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National Fiscal Rules Adoption and Fiscal Discipline in the European Union

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Abstract: Motivated by the fiscal imbalances in the EU countries in the recent period, this paper analyzes the effect of national fiscal rules adoption on fiscal discipline. Using a careful definition of national fiscal rules combined with a novel measure of fiscal discipline (the Global Financial Performance Index—GFPI), propensity score matching estimations that account for potential endogeneity reveal that fiscal rules significantly improve the GFPI. However, this favorable effect dramatically depends upon the type of fiscal rule and different structural factors. These two features, together with alternative measures of fiscal discipline, are found to be key ingredients that should be taken into account when assessing the effects of fiscal rules on fiscal discipline.

Keywords: Fiscal Discipline; National Fiscal Rules; Propensity Score Matching.

JEL Codes: H11, H61, H62.

1. Introduction

The coordination of fiscal behaviors in the European Monetary Union (EMU) is performed under the supranational fiscal rules of the Stability and Growth Pact (SGP, 1997), already reformed three times, and the various national fiscal rules. Nowadays, the study of the relationship between fiscal rules and fiscal discipline became prominent, to the point where the number of existing studies was sufficiently high to fuel the recent meta-analysis of Heinemann et al. [2018]. One of the most interesting conclusion of their analysis is that, while overall fiscal rules provide more fiscal discipline by reducing deficits, the opposite may arise for Euro area countries: fiscal rules seem to be associated with *increased* deficits. Although this striking finding may be consistent with the fiscal imbalances experienced by some European Union (EU) countries during the recent sovereign debt crisis, it calls for a careful reassessment. Consequently, the aim of this paper is to analyze if fiscal rules can indeed shape fiscal behaviors in the EU, towards achieving higher fiscal discipline.

Compared with the existing literature on fiscal rules and fiscal discipline, our study is designed as follows. First, similar to Debrun et al. [2008], we focus exclusively on EU countries, and, in particular, we do not mix them with developing countries as in Combes et al. [2018]. Second, we take at heart to incorporate the suggestions of Heinemann et al. [2018], and particularly the fact that the favorable impact of fiscal rules on fiscal discipline is weakened if possible endogeneity is not controlled for. While recent studies on the EU countries draw upon regression-based methods, including IV (Foremny [2014]), LSDV (Reuter [2015]) or system-GMM (Bergman et al. [2016]), we follow the work of Tapsoba [2012] performed on developing countries, and draw upon quasi-experimental methods, namely, propensity score matching. As such, we account for the issue of self-selection, i.e. the fact that governments may adopt fiscal rules because of a bad structural budget balance. Third, as illustrated by Heinemann et al. [2018], fiscal rules affect fiscal discipline in various ways depending on the measure of the former (e.g. deficit, debt, expenditure, or revenue) and of the latter. Consequently, in addition to the popular measure of fiscal discipline used in the existing literature, namely the cyclically-adjusted primary balance (CAPB)—see Tapsoba [2012], we draw upon an original measure of fiscal discipline, namely a Global Fiscal Performance Index (GFPI). We compute this index in a two-stage approach, with the aim of going beyond single-variable measures (such as the CAPB), in order to capture the various facets of the wide concept of fiscal discipline. Fourth, we pay attention to the selection of fiscal rules. Following Debrun et al. [2008] and Reuter [2015], we drop from our sample the rules that are mostly related to the Medium Term Budgetary Framework (MTBF). This is because, as indicated on the European Commission (EC) website devoted to them, the MTBFs display some notable differences with respect to the traditional definition of fiscal rules by Kopits and Symansky [1998] (namely, "*a sustainable constraint on fiscal policy under the form of a numerical target on a key aggregate of public finances*"); such difference are related to, for example, the considered horizon—usually "*beyond the annual budgetary calendar*", and the form of commitment—usually "*a weaker form of commitment than a pure rule incorporating binding targets*" (see the EC website). By doing so, we improve the homogeneity of our measure of fiscal rules. Finally, Heinemann et al. [2018] suggest that the effect of fiscal rules on fiscal discipline may differ with respect to the characteristics of the study. We explore three sources that may affect the impact of fiscal rules on fiscal discipline, namely: (i) the method used; (ii) the type of fiscal rule; and (iii) the structural characteristics of countries.

Our results are as follows. First, EU countries that adopted fiscal rules significantly improve their fiscal discipline—measured by the CAPB, computed using three alternative measures of the

output gap—with respect to comparable EU countries that did not adopt fiscal rules. Contributing to the debate on the effect of fiscal rules on the CAPB (for example, Debrun and Kumar [2007] reveal the lack of a significant response of the CAPB when fiscal rules are instrumented consistent with the conclusions of Escolano et al. [2012] on the group of EU15 countries, while the response of CAPB is significant and positive in Debrun et al. [2008] and Marneffe et al. [2010]),[1] our study reveals that fiscal rules adoption has a favorable effect on the CAPB in our treatment effect analysis. Capitalizing on this finding, we show that the adoption of fiscal rules enforces fiscal discipline captured by our novel measure, namely the GFPI. These findings, supported by various tests for the quality of the matching, are robust across different matching methods, when using an alternative estimator (namely, the doubly robust inverse-probability-weighted regression adjustment, IPWRA), and when further increasing the vector of control variables or altering the sample.

Second, we reveal important differences in the effect of the various types of fiscal rules, namely, Balance Budget Rules (BBR), Expenditure Rules (ER), and Debt Rules (DR), on fiscal discipline. Specifically, while BBR (ER) significantly improve (leave statistically unchanged) the CAPB consistent with the existing literature, contrary to previous studies our estimations do not support a significant impact of DR on the CAPB. Moreover, while BBR and DR conserve their respective effect on fiscal discipline measured by the CAPB, we show that ER significantly improve the GFPI with a magnitude larger that that of fiscal rules altogether. Subsequent estimations performed using the variables that compose the GFPI confirm that the effect of the various types of fiscal rules can indeed differ, both in significance and magnitude, with the measures of fiscal discipline. In particular, while both BBR and DR significantly reduce the public deficit and the growth of public debt, only BBR (ER) adoption significantly decrease the growth of interest rate (the external deficit).

Third, we unveil that the effect of fiscal rules on fiscal discipline is subject to important heterogeneities, related to macroeconomic factors, political factors, and factors associated with the fiscal rules themselves. Three types of results emerge when comparing the influence of these factors on the effect of fiscal rules on the CAPB and the GFPI: some variables, such as the real GDP per capita or the public debt ratio, reduce the favorable effect of fiscal rules on both measures of fiscal discipline; other variables, such as the mode of election or the number of fiscal rules in place, do not exert a significant impact on the effect of fiscal rules on fiscal discipline irrespective of its measure; finally, some variables significantly affect only the CAPB—for example, electoral cycles (monitoring of fiscal rules) weaken (foster) the favorable effect of fiscal rules—, or only the GFPI—for example, the presence of the SGP fosters the favorable effect of fiscal rules.

We see two first-order policy implications of our work. First, it is of particular importance to use different measures of fiscal discipline when assessing its response following the adoption of various types of fiscal rules, since the effects of fiscal rules may dramatically differ both in significance and magnitude. Second, when following a fiscal discipline goal, it would be of interest to imagine fiscal rules that may account for variations in structural factors (i.e. countries' and rules' characteristics), since such factors can boost, or, on the contrary, mitigate the favorable effects of fiscal rules.

The rest of the paper is structured as follows. Section 2 describes the data by insisting on our novel measure of fiscal discipline, Section 3 presents the methodology, Section 4 reports the bench-

[1] Such a debate is equally at work when differentiating countries depending on their level of economic development: the response of the CAPB is not significant in the sample of 49 advanced and emerging market economies for Cevik and Teksoz [2014], but significant and positive for Tapsoba [2012] who considers 74 developing countries.

mark results, Section 5 assesses their robustness, Section 6 investigates the presence of heterogeneity in the effect of fiscal rules on fiscal discipline, and Section 7 concludes the paper.

2. Data

This section is devoted to the presentation of our main variables, namely fiscal discipline (the dependent variable) and fiscal rules (the main independent variable).

2.1. The measure of fiscal discipline

As discussed by Minea and Tapsoba [2014], fiscal discipline is a complex term that can be approached in several ways. Most of the studies devoted to fiscal discipline usually approach it using a single variable providing information about a fiscal aggregate. The literature on fiscal discipline and fiscal rules makes no exception: in their meta-analysis, Heinemann et al. [2018] consider studies that measure fiscal discipline by fiscal deficit, debt, expenditure, or revenue. Since our goal is not to be exhaustive about the different single-variable measures of fiscal discipline, we first focus on the popular Cyclically Adjusted Primary Balance (CAPB). However, subsequently, we go beyond the CAPB, and build an original measure of fiscal discipline designed to better seize its complexity.

2.1.1. The CAPB as the traditional measure of fiscal discipline

The CAPB was used to measure fiscal discipline in the analysis of Tapsoba [2012] devoted to developing countries. Since it is not directly observable, we estimate it using the residual approach of Fatás and Mihov [2003] and Fatás and Mihov [2006]

$$PBB_{i,t} = \alpha + \beta PBB_{i,t-1} + \gamma GAP_{i,t} + \varphi W_{i,t} + \eta_t + \epsilon_{i,t}, \tag{1}$$

with $PBB_{i,t}$ the primary budget balance. To properly isolate the CAPB through the error term $\epsilon_{i,t}$, i.e. the residual of the PBB after extracting the cyclical elements, we perform several corrections: (i) to avoid an endogeneity problem we instrument the output gap ($GAP_{i,t}$)—computed using the popular Hodrick-Prescott (HP) filter with a smoothing parameter set at 100 given the use of yearly data—by its own lagged value using the system-GMM estimator adapted for self-correlated series to deal with the dynamic panel issues raised by Nickell [1981] and Kiviet [1995]; (ii) we follow Turner [2006], and control in $W_{i,t}$ by inflation and the terms of trade; and (iii) according to Villafuerte and Lopez-Murphy [2010], we account for the price of raw materials through the time fixed effects η_t.

2.1.2. A novel measure of fiscal discipline: the Global Fiscal Performance Index (GFPI)

It is straightforward to observe that the CAPB captures only one dimension of the effectiveness of the fiscal policy: discretionary policy is one proxy among others for fiscal discipline. For example, in the Macroeconomic Imbalance Procedure (MIP) Scoreboard, the European Commission is monitoring a broad set of macroeconomic aggregates to capture the risks of macroeconomic imbalances, including the CAPB, the public deficit, the debt, the external balance, or the level of taxes collected. Consequently, to seize the multiple facets of the fiscal discipline we build an aggregated measure, namely the Global Fiscal Performance Index (GFPI).

