_{t-1} and b_{t-1} are predetermined and thus remain constant in period t.

$$V_{t-1} = \beta \ln \beta + (1+\beta)\ln\left(\frac{1}{1+\beta}\right) + (1+\beta)\ln k_{t-1}$$
$$+ (1+\beta)\ln\left[\frac{1+\gamma-\xi-\theta}{1+\alpha\tilde{A}\mu}(1-\alpha)\tilde{A}\right] + \beta\ln\left[\frac{1+\gamma-\xi-\theta}{1+\alpha\tilde{A}\mu}\alpha\tilde{A}+1\right] \tag{23}$$

Proposition 4. *Assume that the economy has two equilibria of debt-capital ratio as in Propositions 1 and 2. An unanticipated, permanent decrease of μ, from period t, increases indirect utility of agents born in $t-1$. Yet, a permanent reduction of γ, decreases the indirect utility of agents born in t_1.*

Proof. See Appendix A.5. □

Putting it differently, a looser fiscal policy is equivalent to an increase in μ or γ. A rise in the debt-to-GDP limit, μ, leads to a reduction in V_{t-1} because there is a crowding-out: the government must rise the tax rate, since γ is unchanged, so after-tax savings is reduced. A rise in the deficit-to-GDP limit, γ, (with μ is unchanged) prompt an increase in V_{t-1} because the government can finance itself with larger deficits, so a tax rate reduction is possible, increasing savings. Nevertheless, these results are not valid for current and future generations, since the Government has to comply with the debt rule and will probably need to rise taxes in future periods.

Considering the economy in Section 3.2, with only a constant deficit rule, we make a similar exercise. An increase in γ yields an increase in V_{t-1} (see Appendix A.6). In this case, the rationale is the same for the generation born in $t-1$. But for current and future generations we need to consider that the public debt is increasing since there is no debt rule. Perhaps the tax rate could remain in a lower level at the expense of raising debt.

4 First empirical exercise

In this part of the article, we present the first empirical exercise. We estimate a growth equation for a panel of countries with a specification derived from the theoretical model of Section 3.1. The goal is to verify the results of the model. There is no ambition here to prove that the model is true or to determine the direction of causality. As highlighted by Teles and Mussolini (2014), we most certainly deal with significant endogeneity in this framework. Thus, we solely search for the correlations predicted by the model.

Based on equation (15), we implement a specification in which GDP growth depends on the variables of interest in that equation, besides GDP lags, for a cross-country panel data. Since equation (15) is not an equilibrium equation, the results do not describe the equilibrium relationship between variables. Following Teles and Mussolini (2014), we define the empirical model with a non-linear specification with interactions to better fit the findings of the theoretical model. Our model differs from the previous literature since it considers two fiscal rules in the economy, a debt rule and a budget balance rule. Thus, in this empirical exercise, we will naturally check the correlations of these fiscal rules. We

[5] Details in Appendix A.4.

first estimate these correlations by representing the fiscal rules as dummies and then with the fiscal rule strength index.

Some findings of the theoretical model were that public productive expenditures increase productivity and impact growth. This happens because such policies increase the marginal return of capital and thus stimulate private investment. Also, the inclusion of productive expenditures in the production function carries a new channel through which public debt impacts growth. The idea here is to glimpse the extent of the impact of productive expenditure on growth and its interaction with other fiscal variables. Moreover, we add measures of fiscal rules also to verify the model predictions.

4.1 Model and data

We estimate the following regression based on the theoretical model presented earlier.

$$
\begin{aligned}
gr_{it} = a_0 + \sum_{s=1}^{T} a_s gr_{it-s} + \beta_0 z_{it-1} + \beta_1 \frac{d_{it-1}}{y_{it-1}} + \beta_2 z_{it-1} * surplus_{it-1} \\
+ \beta_3 z_{it-1} * tax_{it-1} + \beta_4 z_{it-1} * \frac{d_{it-1}}{y_{it-1}} + \beta_5 \gamma_{it-1} + \beta_6 \mu_{it-1} + \alpha_i + \delta_t + \varepsilon_{it}
\end{aligned}
\tag{24}
$$

Where gr_{it} is the growth rate of GDP per capita of country i in year t and T is the number of lags of gr_{it} included in the dynamic panel. The variable z_{it} represents public productive expenditures. This variable is the sum of central government spending (as % of GDP) on education, health, transportation, communications, and energy. Public productive expenditures interacts with primary surplus ($surplus_{it}$), tax burden on income (tax_{it}) and debt-to-GDP ratio (d_{it}/y_{it}). These variables are all expressed as percentages of GDP. Country and year fixed effects are represented by α_i and δ_t.

Variables γ and μ represent the presence of deficit rules and debt rules, respectively. We use two different measures to estimate the effect of those rules on GDP growth. First, two dummy variables indicating the presence of budget balance rules (representing deficit rules) and debt rules. Then, we use a strength index of budget balance rules and of debt rules. Data on fiscal rules are from the Fiscal Rules Dataset 2017, from the International Monetary Fund. We detail this database in the following subsection, as well as the strength index methodology.

To estimate equation (24) we have an unbalanced panel data of 97 countries over the period 1990-2015. The data for economic growth comes from World Bank Development Indicators. We utilize information released by the International Monetary Fund on data about public debt and primary results (Historical Public Debt Database) and about productive expenditures and tax burden on income (Government Financial Statistics).

4.1.1 Fiscal strength index

Data on fiscal rules is represented by Fiscal Rules Dataset 2017, from the Fiscal Affair Department (FAD) of the International Monetary Fund. The dataset includes information about national and supranational fiscal rules for countries that are members of the IMF. The data includes 96 countries from 1985 to 2015 with information on 28 characteristics of national rules in the following categories: (i) Type of rule, (ii) Year of implementation and year of major revisions, (iii) Number of rules, (iv) Legal basis, (v) Coverage - level of government, (vi) Monitoring procedures, (vii) Enforcement procedures, (viii) Institutional supporting features (Multi-year expenditure ceilings; Fiscal responsibility laws; independent council providing budget assumptions; independent council monitoring implementation), and (ix) Stabilization features (budget balance rule accounting for the cycle; investment excluded). Countries not included in this dataset were considered not to have any fiscal rule during the analysis period.

