

Enhancing credibility and commitment to fiscal rules¹

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Abstract

The objective of this paper is to derive the characteristics of an effective fiscal governance framework, focusing on the incentives that ensure a commitment to the fiscal rules. We study this problem with the use of econometric tools. Our study shows that both economic and institutional factors play an important role in incentivising countries' fiscal efforts. Fiscal balances are affected not only by the economic cycle, but, among others, by the level of public debt and the world economic situation. We find that the existence of numerical fiscal rules, their strong legal entrenchment, surveillance mechanisms, and credible sanctions binding the hands of governments have a significant impact on curbing deficits. The relationship between the Commission and European Union (EU) Member States (MS), where the EU authorities has elements in common with the assumptions of the principal-agent framework. By looking through the lens of this framework, we show that to ensure good fiscal performance, indirect benefits should be envisaged for higher levels of fiscal effort. In order to account for the structural differences of exerting effort by different MS, it is efficient to adjust fiscal effort to the level of indebtedness.

1. Introduction

The recent problems of several European Union (EU) Member States (MS) with conducting countercyclical and prudent fiscal policy have called attention to the importance of the proper design of the fiscal governance framework. Despite the proliferation of numerical fiscal rules after 2000, the weak and, in practice, unenforceable constraints did not prevent many EU MS from expansionary policy during upturns, which led to insufficient fiscal space during downturns, and in turn, solvency problems for some MS.

The effort of conducting sustainable fiscal policy becomes especially difficult to exert in monetary unions, where MS might be tempted by moral hazards. With the backing of the entire union and under the limited control of EU institutions, European Monetary Union (EMU) MS have additional incentives to run high deficits. Thus, they may free-load and

¹This paper was prepared within the Firstrun project, which received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement no 649261. The author would like to thank his colleagues from CASE, Adam Smietanka, who greatly assisted the research.

exploit both own and, to a large extent, common credibility. In such circumstances, strong and credible rules are necessary in order to provide sufficient incentives for conducting countercyclical and prudent fiscal policy.

This paper addresses the problem of the effective design of EU fiscal governance, focusing on the EU's numerical fiscal rules, their enforcement, flexibility, monitoring, and the credibility of the sanctions for their breach. In order to define the properties of the optimal contract between EU institutions and MS, we conduct an econometric analysis of the determinants of the cyclically-adjusted balance (CAB). For this purpose we employ random effects instrumental variables regression and a large set of explanatory variables. We test significance of 20 variables suspected of being inter-related with countries' fiscal policy and compliance with fiscal rules. Among these variables are macroeconomic indicators, indexes and ratings, data on fiscal rules in place, breach of those rules, and other control variables accounting for macroeconomic situation and institutional setup.

Based on the observations from the econometric analysis, we use a game theoretical tool to describe the contractual environment. This is the incentives that agent and principal face, flow of information, the timing of decisions and the impact of randomly experienced shocks. More specifically, we build a dynamic principal-agent model, where the EU authorities act as a collective principal that designs contracts for MS, to illustrate the potential effects of changes in EU fiscal governance arrangements.

In the first part of the paper, we summarize the reforms in EU fiscal governance carried out since the establishment of the framework in 1997. We analyse the regulatory amendments concerning the strength of the rules, their flexibility, monitoring, and enforcement. The paper continues as follows. Chapter III defines fiscal effort and analyses its development in the EU between 2003 and 2017. Chapter IV complements the study by providing the results of the econometric analysis of the fiscal effort. Building on the observations from the econometric analysis, we construct a principal-agent framework to analyse the effects that different properties of fiscal rules have on the fiscal contracts. The derivation of the model and graphical and numerical results are presented in Chapter V. Chapter VI concludes.

