A STRINGENT NECESSITY: ADDRESSING FISCAL BUBBLES WITH FISCAL RULES IN CENTRAL AND EASTERN EUROPE

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ABSTRACT

We study the role of public debt sustainability in the implementation of national fiscal rules in 11 Central and Eastern European (CEE) countries. We ask whether episodes of unsustainable increases in public debt, i.e., “fiscal bubbles”, result in a modification in fiscal frameworks in CEE economies. We first model how the costs and benefits of fiscal rules explain why politicians select different levels of fiscal stringency and, more importantly, how fiscal bubbles bolster politicians’ willingness to tighten fiscal rules via the perception and social pressure channels. On the empirical side, employing a bubble detection algorithm based on recursive unit-root testing, we identify the episodes when public debt reveals explosive (“bubble-like”) behaviour between 2000 and 2021. Then, using the panel fractional probit models, we find that (i) the occurrence of fiscal bubbles increases the propensity of a government to increase the stringency of the fiscal rules, which implies that CEE economies use a tightening of fiscal rules as a means for fiscal adjustment when risks of public debt unsustainability become excessive, (ii) beneficial effects of fiscal bubbles are decreasing in government effectiveness, which signals that the perception channel is likely to dominate the social pressure channel. Alternative empirical specifications and the generalized estimating equation estimation corroborate our findings.

KEYWORDS

Public debt sustainability; fiscal bubbles; fiscal rules; fiscal deficit; fractional probit; Central and Eastern Europe.

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D72, E32, E62, F42, H60, H63.

A stringent necessity: Addressing fiscal bubbles with fiscal rules in Central and Eastern Europe*

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Abstract

We study the role of public debt sustainability in the implementation of national fiscal rules in 11 Central and Eastern European (CEE) countries. We ask whether episodes of unsustainable increases in public debt, i.e., "fiscal bubbles", result in a modification in fiscal frameworks in CEE economies. We first model how the costs and benefits of fiscal rules explain why politicians select different levels of fiscal stringency and, more importantly, how fiscal bubbles bolster politicians' willingness to tighten fiscal rules via the perception and social pressure channels. On the empirical side, employing a bubble detection algorithm based on recursive unit-root testing, we identify the episodes when public debt reveals explosive ("bubble-like") behaviour between 2000 and 2021. Then, using the panel fractional probit models, we find that (i) the occurrence of fiscal bubbles increases the propensity of a government to increase the stringency of the fiscal rules, which implies that CEE economies use a tightening of fiscal rules as a means for fiscal adjustment when risks of public debt unsustainability become excessive, (ii) beneficial effects of fiscal bubbles are decreasing in government effectiveness, which signals that the perception channel is likely to dominate the social pressure channel. Alternative empirical specifications and the generalized estimating equation estimation corroborate our findings.

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1. Introduction

In this paper, we study the role of public debt sustainability in the implementation of national fiscal rules. In particular, we investigate the role of episodes of unsustainable increases in public debt (i.e., fiscal bubbles) on the evolution of the stringency of fiscal rules in Central and Eastern European (CEE) countries. We ask whether such bubbles lead to a significant modification in fiscal frameworks in CEE economies, while accounting for other potential macroeconomic and political determinants of fiscal rule stringency. We focus on CEE EU member states for three reasons. First, as the empirical part of the paper shows, they have *all* faced public debt unsustainable episodes *and* at different periods. In contrast with Western and Southern EU member states, these episodes are not all concentrated around 2010. This introduces some variance between CEE countries that may be absent from other EU member states. Second, CEE countries have recently adopted the European fiscal framework and had to catch up with other EU member states in the application of fiscal rules. Last, CEE countries also faced tremendous budget challenges after the Russian invasion of Ukraine.

The primary motivation behind this paper comes from the unsettled discussion about the costs and benefits of fiscal rules: not only from a macroeconomic but also from a social and political point of view. The controversies surrounding fiscal rules are most notable in the EU, where the design of fiscal rules is a product of complex interactions between national and EU-wide interests, leading to disagreements between member states (see Blanchard, Leandro, & Zettelmeyer, 2021). Additionally, the article tackles the problem of the "swinging pendulum" between looser and tighter application of fiscal rules and procyclicality of fiscal rules in the EU over the last two decades (Bilbiie, Monacelli, & Perotti, 2021). Finally, the paper provides implications for the post-Covid-19 period, when fiscal rules are re-installed after their suspension during the pandemic and amid high inflation rates,[1] as well as the period that followed the Russian aggression on Ukraine, marked by an increase in military spending across the EU, particularly so on its Eastern flank.

In the theoretical part, we develop a framework that explains why politicians select different levels of stringency of fiscal rules. The framework draws on Rodrik's model of linkages between economic policy and growth (Rodrik, 2012). Our model, however, focuses on fiscal rules adoption and fiscal (un)sustainability. It accounts for both benefits and costs of fiscal rule adoption. The former are increased macroeconomic stability. The latter include implementation and monitoring costs, as well as political costs (the government has less room for politically-motivated discretionary actions). We show that fiscal bubbles facilitate the implementation of fiscal rules via the perception and social pressure channels[2].

[1] A return to the rule-based fiscal framework in the post-Covid-19 period is highlighted by the IMF (Caselli et al., 2022). High debt levels, combined with high inflation rates, challenge governments to re-design their medium-term fiscal frameworks. For example, the return to fiscal rules may be supported by reforms that increase their effectiveness.

[2] The perception channel works through the relative benefit of abiding by the rule as perceived by the public, whereas the social pressure channel works through the relative cost of deviating from the rule, hence revealing dishonesty, see Section 3 of the paper.

The empirical framework of the paper consists of two stages. In the first step, we identify the episodes of fiscal bubbles in quarterly debt-to-GDP data. We employ a bubble detection algorithm based on recursive unit-root testing that indicates periods in which public debt reveals explosive ("bubble-like") behaviour (Phillips, Wu & Yu, 2011; Phillips, Shi, & Yu, 2015a, b). Our sample covers 11 CEE countries for the 2000-2021 period. In the second stage, we investigate the impact of the occurrence of fiscal bubbles on change in the stringency of fiscal rules adopted by the EU economies. The detected fiscal bubbles are introduced as an explanatory variable into panel fractional probit models. Controlling for the output gap, cyclically adjusted primary balance, interest payments on public debt, and measures of government effectiveness, we study their impact on fiscal rule stringency. We additionally test whether the countries that are characterized by a lower degree of government effectiveness and that experience a fiscal bubble are more prone to tighten their fiscal rules. Finally, we run several sensitivity checks on our baseline results. For example, we use the generalized estimating equation estimation (Papke & Woolridge, 2008) and investigate whether the results are not subject to the problem of reverse causality between fiscal rules and public debt bubbles.

Several results are worth highlighting. First, using our theoretical framework, we demonstrate how fiscal bubbles can contribute to fiscal rule stringency via the perception and social pressure channels. Second, we identify a number of periodically collapsing bubbles in the public debt in CEE economies, concentrated around – but not limited to – the EMU debt crisis. Third, we show that the occurrence of fiscal bubbles strengthens the propensity of a government to increase the stringency of fiscal rules implemented in each country. Our results suggest that CEE economies use a tightening of fiscal rules as a means for fiscal adjustment required when risks of public debt unsustainability grow to excessive levels. Hence, our results support the view that fiscal rules may be a means to restore confidence in debt sustainability following a fiscal crisis and increase space to conduct fiscal stabilization policy in the future. Fourth, we find out that the beneficial effects of fiscal bubbles are decreasing in government effectiveness. Using our theoretical framework, we can to interpret these results as an indication that the perception channel, which is related to the *benefit* associated with the application of the fiscal rule, is relatively more important than the social pressure channel, which is related to the *costs* of insufficient application of the fiscal rule.

This paper contributes to ongoing debates on public finance sustainability and its macroeconomic determinants. First, following the literature on the costs and benefits of fiscal rules (e.g., Iara & Wolff, 2014; Sacchi & Salotti, 2015), we develop a stylised model that encompasses political motives and, using it, we demonstrate how fiscal bubbles can promote tightening of the fiscal framework. Second, we add to the existing studies on fiscal default episodes (e.g. Reinhart, Reinhart & Rogoff, 2012; Mauro & Zhou, 2021) by utilizing a relatively novel technique of bubble detection in time series (Phillips, Shi, & Yu, 2015a, b), which allows us to date-stamp episodes of debt unsustainability. Third, by accounting for the factors related to fiscal (un)sustainability that influence changes in fiscal rules in CEEs, we expand the catalogue of potential motives to strengthen fiscal rules and contribute to the literature on their determinants (e.g., Hallerberg et al., 2007; Badinger & Reuter, 2017). Moreover, by accounting for potential nonlinearities between fiscal bubbles and fiscal

stringency, we contribute to the literature on the interactions between fiscal rules and fiscal institutions (e.g., Maltritz & Wüste, 2015).

The paper is structured as follows. The following section discusses the related literature and provides a broader context for our analysis. Section 3 establishes the theoretical framework that explains (i) how episodes of public debt unsustainability, i.e. fiscal bubbles, can modify choices made by politicians and promote the strengthening of fiscal rules and (ii) how government effectiveness can moderate the examined relations. The two consecutive sections present empirical evidence. Section 4 checks the evolution of public debt in the CEE economies for the presence of bubble episodes. Building on these findings, Section 5 investigates (i) whether the experience of the fiscal bubble makes politicians more willing to strengthen the fiscal framework and (ii) how that willingness is attenuated or amplified by other characteristics of an economy. Section 6 provides the conclusions.