Our approach to build the GFPI is inspired by the work of CEFT [2016], and consists of two stages. In Stage 1, using five primary indicators of public finance, namely, public deficit, fiscal revenues (considered with a negative sign for consistency with the other indicators), the external

deficit, the growth rate of public debt, and the growth rate of interests (on public debt), we obtain four secondary indices by standardization,[2] that reflect respectively the risk of high deficit, the risk of insufficient collected revenues, the risk of external imbalance, and the risk of unsustainability. In particular, the latter index contains information from the latter two primary indicators (the growth rate of public debt and the growth rate of interests on public debt), and is computed using the Mazziotta-Pareto approach.[3]

In Stage 2, we aggregate the four secondary indexes using the "*Mean-Min Function*" into the MMF index, defined as $MMF_i = M_{z_i} - \alpha\left(\sqrt{(M_{z_i} - \min_j\{z_{ij}\})^2 + \beta^2} - \beta\right)$, with z_{ij} the matrix of our normalized indexes, M_{z_i} the average of the standardized values, $0 \leq \alpha \leq 1$ the intensity of penalty for imbalances, and $\beta \geq 0$ the intensity of the complementarity between the indicators.[4] This index is independent of the choice of the indicator normalization procedure, and since $\alpha \neq 0$ ($\alpha = 0$ corresponds to the arithmetic mean) it avoids compensation in order to capture the effect of each indicator. After taking the opposite sign of this index and normalizing the values, we obtain our GFPI index; comprised between -2 and 4, a higher value of this yearly-frequency index signals better fiscal performance.

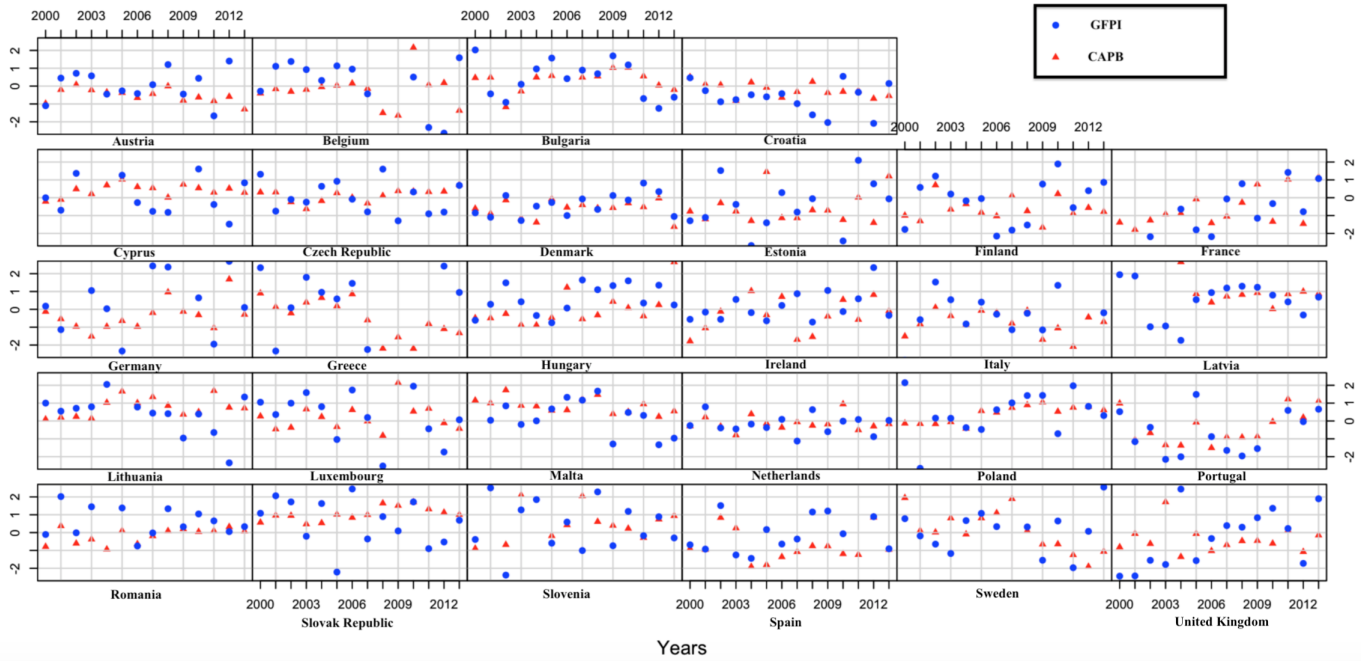

Figure 1: **CAPB and GFPI in the EU countries in our sample**

[2] According to the Competence Centre on Composite Indicators and Scoreboards (COIN) of the European Commission, "*the normalized indicator value for a country is calculated as the ratio of the difference between the raw indicator value and the average divided by the standard deviation.*"

[3] The computation is as follows: assume $X = \{x_{ij}\}$ is a matrix with n units (rows) and m indicators (columns), M_{x_j} is the mean for the indicator j, and St_{x_j} its standard deviation; then, the normalized matrix $Z = \{z_{ij}\}$ is calculated as $z_{ij} = 100 \pm \frac{x_{ij} - M_{x_j}}{St_{x_j}} 10$, where $\pm$ give the polarity of the indicator j. With M_{z_i} and St_{z_i} the mean and the standard deviation of the standardized values for the unit i, respectively, the Mazziotta-Pareto Index (MPI) can be written as $MPI_i^{\pm} = M_{z_i} \pm St_{z_i} cv_i$, with $cv_i = St_{z_i}/M_{z_i}$ the coefficient of variation for unit i. In our analysis, the higher the index, the higher the risk of unsustainability.

[4] We checked beforehand if these variables are not too strongly correlated, to avoid the risk of counting some effects several times when aggregating them (Appendix 3 reports the correlation matrix).

Figure 1 plots the GFPI index and the traditional measure of fiscal discipline (the CAPB) for the EU countries in our sample. A simple visual inspection reveals the differences between the two measures of fiscal discipline; in particular, by embedding information for several variables, the GFPI seems more volatile than the CAPB for most countries, especially during the beginning of the 2000s.

2.2. Fiscal rules

During the last decades the number of fiscal rules increased in the European Union. Compared to only two countries in 1991 (Germany adopted a balanced budget rule in 1969 and a public expenditure rule in 1982, and Luxembourg adopted a debt and a public expenditure rule in 1990), in 2015 all EU countries had at least one national fiscal rule to guarantee public finance sustainability. However, to mitigate the influence of the numerous fiscal rules adopted in response to the recent sovereign debt crisis, we restrain our analysis until 2013. Nevertheless, we are still capturing flexible fiscal rules (see Guerguil et al. [2017]), including e.g. rules that favor investment, rules that include escape clauses, and rules with cyclically-adjusted goals; therefore, we checked that the selected rules are compatible with the supranational framework and also with the flexibility necessary for cyclical adjustment. Consequently, after equally excluding the MTBFs, out of the twenty-eight countries in our sample, twenty countries had at least one national numerical fiscal rule and eight countries did not adopt national fiscal rules by 2013 (see Appendix 1 for the excluded fiscal rules).

Countries	FR (All Fiscal Rules)	BBR (Budget Balance Rules)	DR (Debt Rules)	ER (Expenditure Rules)
Bulgaria	2003-2013	2006-2013	2003-2013	2006-2009 – 2012-2013
Croatia	2009-2013	2012-2013	2009-2013	2012-2013
Denmark	2000-2013	2000-2013	-	2000-2013
Estonia	2000-2013	2000-2013	-	-
Finland	2000-2013	2000-2013	2000-2006 – 2010-2013	2003-2013
France	2000-2013	-	-	2000-2013
Germany	2000-2013	2000-2013	-	2000-2009 – 2012-2013
Greece	2010-2013	-	-	2010-2013
Hungary	2004-2011	2004-2011	-	2010-2011
Latvia	2013	2013	2013	-
Lithuania	2000-2013	-	2000-2013	2008-2013
Luxembourg	2000-2013	-	2000-2013	2000-2013
Netherlands	2000-2013	-	-	2000-2013
Poland	2000-2013	-	2000-2013	2011-2013
Romania	2010-2013	2013	2013	2010-2012
Slovak Republic	2012-2013	-	2012-2013	-
Slovenia	2000-2004	-	2000-2004	-
Spain	2006-2013	2006-2013	-	2011-2013
Sweden	2000-2013	2000-2013	-	2000-2013
United Kingdom	2000-2008 – 2010-2013	2000-2008 – 2010-2013	2001-2008 – 2011 -2013	-

Table 1: **National numerical fiscal rules in the EU countries in our sample**

We measure fiscal rules (FR) through a binary variable that equals one if in a given country for a given year a numerical constraint exists on the national public finance aggregates, namely a budget balance rule (BBR), a debt rule (DR), or a revenue rule (RR). Table 1 summarizes the countries that adopted a rule corresponding to the definition we retained for a national numerical rule during 2000-2013.

3. Methodology

3.1. The propensity scores matching method

As discussed in the introduction, to estimate the causal effect of fiscal rules on fiscal discipline, we follow Tapsoba [2012] and draw upon the propensity scores matching method. The goal is to compute the Average Treatment effect on the Treated (ATT), which is defined as the variation in fiscal discipline (Y) in a country that adopted a FR had it have not adopted a FR, namely

$$ATT = E[(Y_1 - Y_0)|FR = 1] = E[Y_1|FR = 1] - E[Y_0|FR = 1]. \tag{2}$$

Naturally, the problem is that the latter variable $E[Y_0|FR = 1]$ is not observable, and simply comparing the fiscal discipline of the countries that adopted FR with that of countries that did not adopt FR may raise a self-selection issue leading to biased estimates, given that the treatment (i.e. FR adoption) is likely not random. Instead, we compare the fiscal discipline of countries that adopted FR with that of countries that did not adopt FR, but present a close set of observable characteristics X, namely

$$E[Y_1|FR = 1, X] - E[Y_0|FR = 0, X]. \tag{3}$$

However, as the number of variables in the vector X can be large, Rosenbaum and Rubin [1983] propose to match the treated and untreated units based on their propensity scores, defined by the probability of adoption of the treatment—in our case, the adoption of a fiscal rule—conditional on the vector of observable characteristics X. Assuming that the common support hypothesis ($p(X_i) < 1$, i.e. there exist some comparable control units for each treated unit) is verified—which is the case in our study, as shown by Appendix 2.1—the final expression of the ATT becomes

$$ATT = E[Y_1|FR = 1, p(X)] - E[Y_0|FR = 0, p(X)]. \tag{4}$$

3.2. Computational issues

The computation of the ATT requires knowledge about propensity scores and the matching method. Regarding the former, we computed the probability of FR adoption using a vector of characteristics X inspired by existing studies on the determinants of FR. First, we include the lagged value of CAPB, since according to Calderón and Schmidt-Hebbel [2008] and Tapsoba [2012] we expect countries with sound public finance to adopt fiscal rules. Second, in the same vein, the lagged value of the logarithm of the debt ratio to real GDP should negatively impact the likelihood of fiscal rules. Third, countries with high real GDP per capita growth rates may benefit of such good conditions to adopt fiscal rules. Fourth, countries with high inflation rates would be less expected to adopt fiscal rules that they may not respect. Fifth, following Guerguil et al. [2017], we include government stability; its effect on fiscal rules is ambiguous, since stable governments could adopt

fiscal rules to support their policies, but in the same time they may not need such rules given their stability. Sixth, we include a dummy variable to capture the impact of the Stability and Growth Pact (SGP) on the countries in our sample. Seventh, we control for the EU membership through a dummy variable in order to capture the effect of EU accession on the adoption of national fiscal rules. Eighth, we expect a positive relationship between the unemployment rate and fiscal rules adoption, as a sign of countries' efforts to cope with unemployed population in the EU. Ninth, the appreciation of the real effective exchange rate (REER) may signal good macroeconomic conditions that could support the adoption of fiscal rules. Finally, a higher trade openness may signal countries that are more open, and hence more reluctant to adopt fiscal rules that they may not respect.