2. Fiscal governance in the EU: a bird's eye view

The fiscal framework in the EU consists of the EU instruments applicable to all EU MS, the rules applicable to members of the EMU, and national mechanisms. Furthermore, some of the instruments imposed by the EU must also be transposed into national law. The foundations of EU fiscal governance are set out in the Treaties, whereas the mechanisms themselves are defined in the Stability and Growth Pact (SGP), which was introduced in 1997. The mechanisms have a twofold nature, and thus could be grouped into preventive and corrective mechanisms. The aim of the instruments within the preventive arm is to ensure that fiscal policy is conducted in a sustainable manner over the economic cycle,

whereas the preventive arm envisages corrective actions and sanctions in situations when rules are broken.

Since 1997, the SGP has been substantially amended three times. In its seminal version, the SGP defined Medium-Term Budgetary Objectives (MTOs) unilaterally across MS as a nominal deficit or surplus close to the budget balance. From 1997, the monitoring role was taken by both the Commission and the Council. Under the preventive arm, at least three elements were non-existent at the beginning – namely, escape clauses, corrective actions, and sanctions.

The corrective arm – the Excessive Debt Procedure (EDP) – applied to MS that breached the 3% nominal deficit, with an escape clause of special economic circumstances resulting in a 2% contraction in a given year. For MS that breached the limits, the Commission and the Council launched the EDP in order to develop tailored recommendations. In cases when recommendations were not followed, financial sanctions could be implemented. In practice, the procedures for addressing noncompliance with the recommendations were discretionary and lacked automaticity. Moreover, the sanctions were rather late. A fine in the form of a non-interest bearing deposit could be enforced at the earliest 16 months after the start of the procedure.

In 2005, the first major revision was carried out to introduce more flexibility in the procedures. The reform followed two controversial decisions of the EU Council in 2003-2004 concerning the non-enforcement of sanctions for France and Germany despite persistently breaching the 3% deficit rule. The new feature, which allowed for more flexibility, was the escape clause granted to MS, which introduced costly structural reforms. The adjustment path of the preventive arm was redefined as the adjustment of up to 0.5% of GDP per year with the value dependent on the debt overhang and the aging of society. More flexibility was also introduced within the corrective arm, since exceptional circumstances were redefined as the "below-potential growth."

After the global financial crisis, the instruments of fiscal governance were reinforced first in 2011 by the introduction of the Six-Pack Directive, and later in 2013 by the introduction of the Two-Pack² and Fiscal Compact³ (mandatory for EMU MS only). The new instruments aimed at establishing more stringent rules with higher credibility due to the automation of sanctions. Moreover, the amendments aimed at better alignment of the fiscal effort exerted by MS with the business cycle. In addition, increased monitoring was introduced in the form of the autumn draft budget assessments and the mandatory establishment of fiscal councils. To achieve better alignment with the business cycle, the new rule of 0.5% of the CAB was added to the existing numerical rules – namely, to the rule targeting the level of debt and the limit on nominal deficit. Furthermore, since 2011, sanctions have also been present under the preventive arm. Non-compliance with the rec-

²Regulation (EU) no 1173/2011 of the European Parliament and of the Council.

³Title III of the Treaty on Stability, Coordination and Governance in the Economic and Monetary Union.

Table 1: Reforms of the fiscal rules and their enforcement

	<i>2005, SGP Reform</i>	<i>2011, Six-Pack</i>	<i>2013, Fiscal Compact and Two-Pack</i>
<i>Strength of the rules and their legal entrenchment</i>			↑
<i>Flexibility escape clauses</i>	↑	↑	
<i>Flexibility – alignment to the business cycle</i>		↑	↑
<i>Monitoring</i>	↑	↑	
<i>Corrective actions</i>		↑	
<i>Enforcement – strength of sanctions</i>			↑
<i>Enforcement – automaticity of sanctions</i>			↑

↑ denotes increase in the criterion, source: own, based on Eyraud and Wu (2015).

ommendations may now trigger further steps in the procedures, including the possibility of an interest-bearing deposit amounting to up to 0.2% of MS GDP. Furthermore, the sanctions under the corrective arm in the form of a non-interest bearing deposit amounting to 0.2% of GDP were made more automatic by the introduction of a new voting mechanism. Moreover, the timing was improved as, currently, the first sanctions could already be applied four months after a breach of the rules is detected.