The fiscal rule strength index (FSI) is a composite index of four sub-indexes for each type of rule: budget balance rules, debt rules, expenditure rules, and revenue rules. Each sub-index incorporates the following characteristics: legal basis, coverage, enforcement, supporting procedures and institutions[6]. To construct an overall index measuring the strength of fiscal rules, we compute sub-indexes for each type of fiscal rule summing up the indicators terms considered. Most of these indications lie between 0 and 1 (otherwise they were re-scaled). The sub-indexes are normalized to run between 0 and 1. Since Schaechter et al. (2012) do not specify all of the procedures, some adaptations had to be made.[7] The overall index, which runs between 0 and 4 is the sum of all sub-indexes. When a country scores zero, it means that there are no fiscal rules implemented. A score of four means maximum strength (or well designed fiscal rule). A score strictly higher than 0 represents a poorly designed rule. It is worth mention that this index measures the strength of the design of rules, and not the degree of enforcement. As stressed in Schaechter et al. (2012), a higher score reflects the presence of features in line with those identified in previous works, as supporting the rule's effectiveness.

4.2 Results

The results in Table 1 show the correlations of the baseline specification from equation (24), estimated via OLS. We ran a cross-country panel data with country and year fixed effects to mitigate the effect of time-invariant and country-invariant omitted factors. Comparing column one with the others shows that the inclusion of interaction variables considerably improves the estimation results. Columns two and three were estimated with the dummy variables for the fiscal rules, whereas columns four and five utilize the strength index as a measure of the rules.

For all estimations, from column two to five we observe consistent results regarding the direction and significance of the effects of fiscal variables and its interactions on GDP growth. The effect of a shock on productive public spending is positive since it affects savings, but the shock leads to a rise in income taxation, which diminishes the net return of the shock on savings. The sign of the interaction of productive spending and tax burden thus concur with the model. A similar reasoning can be made about the size of the fiscal deficit. In case of primary surplus, the government will not need to capture part of the rise in savings to cover the deficit. Thus, we have a positive signal. Regarding the stock of public debt, an increase in debt, under certain fiscal conditions, may be related to

[6] The characteristic "Supporting procedures and institutions"includes the following categories: Multi-year expenditure ceilings, Fiscal responsibility law, Independent body setting budget assumptions, Independent body monitoring budget implementation

[7] For example, they don't make it clear how to aggregate the indicators for national fiscal rules with indicators for supranational fiscal rules. For a full description of the IMF fiscal rule index, see Schaechter et al. (2012).

increases in growth, as highlighted in Teles and Mussolini (2014). There is also an effect of the interaction with public spending. A positive shock on ξ implicates a rise in interest rates, which, in turn, raises the debt service proportionally on debt size, crowding out private investment.

Turning to the fiscal rules, results were not statistically significant at the 5% level when we use a dummy variable. However, with the index of strength index debt and deficit rules, the coefficients were statistically significant at a 5% level. The theoretical model predicts a positive signal for both rules since it represents their strength. That is, a tighter debt rule means a reduction of μ but a higher index value. The same reasoning holds for the deficit rule. However, only the empiric results for the debt rule endorse the model. For the deficit rule, the index may not adequately replicate the rule's concept since the index builds upon the concept of budget balance rules, that is, any numerical rule over the budget result. According to the database, there is a range of rules sort as budget balance rules, such as structural surplus, over the cycle surplus, zero budget, primary deficit, among others. Also, the index scoring captures, as far as possible, specific features in their design that would increase the effectiveness of the rules. The original article acknowledges this limitation. Schaechter et al. (2012) warns that a high score can well coexist with poor fiscal outcomes because the presence of a feature does not necessarily imply that it is also soundly implemented. Disregarding this limitation, a negative coefficient on the deficit rule strength index can represent a hindrance to productive growth. Considering its interaction with public debt stock, we get that tighter deficit rules are associated with economic growth depending on the size of public debt.

5 Second empirical exercise

Here, we present the second empirical exercise. The aim is to evaluate the effect of fiscal rule adoption and enforcement on the GDP per capita growth rate. We use a cross-country panel with fixed effects and an instrumental variable approach to address the endogeneity problem. We use a relatively new instrument that explores the geographical diffusion of fiscal rules across countries.

Almost all empirical papers mentioned in Section 2 use GMM techniques in cross-country panel data framework to estimate the effect of fiscal rules on some outcome of interest. The Arellano-Bond estimator and system GMM estimator are widely used in panels where: the dependent variable is a function of its past realizations (dynamic panel), and independent variables are not strictly exogenous, i.e., they are correlated with past and possibly current realizations of the error term. This is the case of fiscal rules. However, some problems may emerge from GMM estimations: invalid estimates because of an asymptotic bias when there are "too many instruments" and poor performance if the autoregressive parameter is too close to one. Acemoglu et al. (2019) warns that the critical issue to the validity of those estimates relies on the endogeneity problem, which can occur because of omitted variable bias. In our context, omitted variable bias occurs when there are time-varying factors that simultaneously impact the adoption of fiscal rules and GDP growth. The inclusion of country fixed effects absorbs non-observable time-invariant factors.

The instrumental variable approach is the commonly used approach to tackle the endogeneity problem. The challenge is to find a good instrument for the potentially

Table 1 – OLS for baseline specification

Variables	(1)	(2)	(3)	(4)	(5)
	gr_{it}	gr_{it}	gr_{it}	gr_{it}	gr_{it}
z_{it-1}	-0.0143	0.234*	0.257**	0.238*	0.324**
	(0.0182)	(0.133)	(0.126)	(0.134)	(0.125)
$Debt/GDP_{it-1}$	0.0135	0.0429**	0.0383***	0.0428**	0.0389***
	(0.00961)	(0.0168)	(0.0142)	(0.0173)	(0.0129)
$z_{it-1} * Debt/GDP_{it-1}$		-0.00211	-0.00279*	-0.00225	-0.00401**
		(0.00179)	(0.00160)	(0.00177)	(0.00162)
$z_{it-1} * TaxBurden_{it-1}$		-0.00593*	-0.00626**	-0.00601**	-0.00740**
		(0.00303)	(0.00296)	(0.00302)	(0.00291)
$z_{it-1} * PrimarySurplus_{it-1}$		0.00469**	0.00428**	0.00453**	0.00439**
		(0.00206)	(0.00193)	(0.00201)	(0.00188)
$D\mu_{it-1}$		0.738	0.811		
		(0.763)	(0.784)		
$D\gamma_{it-1}$		-0.726	-1.438*		
		(0.659)	(0.758)		
$D\gamma_{it-1} * Debt/GDP_{it-1}$			0.0202*		
			(0.0106)		
Index μ_{it-1}				0.0607**	0.0702***
				(0.0251)	(0.0265)
Index γ_{it-1}				-0.0466**	-0.0960***
				(0.0222)	(0.0306)
Index $\gamma_{it-1} * Debt/GDP_{it-1}$					0.000832***
					(0.000253)
Observations	1,292	1,121	1,121	1,121	1,121
Number of countries	91	84	84	84	84
Country FE	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES

Note: Robust standard errors, clustered at the country level, are reported in parentheses.

endogenous variable. The instrument needs to satisfies two conditions, relevance and exogeneity. It means that the instrument has to be highly correlated with the explanatory variable of interest (fiscal rules), and it has to be an exogenous source of variation of the adoption of fiscal rules, meaning that it cannot have a direct influence on growth. The literature on this tends to use instruments considered weak or inadequate.[8]

In our attempt to estimate the effect of fiscal rules on economic growth, we use the instrument proposed by Caselli and Reynaud (2020) — they use this instrument to estimate the causal effect of fiscal rules on fiscal balances. The instrument is a measure of fiscal rules in the neighboring countries. The intuition is that the introduction and/or enforcement of fiscal rules in neighboring countries can prompt adoption and/or enforcement of fiscal rules in the domestic economy.[9] This idea originates in political science literature, which argues that there are several channels of dissemination of policy, such as economic competition, learning, socialization, mimicking, and coercion. In sum, fiscal rule adoption in neighboring countries may induce the domestic country to introduce a rule through peer pressure and imitational effects. Acemoglu et al. (2019) use a similar approach to evaluate the effects of democratization on growth. They use regional implementation of democratization as an

[8] See Cherif et al. (2018) for further discussion on 'blunt' and weak instruments.

[9] In her article, Caselli and Reynaud (2020) presents several anecdotal examples that support the assumption that countries look at neighbors' experience when introducing fiscal rules.

instrument for democracy because transitions towards democracy often occur in regional waves.

To capture this process of geographical diffusion, we follow Caselli and Reynaud (2020) and define the contiguity instrument for fiscal rule in country i at time t, FR_{it}, in the following way:

$$contiguity_{i,t} = \sum_{j \neq i}^{n-i} FR_{j,t} * X_{j,i,t}, \tag{25}$$

where j is the neighboring country of domestic country i; $FR_{j,t}$ is dummy variable taking a value 1 when country j has a fiscal rule at time t, and 0 if country j does not have a fiscal rule. $X_{i,j,t}$ takes the value 0 when countries have no common borders and sum the number of countries with shared borders. Therefore, the variable $contiguity_{i,t}$ captures the number of fiscal rules in place in countries with common borders with respect to the domestic economy.

Another way to instrument fiscal rule, presented by Caselli and Reynaud (2020), is to take into account the design of fiscal rules in place since there is evidence that well designed fiscal rule may have a significant impact on fiscal performance (Eyraud et al. (2018)). So, instead of using a dummy variable for a fiscal rule in place, the contiguity instrument, $CFSI_{i,t}$, uses the Fiscal Strength Index (FSI) in the following way:

$$CFSI_{i,t} = \frac{1}{\sum X_{j,i,t}} \sum_{j \neq i}^{n-i} FSI_{j,t} * X_{j,i,t} \tag{26}$$

where $FSI_{j,t}$ is the fiscal rule strength index of the country j at time t (or 0 if country j does not have a rule) and $X_{j,i,t}$ takes value 1 if countries i and j share a border and 0 otherwise. The fiscal rule composite measure of strength is a continuous index measuring the overall strength of fiscal rules in a given country in a given year. We follow the the methodology described in Schaechter et al. (2012) to construct this index. The underlying source of the various fiscal rule components is the IMF Fiscal Rule Dataset. The main idea of the index is to take into account all rules in place in a country and its characteristics.

5.1 Model and data

We estimate a standard growth equation that can be derived from a Cobb-Douglas production function.

$$\Delta \text{ln} y_{it} = \beta_1 FR_{it} + \beta_2 \text{ln} y_{it-1} + \beta_3 \text{ln} k_{it} + \beta_4 \text{ln} g_{it} + \alpha_i + \delta_t \varepsilon_{it} \tag{27}$$

Where $\Delta \text{ln} y_{it}$ is the GDP growth in country i at time t, FR_{it} is the dummy variable of fiscal rule in country i at time t and y_{it-1} is the real GDP per capita lagged. The covariate g_{it} is a proxy for government size and k_{it} is the gross fixed capital formation. α_i denotes country fixed effects, which will absorb the impact of any time-invariant country characteristics, and δ_t denotes year fixed effects. The error term ε_{it} includes all other time-varying unobservable shocks to GDP growth. The instrument for FR_{it} is the variable $contiguity_{i_t}$.

We estimate another specification, using the measure of fiscal rule strength (the FSI), according to:

$$\Delta \ln y_{it} = \beta_1 FSI_{it} + \beta_2 \ln y_{it-1} + \beta_3 \ln k_{it} + \beta_4 \ln g_{it} + \alpha_i + \delta_t + \varepsilon_{it} \tag{28}$$

where $FSI_{i,t}$ is the measure of overall fiscal rule strength of country i at time t. This variable will be instrumented with $CFSI_{i,t}$. The main interest for both specifications is to obtain consistent estimates of β_1.

In addition to fiscal rules data, presented in Section 4.1.1, we used the Country Borders dataset from GeoDataSource.com to build the two instruments aforementioned. This database provides a complete list of countries and the associated land border countries (the neighboring countries).

As our primary outcome variable, we use the GDP per capita growth rate, which we obtained from the World Bank Development Indicators. This measure is available for an unbalanced panel of 268 countries from 1960 to 2018. The proxy for government size is the government final consumption expenditure (as a percentage of GDP). That series and the gross capital formation (as a percentage of GDP) are also from the World Bank Development Indicators. With this, we have a balanced panel of 178 countries over the period 1985-2015.