Regarding the latter, we consider several matching methods for robustness issues. Following Caliendo and Kopeinig [2005, 2008], we draw upon five methods, namely the nearest neighbor matching (with N=1 and N=3 neighbors), the radius matching (with a small, a medium, and a large radius, namely: r=0,01, r=0.025 and r=0.05), the kernel matching, the local linear matching, and the stratification matching. Whenever feasible, we perform the matching with replacement, i.e. each non-treated observation can be used as a match for several treated observations.

4. Benchmark results

4.1. Fiscal discipline measured by the CAPB

We first present estimations using the traditional measure of fiscal discipline from the related literature, namely the cyclically-adjusted primary balance (CAPB). As illustrated by column (1) of Table 2, the probability of adoption of fiscal rules depends significantly on the past primary structural balances; this finding supports our use of matching to control for reverse causality. In addition, a higher (lagged) debt ratio, inflation rate, and trade openness are associated with a decrease in the likelihood of fiscal rules adoption, while the opposite holds for government stability, the unemployment rate, and the real effective exchange rate (REER).

Based on propensity scores estimated using column (1), Table 3, displays the results of the matching. All ATT coefficients reported on line (1) are positive and statistically significant, suggesting that, on average, countries that adopted fiscal rules experience a significant increase of the CAPB with respect to comparable countries that did not adopt fiscal rules. The magnitude of this effect is sizeable, as the improvement of the CAPB (expressed in ratio of GDP) is estimated around 0.5-0.6 percentage points (hereafter pp) depending on the considered method of matching.

Moreover, given the debates on the performances of the Hodrick-Prescott filter for the computation of the output gap, we draw upon a trigonometric filter to compute an alternative output gap, and an alternative CAPB measure. Based on propensity scores estimated in column (2) of Table 2, we report on line (2) of Table 3 the ATTs. Despite some significance loss for N=1 nearest neighbor matching, ATTs are positive, significant, and of comparable magnitude with our previous results.

Finally, some authors, e.g Andersen [2013], point out that the residual method may lead to biased estimates of the CAPB, due to the presence of errors and noise in the fiscal variables. Consequently, we perform the matching using propensity scores computed based on the CAPB series calculated by the IMF using the production-function approach (see Girouard and André [2005] and Fedelino et al. [2009]). Based on column (3) of Table 2, ATTs reported on line (3) of Table 3 are yet again consistent with our previous findings.

Overall, our results contribute to the debate regarding the effect of fiscal rules adoption on fiscal discipline measured by the CAPB, by revealing, based on a treatment effect analysis that

Dependent variable: FR CAPB computed with the:	[1] HP Filter	[2] Trigonometric Filter	[3] IMF Production Function
Intercept	-1.005	-0.952	-3.365**
	(1.055)	(1.171)	(1.318)
$CAPB_{t-1}$	0.113***	0.107***	0.127***
	(0.042)	(0.042)	(0.029)
Debt $ratio_{t-1}$	-0.018***	-0.018***	-0.019***
	(0.003)	(0.003)	(0.003)
Real GDP growth	-0.042	-0.031	-0.041*
	(0.019)	(0.019)	(0.023)
Inflation rate	-0.103***	-0.102***	-0.045*
	(0.026)	(0.026)	(0.023)
Government stability	0.065*	0.067*	0.243*
	(0.200)	(0.200)	(0.222)
SGP	-0.080	-0.083	-0.161
	(0.159)	(0.162)	(0.171)
Dummy EU membership	0.077	0.070	0.015
	(0.386)	(0.386)	(0.455)
Unemployment rate	0.030*	0.029*	0.075***
	(0.019)	(0.019)	(0.022)
REER	0.026***	0.026***	0.047***
	(0.009)	(0.009)	(0.011)
Trade openness	-0.008**	-0.008**	-0.010**
	(0.003)	(0.003)	(0.003)
Adjusted R^2	0.097	0.096	0.250
Observations	392	392	392

Note: Bootstrapped standard errors (with 500 replications) in brackets. *, **, *** indicate the significance level of 10%, 5%, and 1%, respectively.

Table 2: **Probit estimates of the Propensity Scores**

tackles potential endogeneity in the adoption of fiscal rules, a favorable effect in our sample of EU countries. In particular, the magnitude of this effect is somehow weaker for the EU countries with respect to the developing countries—see the results in the analysis of Tapsoba [2012] that employs the same methodology.

	Nearest-neighbor Matching		Stratification Matching	Radius Matching			local linear Matching	kernel Matching	IPWRA
	$N = 1$	$N = 3$		$r = 0.01$	$r = 0.025$	$r = 0.05$			
Dependant variable: $CAPB_{i,t}$ calculated using the Hodrick-Prescott (HP) filter									
[1] ATT	**0.575***	**0.549****	**0.549*****	**0.598****	**0.513****	**0.525****	**0.529****	**0.517****	**0.485*****
	(0.355)	(0.302)	(0.203)	(0.294)	(0.259)	(0.223)	(0.229)	(0.245)	(0.188)
Number of treated observations	202	202	202	198	202	202	202	202	202
Number of control observations	188	188	188	188	188	188	180	188	188
Standardized bias (p-value)	0.496	0.898	0.220	0.374	0.896	0.988	0.496	0.984	-
Dependant variable: $CAPB_{i,t}$ calculated using the trigonometric filter									
[2] ATT	**0.536***	**0.584****	**0.520****	**0.534****	**0.577****	**0.534****	**0.524****	**0.551*****	**0.442****
	(0.305)	(0.253)	(0.205)	(0.257)	(0.244)	(0.218)	(0.218)	(0.216)	(0.194)
Dependant variable: $CAPB_{i,t}$ calculated using the production function approach, source IMF									
[3] ATT	**1.341*****	**1.459*****	**0.640*****	**1.243*****	**1.424*****	**1.389*****	**1.481*****	**1.378*****	**0.898*****
	(0.478)	(0.501)	(0.205)	(0.383)	(0.363)	(0.317)	(0.379)	(0.365)	(0.246)

Note: Bootstrapped standard errors (with 500 replications) in brackets. *, **, *** indicate the significance level of 10%, 5%, and 1%, respectively. For stratification matching the number of strata is five and the level of significance is 0.01. IPWRA stands for the Inverse-Probability-Weighted Regression Adjustment.

Table 3: **Matching Results: ATT of FR on the CAPB**

4.2. A novel measure of fiscal discipline: the Global Fiscal Performance Index (GFPI)

We now look at the effect of fiscal rules adoption on our global fiscal performance index. Based on propensity scores estimated using model (1) in Table 2, line (1) of Table 4 reports the ATTs. Results are comparable with those based on the CAPB: countries having adopted fiscal rules present higher values of the GFPI with respect to comparable countries that did not adopt fiscal rules.

Aside from the comparable effects of fiscal rules adoption on the CAPB and the GFPI, it would be interesting to observe their effect on the components of the GFPI. As illustrated by lines (2)-(6) of Table 4, the effect of fiscal rules on the different GFPI components is fairly different. First, irrespective of the matching method, fiscal rules are found to significantly reduce both public and external deficits—see lines (2) and (6). Second, the favorable effect of fiscal rules on the debt growth rate is not significant for several matching methods, and for none but the stratification matching when considering the interest growth rate, as shown by lines (3) and (4). Finally, fiscal rules are not found to exert a significant effect on the growth of fiscal revenues (considered with a negative sign), irrespective of the matching method. These results show that the impact of fiscal rules on fiscal discipline varies depending on the way fiscal discipline is measured, and, therefore, justifies our strategy of capturing fiscal discipline in several ways. The next section analyzes the robustness of our findings.

	Nearest-neighbor Matching		Stratification Matching	Radius Matching			local linear Matching	kernel Matching	IPWRA
	$N = 1$	$N = 3$		$r = 0.01$	$r = 0.025$	$r = 0.05$			
Dependant variable: $GFPI_{i,t}$									
[1] ATT	**0.457*****	**0.526*****	**0.470*****	**0.482*****	**0.499*****	**0.487*****	**0.494*****	**0.487*****	**0.435*****
	(0.159)	(0.174)	(0.103)	(0.143)	(0.125)	(0.129)	(0.127)	(0.131)	(0.118)
Number of treated observations	202	202	202	198	202	202	202	202	202
Number of control observations	188	188	188	188	188	188	180	188	188
Standardized bias (p-value)	0.496	0.898	0.220	0.374	0.896	0.988	0.496	0.984	-
Dependant variable: $Public\ Deficit_{i,t}$									
[2] ATT	**-2.255*****	**-2.136*****	**-1.765*****	**-2.105*****	**-1.915*****	**-1.906*****	**-1.923*****	**-1.935*****	**-1.921*****
	(0.548)	(0.447)	(0.312)	(0.529)	(0.371)	(0.427)	(0.372)	(0.447)	(0.334)
Dependant variable: $Debt\ growth\ rate_{i,t}$									
[3] ATT	**-6.044**	**-4.446***	**-4.495*****	**-4.167***	**-2.795**	**-3.355**	**-3.825***	**-3.370***	**-4.279***
	(4.345)	(3.071)	(1.270)	(2.399)	(2.684)	(2.974)	(2.763)	(2.409)	(2.407)
Dependant variable: $Interest\ growth\ rate_{i,t}$									
[4] ATT	**-5.984**	**-2.816**	**-4.985*****	**-4.064**	**-2.891**	**-4.471**	**-5.219**	**-4.379**	**-5.001***
	(4.422)	(3.818)	(1.819)	(2.915)	(3.137)	(3.708)	(3.728)	(3.751)	(2.856)
Dependant variable: $Growth\ of\ fiscal\ revenues_{i,t}$									
[5] ATT	**0.338**	**0.140**	**-0.186**	**0.231**	**0.109**	**-0.206**	**-0.226**	**-0.195**	**-0.041**
	(0.610)	(0.471)	(0.324)	(0.436)	(0.429)	(0.482)	(0.397)	(0.499)	(0.420)
Dependant variable: $External\ Deficit_{i,t}$									
[6] ATT	**-21.662*****	**-21.277*****	**-11.953*****	**-21.019*****	**-20.376*****	**-20.210*****	**-19.299*****	**-20.253*****	**-17.223*****
	(6.491)	(4.829)	(4.142)	(5.103)	(3.911)	(4.420)	(3.863)	(4.708)	(3.657)

Note: Bootstrapped standard errors (with 500 replications) in brackets. *, **, *** indicate the significance level of 10%, 5%, and 1%, respectively. For stratification matching the number of strata is five and the level of significance is 0.01. IPWRA stands for the Inverse-Probability-Weighted Regression Adjustment.