The reforms introduced since 1997 affected various parameters of the fiscal framework. To simplify the complexity of the reforms, we summarize the framework by eight features and judge whether the reform might have had a positive or negative impact on each of them (see Table 1).

In recent years, substantial changes were introduced, and not only to the union - wide fiscal framework. The trend of the proliferation of national fiscal instruments along with the increasing number of fiscal councils and the strength of their mandates could be observed in the EU. Already in 2014 there were more than 100 different numerical rules in all EU MS, which is over two times more than in 2014 (Begg, 2016). Since the establishment of the Fiscal Policy Council in Sweden in 2007, almost all EU MS have introduced institutions with similar mandates designed to monitor compliance with the elevated numerical rules. Simultaneous to the increase in the number of numerical rules, problems concerning commitment and enforceability were often experienced. The methods for non-compliance

with the national rules and the limits imposed by the EU varied. In some cases when MS were in dire straits, the rules were simply abandoned. In other cases, the parameters of the rules were recalibrated or the obligations were met thanks to window dressing, like the reclassification of public sector liabilities (Begg et al., 2017).

3. Fiscal effort in the EU and its evolution

The goal of the reforms was to establish appropriate incentives for MS, so that their efforts are aligned with the business cycle. Fiscal effort is a concept that is not directly measurable, as it aims to quantify something as intangible as "the attempt to produce something." The efforts of governments concerning deleveraging could depend on numerous factors – namely, political environment, percentage of fixed expenses, and, needless to say, economic circumstances. Thus, to have a one-size-fits-all measure, some specificities must be ignored. Traditionally, fiscal effort is defined as the CAB. A more refined concept than the structural budget balance, the CAB is an indicator of the nominal budget balance corrected by a cyclical component plus a broad range of factors, such as asset and commodity prices or output composition effects (Bornhorst, 2011).

The CAB is estimated using the top-down approach – that is, as the product of the output gap and a parameter reflecting the reaction of the government balance to a change in the output gap (the so-called budgetary semi-elasticity) (Mourrel, 2014). A crucial parameter utilized for the estimation is thus potential GDP, along with the semi-elasticities of revenue and expenditure components, which serve to estimate budgetary semi-elasticity.

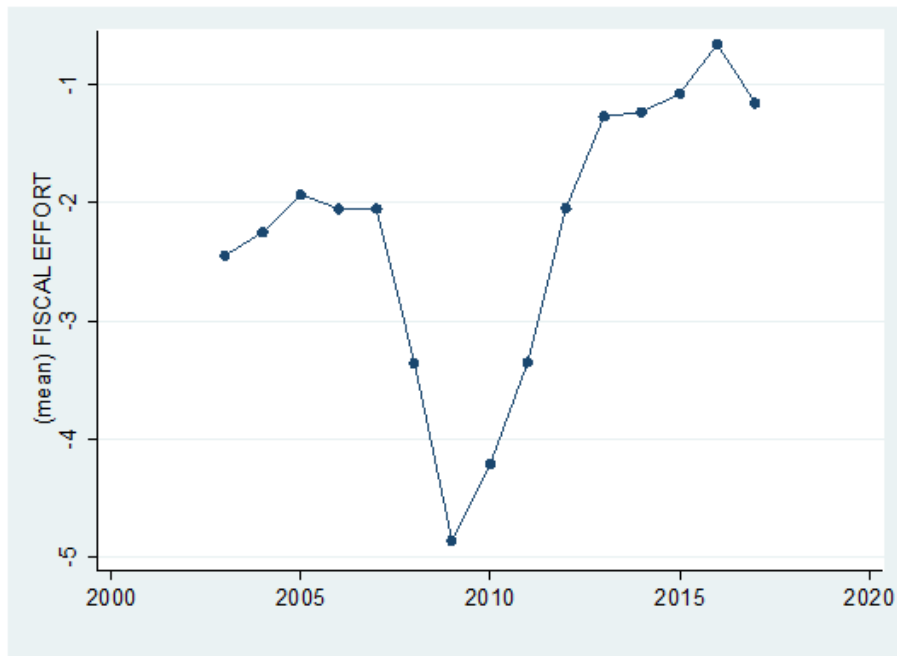
In this paper, in order to maximize the number of observations, we follow the traditional approach. The fiscal effort used in the subsequent analyses is the top-down estimate of the CAB of general government. The CAB was derived from the AMECO database.⁴