5.2 Estimation and results

Our exogeneity assumption is that economic growth in the domestic country is correlated with neighbors' fiscal rule adoption only through domestic fiscal rules. Formally, the exclusion restriction we assume implies that fiscal rules and past GDP are orthogonal to contemporaneous and future shocks to GDP and that the error term, ε_{it}, is serially uncorrelated (Acemoglu et al. (2019)). Still accordingly to the authors, that assumption requires that we include in the estimation sufficiently many lags of GDP to eliminate the residual serial correlation in ε_{it} and to remove any GDP trend that precedes a fiscal rule adoption. Thus, by including lags of GDP per capita, we are both controlling for the fact that fiscal rules are adopted more frequently after economic crises and sum up the impact of a range of economic factors that affect both growth and fiscal results.[10] We use the fixed effects estimator to handle omitted factors that correlate with GDP and fiscal rule adoption and are unobservable. Year-fixed effects operate, for example, as a control for global shocks, and country fixed effects control time-invariant characteristics that may affect growth, such as geography.

Table 2 shows the first stage results for the contiguity instrument.[11] For all samples but Europe and advanced countries, the correlation between the instrument and the dummy variable for fiscal rule adoption is statistically significant at the 1% level. This can be related to the fact that Europe was a pioneer in adopting fiscal rules, and for this, the instrument loses meaning. Despite a F statistic of less than 10 for some subsamples, we do not find that the reason is a possible weak instrument. We did several weak instruments and weak-robust-instruments tests that confirmed that the instrument seems strong. Here we report Sanderson and Windmeijer (2016) test, which seems an adequate statistic for

[10] We made estimations with up to 5 lags of GDP per capita. However, the only lag with statically significant was $t-1$. Thus, we report the tables with only one lag.

[11] We have started by estimating OLS simple conditional correlations of economic growth and any type of rule, debt rules, and budget balance rules. We found positive and statistically significant coefficients for FR_{it}, which could be an indication of the effects of fiscal rule adoption. Tables not reported but are available upon request.

our case with one endogenous variable and one instrument. The Stock and Wright statistic tests the null hypothesis of the coefficients to be jointly equal to zero even for the case of a weak instrument.

Table 3 shows the results for the second stage. Excluding Europe and Advanced subsamples, the fiscal rule effect on economic growth is positive and significant at the 1% level. Results for the sign of the convergence and the capital accumulation coefficients are as expected. In addition, the government size, proxied by government final consumption expenditure as % of GDP, is negative and statistically significant for all samples — at the 1% level for Europe and Advanced sub-samples and at the 5% level for the remaining samples. This result is in line with literature on government size effects (Fölster and Henrekson, 2001).

Regarding the effect of fiscal rules, coefficient numbers in Table 3 are percentage points, so the results for the full sample (column 1), the sample excluding European countries (column 2), and the one excluding advanced countries (column 4) indicate a positive effect on economic growth between 3% and 4%, meaning that adopting fiscal rules improves GDP growth rate of low and middle-income countries. We have also estimated the effects of debt and budget balance rules separately on economic growth because they are the most common types of rules in our panel of countries and are the rules used in our theoretical model. Those results are presented in Tables 6 to 9 in Appendix B. In this case, debt rules alone present a slightly higher positive effect than budget balance rules for the three subsamples mentioned above.

Table 2 – First stage contiguity instrument results

Variables	(1) FR_{it}	(2) FR_{it}	(3) FR_{it}	(4) FR_{it}	(5) FR_{it}
$Contiguity_{it-1}$	0.136***	0.153***	0.0619*	0.148***	0.0958*
	(0.0202)	(0.0217)	(0.0322)	(0.0193)	(0.0481)
Observations	4,555	3,509	1,046	3,489	1,066
R-squared	0.305	0.293	0.444	0.325	0.353
No. countries	177	137	40	140	37
Sample	Full	No europe	Europe	No Advanced	Advanced
F-stat 1st Stage	8.387	5.792	14.73	7.001	12.52
Stock-Wright p-value	0.0001	0.0001	0.0001	0.0000	0.3468
SW F-stat	45.37	50.27	3.69	58.66	3.97
SW p-val	0.0000	0.0000	0.0621	0.0000	0.054

Note: Robust standard errors, clustered at the country level, are reported in parentheses. Other covariates not reported.

Equation (28) presented an alternative specification that uses a continuous fiscal rule strength index instead of a simple fiscal rule dummy. The rationale is that just introducing any rule might not reflect an impact on economic growth because it might not significantly impact fiscal variables. In this sense, we introduce a measure that accounts for the design of fiscal rules in place, so that a well-designed rule can make a difference. The contiguity fiscal strength index (CFSI) is used as an instrument. An important limitation of the index is that it captures only characteristics related to rules' design and not their implementation and compliance, leaving aside the critical enabling factor of the public and political support to the rule.

Table 3 – Second stage contiguity instrument results

Variables	(1) $\Delta \ln Y$	(2) $\Delta \ln Y$	(3) $\Delta \ln Y$	(4) $\Delta \ln Y$	(5) $\Delta \ln Y$
FR_{it}	3.340***	3.078***	9.040*	4.046***	-0.668
	(1.027)	(1.038)	(5.127)	(1.227)	(1.105)
$\ln Y_{it-1}$	-5.538***	-4.777***	-15.22**	-5.189***	-3.857***
	(0.859)	(0.822)	(5.949)	(0.937)	(0.984)
$\ln K_{it}$	3.607***	3.277***	5.639***	3.350***	2.126
	(0.660)	(0.735)	(1.835)	(0.713)	(1.788)
$\ln G_{it}$	-2.212**	-1.824**	-11.58***	-1.860**	-9.786***
	(0.909)	(0.897)	(3.530)	(0.886)	(2.636)
Observations	4,555	3,509	1,046	3,489	1,066
No. countries	177	137	40	140	37
Country FE	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES
Sample	Full	No europe	Europe	No Advanced	Advanced

Note: Robust standard errors, clustered at the country level, are reported in parentheses. Constant term and year fixed effects not reported. Coefficients are p.p. since ΔlnY is multiplied by 100.

Table 4 shows first stage results. Even though the F statistic is less than 10, the other tests confirm it is not weak. Unlike the dummy case, the instrument is also relevant for Europe and Advanced subsamples since the FSI can capture changes in already existing rules, not only by adopting new ones. For example, we can cite the reforms made in 2005 and 2011 to the Stability and Growth Pact as strengthening the existing rule. This is captured by the index and can foster reforms in neighboring countries. Table 5 shows second stage results. The effect of improving the fiscal rules design is positive and significant, except for the Advanced subsample. For the samples 'No Europe' and 'No Advanced' (which includes Developing and Low-Income countries), the magnitude of the coefficient and the level of significance are higher, indicating that these groups of countries can benefit more from well-designed fiscal rules. Tables 10 to 13 present the results for the debt rule subindex and budget balance rule subindex. By comparing these two subindexes, the first one presents better results (in terms of statistical significance and magnitude) than the latter. This could mean that debt rules are a better recipe for economic growth in developing and low-income countries.