Table 4: **Matching Results: ATT of FR on the GFPI, and its components**

5. Robustness

We investigate the robustness of our results in several ways. First, following Rosenbaum and Rubin [1985], we analyze the conditional independence assumption, i.e. the absence of significant differences between the observable characteristics of the treated and non-treated observations. To this end, we look at the absolute standardized mean difference (ASMD) between FRers and the non-FRers. The results of the equality test of the mean difference (standardized bias) between the observables of FRers and non-FRers returns high p-values, namely above 0.1 in all but two cases when using the CAPB (see Table 3), and in all cases when using the GFPI (see Table 4). Consequently, there are no statistical differences between the two groups after matching, which supports the efficiency of our matching procedure.

Second, to see if our results are specific to the use of the propensity-score matching method, we draw upon the inverse-probability-weighted regression adjustment (IPWRA) estimator, which uses coefficients from a weighted regression to obtain averages of treatment-level predicted outcomes. The weights come from the estimated inverse probabilities of treatment, and the treatment effects correspond to the contrasts of the averages. This estimator is considered as a doubly robust estimator: it is robust to a potential misspecification bias in the propensity score, and is not sensitive to the sample size (see, e.g. Imbens and Wooldridge [2008] for a comprehensive review of the method). Estimations reported in the last columns of Table 3 (for the CAPB) and Table 4 (for the GFPI) confirm that, except for some minor magnitude loss, fiscal rules improve fiscal discipline irrespective of the way it is being measured.

	Nearest-neighbor Matching		Stratification Matching	Radius Matching			local linear Matching	kernel Matching	IPWRA
	$N = 1$	$N = 3$		$r = 0.01$	$r = 0.025$	$r = 0.05$			
Dependant variable: $CAPB_{i,t}$ calculated with the Hodrick-Prescott (HP) filter									
[1] ATT-CAPB	**0.575***	**0.549****	**0.549*****	**0.598****	**0.513****	**0.525****	**0.529****	**0.517****	**0.485*****
	(0.355)	(0.302)	(0.203)	(0.294)	(0.259)	(0.223)	(0.229)	(0.245)	(0.188)
[2] Adding external deficit	**0.518***	**0.511****	**0.552*****	**0.403**	**0.432****	**0.456****	**0.405****	**0.442****	**0.423*****
	(0.296)	(0.245)	(0.210)	(0.254)	(0.204)	(0.212)	(0.222)	(0.213)	(0.175)
[3] Adding growth fiscal revenues	**0.598****	**0.494***	**0.503*****	**0.567***	**0.446***	**0.453****	**0.432****	**0.446****	**0.439*****
	(0.324)	(0.277)	(0.193)	(0.295)	(0.255)	(0.216)	(0.211)	(0.238)	(0.182)
[4] Adding output gap	**0.400**	**0.439***	**0.552*****	**0.506***	**0.505****	**0.535****	**0.522****	**0.541*****	**0.484*****
	(0.362)	(0.278)	(0.203)	(0.309)	(0.242)	(0.227)	(0.258)	(0.242)	(0.191)
[5] Adding lagged squared debt	**0.147**	**0.549****	**0.523*****	**0.579***	**0.585*****	**0.562*****	**0.536*****	**0.558*****	**0.452*****
	(0.372)	(0.280)	(0.200)	(0.312)	(0.172)	(0.208)	(0.201)	(0.225)	(0.175)
[6] Adding gov. fragmentation	**0.373**	**0.303*****	**0.521*****	**0.509***	**0.491****	**0.512****	**0.527****	**0.508****	**0.466****
	(0.297)	(0.309)	(0.205)	(0.301)	(0.217)	(0.251)	(0.241)	(0.222)	(0.191)
[7] Adding election	**0.238**	**0.384***	**0.531*****	**0.560****	**0.541*****	**0.482****	**0.466****	**0.482****	**0.454****
	(0.300)	(0.244)	(0.202)	(0.228)	(0.203)	(0.236)	(0.213)	(0.203)	(0.186)
[8] Adding emerging country	**0.334**	**0.413**	**0.549*****	**0.354**	**0.467****	**0.534****	**0.518****	**0.529****	**0.474*****
	(0.304)	(0.271)	(0.204)	(0.273)	(0.218)	(0.217)	(0.232)	(0.237)	(0.188)
[9] Adding PSC reforms	**0.372**	**0.626****	**0.547*****	**0.551****	**0.555*****	**0.532****	**0.533*****	**0.542****	**0.494****
	(0.327)	(0.277)	(0.206)	(0.246)	(0.214)	(0.242)	(0.189)	(0.274)	(0.195)
[10] Excl. New EU & Greece	**1.208***	**1.268**	**1.149*****	**1.250**	**1.147***	**1.214***	**1.346***	**1.216***	**1.406*****
	(0.893)	(0.863)	(1.203)	(0.961)	(1.147)	(0.744)	(1.346)	(0.747)	(0.425)

Note: Bootstrapped standard errors (with 500 replications) in brackets. *, **, *** indicate the significance level of 10%, 5%, and 1%, respectively. For stratification matching the number of strata is five and the level of significance is 0.01. IPWRA stands for the Inverse-Probability-Weighted Regression Adjustment.

Table 5: **Matching Results: ATT of FR on the CAPB—Robustness**

	Nearest-neighbor Matching		Stratification Matching	Radius Matching			local linear Matching	kernel Matching	IPWRA
	$N=1$	$N=3$		$r=0.01$	$r=0.025$	$r=0.05$			
Dependant variable: $GFPI_{i,t}$									
[1] ATT-GFPI	**0.457***** (0.159)	**0.526***** (0.174)	**0.470***** (0.103)	**0.482***** (0.143)	**0.499***** (0.125)	**0.487***** (0.129)	**0.494***** (0.127)	**0.487***** (0.131)	**0.435***** (0.118)
[2] Adding external deficit	**0.273** (0.203)	**0.316*** (0.174)	**0.366***** (0.097)	**0.254*** (0.158	**0.282*** (0.169)	**0.323**** (0.161)	**0.347***** (0.138)	**0.306**** (0.169)	**0.352***** (0.139)
[3] Adding growth fiscal revenues	**0.505***** (0.151)	**0.539***** (0.160)	**0.446***** (0.094)	**0.488***** (0.132)	**0.465***** (0.166)	**0.468***** (0.153)	**0.460***** (0.131)	**0.479***** (0.164)	**0.387***** (0.120)
[4] Adding output gap	**0.517***** (0.171)	**0.544***** (0.176)	**0.474***** (0.102)	**0.527***** (0.166)	**0.541***** (0.154)	**0.527***** (0.127)	**0.516***** (0.126)	**0.531***** (0.138)	**0.427***** (0.136)
[5] Adding lagged squared debt	**0.413**** (0.182)	**0.512***** (0.188)	**0.461***** (0.102)	**0.487***** (0.131)	**0.567***** (0.120)	**0.561***** (0.129)	**0.544***** (0.115)	**0.563***** (0.125)	**0.409***** (0.145)
[6] Adding gov. fragmentation	**0.529***** (0.193)	**0.470***** (0.159)	**0.458***** (0.102)	**0.476***** (0.142)	**0.513***** (0.158)	**0.508***** (0.123)	**0.521***** (0.170)	**0.512***** (0.101)	**0.382***** (0.146)
[7] Adding election	**0.546***** (0.169)	**0.516***** (0.146)	**0.488***** (0.103)	**0.511***** (0.161)	**0.509***** (0.134)	**0.517***** (0.148)	**0.503***** (0.134)	**0.511**** (0.139)	**0.422***** (0.135)
[8] Adding emerging country	**0.496***** (0.161)	**0.536***** (0.159)	**0.470***** (0.103)	**0.556***** (0.156)	**0.532***** (0.132)	**0.530**** (0.127)	**0.513***** (0.143)	**0.524***** (0.155)	**0.426***** (0.137)
[9] Adding PSC reforms	**0.544***** (0.175)	**0.511***** (0.169)	**0.476***** (0.103)	**0.491***** (0.154)	**0.526***** (0.154)	**0.536***** (0.134)	**0.526***** (0.115)	**0.533***** (0.132)	**0.427***** (0.128)
[10] Excl. New EU & Greece	**0.759***** (0.201)	**0.703***** (0.247)	**0.670***** (0.200)	**0.678**** (0.296)	**0.682***** (0.228)	**0.717***** (0.242)	**0.729***** (0.202)	**0.713***** (0.209)	**0.650***** (0.158)

Note: Bootstrapped standard errors (with 500 replications) in brackets. *, **, *** indicate the significance level of 10%, 5%, and 1%, respectively. For Stratification matching, the number of strata is five and the level of significance is 0.01. IPWRA stands for the Inverse-Probability-Weighted Regression Adjustment.

Table 6: **Matching Results: ATT of FR on the GFPI—Robustness**

Third, the matching procedure rests on propensity scores. To verify if estimated ATTs are sensitive to propensity scores, we perform two tests. On the one hand, we follow Tapsoba [2012] and consider an additional set of control variables in the probit specification, namely: external deficit, the growth of fiscal revenues, the output gap, the lagged squared debt ratio, the government fragmentation, a dummy variable for the presence of elections, a dummy variable for emerging countries, and a dummy variable indicating if there was a reform of the SGP—2005, 2011 (the Six Pack), and 2013 (the Two Pack). Based on propensity scores computed using the probit models from columns (2)-(8) in Appendix 4, Table 5 and Table 6 report the ATTs for the CAPB and GFPI, respectively, and confirm the robustness of our benchmark results, both in significance and magnitude.