Since the measure of the CAB already incorporates the impact of the business cycle on public finance, it could be expected that the level of the so defined fiscal effort shall be independent from the economic cycle. However, it might be suspected that there are other factors that influence the level of exerted fiscal effort but are not linked directly to the MS economic cycle. Against this backdrop, as shown by Figure 1 and Figure A.6 in Appendix, the average fiscal effort in the EU was volatile between 2003 and 2017. In other words, it could be suspected that the effort defined as the CAB has been significantly affected by factors other than just the position of the business cycle.

Over the years preceding the crisis (2003-2007), the CAB fluctuated between -2.05 and -1.93%. In 2009, after the outbreak of the crisis, the value dropped to -4.86%, on average. Since 2013, the values were much more favourable, and the EU country-average ranged from -0.66% in 2015 to -1.26% in 2013. As shown by the graphs, structural deficits have been persistent, especially before the recent reforms of EU fiscal governance. It could be

⁴The real-time dataset can be freely accessed via the FIRSTUN website <http://www.firstun.eu/>.

Figure 1: Formation of financial stress in sample countries



Source: own, based on AMECO, the ex-post CAB used for the analysis originated from the oldest available vintages, which was a six-year lag for observations from 2003-2011, a five-year lag for 2012, a four-year lag for 2013, a three-year lag for 2014, a two-year for lag 2015, a one-year lag for 2016, and a same assessment for 2017.

concluded that the strength of the rules and their monitoring and enforcement have failed to encourage the buildup of sufficient buffers in good times. Although the output gap was positive or close to zero from 1999 to 2008, MS recorded, on average, a deficit in the CAB, which was higher than their economic growth. In turn, the level of debt between 2003 and 2014 increased by 26.2 percentage points in the EU-28 and 23.7 percentage points in the EMU.⁵

The high volatility of the average fiscal effort may suggest that there are other economic factors than the position of the cycle that determine the fiscal effort exerted by EU MS. As the observed fiscal effort was substantially higher before and throughout the crisis than it was after the crisis, the development of the fiscal effort may also point to the observation that the recent reforms had a positive effect on curbing the government expenditure of EU

⁵Source: Government Finance Statistics, Eurostat.

MS.

Similar interpretations of the development of and cause behind deficits are common in the literature. The problem of the effectiveness of the EU governance framework and the procyclicality of fiscal policy was analysed, among others, by Eyraud and Wu (2015). Despite depicting that the fiscal policy was too expansionary, the authors showed that the fiscal policy was procyclical in the period of 1999-2013. The procyclicality was marked during upturns since 1999, while it was mildly countercyclical during downturns.

4. Fiscal free riding in a the EMU

To verify which particular factors are behind high structural deficits and their volatility, we conduct an econometric analysis. We complement the recent literature by placing the center of gravity on numerical fiscal rules and the effectiveness of the fiscal governance reforms, while controlling for other relevant factors.