2. Related literature

An objective of most early studies on fiscal rules (starting from Poterba, 1994, and Bohn and Inman, 1996) was to determine whether such rules can have an effect on government budget deficits. The main conclusion from these studies is that budget rules do make a difference for fiscal sustainability. Moreover, the studies showed that budgetary adjustments in the form of tax increases and/or spending cuts were more efficient, and that debts were lower in states with relatively strict anti-deficit rules, in particular where no-deficit rules are accompanied by debt limits. This feature was not contradicted during the Covid-19 pandemic crisis (López-Santana and Rocco, 2021). However, to date, the impact of fiscal rules on the cyclical feature of fiscal policy remains disputed: either they can be shown as highly restrictive and with pro-cyclical effects (Biolsi and Kim, 2021), or conducive to counter-cyclical policies (Jalles, 2018; Larch, Orseau and van der Wielen, 2021). Furthermore, fiscal rules can be virtually ineffective if a political consensus emerges to overturn them (as shown by Auerbach, 2008, for the United States, at the federal level, and, theoretically, by Arawatari and Ono, 2021). Dharmapala (2006) goes some way towards reconciling the two scenarios, by showing that it is all the easier to evict a rule if the budgetary rules are purely statutory, i.e., if they can be revised or cancelled by a simple majority vote.

Some other potentially negative effects of fiscal rules are also sometimes noted. Ardanaz, Cavallo, Izquierdo, & Puig (2021) show that, in countries with no fiscal rule or with a rigid fiscal rule, a fiscal adjustment of at least 2% of GDP is associated with an average 10% reduction in public investment. Conversely, when fiscal rules are flexible, the negative effect of fiscal adjustments on public investment disappears, implying that flexible rules protect public investment during consolidation episodes, reducing macroeconomic volatility. The corollary, according to Ardanaz et al. (2021), is that the design of fiscal rules should incorporate a pro-growth dimension in addition to the objective of fiscal sustainability. Eklou and Joanis (2019), as well as Gootjes et al. (2021), show that fiscal rules have a significant effect on political and economic cycles, and that this effect is reinforced after the 2007-2009 crisis. Their analysis concerns a panel of countries, with a wide variety of contexts and rules. In general, as

highlighted by Grembi et al. (2016), the effectiveness of fiscal rules is questioned both due to commitment and enforcement problems. Using a quasi-experimental design, they show that fiscal rules do reduce the accumulation of debt by local governments, but those effects are stronger when political distortions are larger. However, fiscal rules and institutions do not necessarily modify the governments' behaviour under all conditions – Ardanaz and Izquierdo (2022) find little evidence that the presence of fiscal rules has some effect on public spending categories over the business cycle.

Consequently, the implementation and effectiveness of fiscal rules may materially depend on various features of particular economic and political systems. Hallerberg et al. (2007) show that governments of EU countries have incentives to implement more stringent fiscal rules when the ruling coalition is more fragmented but also in institutional settings that favour the "contract" approach to the budget process that involves bargaining among policymakers. Based on a broad panel of EU countries, Bergman et al. (2016) find that fiscal rules and government effectiveness may be treated as partial substitutes in promoting fiscal sustainability. This result is confirmed in a broader study by Badinger and Reuter (2017) who show that fiscal rules tend to be more stringent when countries have a weaker system of checks and balances on the government. Carranza-Ugarte et al. (2023) demonstrate that the effectiveness of fiscal rules does not depend solely on maintaining control over fiscal stance but involves the ability of the government to simultaneously retain public investment.

Interestingly, most of the issues pertaining to the fulfilment of fiscal rules – (possible) pro-cyclicality, the stringency of the fiscal rule that dampens public investments, and political influence to circumvent the rule – were all anticipated at the early stages of EU membership by CEE countries (Coricelli, 2004). While Semik and Zimmermann (2022) document the adjustment policies to reduce debt-to-GDP ratios in the CEE countries and conclude that expenditure cuts have been more effective at achieving this outcome than increases in taxes and contributions, Fincke and Wolski (2016) show that EU membership has shifted CEE countries towards more countercyclical fiscal policies. However, none of these papers questions the impact of debt on the fulfilment of EU fiscal rules. Yet, in a different context, Ulloa-Suárez (2023) finds that changes in the macroeconomic and political context affect the likelihood that fiscal rules will be respected. Our investigation goes deeper in this direction.

3. Theoretical framework

In this section, we develop a stylised model of fiscal rule adoption and use it to explain how policy choices can change in the aftermath of a fiscal bubble. We borrow a general idea of costly government interventions and the diversion of profits related to such interventions in a multi-country environment from Rodrik (2012). In a nutshell, the model explains why countries select different degrees of fiscal rules stringency. Fiscal rules contribute to stabilising an economy, i.e., decrease macroeconomic volatility. Their adoption, however, entails two costs. First, implementation and monitoring costs. Second, political costs since the government has less room for politically-motivated discretionary actions.

3.1 The baseline framework

Let macroeconomic volatility σ_m be the aggregate measure of output and price volatilities:

$$\sigma_m(r, g) = \sigma(g)[1 + \theta(1 - r)] \quad (1)$$

where g is an indicator of government effectiveness, r informs about the intensity of fiscal rules and ranges from 0 (no fiscal rules adopted) to 1, and θ measures the sensitivity of macroeconomic volatility to fiscal rule stringency as perceived by the public. We assume that macroeconomic volatility depends on the reaction of the public (companies, consumers, savers) to the application of the fiscal rule: the higher the transparency in adopting a stringent fiscal rule, the lower the macroeconomic cost (see Gootjes & De Haan, 2022). We also assume an informational asymmetry between the public and the government about how stringent this application may be[3]. A rise in government effectiveness alleviates overall volatility, so it is assumed that $\sigma(g)$ is decreasing in g, that is $\sigma'(g) < 0$. The adoption of fiscal rules has a mitigating impact on volatility; this reflects the reduction in procyclicality of fiscal policy responses to shocks in the presence of fiscal rules (see, e.g., Guerguil et al., 2017).[4]

The adoption of any fiscal rule is costly. The cost of implementing fiscal rules is defined as $\phi(g)\alpha(r)$. The $\alpha(r)$ term captures implementation costs and it is increasing in r at a rising rate, so $\alpha'(r) > 0, \alpha''(r) > 0$, and $\alpha(0) = 0$. The $\phi(g)$ term shifts the implementation cost and it is supposed to measure the importance of government effectiveness. When the government is more effective, one can expect that the adoption of fiscal rules will be less costly. Accordingly, we assume that $\phi(g)$ is decreasing in government effectiveness, so $\phi'(g) < 0$.

The social loss function includes both macroeconomic volatility and the cost of implementing fiscal rules:

$$L^S(r, g) = \sigma_m(r, g) + \phi(g)\alpha(r) \quad (2)$$

The socially optimal intensity of fiscal rules can be determined by minimising the social loss function. The control variable is the intensity of the fiscal rule, from a looser to tighter application of fiscal rules, as exemplified by Bilbiie et al. (2021). The government effectiveness is a conditioning variable that we will examine below. In contrast with the application of a fiscal rule, it is not a control variable that the government may discretionarily modify. Thus, the first-order condition is simply:

$$-\sigma(g)\theta + \phi(g)\alpha'(r) = 0 \quad (3)$$

and it implicitly defines r^{**} that minimises the loss function. Given that $\frac{\partial^2 L^S}{\partial r^2} = \alpha''(r) > 0$, the second-order condition is met.

The optimization problem is illustrated in Figure 1. In a baseline case with no fiscal rules, $r = 0$, the implementation cost (broken line) is nil but macroeconomic volatility (dotted line) is substantial. The resulting social loss (solid line) is suboptimal. The loss can be reduced by

[3] In the first stage, we assume that θ is constant. We introduce it as an endogenous process later on.

[4] Our framework is a stylised one, and it captures the general finding. Noteworthy, the differences in the design of fiscal rules may matter, as shown by Guerguil et al. (2017) (see also, e.g., Jonas, 2012).

adopting fiscal rules and a corresponding rightward movement along the social loss function. Setting the intensity of fiscal rules at its socially optimal level brings in the benefit equal to the difference between the social loss at $r = 0$ and the one at $r = r^{**}$.

[Figure 1 around here]

3.2 Political dimension

Politicians do not minimise the social loss function. It is because they take into account the political outcomes of fiscal rule tightening. The tighter the rules, the less leeway in the fiscal policy is left to politicians to attain some other goals, i.e., political goals that go beyond those included in the social loss function. For example, when politicians adopt fiscal rules, they tie their hands and cannot use fiscal policy to build government support for the upcoming elections (following the seminal contribution by Nordhaus, 1975) or to invest in new infrastructures (as highlighted in the EU by, e.g., Balassone & Franco, 2000).

Political motives can be captured with the payoff to politicians, $\tilde{\pi}(r)$, which is maximal when there are no fiscal rules and decreases in r, initially, when the rules are not that binding, at a slower pace and then, when rules become more stringent, at a faster pace.

In analogy with the society, it is convenient to define the loss to politicians, $\pi(r)$, instead of a payoff. Given that $\pi(r) \equiv -\tilde{\pi}(r)$, the loss to politicians $\pi(r)$ is negative and increasing in r, i.e., $\pi'(r) > 0$.