Our results in a nutshell: fiscal rule adoption positively affects economic growth in developing and low-income countries since those subsamples coefficients of fiscal rule were positive and statistically significant vis-a-vis Europe and advanced countries subsamples. This might be because developing and low-income countries have room to benefit from adopting fiscal rules, even if the rules are poorly designed and not complied with them. It signals fiscal responsibility. For Europe, the instruments based on the fiscal strength index seem relevant, and the effect on growth is positive. Since European countries were pioneers in adopting fiscal rules in the early 90s, nowadays, they have to adjust existing rules to new realities, such as high debt levels and slower GDP growth. When considering the sub-indexes results, the debt rule outperforms the budget balance rule, especially for developing and low-income countries.

Table 4 – First stage for the contiguity fiscal strength index (FSI)

Variables	(1) FSI_{it}	(2) FSI_{it}	(3) FSI_{it}	(4) FSI_{it}	(5) FSI_{it}
$CFSI_{it-1}$	0.705***	0.407***	0.597***	0.566***	0.695***
	(0.0883)	(0.105)	(0.115)	(0.117)	(0.134)
Observations	4,555	3,509	1,046	3,489	1,066
R-squared	0.361	0.173	0.540	0.251	0.508
No. countries	177	137	40	140	37
Sample	Full	No europe	Europe	No Advanced	Advanced
F-stat 1st Stage	7.244	4.066	8.085	4.503	5.253
Stock-Wright p-value	0.002	0.0098	0.0005	0.0007	0.0264
SW F-stat	63.86	15.09	27.08	23.39	27.07
SW p-val	0.000	0.0002	0.000	0.000	0.000

Note: Robust standard errors, clustered at the country level, are reported in parentheses. Other covariates not reported.

Table 5 – Second stage for the contiguity fiscal strength index (FSI)

Variables	(1) $\Delta \ln Y$	(2) $\Delta \ln Y$	(3) $\Delta \ln Y$	(4) $\Delta \ln Y$	(5) $\Delta \ln Y$
FSI_{it}	1.424**	3.880**	2.367*	3.340***	0.719
	(0.570)	(1.714)	(1.217)	(1.231)	(0.576)
$\ln Y_{it-1}$	-4.752***	-4.584***	-8.817***	-4.757***	-5.273***
	(0.759)	(0.820)	(2.522)	(0.892)	(0.972)
$\ln K_{it}$	3.672***	3.371***	4.539***	3.450***	2.548
	(0.655)	(0.726)	(1.337)	(0.701)	(1.906)
$\ln G_{it}$	-2.088**	-1.835**	-10.03***	-1.808**	-9.954***
	(0.942)	(0.905)	(2.454)	(0.910)	(2.878)
Observations	4,555	3,509	1,046	3,489	1,066
No. countries	177	137	40	140	37
Country FE	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES
Sample	Full	No europe	Europe	No Advanced	Advanced

Note: Robust standard errors, clustered at the country level, are reported in parentheses. Constant term and year fixed effects not reported. Coefficients are p.p. since ΔlnY is multiplied by 100.

6 Conclusion

We have proposed an overlapping generations model with endogenous growth, in which the government imposes two fiscal rules — a debt rule and a deficit rule — and showed the conditions for a balanced growth path to exist. For an initial public debt-to-capital ratio sufficiently large, it is not possible to comply with the rules. However, the two fiscal rules can be sustained with a sufficiently low initial public debt-to-capital ratio. In terms of welfare, a fiscal policy in the direction of loosening the fiscal rules leads to a reduction of the indirect utility of agents because of a crowding-out effect since the government must raise taxes.

Thereafter, we conduct an empirical exercise to verify some results of the theoretical model. We estimate a growth equation for a panel of 97 countries using a specification derived from Section 4.1 to search the correlations predicted by the model. We measured fiscal rules in two ways: with a dummy variable indicating the presence of a rule of each type and a fiscal strength index for each type of rule. Only the estimations with the fiscal strength index coefficients for fiscal rules were statistically significant. We would also expect a positive signal for both rules since the index represents their strength, but only the debt rule endorsed the model prediction. The index for the deficit rule may not adequately replicate the rule's definition from the theoretical model because the index is a mix of several types of rules under the umbrella of "budget balance rules."Here, we used country and year fixed effects, but endogeneity was not handled yet.

Lastly, we empirically evaluate the effect of fiscal rules on economic growth by addressing the endogeneity problem with an instrumental variable approach. The instrument — a measure of fiscal rules in the neighboring countries — is relatively new in the literature and has never been used in this context. It explores the geographical diffusion of fiscal rules across countries. Again, we analyze two cases. First, the contiguity instrument, built with a dummy variable, means that introducing fiscal rules in neighboring countries can prompt the adoption of fiscal rules in the domestic economy. In this case, we found that fiscal rule adoption positively affects economic growth only in developing and low-income countries. It is indicative that these countries have benefited from adopting fiscal rules, even if the rules are poorly designed. This instrument was not even relevant for Europe and advanced countries' subsamples.

In the second case, the contiguity-fiscal-strength-index instrument means that improving or reforming fiscal rules in neighboring countries can prompt the same outcome in the domestic economy. Since the Fiscal Strength Index also captures changes in already existing rules, the effect of improving the fiscal rules' design was observed even in the European sample. For developing and low-income countries, this result corroborates the one from the previous paragraph. In addition, for this group of countries, debt rules' results, in both cases, outperform budget balance rules. This could mean that debt rules are a better recipe for economic growth in developing and low-income countries.