On the other hand, we perform estimations on the sub-sample of core EU countries, by excluding the new EU countries, i.e. that entered the EU after 2004, and Greece. Using propensity scores computed based on the last column of Appendix 4, we reveal in the last line of Table 5 (for CAPB) and Table 6 (for GFPI) ATTs that support—yet again—a favorable effect of fiscal rules on fiscal discipline. Nevertheless, compared with our previous findings, the significance of the effect is weaker for the CAPB (only in six out of eight cases), and its magnitude stronger for both CAPB and GFPI. Such differences motivate the next section, devoted to the analysis of possible heterogeneities in the effect of fiscal rules on fiscal discipline.

6. Heterogeneity

6.1. The type of fiscal rule

So far, our analysis focused on the effects of fiscal rules altogether. In the following, based on the propensity scores estimated using the columns (1)-(3) in Appendix 5, we look at the effect of the different types of fiscal rules, namely, budget balance rules (BBR) in Table 7, expenditure rules (ER) in Table 8, and debt rules (DR) in Table 9,[5] on fiscal discipline. Prior to discussing the results in detail, we report that the common support hypothesis is verified for each type of fiscal rule (see Appendix 2.2, Appendix 2.3, and Appendix 2.4); the high p-values of the standardized bias test support the conditional independence assumption (see Tables 7, 8, and 9); and using the inverse-probability-weighted regression adjustment estimator confirms our findings based on propensity scores matching (see the last columns of Tables 7, 8, and 9).

Regarding the traditional measure of fiscal discipline, the line (1) in Tables 7, 8, and 9 presents the effects of the different types of fiscal rules on the CAPB. We reveal two important effects. On the one hand, the adoption of BBR generates a significant improvement of the CAPB with respect to comparable countries that did not adopt BBR. The magnitude of this effect is economically meaningful, around 0.5-0.6 percentage points, and comparable with our findings when considering all fiscal rules together. On the other hand, neither ER, nor DR, make a significant difference in terms of fiscal discipline when measured by the CAPB. While the lack of effect of ER on the CAPB is consistent with the conclusions of previous studies, including e.g. Debrun et al. [2008], Reuter [2015], and Bergman et al. [2016], the absence of a significant effect of DR on the CAPB is more novel with respect to existing studies; for example, DR are associated with a significantly higher CAPB when combined with BBR in Debrun et al. [2008], or by themselves in Bergman et al. [2016].

[5] Due to the low number of countries that adopted Revenue Rules (Denmark, Lithuania, and the Netherlands), we decided not to present the results of their effect on fiscal discipline.

A possible explanation is that all EU countries are already subject to the 60% debt rule of the SGP, so they have little incentives to respect their national DR.

Let us now look at our novel measure of fiscal discipline, namely the GFPI. ATTs reported on the line (2) of Tables 7, 8, and 9 reveal a fairly different picture in the effects of fiscal rules on GFPI compared with the CAPB, on two grounds. First, in addition to BBR, ER significantly improve the GFPI; therefore, the effect of ER on fiscal discipline crucially depends on the way it is being measured, since the presence of ER can either make no statistical difference (when measured by the CAPB) or significantly improve it (when measured by the GFPI). Second, while the size of the effect of BBR on the CAPB was comparable to the size of the effect of fiscal rules altogether, differences in magnitude are at work when considering the GFPI index; indeed, compared with the effect of fiscal rules altogether, estimated around 0.45-0.5, the impact of BBR on the GFPI is roughly 40% higher (the estimated ATTs are around 0.7 pp), and this is also the case for the effect of ER (the estimated ATTs are around 0.6 pp).

Given such differences in the effect of fiscal rules on CAPB and GFPI, we examine their impact on the variables composing the GFPI. First, as shown by the line (3) of Tables 7, 8, and 9, similar to the effect of fiscal rules altogether, the presence of BBR or ER yields significantly lower public deficits (with no significant effect of DR). The magnitude of this favorable effect is slightly higher on average for ER (around 2.1 pp) compared with fiscal rules altogether (around 1.8-2.1 pp), and fairly larger for BBR (around 2.5-2.6 pp). Second, the significance of the effect of BBR and ER on the growth of public debt is comparable with that of fiscal rules altogether—six out of eight ATTs are significant, with no significant impact of DR (see the line (4) of Tables 7, 8, and 9). Similar to public deficits, the growth of public debt responds slightly more to ER (around 4-5 pp) and much more to BBR (around 6.3 pp) compared with its response to fiscal rules altogether (around 3.4-4 pp). Third, contrary to their significant effect on public deficit and the growth of public debt, ER, similar to DR, do not significantly affect the growth of interest rate (see the line (5) of Tables 7 and 8). However, while the effect of fiscal rules altogether was not found to be significant, the presence of BBR significantly decreases the growth of interest rate (seven out of eight ATTs are significant) by 7-8 pp (see the line (5) of Table 7). Fourth, similar to the lack of a significant effect of fiscal rules altogether, the estimated ATTs of the impact of BBR, ER, and DR on the growth of fiscal revenues are not statistically significant, as illustrated by the line (6) of Tables 7, 8, and 9. Fifth, compared with ATTs estimated between 12 and 22 pp for fiscal rules altogether, the ATTs of the effect on the external deficit are mostly not significant. This is the case particularly for BBR (no significant ATT, see the line (7) in Table 7) and for DR (three significant ATTs, see the line (7) in Table 8), while the estimated impact of ER is particularly robust—all eight ATTs are significant on the line (7) in Table 9—and around 50% higher compared with the impact of fiscal rules altogether (around 30 pp, compared with around 20pp).

Overall, our results show that—contrary to the lack of significant impact of DR—the effect of BBR and ER differs both in significance and magnitude compared with the impact of fiscal rules altogether, depending on the considered fiscal rule and fiscal variable (except for the growth of fiscal revenues, which was not found to be significantly affected).

	Nearest-neighbor Matching		Radius Matching			local linear Matching	kernel Matching	IPWRA
	$N = 1$	$N = 3$	$r = 0.01$	$r = 0.025$	$r = 0.05$			
Dependant variable: $CAPB_{i,t}$								
[1] ATT	**0.570*****	**0.581*****	**0.476*****	**0.568*****	**0.545*****	**0.557*****	**0.554*****	**0.407****
	(0.222)	(0.217)	(0.183)	(0.201)	(0.177)	(0.182)	(0.191)	(0.166)
Number of treated observations	107	107	106	107	107	107	113	116
Number of control observations	240	240	232	239	240	240	248	276
Standardized bias (p-value)	0.404	0.879	0.865	0.966	0.974	0.404	0.975	-
Dependant variable: $GFPI_{i,t}$								
[2] ATT	**0.751*****	**0.730*****	**0.691*****	**0.727*****	**0.698*****	**0.678*****	**0.699*****	**0.568*****
	(0.185)	(0.157)	(0.145)	(0.147)	(0.158)	(0.126)	(0.167)	(0.114)
Dependant variable: $Public\ Deficit_{i,t}$								
[3] ATT	**-2.492*****	**-2.489*****	**-2.435*****	**-2.651*****	**-2.663*****	**-2.635*****	**-2.637*****	**-2.544*****
	(0.525)	(0.402)	(0.447)	(0.419)	(0.325)	(0.393)	(0.361)	(0.297)
Dependant variable: $Debt\ growth\ rate_{i,t}$								
[4] ATT	**-5.493**	**-6.181***	**-5.519**	**-5.746****	**-6.351****	**-6.358****	**-6.151****	**-6.453*****
	(4.217)	(3.441)	(3.483)	(2.486)	(3.041)	(2.713)	(2.689)	(1.378)
Dependant variable: $Interest\ growth\ rate_{i,t}$								
[5] ATT	**-7.643***	**-7.098**	**-8.854****	**-7.593****	**-8.040****	**-7.421****	**-7.682****	**-6.278*****
	(4.322)	(4.543)	(3.692)	(4.010)	(3.395)	(3.786)	(3.218)	(2.369)
Dependant variable: $Growth\ of\ fiscal\ revenues_{i,t}$								
[6] ATT	**-0.295**	**-0.163**	**-0.112**	**-0.093**	**-0.122**	**-0.123**	**-0.107**	**-0.070**
	(0.676)	(0.560)	(0.371)	(0.429)	(0.404)	(0.458)	(0.498)	(0.410)
Dependant variable: $External\ Deficit_{i,t}$								
[7] ATT	**-8.432**	**-5.350**	**-4.261**	**-3.006**	**-3.341**	**-3.052**	**-3.231**	**-3.832**
	(7.549)	(6.869)	(5.925)	(5.224)	(4.849)	(4.453)	(4.802)	(4.634)

Note: Bootstrapped standard errors (with 500 replications) in brackets. *, **, *** indicate the significance level of 10%, 5%, and 1%, respectively. IPWRA stands for the Inverse-Probability-Weighted Regression Adjustment.