The politician selects the intensity of fiscal rules in order to minimize the following loss function:

$$L^P(r, g) = \lambda L^S(r, g) + \pi(r) \tag{4}$$

where λ measures the strategic behaviour of the politician, i.e. the extent to which she/he cares about social welfare or her/his "honesty". Given that the government effectiveness is a conditioning variable (and not the decision variable), the first-order condition is:

$$-\sigma(g)\theta + \phi(g)\alpha'(r) + \frac{1}{\lambda}\pi'(r) = 0 \tag{5}$$

It implicitly defines r^* that minimises the political loss function. It is assumed that the second-order condition is met, $\frac{\partial^2 L^P(r^*)}{\partial r^2} > 0$, so the second derivative of π is positive or not too negative, i.e., $\pi''(r^*) > -\lambda\phi(g)\alpha''(r^*)$.[5]

Condition (5) can be used to see that politicians choose rules that are less stringent than socially optimal, i.e., $r^* < r^{**}$. One can see this by comparing Equations (3) and (5). They can be rewritten as $L_r^S(r, g) = 0$ and $L_r^S(r, g) = -\frac{1}{\lambda}\pi'(r) < 0$, respectively. Given that $L_r^S(r, g)$ is

[5] The assumption is useful but not critical. It simply excludes the border solution, i.e. $r^* = 0$.

increasing in r, the intensity of fiscal rules selected by politicians will be smaller than would be socially optimal.

In Figure 2, the political loss function L^P is depicted with a solid line and the loss to politicians $\pi(r)$ with a dotted line. The latter loss is negative because politicians gain on pursuing their own goals. Accordingly, the political loss function is below the social loss function (a broken line). In line with our findings, the minimum of the political loss function is at a lower level of fiscal rules intensity ($r = r^*$) than the minimum of the social loss function ($r = r^{**}$).

[Figure 2 around here]

3.3 Fiscal rule stringency and bubbles

The bubbles are likely to facilitate the implementation of fiscal rules, as they may make the adoption of fiscal rules more stringent and more transparent. We model their effects via two channels which we call the perception channel and social pressure channel.

The perception channel works via the changes in the perceived gain of having the fiscal rule, which can be measured by the θ parameter used in Equation (1). When the bubble hits an economy, the perceived gain is likely to go up (abiding by the fiscal rule is perceived as a consistent reaction to the excessive rise in public debt), so it will be socially optimal to increase the stringency of fiscal rules.

To explain the mechanism more formally, let us assume that the *perceived* gain of the fiscal rule is a fraction of the *true* gain θ^T, which can be related to the informational advantage of the government over the public:

$$\theta = \kappa\theta^T \tag{6}$$

where $0 < \theta^T$, and $0 < \kappa \leq 1$. Under perfect information, κ would be equal to 1 and under imperfect information, it is below unity. The fiscal bubble can reduce information asymmetry between the public and the government because it incentivises the public to get more knowledge of what went wrong and what the benefits of a stringent fiscal rule could be. Accordingly, the κ parameter goes up and the perceived gain of having more stringent fiscal rules gets closer to the true gain.

The changes induced by the bubble are depicted in Figure 3. It illustrates the first-order condition of loss minimisation (see Equation (5)). The downward-sloping dotted line is the (negative of the) first derivative of the social loss function. It intersects the zero line at the socially optimal level of fiscal rule stringency, i.e., $r = r_0^{**}$. The hump-shaped dotted curve is the first derivative of the loss to politicians (scaled by λ). The intersection of both lines determines the fiscal rule stringency that solves the politician's problem, i.e., $r = r_0^*$ (point O). The bubble episode reduces informational asymmetry, and consequently, θ goes up so the first derivative of the social loss function shifts upwards to the location depicted with a solid blue

line, and the new socially optimal level of fiscal rule stringency is r_1^{**}. As explained above, the politician cares also about political payoff and, therefore, selects level r_{1A}^{*} (point A).

[Figure 3 around here]

To complete the picture, we introduce the second channel. The social pressure channel works via the "honesty" of the government, i.e., the λ parameter. It can be considered a measure of social pressure on the government and the quality of political institutions (governance, political system, etc.). It can also be interpreted in terms of the degree of the benevolence of the social planner or her strategic behaviour. The bubble episode is likely to raise social pressure on the government to get fiscal policy right and introduce arrangements that protect society against the discretion of the government. In terms of the model, the λ parameter increases. Another interpretation in the empirical context studied below would be that the same parameter can encompass the impact of euro adoption. Accordingly, its change would be motivated by external pressure on the government rather than social pressure.

In Figure 3, the rise in the social pressure on the government is illustrated with the downward shift of the (scaled) first derivative of the loss to politicians to the location depicted with the solid black line. The level of fiscal rule stringency selected by the politician is r_{1B}^{*} (point B) rather than r_{1A}^{*} (point A). This results in the convergence of the fiscal rule stringency selected by the politician with the socially optimal level as the difference between r_1^{**} and r_{1B}^{*} is smaller than the one between r_0^{**} and r_0^{*}.

3.4 Fiscal rule stringency, bubbles, and government effectiveness

It is worthwhile to describe the impact of the bubble on fiscal rule stringency more formally. Let us consider two states: one without a bubble (state 0) and another with a bubble (state B). Taking into account both the perception channel and social pressure channel, we can denote the relevant parameters in the two states as θ_0, λ_0 and θ_B, λ_B, respectively. The first-order condition (Equation (5)) applied to both states delivers:

$$\phi(g)\alpha'(r_s) - \sigma(g)\theta_s + \lambda_s^{-1}\pi'(r_s) = 0 \qquad (7)$$

where the state $s = \{0, B\}$. Using it, one can demonstrate that

$$\Omega(g)\Delta r = \sigma(g)\Delta\theta + \frac{\Delta\lambda}{\lambda_0\lambda_B}\pi'(r_0) \qquad (8)$$

where the change of a generic variable x is defined as $\Delta x = x_B - x_0$, $\Omega(g) = \phi(g)c_{\alpha'} + c_{\pi'}$, and $c_{\alpha'} = \frac{\Delta\alpha'}{\Delta r}$, $c_{\pi'} = \frac{1}{\lambda_B}\frac{\Delta\pi'}{\Delta r}$. We assume that both c's are approximately constant and $c_{\pi'}$ is not too negative, so $\Omega(g)$ is positive. The latter assumption is in line with the premise that the second derivative of $\pi(r)$ is not too negative. Taking into account the working of both channels via which a fiscal bubble affects fiscal rule stringency, and in particular that $\Delta\theta$ and $\Delta\lambda$ are

positive, it is easy to find out that Δr is positive as well. This result corresponds to the choice of a higher fiscal rule index by politicians as illustrated by the rise from r_0^* to r_{1B}^* in Figure 3.

Interestingly, the magnitude of the overall effect of a bubble on fiscal rule stringency depends on government effectiveness. We can use Equation (8) to establish how the sensitivity of the fiscal rule index to a fiscal bubble, Δr, varies with government effectiveness, g. The simple comparative statics exercise reveals that

$$\frac{\partial \Delta r}{\partial g} = \frac{\Delta \theta}{\Omega(g)}\left[\sigma'(g) - \phi'(g) c_{\alpha'} \frac{\Delta r}{\Delta \theta}\right]. \tag{9}$$

In general, it is not possible to determine the sign of the derivative because the bracketed term can take both negative and positive values. Nevertheless, we can cast some light on the role of government effectiveness in shaping the sensitivity of fiscal rule stringency to fiscal bubbles by discussing the components of that expression.

The first term in brackets, $\sigma'(g)$, can be interpreted as a measure of substitutability between fiscal rules and government effectiveness. If, for example, it is high in absolute terms, then government effectiveness has a strong mitigating impact on macroeconomic volatility (see Equation (1)) and, hence the need for fiscal rules is limited. Intuitively, the tightening of the fiscal framework can be substituted by a relatively small rise in government effectiveness.[6]

The second term, $\phi'(g)$, can be seen as a proxy for the degree of complementarity between fiscal rules and government effectiveness. For instance, when it is high in absolute terms, the costs of strengthening fiscal rules, $\phi(g)\alpha(r)$, can be tempered. Intuitively, a rise in government effectiveness provides more room for fiscal rules making the cost of their adoption (or their tightening) smaller.[7]

The last term, $\frac{\Delta r}{\Delta \theta}$, is related to the relative importance of the perception channel in tightening fiscal rules in response to a fiscal bubble. It can be seen from Equation (8) that the relative importance of that channel is given by $\frac{\sigma(g)\Delta\theta}{\Omega(g)\Delta r}$. Thus, the smaller the ratio $\frac{\Delta r}{\Delta \theta}$, the more important the perception channel and the less important the social pressure channel.

Consequently, we can say that government effectiveness will attenuate the sensitivity of fiscal rule stringency to fiscal bubbles when the degree of substitutability between fiscal rules and government effectiveness is relatively high, complementarity between them is weak, and the relative importance of the perception channel is high. The sensitivity will be amplified by government effectiveness under the opposite conditions, i.e., weak substitutability and strong complementarity between fiscal rules and government effectiveness and when the social pressure channel is important. The findings about substitutability and complementarity are rather obvious. The implications of the relative importance of two channels, however, go beyond plain intuition and are not that straightforward. All these results will be useful when interpreting empirical results.