Traditionally, to investigate the factors underlying prudent and countercyclical fiscal policy or successful deleveraging, research papers utilize CAB as a dependent variable and focus on a limited group of countries and a rather short time perspective. Nerlich and Reuter (2015) focus, as we do in this paper, on the EU, and analyse the interactions between rules and fiscal space, which is understood as a country's room for manoeuvre concerning fiscal policy. They find strong evidence for fiscal rules being associated with higher fiscal space. They also argue that a country with either low or high fiscal space might introduce fiscal rules to either increase its fiscal space in the future or preserve good conditions. The strongest positive impact could be attributed to expenditure rules and balanced budget rules.

Plekhanov et al. (2007) analyse the determinants of fiscal consolidations in OECD countries using, among other tools, cross-country econometric analysis and model-based simulations. The authors analyse deep factors of successful consolidations and classify these consolidations in order to explain the key factors in their success. The analysis revealed that fiscal consolidations are usually initiated during times of fiscal distress, as reflected in high and rising public debt levels and relatively weak economic activity. Revenue-based fiscal adjustments have tended to be less durable than consolidations, which rely on cuts in current expenditures. According to the results of the econometric analysis, institutions and government stability are important determinants of successful fiscal adjustments.

Cevik and Teksoz (2014) examine the determinants of fiscal policy behavior on a broad sample of countries within the period 1990-2012. Their empirical results show that discretionary fiscal policy has an inertial nature. Namely, debt overhang and output gap determine future balances. In addition, the authors find the role of financial, demographic, and institutional factors to be significant. Importantly, fiscal rules and a higher institutional quality reduce the volatility of the fiscal balance over time.

In this paper, we employ an empirical model to explain the inter-relations between fiscal effort and both economic and institutional factors in a panel of 27 EU MS between

2003 and 2017. As the left-hand side variable, we utilize the CAB from the annual macroeconomic database of the European Commission’s Directorate General for Economic and Financial Affairs – AMECO.⁶ To obtain as long a time series as possible, we use the longest possible vintage of the CAB available. Thus, we use a six-year lagged estimate for years 2003-2011, a five-year for 2012, a four-year for 2013, a three-year for 2014, a two-year for 2015, a one-year for 2016, and an ex-ante assessment for 2017. As the estimates of the CAB could be revised quite substantially, we use ex-post estimates in order to have the most accurate indicators of fiscal effort, which is less accurate when estimated in real time.⁷

The initial database contained 20 variables suspected of being inter-related with countries’ fiscal policy and compliance with fiscal rules (see summary in Table B2 and B3, Appendix). Among these variables are macroeconomic indicators, indexes and ratings, data on fiscal rules in place, breach of those rules, and other control variables, such as the year when the SGP was reinforced, in the form of a dummy variable.

The explanatory variables included in the database could be grouped into macroeconomic and institutional variables. The macroeconomic variables aimed at explaining the internal and external conditions of conducting sustainable fiscal policy, which likely may go beyond the business cycle already incorporated in the CAB. Nevertheless, we use the real GDP growth rate to test whether this impact was fully captured. To account for difficulty in exerting effort, we also include variables related to current debt burden – namely, the current debt-to-GDP ratio, the debt-to-GDP ratio in 2003 (to control for different levels of indebtedness at the beginning of the analysed period), and the cost of debt represented by the yield on government bonds with a 10-year maturity. Furthermore, as a proxy of the current external economic situation, we use the IFO Business Climate Index.

Concerning institutional variables, in the first instance, we include the Fiscal Rules Index (FRI), which is a proxy on how much policy makers are restrained by the fiscal rules. The index is estimated by the EC services and available for the majority of the EU MS. The index encompasses coverage of the various rules, their statutory base, monitoring and enforcement mechanisms, as well as experience with respect to the rule. The FRI covers numerical rules (such as budget balance, debt, expenditure, and revenue rules) on all levels of government.

Finally, we introduced dummy variables for the EDP (being in place in a given year and for a given country), for the EU fiscal reforms (introduced in 2005, 2011, and 2013), and for the well-defined financial sanctions in place – more specifically, for the MS covered by the Fiscal Compact after 2013.