Table 7: **Matching Results with BBR (Budget Balance Rules) as the treatment variable**

	Nearest-neighbor Matching		Radius Matching			local linear Matching	kernel Matching	IPWRA
	$N = 1$	$N = 3$	$r = 0.01$	$r = 0.025$	$r = 0.05$			
Dependant variable: $CAPB_{i,t}$								
[1] ATT	**0.394**	**0.419**	**0.478***	**0.364**	**0.385**	**0.396**	**0.391***	**0.325**
	(0.435)	(0.366)	(0.290)	(0.245)	(0.267)	(0.272)	(0.232)	(0.213)
Number of treated observations	121	121	118	120	121	121	121	122
Number of control observations	257	257	232	253	257	257	257	270
Standardized bias (p-value)	0.711	0.950	0.989	0.974	0.995	0.711	0.993	-
Dependant variable: $GFPI_{i,t}$								
[2] ATT	**0.664*****	**0.635*****	**0.578*****	**0.630*****	**0.610*****	**0.626*****	**0.621*****	**0.509*****
	(0.178)	(0.173)	(0.162)	(0.150)	(0.094)	(0.166)	(0.107)	(0.116)
Dependant variable: $Public\ Deficit_{i,t}$								
[3] ATT	**-2.272*****	**-2.079*****	**-1.942*****	**-2.177*****	**-2.074*****	**-2.165*****	**-2.145*****	**-1.691*****
	(0.718)	(0.583)	(0.562)	(0.508)	(0.619)	(0.429)	(0.482)	(0.370)
Dependant variable: $Debt\ growth\ rate_{i,t}$								
[4] ATT	**-3.617**	**-3.644**	**-5.792***	**-4.370***	**-4.549****	**-5.120****	**-4.648****	**-4.667*****
	(3.989)	(2.563)	(2.333)	(2.538)	(2.172)	(2.485)	(2.164)	(1.377)
Dependant variable: $Interest\ growth\ rate_{i,t}$								
[5] ATT	**-5.522**	**-3.272**	**-1.842**	**-2.219**	**-2.555**	**-3.091**	**-2.648**	**-2.252**
	(3.798)	(2.614)	(2.532)	(2.903)	(2.666)	(2.722)	(3.003)	(2.018)
Dependant variable: $Growth\ of\ fiscal\ revenues_{i,t}$								
[6] ATT	**-0.214**	**-0.114**	**-0.041**	**-0.080**	**-0.113**	**-0.159**	**-0.119**	**0.013**
	(0.538)	(0.506)	(0.473)	(0.464)	(0.467)	(0.525)	(0.583)	(0.411)
Dependant variable: $External\ Deficit_{i,t}$								
[7] ATT	**-30.115*****	**-32.943*****	**-30.388*****	**-31.330*****	**-29.798*****	**-30.877*****	**-30.158*****	**-24.684*****
	(7.565)	(6.166)	(6.208)	(7.321)	(5.867)	(6.773)	(6.923)	(4.670)

Note: Bootstrapped standard errors (with 500 replications) in brackets. *, **, *** indicate the significance level of 10%, 5%, and 1%, respectively. IPWRA stands for the Inverse-Probability-Weighted Regression Adjustment.

Table 8: **Matching Results with ER (Expenditure Rules) as the treatment variable**

	Nearest-neighbor Matching		Radius Matching			local linear Matching	kernel Matching	IPWRA
	$N = 1$	$N = 3$	$r = 0.01$	$r = 0.025$	$r = 0.05$			
Dependant variable: $CAPB_{i,t}$								
[1] ATT	**0.086**	**0.228**	**0.290**	**0.145**	**0.133**	**0.134**	**0.151**	**0.049**
	(0.453)	(0.287)	(0.327)	(0.245)	(0.343)	(0.214)	(0.342)	(0.211)
Number of treated observations	90	90	86	90	90	90	90	90
Number of control observations	238	225	182	223	225	225	225	302
Standardized bias (p-value)	0.271	0.915	0.860	0.896	0.897	0.271	0.910	-
Dependant variable: $GFPI_{i,t}$								
[2] ATT	**0.178**	**0.195**	**0.108**	**0.241**	**0.160**	**0.160**	**0.147**	**0.0.95**
	(0.254)	(0.226)	(0.200)	(0.178)	(0.171)	(0.161)	(0.178)	(0.156)
Dependant variable: $Public\ Deficit_{i,t}$								
[3] ATT	**-0.633**	**-0.823**	**-0.861**	**-0.332**	**-0.427**	**-0.409**	**-0.407**	**-0.519)**
	(0.733)	(0.603)	(0.695)	(0.647)	(0.521)	(0.568)	(0.490)	(0.354)
Dependant variable: $Debt\ growth\ rate_{i,t}$								
[4] ATT	**-0.265**	**-1.805**	**-2.712**	**-0.598**	**-0.368**	**-0.440**	**-0.454**	**-0.973**
	(4.866)	(3.328)	(3.058)	(3.064)	(2.595)	(3.132)	(3.191)	(1.717)
Dependant variable: $Interest\ growth\ rate_{i,t}$								
[5] ATT	**0.629**	**0.161**	**-0.427**	**0.952**	**-0.037**	**-0.047**	**0.291**	**0.322**
	(5.019)	(4.559)	(4.080)	(3.821)	(3.179)	(3.044)	(3.644)	(2.895)
Dependant variable: $Growth\ of\ fiscal\ revenues_{i,t}$								
[6] ATT	**0.084**	**0.175**	**-0.047**	**0.117**	**0.041**	**0.151**	**0.077**	**-0.030**
	(0.886)	(0.810)	(0.660)	(0.638)	(0.551)	(0.618)	(0.537)	(0.504)
Dependant variable: $External\ Deficit_{i,t}$								
[7] ATT	**-12.789**	**-12.117***	**-11.375**	**-9.960***	**-9.772**	**-10.359***	**-9.984**	**-9.914**
	(9.354)	(7.266)	(8.069)	(6.045)	(6.237)	(6.430)	(6.990)	(5.365)

Note: Bootstrapped standard errors (with 500 replications) in brackets. *, **, *** indicate the significance level of 10%, 5%, and 1%, respectively. IPWRA stands for the Inverse-Probability-Weighted Regression Adjustment.

Table 9: **Matching Results with DR (Debt Rules) as the treatment variable**

6.2. Structural factors

Having revealed that the effect of fiscal rules adoption on fiscal discipline varies between the different types of fiscal rules, we now investigate if this effect may be subject to heterogeneity. To this end, we follow Tapsoba [2012], and estimate the following control regression

$$Y_{i,t} = \alpha + \beta FR_{i,t} + \gamma\ PS_{i,t} + \varphi X_{i,t}\ + \delta(FR_{i,t}\ *\ X_{i,t}) + \epsilon_{i,t}, \tag{5}$$

with Y the measure of fiscal discipline (CAPB or GFPI), PS the propensity score that controls for self-selection, and X the vector of factors that may trigger the heterogeneity in the effect of fiscal rules. We consider three groups of factors. First, macroeconomic factors include real GDP per capita, the lagged value of debt (in ratio of GDP), and the variable bad times, which is defined as a binary variable equal to one during the years of financial crisis (2007-2008) and sovereign debt crisis (2010-2011). Second, political factors include the mode of election, and the electoral cycles. Third, fiscal-rule related factors include the number of years during which a national rule has been in force, the presence of the Stability and Growth Pact (SGP), the presence of an independent institution in charge of the fiscal discipline monitoring, and the number of rules in force.

Results are reported in Table 10 (for the CAPB) and Table 11 (for the GFPI). In particular, the significance of the coefficient of the propensity score supports—once again—the importance of controlling for the self-selection bias by using the propensity score matching method. The effect of the different variables can be classified in three groups. First, out of the nine variables considered, two of them exert the same type of significant effect on the two measures of fiscal discipline, namely, CAPB and GFPI. As the real GDP per capita increases, the favorable effect of fiscal rules adoption on both CAPB and the GFPI is reduced; this may reflect a more procyclical behavior of some of the most developed EU countries. In addition, a higher (lagged) public debt ratio reduces the favorable effect of fiscal rules on the CAPB and the GFPI; with high debt ratios, a large debt burden may weaken the fiscal discipline.

Second, some variables do not significantly affect the impact of fiscal rules on fiscal discipline irrespective of its measure, namely, the mode of election and the number of fiscal rules in place. The latter finding may be consistent with Commission [2010], suggesting that what matters is the interaction between fiscal rules rather than their number.

Third, some variables significantly affect the CAPB but not the GFPI, and conversely. In the former group, bad times and electoral cycles reduce only the favorable effect of fiscal rules on the CAPB (and do not affect it when using the GFPI), while the number of years since the rule was in force (a signaling effect) and the presence of a monitoring institution (that potentially affects the implementation of fiscal rules) further support the favorable impact of fiscal rules on the CAPB (but not on the GFPI). Conversely, in the latter group, only in combination with the SGP do fiscal rules improve the GFPI (probably through the incentives provides by the 3% numerical rule on the deficit), while their favorable effect on the CAPB is not affected by the SGP.

Altogether, these results show that the favorable effect of fiscal rules on fiscal discipline may be altered by various factors that seize different structural characteristics. Importantly, we find that the effect of such factors is fairly different when using alternative measures of fiscal discipline.[6]

[6]Similar conclusions are found when using a logit, instead of a probit model, to compute propensity scores (results are available upon request).

Variables	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]
Dummy variable FR	0.328^{***}	1.187^{***}	0.427^{***}	0.295^{***}	0.406^{***}	0.183^{***}	0.386^{***}	0.286^{***}	0.179^{***}
	(0.391)	(0.252)	(0.021)	(0.031)	(0.033)	(0.212)	(0.104)	(0.032)	(0.070)
Propensity Score	-0.361^{***}	-0.144^{*}	-0.348^{***}	-0.325^{***}	-0.362^{***}	-0.349^{***}	-0.388^{***}	-0.370^{***}	-0.362^{***}
	(0.963)	(0.176)	(0.068)	(0.110)	(0.099)	(0.119)	(0.114)	(0.101)	(0.103)
Macroeconomics Factors									
FR * Real gdp per capita	-0.0000003^{*}								
	(0.0000002)								
FR * Debt ratio$_{t-1}$		-0.015^{***}							
		(0.004)							
FR * Bad Time			-0.317^{***}						
			(0.025)						
Political factors									
FR * Election mode				0.010					
				(0.010)					
FR * Electoral cycles					-0.347^{***}				
					(0.195)				
Factors linked with Rules									
FR * Number years						0.082^{***}			
covered by rules						(0.029)			
FR * SGP							-0.095		
							(0.155)		
FR * monitoring institution								0.191^{***}	
								(0.041)	
FR * number of rules									0.059
									(0.042)
Observations	392	392	392	392	392	392	392	392	392

Note: Bootstrapped standard errors (with 500 replications) in brackets. *, **, *** indicate the significance level of 10%, 5%, and 1%, respectively.
For each column, the intercept and the variable not interacted with FR are included but not reported.

Table 10: **Nonlinearities in the effect of FR on the CAPB**

Variables	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]
Dummy variable FR	0.534^{***}	1.093^{***}	0.447^{***}	0.447^{***}	0.462^{***}	0.836^{***}	0.252	0.436^{***}	0.658^{***}
	(0.155)	(0.141)	(0.021)	(0.147)	(0.150)	(0.316)	(0.165)	(0.148)	(0.197)
Propensity Score	-0.302^{***}	-0.229^{**}	-0.241^{**}	-0.260^{**}	-0.277^{**}	-0.270^{**}	-0.203^{*}	-0.219^{**}	-0.362^{***}
	(0.131)	(0.051)	(0.131)	(0.129)	(0.134)	(0.129)	(0.132)	(0.129)	(0.133)
Macroeconomics Factors									
FR * Real gdp per capita	-0.0000005^{***}								
	(0.0000002)								
FR * Debt ratio$_{t-1}$		-0.012^{***}							
		(0.002)							
FR * Bad Time			0.071						
			(0.144)						
Political factors									
FR * Election mode				0.240					
				(0.403)					
FR * Electoral cycles					-0.082				
					(0.106)				
Factors linked with Rules									
FR * Number years						-0.058			
covered by rules						(0.043)			
FR * SGP							0.578^{**}		
							(0.242)		
FR * monitoring institution								0.148	
								(0.125)	
FR * number of rules									-0.135
									(0.093)
Observations	392	392	392	392	392	392	392	392	392

Note: Bootstrapped standard errors (with 500 replications) in brackets. *, **, *** indicate the significance level of 10%, 5%, and 1%, respectively.
For each column, the intercept and the variable not interacted with FR are included but not reported.