[6] It, of course, does not mean that raising government effectiveness is a soft task. It is a different issue.

[7] Both conclusions can be demonstrated more formally by using the first-order condition and solving for $\frac{\partial r}{\partial g}$.

To sum up, in this section, we demonstrated that: (i) politicians select a suboptimal level of fiscal rule stringency, (ii) a fiscal bubble is conducive to the tightening of the fiscal framework and works via perception and social pressure channels, (iii) government effectiveness affects the beneficial effects of a fiscal bubble on the fiscal framework and its role depends on substitutability and complementarity between government effectiveness and fiscal rules, as well as on the relative importance of the two channels.

4. Detection of fiscal bubbles

The literature on public debt sustainability is a very large one. It draws on many different approaches, some based on historical data (see the seminal contribution of Hamilton & Flavin, 1986), and some model-based (see the seminal contribution by Bohn, 1998). In the end, the concept of debt sustainability does not easily translate into an operational framework.

This section presents the first stage of the empirical analysis that endeavours to make debt sustainability more operational. Actually, we follow a method that aims at detecting and time-stamping the episodes of public debt unsustainability (i.e., fiscal bubbles) in CEE countries[8]. Conceptually, we define unsustainable fiscal policy as an episode of an increase in the public debt-to-GDP ratio, which cannot be continued in infinity (or represents a "mildly explosive behaviour"). In what follows, we will refer to such a situation as a "fiscal bubble", a term meant to describe a rapid escalation of public debt in certain periods. The detection of bubbles is based on Phillips, Shi, & Yu (2015a, b), which relies on recursive right-tailed augmented Dickey-Fuller tests and is generally referred to as the generalized supremum ADF (GSADF). This procedure allows for, on the one hand, the nearly real-time detection of unsustainable behaviour, and, on the other hand, the time-stamping of multiple bubbles in the debt-to-GDP series in each economy.[9]

The algorithm employs the sequential computing of the ADF statistics over all the possible time-spans (i.e., subsamples) and selecting the sup value of the ADF statistic sequence. The two key steps are as follows. First, the backward sup ADF (BSADF) statistic is obtained for a sequence of subsamples with the endpoint fixed at r_2 and the start point r_1, varying from 0 to $r_2 - r_0$:

$$BSADF_{r_2}(r_0) = \sup_{r_1 \epsilon [0, r_2 - r_0]} \left\{ ADF_{r_1}^{r_2} \right\}, \tag{10a}$$

where $ADF_{r_1}^{r_2}$ is the ADF statistic for the subsample that runs from r_1 to r_2, while r_0 is the minimum window width and the entire sample range is between 0 and 1. Second, for each

[8] Bökemeier & Stoian (2018) and Grosu, Pintilescu & Zugravu (2022) test for fiscal reactions to public debt (*à la* Bohn) in 10 and 11 CEE countries, respectively, but they cannot identify a specific year for debt unsustainability within their sample. Bökemeier & Stoian (2018) rely on counterfactuals to analyse whether a year beyond their sample identifies as sustainable or unsustainable.

[9] It might be noted that in an earlier paper Phillips, Wu & Yu (2011) proposed a *sup* ADF (SADF) method with a single recursion. For the purpose of fiscal bubble detection, however, the generalized version (with double recursion) seems more appropriate, as the SADF in principle detects only up to one bubble in a series.

endpoint r_2. Varying from r_0 to 1, we obtain the BSADF statistic and calculate the GSADF statistic as the sup value of such a sequence:

$$GSADF(r_0) = \sup_{r_2 \epsilon [r_0, 1]} \{BSADF_{r_2}(r_0)\}. \quad (10b)$$

The ADF statistics are computed from the conventional equation, in our case using the debt-to-GDP (d_t) dynamics:

$$\Delta d_t = \mu + \delta d_{t-1} + \sum_{i=1}^{p} \varphi_i \Delta d_{t-i} + \varepsilon_t, \quad (11)$$

where μ is a constant, and ε_t is an error term. However, unlike in the usual procedure, the alternative hypothesis states that $\delta > 1$ (the null is conventionally $\delta = 1$). Hence, the rejection of the null leads to a conclusion that the process is mildly explosive. The critical asymptotic and selected finite sample values for the existence of a bubble are provided by Phillips, Shi, & Yu (2015a, p. 1050) but can be obtained by an appropriate Monte-Carlo simulation (Caspi, 2017).

Next, date-stamping of the explosive episodes is possible by comparing each element of the estimated $BSADF_{r_2}(r_0)$ sequence to the corresponding right-tailed critical values of the standard ADF statistic (Caspi, 2017, p. 7; Phillips et al., 2015a, p. 1056). The origination point is the first observation, in which $BSADF_{r_2}(r_0)$ crosses the corresponding critical value from below, whereas the estimated termination point is the first observation, in which $BSADF_{r_2}(r_0)$ crosses the critical value from above – the approach we follow in this study. In a similar context, Esteve and Prats (2023a) detected several bubbles in the behaviour of the Spanish public debt series. In another paper (Esteve and Prats, 2023b), they studied the net international investment position of Spain. Here, we do not only apply an analogical approach to several CEE countries, but also demonstrate how unsustainable episodes influence the adoption of fiscal rules (see Section 5).

When identifying bubbles in public debt series in CEE economies, we rely on the following procedure. We only consider fiscal bubbles to occur when two conditions are met for the same quarter: (a) the GSADF statistics exceeds the 95% critical value and (b) the debt-to-GDP ratio is increasing. In line with Esteve and Prats (2023a), we consider the cases when the GSADF statistic exceeds the sequence of critical values but the debt ratio is falling, to be fiscal adjustment episodes (not bubbles) and we do not hypothesise that they would affect the adoption of fiscal rules (we do not include them in the subsequent analysis). Additionally, given that the analysis in Section 5 below is based on annual data and to account for the length of budgetary procedures, we consider two neighbouring episodes to constitute a single bubble if they occur in two quarters within the same year or in two consecutive years. We compute the sequences of GSADF statistics for each country, with a minimum window width of 18 quarters (20.5% of the sample size), i.e. as implied by the formula recommended by Phillips et al. (2015a, p. 1050). In the Monte-Carlo simulation generating a sequence of 95% critical values, we rely on 1000 replications of the null random walk model and the accurate sample size. The results of the comparison of the series of critical values and computed GSADF statistics for each country are depicted in Figure 4, including also the underlying debt series. Table 1, on the other hand, summarizes the dates of identified episodes.

[Figure 4 around here]

[Table 1 around here]

The bubble identification procedure leads to the detection of a total of 14 fiscal bubbles in CEE economies, at least one in each of the countries, and two episodes in three of them: Estonia, Hungary, and Romania. The episodes of debt unsustainability are not synchronised across CEE countries, and they cannot be attributed to a common determinant. Even though the majority of episodes begin during the Global Financial Crisis and the Eurozone debt crisis (around 2009-2011), there are several notable fiscal bubble incidents either before the sovereign debt crisis (e.g., Poland and Hungary, where the episodes begin in 2004 and 2005) or a few years after (e.g., Bulgaria, Estonia, Romania, with the most recent bubble in the sample starting in 2020).

5. The effects of fiscal bubbles on fiscal rules stringency

This section presents the second stage of the empirical analysis, which aims at capturing the effect of public debt unsustainability episodes (i.e., fiscal bubbles) on the degree of fiscal rules stringency in CEE economies. The section describes the data sources and preparation, along with the panel-data modelling methods used in this part of the study. Next, it presents and discusses the empirical findings.

5.1. Data and specifications of panel-data models

We investigate the relationship between fiscal bubbles and fiscal rules stringency in a panel of eleven CEE economies and data spanning between 2000 and 2021. The dependent variable used in the empirical models is the measure of fiscal rules stringency. This indicator is based on the European Commission's Fiscal Rule Index, constructed from a set of legal criteria, including the existence of monitoring bodies and correction mechanisms.[10] For the purpose of empirical modelling, we standardize the indicator, *FR*, to range between zero and one, using the index value for all countries in our sample (see Table 2). Such a transformation allows us to introduce this measure as the outcome variable in a panel fractional-response probit specifications, as explained below. The *FR* variable is expressed in annual frequency and its larger values reflect a higher degree of fiscal rule stringency.

Our main explanatory variable is the fiscal bubble indicator (*FB*), based on the public debt unsustainability episodes identified in Section 4. Given the properties of the dependent variable, we transform the fiscal bubble series from quarterly to annual frequency in such a way the *FB* indicator shows country-years in which the episodes of fiscal unsustainability begin. Moreover, we account for a number of country-level characteristics which may influence governments'

[10] The EC numerical fiscal rules are used in the study primarily because they give a longer coverage than other indicators, such as the Badinger and Reuter (2017) measure.

decisions to tighten or loosen their fiscal rules. Here, we consider the annual changes in the general government debt-to-GDP ratio, a measure of the cyclically-adjusted primary balance, and interest payments on the general government debt to GDP. The output gap variable controls for the role of a country's macroeconomic conditions which affect its fiscal space and a possibility of public finance consolidation. Next, we take into account the government effectiveness index from the World Bank's Worldwide Government Indicators. This variable reflects the perception of the government's credibility and the civil service's independence from political pressures. Hence, it is directly connected to mechanisms beyond the implementation of fiscal rules depicted in Section 3. Finally, since five out of eleven countries joined the EMU during the period of the analysis, we control for a country's accession to the monetary union, which imposes additional requirements for fiscal discipline in member states.