The large number of potentially correlated covariates available in each of these two vectors means that the model space is limited and allows for comparing only plausible specifications. To verify the link between these time-variant and/or country-specific vari-

⁶See <http://www.firstrun.eu/> for real-time data from the AMECO database.

⁷For the discussion of the reasons and magnitude of the CAB revision, see Busse (2017).

ables, we use a random-effects specifications of the form:

$$FE_{i,t} = \alpha + \beta MACRO_{i,t} + \gamma INST_{i,t} + u_{i,t} \quad (1)$$

Within the macro variables reported in the final specification (Appendix – Table A2: Estimation Results), the IFO Business Climate Index and the general government debt ratio were included. As the analysis showed, the growth rate was not statistically significant, meaning that EU MS exert fiscal effort independent of GDP growth. However, according to the estimates, it is easier to exert effort when the external economic situation is favourable and the debt overhang is low. The one percentage point increase in the level of debt resulted in a 0.015-0.025 percentage point decrease in the CAB, depending on the model specification.

Highly interrelated with fiscal effort is effectiveness of institutions, included in the model in the form of the FRI. All in all, an increase in the index, which ranged from a minimum value of -0.959 to a maximum of 3.868, resulted in a 0.74-0.78 percentage point improvement in the CAB. In addition, fear of sanctions was important for commitment to prudent fiscal policy.⁸ In the group of economies covered by the Fiscal Compact, fiscal effort was 0.95 to 1.75 percentage points higher.

In order to verify whether specific properties of the institutional framework have a role, we also test the significance of specific types of rules. For this purpose, we eliminate the FRI from the right-hand side variables (see specification B and E) and include dummies standing for the presence of particular rules. We find that the existence of only expenditure rules has a strong impact on fiscal effort. The existence of such resulted, on average, in a 2 percentage point improvement of the CAB. In addition, we find that the presence of other rules did not have a statistically significant impact on fiscal effort.

We also test the impacts of the reforms in 2005, 2011, and 2013, bearing in mind the parameters of the fiscal framework, which were affected (see Table 1). We find that the SGP reform in 2005, which provided more flexibility, had a negative influence on the exerted fiscal effort, whereas the changes introduced in 2011 had a substantial positive impact. After the 2011 reform, all EU MS have exerted more effort by approximately two percentage points. Amendments to the framework, which have been operational since 2013, were not proven to have a significant impact.

As there is likely an endogeneity problem related with the simultaneity between the change in debt and fiscal effort, we also estimate an instrumental variables regression. More specifically, to correct for the endogeneity issue, we instrument the contemporaneous level of debt with its initial level and all other right-hand variables (columns D-F, Table B4, Appendix).

⁸Namely, the increased automaticity and strength of sanctions after 2013 in the EMU, Denmark, and Romania, which are bound by both the fiscal and economic coordination provisions of the Fiscal Stability Treaty.

Since, as the econometric analysis proved, the fiscal effort does not depend on the stage of the business cycle, the ex-post CAB is a good proxy of fiscal effort. Nevertheless, the effort is affected by the external situation and the debt overhang. MS are tempted to spend more when the world economic situation is worse and when their indebtedness is high. The second observation might relate to the debt servicing cost, which usually increases more than proportionally with the increase of debt, or partially to the fact that some long-term features of MS conducting expansionary fiscal policies are not addressed by the set of explanatory variables. The estimates also proved that some features of the institutional setup have an especially significant impact. The results provide clear evidence that expenditure rules and the inevitability of sanctions are effective features of the institutional setup that help to curb government expenditure. However, we are modest in interpreting the causality of institutional factors. We bear in mind that institutions may impact fiscal effort and that fiscally responsible governments might be more willing to improve the institutional setup. As the FRI grasps both national and super national instruments, we suspect that the causality is rather of the first type.