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Appendix A: Proofs and derivations

A.1 Proof of Proposition 1

Set equation (15) equal to (16):

$$\frac{\gamma\tilde{A}}{d/k} = \frac{\beta}{(1+\beta)}\left[\frac{1+(\gamma-\xi-\theta)}{1+\alpha\mu\tilde{A}}\right](1-\alpha)\tilde{A} - \gamma\tilde{A} - \frac{d_t}{k_t} - 1$$

Define:

$$x \equiv \frac{d}{k}$$
$$\Psi(x,\gamma) = \frac{\gamma\tilde{A}}{x} + 1$$
$$\Phi(x,\gamma) = \frac{\beta}{(1+\beta)}\left[\frac{1+(\gamma-\xi-\theta)}{1+\alpha\mu\tilde{A}}\right](1-\alpha)\tilde{A} - \gamma\tilde{A} - x$$

Differentiating with respect to x:

$$\frac{\partial\Psi}{\partial x} = -\frac{\gamma\tilde{A}}{x^2} \; < \; 0$$
$$\frac{\partial\Phi}{\partial x} = -1 \; < \; 0$$

Functions Ψ and Φ are decreasing and convex in x. If $x \to 0$, $\Psi(x) \to \infty$ and if $x \to \infty$, $\Psi(x) \to 1$. If $x \to \infty$, $\Phi(x) < 0$ and, if the condition $\frac{\beta(1-\alpha)}{1+\beta}\left(\frac{1+\gamma-\xi-\theta}{1+\alpha\tilde{A}\mu}\right) > \gamma$ is satisfied, $\Phi(0) \in (0,\infty)$.

Moreover,

$$\frac{\partial\Psi}{\partial\gamma} = \frac{\tilde{A}}{x} \; > \; 0$$
$$\frac{\partial\Phi}{\partial\gamma} = -\tilde{A} + \frac{\beta(1-\alpha)\tilde{A}}{(1+\beta)(1+\alpha\mu\tilde{A})} \; < \; 0$$

since $\frac{\beta(1-\alpha)\tilde{A}}{(1+\beta)(1+\alpha\mu\tilde{A})} \in (0,1)$.

Thus, an increase in γ shifts Ψ upwards and Φ downwards. Thereby, for low values of γ, there exists two steady-states, and for a large γ, there is no steady-state. Therefore, $\exists\ \gamma'$ such that if $\gamma = \gamma'$, there will be one steady-state where Ψ and Φ tangent.

Besides,

$$\frac{\partial\Psi}{\partial\mu} = \; 0$$
$$\frac{\partial\Phi}{\partial\mu} = -\frac{\beta}{1+\beta}\frac{(1-\alpha)\tilde{A}^2\alpha}{(1+\alpha\tilde{A}\mu)^2}[1+\gamma-\xi-\theta] \; < \; 0$$

So an increase in μ has no effect over Ψ but shifts Φ downwards. A decrease in μ shifts Φ up. Thus, for a sufficiently high μ, there won't exist a steady-state.

A.2 Proof of Proposition 2

The definition of $x = d/k$ implies that

$$\frac{x_{t+1}}{x_t} = \frac{d_{t+1}/k_{t+1}}{d_t/k_t} = \frac{d_{t+1}/d_t}{k_{t+1}/k_t}$$

Define $\hat{D} := \frac{d_{t+1}}{d_t}$ and $\hat{K} := \frac{k_{t+1}}{k_t}$. Thus, $\frac{x_{t+1}}{x_t} = \frac{\hat{D}}{\hat{K}} \implies x_{t+1} = \frac{\hat{D}}{\hat{K}} x_t$.
The differential is

$$\frac{\partial x_{t+1}}{\partial x_t} = \frac{\partial \hat{D}}{\partial x_t}\frac{x_t}{\hat{K}} + \frac{\hat{D}}{\hat{K}} - \frac{\partial \hat{K}}{\partial x_t}\frac{\hat{D}}{\hat{K}^2}x_t$$

Around the steady-state, we have $\hat{D} = \hat{K}$ and $x_{t+1} = x$, then

$$\frac{\partial x_{t+1}}{\partial x_t} = 1 + \frac{1}{\hat{K}}\left(\frac{\partial \hat{D}}{\partial x}x_t - \frac{\partial \hat{K}}{\partial x}x_t\right)$$

Using equations (15) and (16), we have the following differentials:

$$\frac{\partial \hat{K}}{\partial x} = -1 \quad \text{and} \quad \frac{\partial \hat{D}}{\partial x} = -\frac{\gamma \tilde{A}}{x^2}$$

Thus, we have that

$$\frac{\partial x_{t+1}}{\partial x_t} = 1 + \frac{1}{\hat{K}}\left(x_t - \frac{\gamma \tilde{A}}{x_t}\right)$$

Taking into account the term in parentheses in the above equation, if $x \to 0$, this term goes to $-\infty$. If $x \to \infty$, the term goes to ∞. Then, $\frac{\partial x_{t+1}}{\partial x_t} < 0$ for low levels of x, and $\frac{\partial x_{t+1}}{\partial x_t} > 1$ for higher levels of x.

Therefore,

$$\frac{\partial x_{t+1}}{\partial x_t} < 1 \quad \text{in the equilibrium with low } x$$
$$\frac{\partial x_{t+1}}{\partial x_t} > 1 \quad \text{in the equilibrium with high } x$$

Hence, x_1 is a stable equilibrium and x_2 an unstable equilibrium.

A.3 Proof of Proposition 3

Let equation (19) be written as a function: $m(x) = x^3 + \Gamma_1 x^2 - \Gamma_2 x + \Gamma_3$. It follows that:

$$\lim_{x \to -\infty} m(x) = -\infty \quad \text{and} \quad \lim_{x \to \infty} m(x) = \infty$$

Since $m(x)$ is cubic, this implies that it it continuous. Thus, by the intermediate value theorem, $\exists\ x'$ such that $m(x') = 0$. Hence, there exists at least one real root. Given the model parameters, coefficients Γ_1 and Γ_3 are both greater than zero. Thus, if the following condition is satisfied, Γ_2 is also positive

$$\frac{\beta}{1+\beta}(1-\alpha)(1+\gamma-\xi-\theta) > \frac{1}{\tilde{A}} + \gamma(1+\alpha)$$

Thus, the signals of coefficients of $m(x)$ are: $+ \ + \ - \ +$, which implies that there exists two sign changes, so there are either two or no positive roots. For negative roots, we look at $m(-x)$ signs: $- \ + \ + \ +$, which implies only one sign change, therefore, there exists one negative root.