[Table 2 around here]

Table 3 summarizes the basic descriptive statistics for all the variables employed in the panel-data modelling. As mentioned, the dependent variable (FR) is a continuous variable in the range of zero to one, while the fiscal bubble variable (FB) is an indicator, binary variable. Apart from the euro area membership dummy (EMU), all remaining variables are continuous. The panel is roughly balanced with 231 country-year observations.[11]

[Table 3 around here]

To further illustrate the behaviour of our dependent and the main explanatory variables, Figure 5 superimposes the fiscal bubble (FB) episodes on the series of fiscal rule indices (FR) between 2000 and 2021. By construction, the fiscal bubble episodes are infrequent. All the economies, apart from Estonia, Hungary, and Romania, experienced just a single episode of the bubble through this period. In most cases, the episodes of fiscal unsustainability appear around the period of 2008-2013, with notable exceptions of Poland, when the bubble started around the EU-accession period (2004), and Romania, where the second episode identified for this economy began during the Covid-19 crisis of 2020. When it comes to fiscal rule indicators, we observe a clear increase in their values for all economies over two decades. In some cases, such as Bulgaria, Poland, or Slovakia, this increase is a result of several, consecutive changes in the fiscal rule stringency. Some countries, however, such as Czechia or Slovenia, saw only a single adjustment in the fiscal rule index.

[Figure 5 around here]

[11] Note that there are three missing observations, all for the year 2000: $CAPB$ and $OUTPUT\_GAP$ for Croatia and D_INT_DEBT for Poland.

Before discussing the empirical models employed in the analysis, we test the panel dataset for stationarity. Table 4 contains three unit-root panel-data tests, each of them run both in a specification with a constant and with a constant and deterministic trend. An important result of the series of tests is that FR, the dependent variable in our analysis, reveals a trend-stationary behaviour. It seems to reflect the fact that, in general, the use of fiscal rules as a policy tool was becoming more prevalent in CEE economies between 2000 and 2021. We incorporate this feature into the panel regression specifications by introducing country-year fixed effects that control for a trend-like behaviour of the FR variable. When it comes to the rest of the variables, the majority of tests point to the rejection of unit root in both specifications.

[Table 4 around here]

The main goal of our panel-data model is to capture the relationship between the occurrence of fiscal bubbles (FB) and the fiscal rules index (FR) in CEE economies. Hence, in the linear form, we consider the following panel regression specification:

$$FR_{it} = \mu_i + \eta_t + \alpha t \times \mu_i + \beta FB_{i,t-2} + \boldsymbol{\gamma}' \boldsymbol{Z}_{i,t-2} + \varepsilon_{it}, \tag{12}$$

where μ_i and η_t denote country-specific and time-fixed effects, respectively, while the term $t \times \mu_i$ represents country-specific time trends. Such a specification allows us to simultaneously control for a number of unobserved characteristics: omitted variables at the country level, common effects related, for example, to a general tendency to impose more stringent fiscal rules, and the potentially trending behaviour of fiscal rules in each country. Apart from the main explanatory variable, the measure of the fiscal bubble (FB), regressions include a set of control variables gathered in vector $\boldsymbol{Z}$. Following the Badinger and Reuter (2017) study on fiscal rule determinants, all independent variables, with the exception of the EMU membership, are lagged by two years. The rationale behind using the lagged values of explanatory variables is twofold. First, the economic or political conditions and fiscal rule stringency may be endogenous.[12] Second, due to long political processes, the implementation of fiscal rules following any event needs to account for time lags.

Panel regressions in Eq. (12) are expressed in the fractional probit form and estimated using the quasi-maximum likelihood approach put forward by Papke and Wooldridge (1996). Such an approach suits well the nature of the dependent variable. Apart from the two-way fixed effects and country-specific trend, we also estimate the relationship using a newer generalized estimating equation (GEE) with population averaged effects (Papke and Woolridge, 2008), which has better properties than a standard fractional probit in accounting for correlation structures in error terms in a panel-data setting.

[12] We also estimate the reversed equation and investigate a potential explanatory power of fiscal rules stringency for the occurrence of fiscal bubbles. We do not find any indication of the reverse relationship between fiscal rules and fiscal bubbles. Those results are available upon request.

5.2. Baseline results and discussion

We present the results of the panel fractional probit estimation in three settings. First, we report the two-way fixed effects specifications, gathered in columns (1)–(3) of Table 5. In columns (4)–(6), we show specifications augmented with country-specific trends, before going to the GEE models, presented in the last three columns. In each case, we start by reporting the minimal specification, with FB as the sole explanatory variable. Next, we introduce the set of control variables, paying special attention to the $GOVT\_EFF$ variable which, unlike other controls, reveals a trend-stationary behaviour.

[Table 5 around here]

The main message from the estimated models is that the occurrence of a fiscal bubble, which may be understood as a threat to fiscal sustainability, leads to a higher degree of fiscal rules stringency and enhances budgetary discipline in the panel of CEE economies. Even though the statistical significance of the coefficients on the FB variable is not very high, this result is consistent across all the specification and competing estimators, and it is robust to the inclusion of control variables.[13] The estimated coefficients on the main predictor of interest (FB) oscillate between 0.180 and 0.274. Given that the dependent variable, the fiscal-rule stringency index (FR), is in the range from zero to one, this implies that the economic significance of the effect is substantial.

Notably, the empirical results in Table 5 indicate the role of fiscal bubble episodes goes above and beyond the impact of debt-to-GDP dynamics on the adoption of fiscal rules. Although the point estimates on most of the coefficients on D_DEBT are positive in most of the specifications, they are low and close to zero. The role of the remaining determinants turns out to be almost non-existent. Apart from the indicator of government effectiveness, we do not find any substantial relationships between other fiscal, macro, and political determinants and fiscal rule stringency in the fixed-effects panel models. Interestingly, the GEE models (columns 7–9) demonstrate some role of the output gap for the implementation of fiscal rules, suggesting that better macroeconomic conditions may facilitate a strengthening of fiscal rules in CEE economies.

The empirical results may be interpreted using the theoretical framework laid out in Section 3. Following the episodes of fiscal bubbles, potential benefits outweigh the costs of fiscal rule adoption which incentivises governments to introduce more stringent control over public finance and prevent the negative effect of fiscal instability on macroeconomic performance. Our results suggest that CEE economies indeed use a tightening of fiscal rules as a means (or: a key component) for fiscal adjustment required when risks of public debt unsustainability grow to excessive levels and limits to further expansion of public debt are achieved. It seems that

[13] Taking into account that we deal with a relatively small sample and the fact that the identified fiscal bubble episodes are very infrequent, statistical significance at the 0.15 level should be considered satisfactory. Moreover, the p-values on coefficients in specification (1), (7), and (8) are only marginally above the 0.1 significance level.

together with a fiscal bubble occurrence, governments of CEE countries reach a turning point that calls for substantial reforms of public finance. A credible commitment to fiscal reform is undertaken to address concerns about debt sustainability and related vulnerabilities. Hence, the results seem to support the view that fiscal rules are a measure used to restore confidence in debt sustainability following a fiscal crisis and increase space to conduct fiscal stabilization policy in the future.

5.3. Extension: the role of government effectiveness

As an extension to the baseline results, we investigate the effects of fiscal bubbles on fiscal rules stringency in CEE countries conditional on the remaining control variables included in panel modelling. To achieve this goal, we run six additional fixed-effect panel-data models with deterministic trends, in which we interact, in turn, all of the controls from the baseline models with the FB indicator. The results of the main and interaction effects estimated in such panel regressions are presented in Table 6. It turns out that for four out of six predictors we find no evidence of any noticeable moderating relationship. Such an effect is statistically significant and positive for the panel regression with $OUTPUT\_GAP$ as a moderating variable. This suggests that the CEE governments are more likely to strengthen their fiscal rules following a fiscal bubble occurrence when they are faced with a positive output gap, possibly indicating more favourable macroeconomic conditions. However, the moderating effect is much more pronounced and significantly negative when the $GOVT\_EFF$ variable is interacted with fiscal bubbles (column 5). In this formulation, but also in the specification with the output gap as an interacted predictor, it is worth noticing that the statistical significance of the coefficients on the FB variable is high. Below we focus on the $GOVT\_EFF$ case and discuss in more detail how it affects our baseline relationship.

[Table 6 around here]

Based on the panel-data model with interactions, Figure 6 displays the moderating effect of government effectiveness on the relationship between fiscal bubbles and fiscal rules. It shows a downward-sloping behaviour of the average marginal effects. When the indicator of government effectiveness takes low values, the impact of fiscal bubbles (FB) on the stringency of fiscal rules (FR) is visibly stronger than for its higher values. In particular, the marginal effects are positive, at the 0.1 significance level, up to the $GOVT\_EFF$ of around 0.7, which is slightly above its mean values in the sample (0.611). Once the government effectiveness indicator reaches higher values, the marginal effect becomes insignificant implying no relationship between fiscal bubble occurrence and fiscal-rule indicators. This result may be interpreted in the light of a junction between the overall effectiveness of a country's government and its fiscal framework. When a CEE country experiences relatively low effectiveness and is hit by an episode of fiscal bubble, it tries to improve its credibility in fiscal policy by strengthening its institutions – here, by upgrading its fiscal rules and introducing a more transparent fiscal anchor. On the contrary, if a country has reached relatively high levels of

government effectiveness, the potential benefits of strengthening the rules is smaller, and the incentives to tighten fiscal rules diminish.