Table 11: **Nonlinearities in the effect of FR on the GFPI**

7. Conclusion

Motivated by the fiscal imbalances in EU countries in the recent period, this paper analyzed the effect of national fiscal rules on fiscal discipline. Using a careful definition of national fiscal rules combined with a novel measure of fiscal discipline (namely, the Global Financial Performance Index—GFPI), propensity score matching estimations that account for potential endogeneity revealed that the adoption of fiscal rules significantly improves the GFPI, corroborating their favorable effect on the popular measure of fiscal discipline—the CAPB—emphasized by some of the existing studies. This effect, robust to various alternative specifications, is however dramatically affected by the type of fiscal rule and different structural factors (i.e. countries' and rules' structural characteristics). These two features, together with alternative measures of fiscal discipline, are found to be important features that must be taken into account when assessing the effects of fiscal rules on fiscal discipline.

We see several possibilities for future work. First, close to our study, it would be interesting to look at the response of fiscal discipline to the so-called second-generation fiscal rules (see Eyraud et al. [2018]), which potentially add flexibility and enforceability to the simplicity feature of the traditional fiscal rules. Reuter [2019] pointed out that even if they are not respected, the mere presence of fiscal rules improves the fiscal discipline. Second, beyond national fiscal rules, one could explore the relationship between sub-national fiscal rules and fiscal discipline, from a cross-country perspective. Third, since our empirical analysis was conducted on EU countries, future studies could investigate the nature of the effect of fiscal rules on fiscal discipline in other economic and monetary areas, including the two African monetary unions—the CEMAC and the WAEMU.

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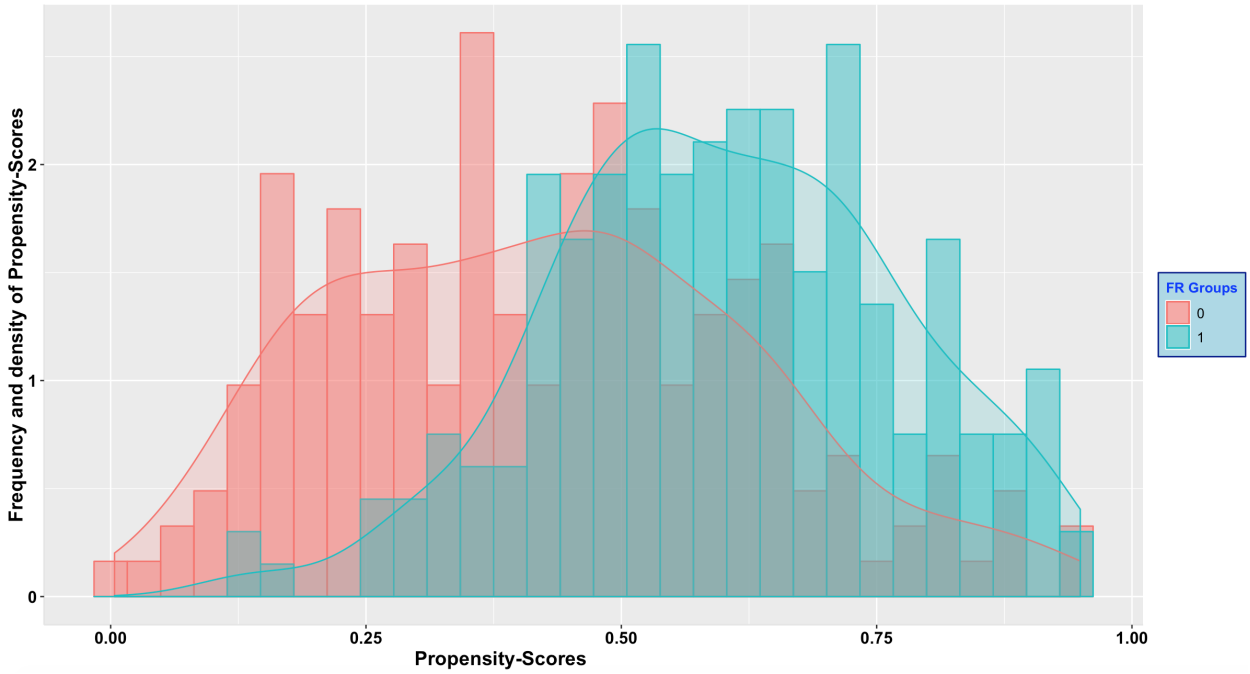
Appendices

Countries/Fiscal Rules Excluded	BBR	DR	ER	RR
Austria	2000-2013: MTBF (IMF Fiscal Rules Database and Reuter, 2015)			
Belgium	Belgium adopted a BBR in 2014 (according to IMF and European Commission databases), so it does not have a fiscal rule during our study period			
France	2013: MTBF. The rule is written in the public finance programming law that can be revised, so it is not comparable with a numerical fiscal rule described by Kopits and Symansky (1998)			2006-2013: MTBF
United Kingdom	2009: Fiscal rule abandoned during 2009 (IMF fiscal rules database and Reuter, 2015)	2009: Fiscal rule abandoned during 2009 (IMF fiscal rules database). 2010: Fiscal rule also abandoned in 2010.		

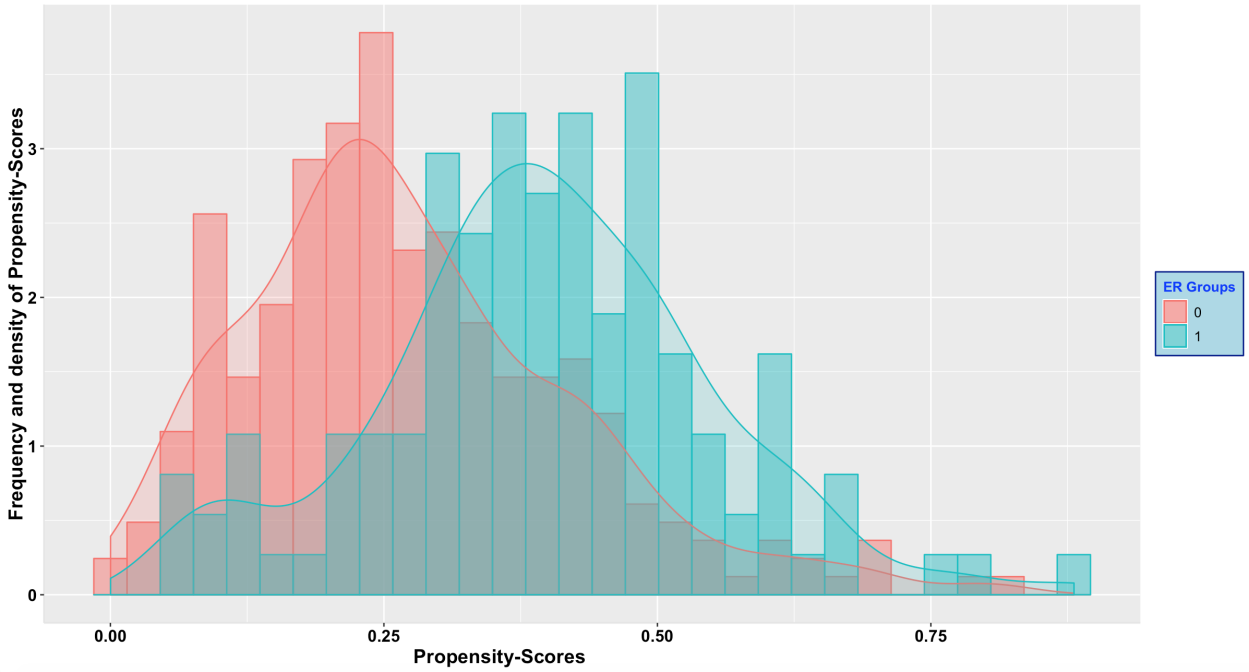
Note: MTBF stands for Medium Term Budgetary Framework.

Appendix 1. National numerical fiscal rules excluded by our definition

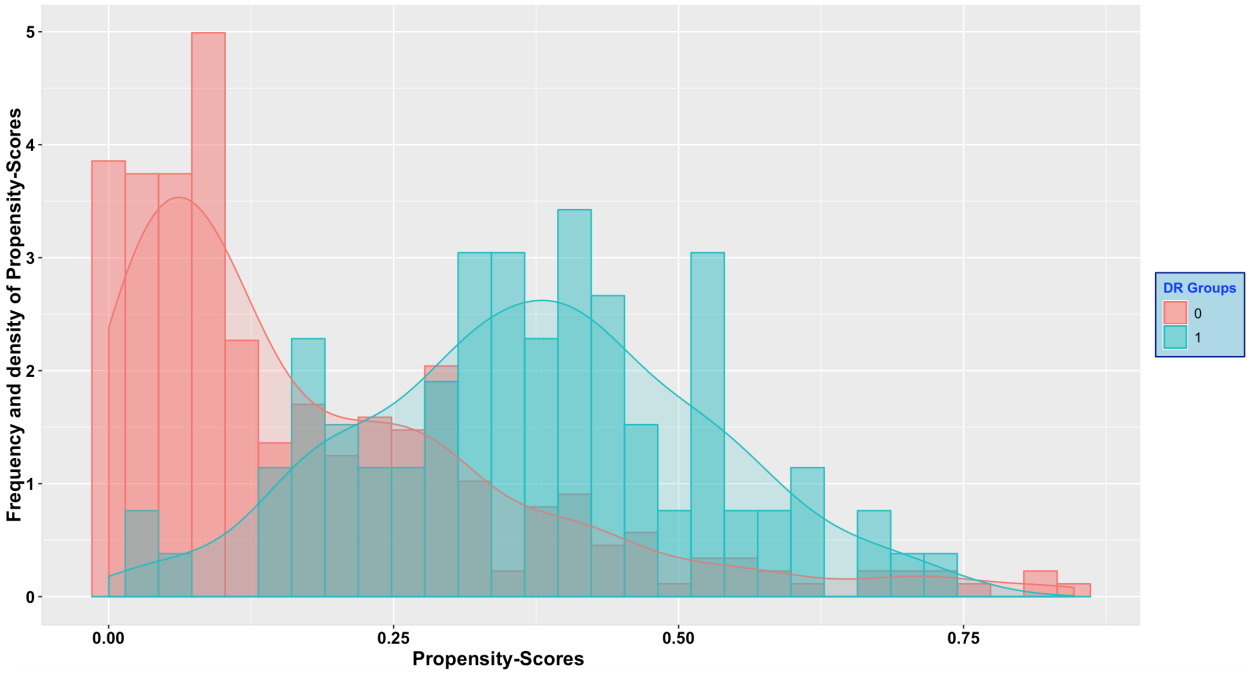


Appendix 2.1: Common Support Region for FR

Appendix 2.2: Common Support Region for BBR



Appendix 2.3: Common Support Region for ER



Appendix 2.4: Common Support Region for DR

	Total Budget Balance	External Deficit	Growth of Fiscal Revenues	Sustainability Debt Index
Total Budget Balance	1.000	-0.338	-0.010	-0.099
External Deficit	-	1.000	-0.002	0.052
Growth of Fiscal Revenues	-	-	1.000	0.017
Sustainability Debt Index	-	-	-	1.000