A.4 Derivation of equation 23

Inserting equation (11) in the utility function yields the following indirect utility function:

$$V_t = \ln\left[(1-\tau)w_t - \frac{\beta}{1+\beta}(1-\tau)w_t\right] + \beta \ln\left[\frac{\beta}{1+\beta}(1-\tau)w_t(1+r_{t+1}(1-\tau))\right] \tag{29}$$

Inserting equations (13) and (14) above yields:

$$\begin{aligned} V_t &= \beta\ln\beta + (1+\beta)\ln\left(\frac{1}{1+\beta}\right) + (1+\beta)\ln k_t \\ &+ (1+\beta)\ln\left[\frac{1+\gamma-\xi-\theta}{1+\alpha\tilde{A}\mu}(1-\alpha)\tilde{A}\right] + \beta\ln\left[\frac{1+\gamma-\xi-\theta}{1+\alpha\tilde{A}\mu}\alpha\tilde{A} + 1\right] \end{aligned}$$

A.5 Proof of Proposition 4

Since $(1+\gamma-\xi-\theta) > 0$, the derivative of equation (23) with respect to μ is:

$$\frac{\partial V_{t-1}}{\partial\mu} = -\frac{\alpha\tilde{A}(1+\beta)}{1+\alpha\tilde{A}\mu} - \frac{\beta\alpha\tilde{A}^2(1+\gamma-\xi-\theta)(1-\alpha)}{1+\alpha\tilde{A}\mu+\alpha\tilde{A}(1+\gamma-\xi-\theta)} < 0$$

The derivative of equation (23) with respect to γ is:

$$\frac{\partial V_{t-1}}{\partial\gamma} = \frac{1+\beta}{1+\gamma-\xi-\theta} + \frac{\beta}{\mu+1+\gamma-\xi-\theta} + 1/\alpha\tilde{A} > 0$$

A.6 Welfare analysis of the economy with only deficit rule

Inserting equation (17) in (29):

$$\begin{aligned} V_t &= \beta\ln\beta + (1+\beta)\ln\left(\frac{1}{1+\beta}\right) + (1+\beta)\ln\left[\frac{(1+\gamma-\xi-\theta)}{1+\alpha d_t/k_t}(1-\alpha)\tilde{A}k_t\right] \\ &+ \beta\ln\left[1+\alpha\frac{d_t}{k_t} + \alpha\tilde{A}(1+\gamma-\xi-\theta)\right] - \beta\ln\left(1+\alpha\frac{d_t}{k_t}\right) \end{aligned}$$

Working the equation above, for agents born in $t-1$ the indirect utility is:

$$V_{t-1} = \beta \ln \beta + (1+\beta) \ln \left(\frac{1}{1+\beta} \right) + 2(1+\beta) \ln k_{t-1} - (1+2\beta) \ln (k_{t-1} + \alpha d_{t-1})$$
$$+ (1+\beta) \ln [(1-\alpha)\tilde{A}(1+\gamma-\xi-\theta)] + \beta \ln [(k_{t-1} + \alpha d_{t-1} + \alpha \tilde{A} k_{t-1}(1+\gamma-\xi-\theta)]$$

Taking the differential:

$$\frac{\partial V_{t-1}}{\partial \gamma} = \frac{(1+\beta)}{1+\gamma-\xi-\theta} + \frac{\beta \tilde{A}}{1/\alpha + d_{t-1}/k_{t-1} + \tilde{A}(1+\gamma-\xi-\theta)} > 0$$

Appendix B: Tables

Table 6 – Debt rule - first stage contiguity instrument results

Variables	(1) DR_{it}	(2) DR_{it}	(3) DR_{it}	(4) DR_{it}	(5) DR_{it}
ContiguityDR_{it-1}	0.146***	0.148***	0.0908***	0.139***	0.143***
	(0.0181)	(0.0258)	(0.0216)	(0.0232)	(0.0285)
Observations	4,555	3,509	1,046	3,489	1,066
R-squared	0.309	0.257	0.490	0.273	0.452
No. countries	177	137	40	140	37
Sample	Full	No europe	Europe	No Advanced	Advanced
F-stat 1st Stage	7.898	4.492	8.841	4.523	10.56
Stock-Wright p-value	0.0002	0.0012	0.000	0.0002	0.9342
SW F-stat	64.95	32.92	17.73	35.91	25.24
SW p-val	0.0000	0.0000	0.0001	0.0000	0.0000

Note: Robust standard errors, clustered at the country level, are reported in parentheses. Other covariates not reported.

Table 7 – Debt Rule - second stage contiguity instrument results

Variables	(1) $\Delta \ln Y$	(2) $\Delta \ln Y$	(3) $\Delta \ln Y$	(4) $\Delta \ln Y$	(5) $\Delta \ln Y$
DR_{it}	2.980***	2.927**	6.880*	4.219**	0.0400
	(1.146)	(1.418)	(3.881)	(1.708)	(0.782)
$\ln Y_{it-1}$	-5.206***	-4.510***	-12.82***	-4.925***	-4.472***
	(0.833)	(0.805)	(4.485)	(0.929)	(0.795)
$\ln K_{it}$	3.583***	3.246***	5.235***	3.294***	2.188
	(0.669)	(0.754)	(1.521)	(0.736)	(1.825)
$\ln G_{it}$	-1.890*	-1.525	-10.09***	-1.471	-9.940***
	(0.995)	(0.990)	(2.839)	(0.990)	(2.771)
Observations	4,555	3,509	1,046	3,489	1,066
No. countries	177	137	40	140	37
Country FE	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES
Sample	Full	No europe	Europe	No Advanced	Advanced

Note: Robust standard errors, clustered at the country level, are reported in parentheses. Constant term and year fixed effects not reported. Coefficients are p.p. since ΔlnY is multiplied by 100.

Table 8 – Budget balance rule - first stage contiguity instrument results

Variables	(1) BBR_{it}	(2) BBR_{it}	(3) BBR_{it}	(4) BBR_{it}	(5) BBR_{it}
$ContiguityBBR_{it-1}$	0.143***	0.160***	0.0638*	0.153***	0.102*
	(0.0219)	(0.0210)	(0.0343)	(0.0200)	(0.0510)
Observations	4,555	3,509	1,046	3,489	1,066
R-squared	0.307	0.283	0.475	0.318	0.390
No. countries	177	137	40	140	37
Sample	Full	No europe	Europe	No Advanced	Advanced
F-stat 1st Stage	7.514	5.400	16.10	6.769	5.847
Stock-Wright p-value	0.0009	0.0014	0.0005	0.0002	0.233
SW F-stat	42.67	58.24	3.46	58.18	3.97
SW p-val	0.0000	0.0000	0.0704	0.0000	0.0539

Note: Robust standard errors, clustered at the country level, are reported in parentheses. Other covariates not reported.