[Figure 6 around here]

The empirical relevance of government effectiveness complies with findings derived from our theoretical framework. In Section 3.4, we demonstrate that government effectiveness can modify the response of fiscal rule stringency to a fiscal bubble and describe factors behind this nexus. The empirical finding that the average marginal effects of bubbles on the stringency of the fiscal rule is decreasing in government effectiveness lends support to the notion that there is more substitutability than complementarity between fiscal rules and government effectiveness in CEE countries. Moreover, the results seem to corroborate the hypothesis that the perception channel is important and likely to dominate the social pressure channel. They can also imply that the relative benefit of strengthening fiscal rules for an improvement in the public perception of the government's policies may be attenuated when the government effectiveness is already high. However, the latter claims call for further research, preferably with some further proxies on the strength of perception and social pressure channels.

6. Conclusions

This paper studies the role of public debt sustainability in implementing national fiscal rules in 11 Central and Eastern European countries. We ask whether episodes of the unsustainable increase in public debt, which we call fiscal bubbles, result in a modification in fiscal frameworks in CEE economies while accounting for other potential macroeconomic and political determinants of fiscal rule stringency. To that end, we build a stylised model that accounts for the costs and benefits of fiscal rules, explains why the level of fiscal stringency can be suboptimal, and, more importantly, how fiscal bubbles contribute to the tightening of the fiscal framework through the perception and social pressure channels.

We identify 14 fiscal bubbles, at least one in each of the 11 CEE economies, and reveal that bubbles occurred mainly around the EMU debt crisis, albeit were not limited to that period. The robust relationship between fiscal bubbles and the strengthening of fiscal framework found in the data supports the view that fiscal rules may contribute to restoring confidence in debt sustainability in the aftermath of fiscal crises and provide more space for accommodative fiscal policy in the medium run.

Interestingly, we uncover that the link between fiscal rule stringency and fiscal bubbles is more prominent in countries that experience relatively low government effectiveness. Accordingly, the adoption of tighter fiscal rules by such countries may be considered a substitute for government effectiveness in the short run and a factor that contributes to building effectiveness in the medium-term perspective.

By uncovering an important mechanism behind fiscal rule stringency our study informs the on-going debates on fiscal framework adjustments in CEE countries and beyond. It shows that

fiscal risks recently brought by the legacy of Covid-19 fiscal stimulus, higher defence spending, and energy transition in Europe are important arguments in the discussion on strengthening or modifying the national fiscal rules. Further studies in this area can look into various sources of episodes fiscal unsustainability and their impact on changes in fiscal rules, as well as competing domestic and international political factors that influence their implementation and enforcement.

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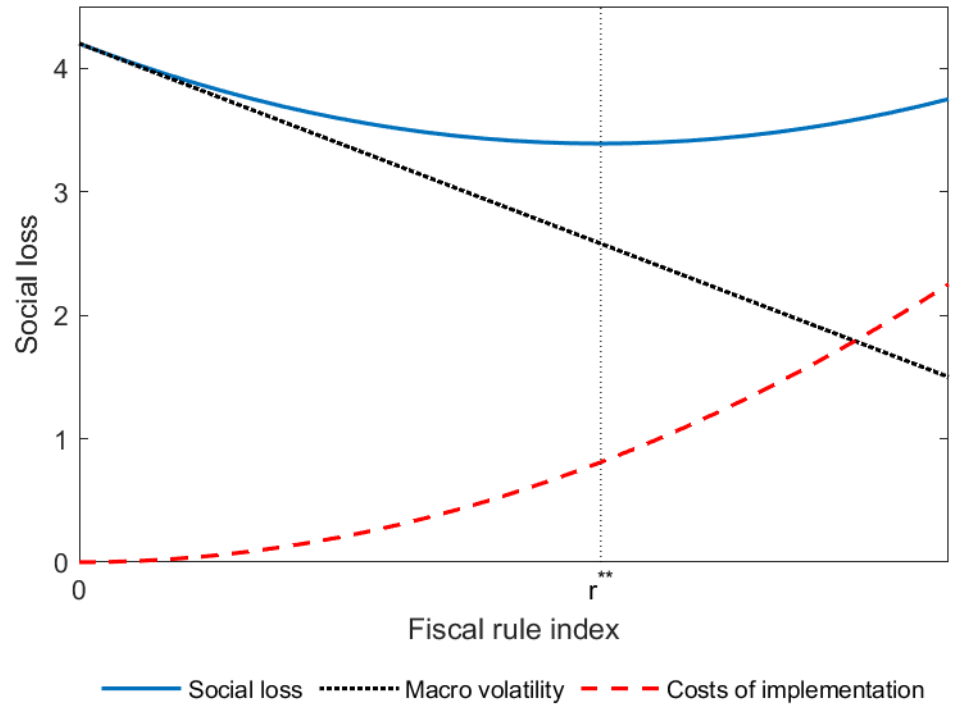