Appendix 3: Correlations between the four indicators used to construct the GFPI

Dependent variable	[1] FR	[2] FR	[3] FR	[4] FR	[5] FR	[6] FR	[7] FR	[8] FR	[9] FR	[10] FR
Intercept	-1.005	-0.966	-0.962	-1.053	-0.747	-1.100	-0.934	-0.992	-0.769	-0.643
	(1.054)	(1.031)	(1.058)	(1.063)	(1.058)	(1.058)	(1.054)	(1.067)	(1.064)	(3.868)
$CAPB_{t-1}$	0.113***	0.118***	0.115***	0.113***	0.108***	0.109***	0.114***	0.113***	0.110***	0.137**
	(0.042)	(0.043)	(0.043)	(0.043)	(0.043)	(0.043)	(0.042)	(0.042)	(0.042)	(0.072)
Debt $ratio_{t-1}$	-0.018***	-0.019***	-0.019***	-0.018*	-0.026***	-0.018***	-0.018***	-0.018***	-0.019***	-0.043***
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.006)
Real GDP growth	-0.027	-0.032	-0.026	-0.029	-0.027	-0.029	-0.029	-0.027	-0.030	-0.078
	(0.020)	(0.020)	(0.020)	(0.020)	(0.020)	(0.020)	(0.020)	(0.020)	(0.020)	(0.056)
Inflation rate	-0.103***	-0.099***	-0.102***	-0.104***	-0.105***	-0.103***	-0.100***	-0.104***	-0.098***	-0.167*
	(0.026)	(0.025)	(0.026)	(0.027)	(0.026)	(0.026)	(0.026)	(0.027)	(0.027)	(0.117)
Government stability	0.065*	0.016	0.073	0.076	0.137	0.037	0.112	0.066	-0.082	-0.199
	(0.200)	(0.200)	(0.201)	(0.204)	(0.203)	(0.201)	(0.201)	(0.200)	(0.201)	(0.393)
SGP	-0.080	-0.104	-0.072	-0.086	-0.095	-0.036	-0.036	-0.074	-0.078	-1.522***
	(0.162)	(0.163)	(0.162)	(0.164)	(0.162)	(0.164)	(0.164)	(0.177)	(0.162)	(0.494)
Dummy EU membership	0.077	0.068	0.058	0.086	0.091	0.077	-0.077	0.076	0.118	-
	(0.386)	(0.379)	(0.388)	(0.388)	(0.387)	(.390)	(0.390)	(0.387)	(1.068)	-
Unemployment rate	0.030*	0.050**	0.030*	0.033*	0.027*	0.028*	0.029*	0.030*	0.027	0.075*
	(0.019)	(0.020)	(0.019)	(0.022)	(0.019)	(0.019)	(0.019)	(0.019)	(0.019)	(0.040)
REER	0.026***	0.027***	0.025***	0.026***	0.026***	0.027***	0.028***	0.026***	0.024***	0.054*
	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)	(0.036)
Trade openness	-0.008**	-0.009***	-0.008**	-0.008***	-0.008**	-0.008**	-0.008***	-0.008***	-0.009***	-0.010**
	(0.003)	(0.002)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.005)
Adding external deficit		-0.005**								
		(0.002)								
Adding growth fiscal revenues			-0.015							
			(0.023)							
Adding output gap				1.410						
				(5.347)						
Adding lagged squared debt					0.00006					
					(0.00006)					
Adding gov. fragmentation						0.266				
						(0.303)				
Election							0.189*			
							(0.113)			
Emerging country								0.017		
								(0.197)		
PSC reforms									0.288*	
									(0.172)	
Adjusted R^2	0.097	0.106	0.094	0.093	0.095	0.095	0.098	0.093	0.098	0.415
Observations	392	392	392	392	392	392	392	392	392	392

Note: Bootstrapped standard errors (with 500 replications) in brackets. *, **, *** indicate the significance level of 10%, 5%, and 1%, respectively. In column [10] the probit estimated when excluding the new EU countries (that entered the EU after 2004) and Greece (since all remaining countries were in EU, the dummy EU membership is dropped).

Appendix 4. Probit estimates of the Propensity Scores—Robustness

Dependent variable	BBR	ER	DR
Intercept	-1.989*	-0.154	-4.259***
	(1.173)	(1.230)	(1.179)
$CAPB_{t-1}$	0.110**	0.070*	0.037
	(0.048)	(0.043)	(0.047)
Debt $ratio_{t-1}$	-0.015***	-0.007**	-0.021***
	(0.003)	(0.003)	(0.004)
Real GDP growth	-0.019	-0.077***	0.015
	(0.019)	(0.020)	(0.020)
Inflation rate	-0.091***	-0.062*	-0.063***
	(0.027)	(0.037)	(0.024)
Government stability	0.394*	0.552***	0.609***
	(0.206)	(0.169)	(0.241)
SGP	-0.379**	0.201	-0.401**
	(0.168)	(0.165)	(0.194)
Dummy EU membership	0.089	-0.055	0.299
	(0.394)	(0.446)	(0.439)
Unemployment rate	0.016	-0.0006	0.073***
	(0.021)	(0.020)	(0.021)
REER	0.033***	0.0004	0.036***
	(0.010)	(0.010)	(0.009)
Trade openness	-0.019***	-0.004	0.001
	(0.004)	(0.003)	(0.004)
Adjusted R^2	0.170	0.105	0.200
Observations	392	392	392

Note: Bootstrapped standard errors (with 500 replications) in brackets.
*, **, *** indicate the significance level of 10%, 5%, and 1%, respectively.

Appendix 5. Probit estimates of the Propensity Scores for BBR, ER, and DR

Variable	Source
Debt/GDP ratio	IMF Historical Database
Term of trade (index)	IMF
Primary Balance	AMECO Database
Revenues of public administrations	Eurostat
Inflation	IMF
Commodity Price Index	Federal Reserve Bank of St Louis
Real GDP	World Bank
Population	World Bank
Government Stability	World Bank (WGI)
Dependency ratio	World Bank (WGI)
Government fragmentation	World Bank (DPI 2015)
Election mode	World Bank (DPI 2015)
Electoral Cycles	World Bank (DPI 2015)
External Deficit	Eurostat
Fiscal Rules	IMF Fiscal Rules Database
Number of rules	IMF Fiscal Rules Database
Number of years covered by rules	Authors' calculations
(cyclically-adjusted or rules which exclude public investment)	IMF Fiscal Rules Database
Total Budget Balance	IMF
Structural budget balance (Hodrick Prescott filter)	Authors' calculations
Structural budget balance (Trigonometric filter)	Authors' calculations
Structural budget balance (production function approach)	IMF
Interest on debt	World Bank (WDI)
Output Gap (Hodrick Prescott filter)	Authors' calculations
Output Gap (Trigonometric filter)	Authors' calculations
Real Effective Exchange Rate	Eurostat
Trade openness	OECD

Appendix 6. Sources of all the variables used in the study

Variable	N	Mean	Min	Max	sd
Public Debt (% of GDP)	392	53.202	3.664	177.677	30.37
Term of trade (index)	392	0.9975	0.8906	1.2320	0.0398
Inflation	392	3.27	-1.70	45.70	3.6541
Commodity Price Index	392	120.63	58.25	192.57	49.013
Growth real gdp	392	2.050	-14.559	12.920	3.913
Government Stability	392	0.8045	-0.7798	1.7602	0.4635
Government fragmentation	392	0.3716	0.0000	0.8278	0.2582
Electoral Cycles	392	0.3214	0.0000	1.0000	0.4676
Election mode	392	1.735	0.000	2.000	0.6484
External Deficit	392	30.76	-140.30	156.00	44.3296
Fiscal Rules	392	0.5204	0.0000	1.0000	0.5002
Expenditure Rules	392	0.2959	0.0000	1.0000	0.4636
Budget Balance Rules	392	0.2959	0.0000	1.0000	0.4570
Debt Rules	392	0.2296	0.0000	1.0000	0.4211
PSC reforms	392	0.2143	0.0000	1.0000	0.4108
Number of national fiscal rules	392	0.9388	0.0000	3.0000	1.0346
Number of years covered by fiscal rules	392	7.158	0.000	14.000	6.0602
Total Budget Balance (% of GDP)	392	-2.794	-32.000	6.700	3.7569
Cyclically Adjusted Primary Balance - Hodrick Prescott filter - (% of GDP)	392	0.0000	-19.744	11.076	1.950
Cyclically Adjusted Primary Balance - Trigonometric filter - (% of GDP)	392	0.0000	-19.552	11.171	1.9629
Cyclically Adjusted Primary Balance - IMF production function approach - (% of GDP)	356	-0.9007	-10.672	7.8373	2.9439
Global Fiscal Performance Index (GFPI) (% of GDP)	392	0.0000	-2.2001	4.6229	1.0000
Growth of debt interest	392	4.166	-56.075	126.05	17.685
Output Gap (Hodrick Prescott filter)	392	-0.00009	-0.0471	0.0752	0.0159
Real Effective Exchange Rate	392	98.51	66.07	184.36	9.5713
Trade openness	392	55.83	22.23	142.63	24.725
Emerging country	392	0.2143	0.0000	1.0000	0.4108
Growth of fiscal revenues (with a negative sign)	392	-0.1746	-18.329	10.488	3.117
Dummy EU membership	392	0.0000	0.0332	1.0000	0.1793
Lagged squared debt ratio	392	3518.5	13.42	29617.1	3855.7
Unemployment rate	392	8.819	1.805	27.466	4.2969

Appendix 7. Descriptive statistics