Table 9 – Budget Balance Rules - second stage contiguity instrument results

Variables	(1) $\Delta \ln Y$	(2) $\Delta \ln Y$	(3) $\Delta \ln Y$	(4) $\Delta \ln Y$	(5) $\Delta \ln Y$
BBR_{it}	2.391***	2.501**	6.393	3.190***	-0.786
	(0.917)	(1.094)	(4.226)	(1.166)	(1.025)
$\ln Y_{it-1}$	-5.042***	-4.478***	-12.41**	-4.736***	-3.740***
	(0.760)	(0.761)	(5.073)	(0.835)	(0.944)
$\ln K_{it}$	3.646***	3.326***	5.493***	3.395***	2.045
	(0.650)	(0.729)	(1.647)	(0.703)	(1.814)
$\ln G_{it}$	-2.080**	-1.720*	-10.08***	-1.721*	-9.878***
	(0.920)	(0.909)	(2.637)	(0.895)	(2.641)
Observations	4,555	3,509	1,046	3,489	1,066
No. countries	177	137	40	140	37
Country FE	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES
Sample	Full	No europe	Europe	No Advanced	Advanced

Note: Robust standard errors, clustered at the country level, are reported in parentheses. Constant term and year fixed effects not reported. Coefficients are p.p. since ΔlnY is multiplied by 100.

Table 10 – Debt rule - first stage for the contiguity fiscal strength sub-index

Variables	(1) DR $index_{it}$	(2) DR $index_{it}$	(3) DR $index_{it}$	(4) DR $index_{it}$	(5) DR $index_{it}$
CDR $index_{it-1}$	0.685***	0.462***	0.490***	0.568***	0.682***
	(0.0843)	(0.113)	(0.110)	(0.121)	(0.127)
Observations	4,555	3,509	1,046	3,489	1,066
R-squared	0.351	0.189	0.532	0.245	0.522
No. countries	177	137	40	140	37
Sample	Full	No europe	Europe	No Advanced	Advanced
F-stat 1st Stage	6.705	3.973	7.965	3.898	6.451
Stock-Wright p-value	0.0006	0.0118	0.000	0.0004	0.0155
SW F-stat	66.2	16.68	19.76	22.13	28.73
SW p-val	0.0000	0.0001	0.0001	0.0000	0.0000

Note: Robust standard errors, clustered at the country level, are reported in parentheses. Other covariates
not reported.

Table 11 – Debt rule - second stage for the contiguity fiscal strength sub-index

Variables	(1) $\Delta \ln Y$	(2) $\Delta \ln Y$	(3) $\Delta \ln Y$	(4) $\Delta \ln Y$	(5) $\Delta \ln Y$
DR index$_{it}$	5.969***	11.67**	13.52**	12.03***	2.899
	(2.212)	(5.942)	(5.786)	(4.620)	(2.176)
$\ln Y_{it-1}$	-4.944***	-4.567***	-11.78***	-4.925***	-5.426***
	(0.800)	(0.832)	(3.397)	(0.941)	(1.040)
$\ln K_{it}$	3.674***	3.320***	5.314***	3.411***	2.613
	(0.660)	(0.737)	(1.700)	(0.713)	(1.950)
$\ln G_{it}$	-2.055**	-1.738*	-10.43***	-1.736*	-9.843***
	(0.952)	(0.925)	(2.590)	(0.930)	(2.907)
Observations	4,555	3,509	1,046	3,489	1,066
No. countries	177	137	40	140	37
Country FE	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES
Sample	Full	No europe	Europe	No Advanced	Advanced

Note: Robust standard errors, clustered at the country level, are reported in parentheses. Constant term and year fixed effects not reported. Coefficients are p.p. since ΔlnY is multiplied by 100.

Table 12 – Budget Balance rule - first stage for the contiguity fiscal strength sub-index

Variables	(1) BBR index$_{it}$	(2) BBR index$_{it}$	(3) BBR index$_{it}$	(4) BBR index$_{it}$	(5) BBR index$_{it}$
CBBR index$_{it-1}$	0.685***	0.462***	0.490***	0.568***	0.682***
	(0.0843)	(0.113)	(0.110)	(0.121)	(0.127)
Observations	4,555	3,509	1,046	3,489	1,066
R-squared	0.369	0.180	0.538	0.248	0.513
No. countries	177	137	40	140	37
Sample	Full	No europe	Europe	No Advanced	Advanced
F-stat 1st Stage	8.650	4.536	8.391	4.799	6.065
Stock-Wright p-value	80.12	18.09	24	29.76	30.28
SW F-stat	0.0000	0.0000	0.0000	0.0000	0.0000
SW p-val	0.0325	0.0263	0.0035	0.0017	0.459

Note: Robust standard errors, clustered at the country level, are reported in parentheses. Other covariates not reported.

Table 13 – Budget Balance rule - second stage for the contiguity fiscal strength sub-index

Variables	(1) $\Delta \ln Y$	(2) $\Delta \ln Y$	(3) $\Delta \ln Y$	(4) $\Delta \ln Y$	(5) $\Delta \ln Y$
BBR index$_{it}$	2.788*	9.560*	5.366	9.739**	0.645
	(1.617)	(5.300)	(3.269)	(3.904)	(1.492)
$\ln Y_{it-1}$	-4.548***	-4.431***	-8.013***	-4.676***	-4.708***
	(0.731)	(0.780)	(2.418)	(0.857)	(0.875)
$\ln K_{it}$	3.617***	3.320***	4.229***	3.396***	2.268
	(0.649)	(0.731)	(1.220)	(0.702)	(1.830)
$\ln G_{it}$	-2.076**	-1.821**	-9.740***	-1.797**	-9.983***
	(0.938)	(0.898)	(2.413)	(0.901)	(2.789)
Observations	4,555	3,509	1,046	3,489	1,066
No. countries	177	137	40	140	37
Country FE	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES
Sample	Full	No europe	Europe	No Advanced	Advanced

Note: Robust standard errors, clustered at the country level, are reported in parentheses. Constant term and year fixed effects not reported. Coefficients are p.p. since ΔlnY is multiplied by 100.