Figure 1. Social loss, macro volatility, and cost of fiscal rules implementation

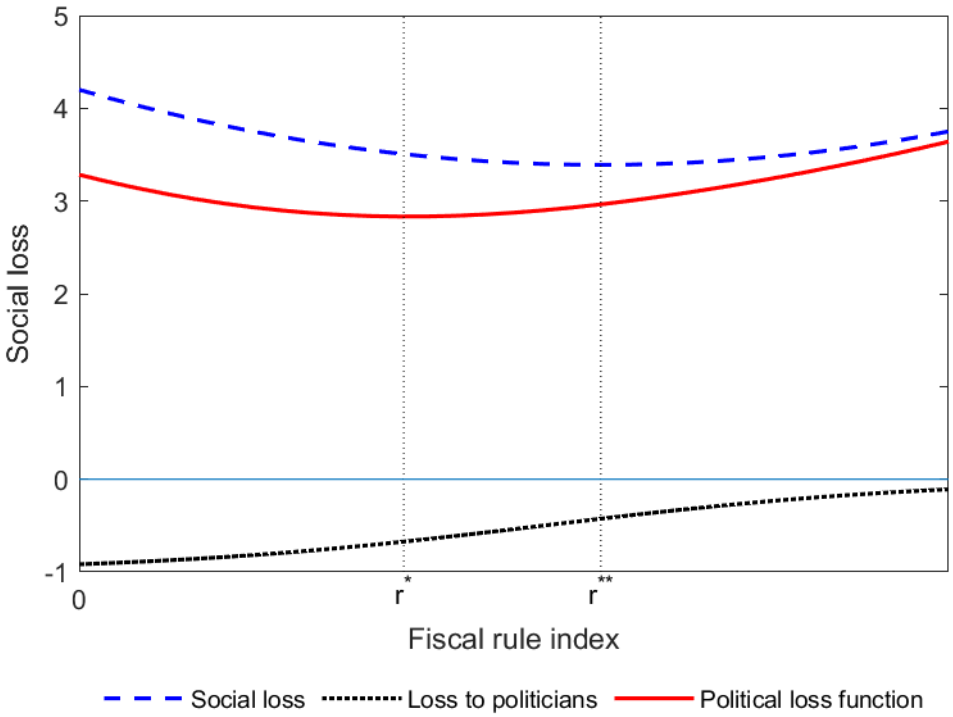

Figure 2. Social loss vs. political loss

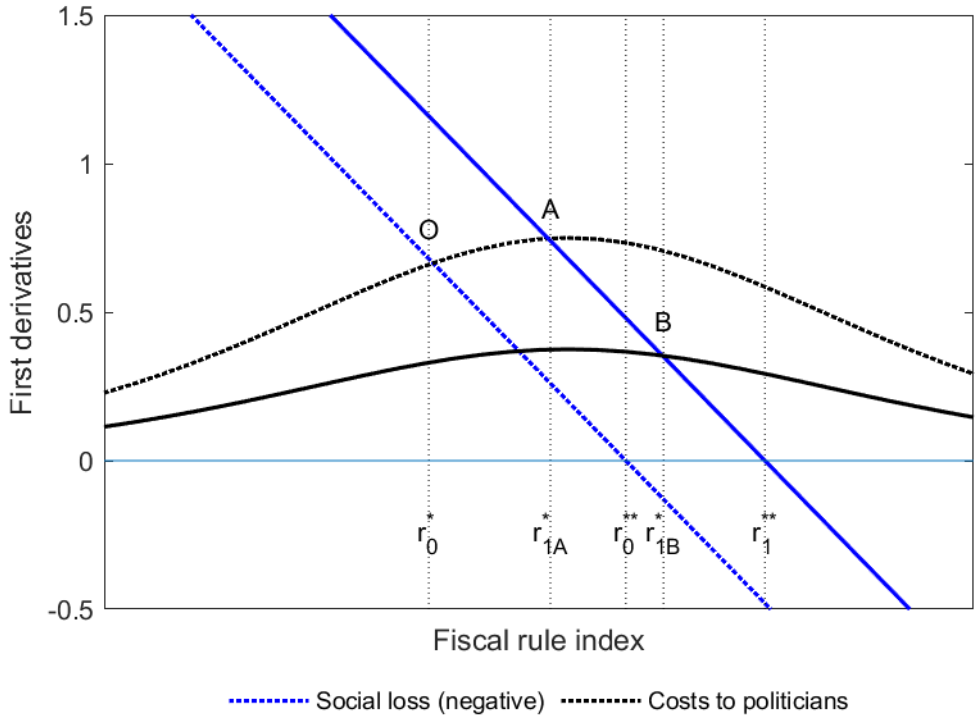

Figure 3. Fiscal rules stringency and bubbles

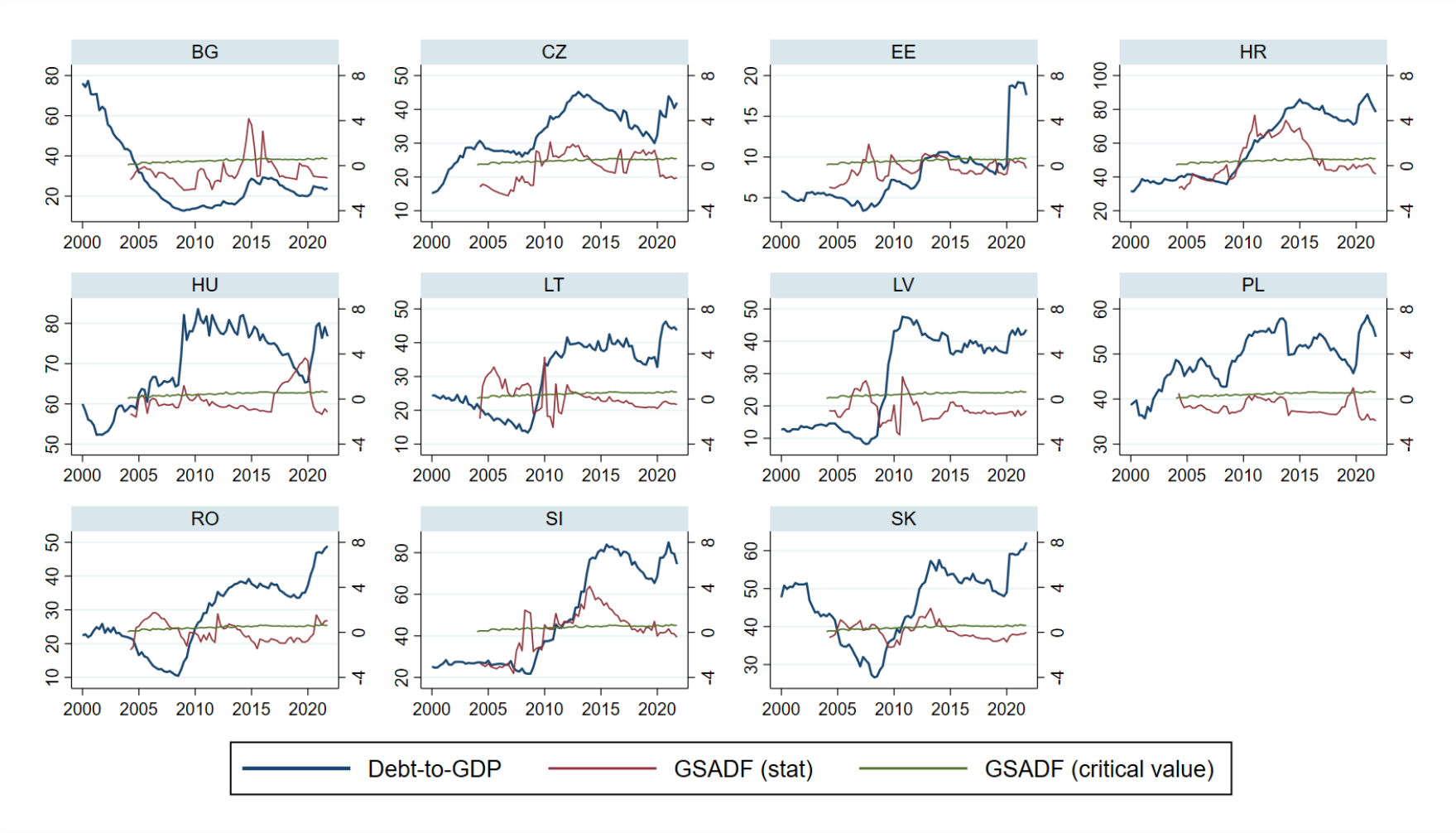

Figure 4. Identification of fiscal bubble in CEE countries: debt-to-GDP ratios and GSADF statistics

Notes: The figure displays the debt-to-GDP ratios in CEE countries, the values of sequential GSADF statistics, and the simulated 95% critical values used in the fiscal bubble identification procedure.

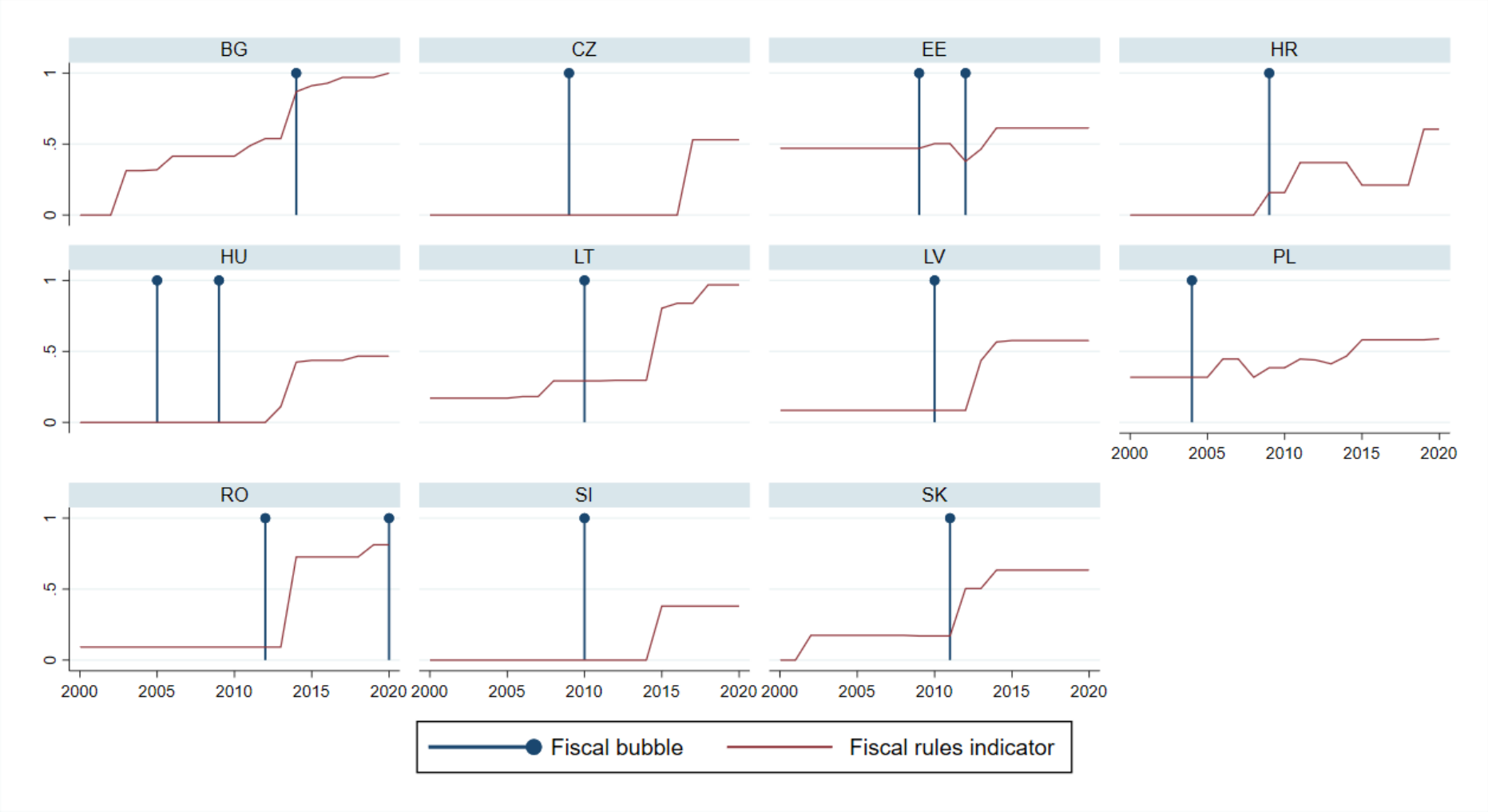

Figure 5. Identified fiscal bubble episodes and fiscal rule stringency indicator

Notes: The figure plots the beginnings of fiscal bubble episodes (vertical lines) and values of the standardized fiscal rule indicator in the panel of CEE economies between 2000 and 2020.

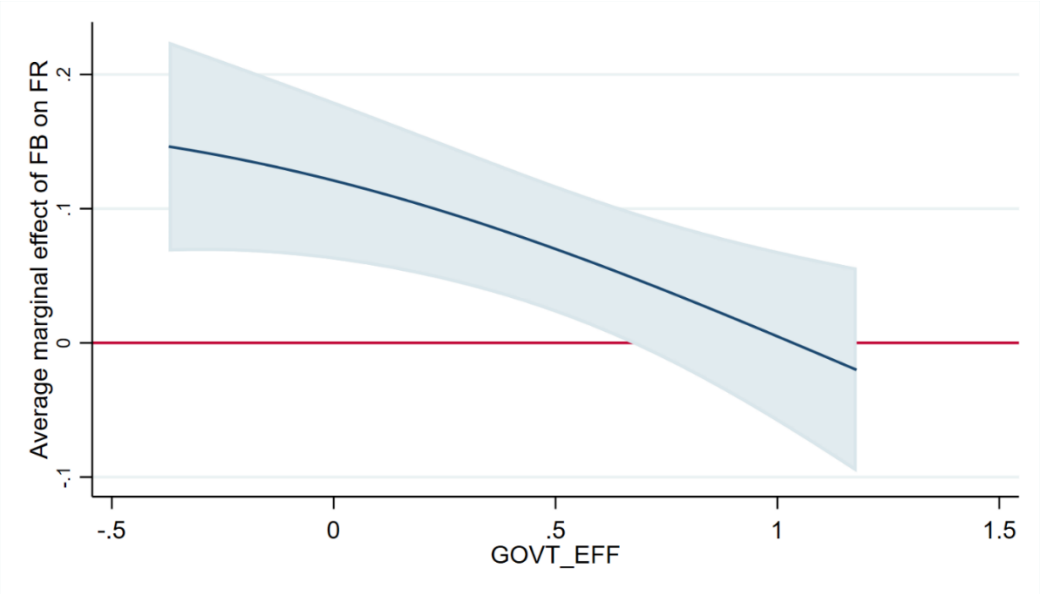

Figure 6. Average marginal effects of fiscal bubbles on the stringency of fiscal rules under different values of the government effectiveness index

Notes: The figure depicts the average marginal effects of the fiscal bubble episodes (FB) on the fiscal rule index (FR) for different values of the government effectiveness indicator ($GOVT\_EFF$); the effects are based on the panel-data regression showed in Table 6, column 5; bands represent 90-percent confidence intervals around the baseline estimates.

Table 1. Fiscal bubble episodes identified in CEE countries

Country	Number of episodes	Dates of episodes
Bulgaria	1	2014Q3-2016Q2
Croatia	1	2009Q4-2016Q1
Czechia	1	2009Q2-2014Q1
Estonia	2	2009Q4-2010Q1, 2012Q3-2014Q4
Hungary	2	2005Q2, 2009Q1-2010Q2
Latvia	1	2010Q4-2011Q2
Lithuania	1	2010Q1-2013Q1
Poland	1	2004Q2
Romania	2	2012Q1-2013Q3, 2020Q4-2021Q4
Slovakia	1	2011Q1-2014Q2
Slovenia	1	2010Q1-2017Q3

Notes: The table shows the episodes of fiscal bubbles identified with the GSADF procedure at the 95% confidence level. Episodes correspond only to periods of an increase in the public debt-to-GDP series relative to the period $t-4$. See the main text for detailed explanations.

Table 2. Variable names, descriptions, and data sources

Mnemonic	Description	Raw data source
FR	Fiscal Rule Index based on a set of legal implementation, monitoring, and correction criteria; normalized to the range of 0 to 1	European Commission
FB	Fiscal bubble indicator; takes the value of 1 on the year in which the fiscal bubble episode begins, and 0 otherwise	Own estimation
D_DEBT	Annual change in the general government consolidated gross debt to GDP [percent]	Eurostat
$CAPB$	Cyclically adjusted net lending or net borrowing of the general government to GDP [percent]	Ameco
D_INT_DEBT	Annual change in the interest payable on the general government debt relative to GDP [percent]	Eurostat
$OUTPUT\_GAP$	The gap between actual GDP and trend GDP, relative to trend GDP [pp]	Ameco
$GOVT\_EFF$	The Worldwide Governance Indicators: government effectiveness [index]	World Bank
EMU	Indicator variable; takes the value of 1 when a country is an EMU member, and 0 otherwise	Own elaboration

Table 3. Descriptive statistics of variables used in panel-data models

Variable	N	Mean	Median	Min	Max	SD	IQR	Skewness	Kurtosis
FR	231	0.307	0.296	0	1	0.275	0.503	0.566	2.396
FB	231	0.061	0.000	0	1	0.239	0	3.683	14.565
D_DEBT	231	0.977	-0.100	-13.5	18.5	4.689	4.6	1.005	4.759
CAPB	230	-1.14	-0.900	-8.6	6.1	2.47	3.3	-0.244	3.314
D_INT_DEBT	230	-0.073	-0.100	-2	1.2	0.322	0.3	-1.137	10.972
OUTPUT_GAP	230	-0.037	-0.100	-11.2	11.4	3.628	4.3	-0.089	4.168
GOVT_EFF	231	0.611	0.678	-.372	1.335	0.395	0.467	-0.75	2.755
EMU	231	0.212	0.000	0	1	0.41	0	1.408	2.984

Table 4. Panel unit-root tests for variables included in panel-data models

Variable	Levin-Lin-Chu		Breitung		Im-Pesaran-Shin	
	const	const + trend	const	const + trend	const	const + trend
FR	0.114	-2.645***	1.690	-1.571*	3.491	-2.115**
FB	-6.092***	-4.674***	-9.679***	-9.001***	-7.063***	-7.149***
D_DEBT	-2.626***	-2.538***	-4.702***	-3.148***	-2.958***	-3.542***
CAPB	-2.431***	-2.787***	-3.190***	-1.871**	-1.477*	-2.836***
D_INT_DEBT	-7.831***	-3.541***	-5.822***	-4.274***	-4.406***	-4.832***
OUTPUT_GAP	-4.333***	-3.010***	-3.635***	-1.548*	-1.240	-1.331*
GOVT_EFF	-3.194***	-2.200**	0.435	-2.105**	-1.870***	-3.457***

Notes: The table reports the following statistics LLC adjusted t, Breitung lambda statistic, Im-Pesaran-Shin Z statistics; the null hypothesis: panels contain unit roots; the tests are run with both a constant and a constant and a deterministic trend; variables missing a single observation (see Table 3) are tested in a balanced panel spanning from 2000 to 2021; ***, **, and * denote statistical significance at 0.01, 0.05, and 0.1 levels, respectively.

Table 5. Panel model results: direct effects of fiscal bubble occurrence

Dep. var: *FR*	(1) 2-way FE	(2) 2-way FE	(3) 2-way FE	(4) 2-way FE + trends	(5) 2-way FE + trends	(6) 2-way FE + trends	(7) GEE pop averaged	(8) GEE pop averaged	(9) GEE pop averaged
FB	0.220†	0.274**	0.270**	0.200*	0.235*	0.220*	0.180†	0.201†	0.221*
	(0.136)	(0.134)	(0.126)	(0.119)	(0.132)	(0.125)	(0.117)	(0.130)	(0.115)
D_DEBT		0.0168	0.0166		-0.0001	0.0019		0.0107	0.0105
		(0.0170)	(0.0169)		(0.0139)	(0.0161)		(0.0173)	(0.0159)
CAPB		0.0435	0.0438		0.00253	0.00934		0.00763	0.00746
		(0.0342)	(0.0348)		(0.0245)	(0.0283)		(0.0175)	(0.0153)
D_INT_DEBT		-0.0280	-0.0353		-0.0318	-0.0705		-0.0809	-0.0553
		(0.0994)	(0.101)		(0.126)	(0.146)		(0.114)	(0.107)
OUTPUT_GAP		0.0374	0.0377		0.0120	0.0182		0.0272*	0.0293**
		(0.0266)	(0.0271)		(0.0235)	(0.0262)		(0.0165)	(0.0147)
GOVT_EFF		0.122			0.567*			-0.316	
		(0.393)			(0.343)			(0.381)	
EMU		-0.233	-0.219		0.278	0.255		-0.0135	-0.0183
		(0.364)	(0.354)		(0.262)	(0.273)		(0.266)	(0.212)

Notes: The table shows the results of fractional panel probit estimation; dependent variable is the standardized fiscal rule index; see Eq. (12); two-way fixed effects (1-3), two-way fixed effects and country-specific trends (4-6), generalized estimating equation with population averaged effects (7-9); robust standard errors clustered at the country level in parentheses; **, *, and † denote statistical significance at the 0.05, 0.1, and 0.15 levels, respectively.

Table 6. Interaction effect between fiscal bubble indicators and other potential determinants of fiscal rules stringency

Dep. var: *FR*	(1) *D_DEBT*	(2) *CAPB*	(3) *D_INT_DEBT*	(4) *OUTPUT_GAP*	(5) *GOVT_EFF*	(6) *EMU*
FB	0.255*	0.173	0.228**	0.427**	0.541**	0.304†
	(0.144)	(0.139)	(0.105)	(0.174)	(0.177)	(0.189)
mod	0.000125	0.00377	-0.0337	0.00260	0.604*	0.315
	(0.0132)	(0.0261)	(0.134)	(0.0226)	(0.341)	(0.271)
FB x mod	-0.00429	-0.0463	0.0382	0.0498†	-0.522**	-0.192
	(0.0311)	(0.0543)	(0.314)	(0.0326)	(0.225)	(0.252)

Notes: The table shows the results of fractional probit panel models augmented with interaction effects between the fiscal bubble variable (*FB*) and each of the additional predictors (*mod*); an interacted predictor is indicated in a column title; the whole set of variables (see Table 2, column 5) is included in each specification; only the main and interaction effects are reported for each specification of interest; **, *, and † denote statistical significance at the 0.05, 0.1, and 0.15 levels, respectively.

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