The evidence from the econometric analysis proves the plausibility of the assumptions of the principal-agent framework. Firstly, the EU institutions react to economic conditions in EU MS with a delay and with a certain amount of noise. As the EC monitors and evaluates aggregate real-time figures, it does not have an entirely clear picture of the effort that led to a certain level of "fiscal" output. The issue of private information is an inherent feature of the relationship between the Commission and MS, as well as an important feature of principal-agent framework (Hodson, 2009).

Moreover, the political incentives of the Commission and EU MS differ, with national governments being tempted by higher spending to increase their chances for reelection. On the contrary, the Commission aims at optimizing the economic situation of all MS and does not have such strong incentives to allow for expansionary fiscal policy. This is also an important element of the principal-agent relationship present in the EU fiscal governance framework, namely payment for effort. In the case of fiscal balances exceeding the limits, EU institutions are able to impose financial sanctions in form of both interest bearing and non-interest bearing deposits. The gains of MS of conducting prudent and sustainable fiscal policy could also be indirect in the form of country-specific recommendations and pressure from financial markets (Gros and Alcidi (2015)).

The view on the relationship between the Commission and MS through the principal-agent lens has already been offered by a number of political economy papers (see e.g. Hodson (2009); Hussein and Menond (2003); Mahera et al. (2009)). In this paper, we go beyond the qualitative framework and show quantitatively what the impact might be of different features of EU fiscal governance on the effort and credibility of the contract between the principal and agent. To contribute to the understanding of this dynamic relationship, we employ a fully-developed continuous-time principal-agent model, and present a sensitivity analysis of the results to particular changes in the parameters of the model. Keeping in mind the political constraint of introducing fiscal rules perfectly adjusted to

each MS, the next section aims at answering the following questions:

- How to design an optimal fiscal contract in terms of payoffs and obligations?
- How does the current setup differ from the optimal contract?
- What are the properties of the contract which make it credible – that is, when will agents meet their contractual obligations?
- How to design the contract to account for the different costs between MS in exerting fiscal effort?

5. The model

The model used in this paper builds on the major contribution of Sannikov (2008), which developed the method for deriving and studying continuous-time principal-agent problems. Compared with the discrete-time recursive approach, the method proposed by Sannikov is less computationally intensive and easier to execute.⁹ Moreover, it enables us to study dynamics in an infinite time horizon.

To derive the optimal contract in the complex stochastic dynamic setup, a number of mathematical derivations are necessary. Since the paper concentrates on the applied side of the model, some of the technicalities were omitted in the main body of the paper.

In the contractual environment of the model, the effect of MS fiscal effort, which is observed in real time, is the nominal level of debt. The level of debt evolves according to the equation:

$$dD_t = A_t dt + \sigma dZ_t \quad (2)$$

where Z_t stands for a random motion process which could be associated with all random exogenous factors. Parameter σ is known and stands for the strength of imperfect action monitoring. A_t could be associated with fiscal effort.

As the econometric analysis proved, Z_t in reality refers to the economic situation associated with the business cycle. Since these factors cannot be perfectly monitored by the Commission, the effort of MS is to some extent unknown. The Commission is able to observe the CAB, but based on ex-ante estimates, it cannot be completely accurate in judging the fiscal effort exerted by the MS.

The principal maximizes its profit, which we associate with the fiscal stance of the MS. The maximization of profit takes place before the arrangements start. The principal needs to commit to a long-term contract and follow the rules it had implemented. Thus, in this model approach, once the rules of the game are established, they cannot be modified.

⁹See e.g. (Holmstrom and Milgrom, 1991) or Phelan and Townsend (1991) for a computable long-term discrete-time framework.

The principal's intertemporal profit could be characterized as:

$$U_0^A = E \left[r \int_0^\infty e^{-rt} (A_t - P_t) dt \right] \quad (3)$$

where r is a common discount rate and P_t stands for the pay-off scheme for the exerted effort. This could be treated as a synthetic measure of the Commission's penalties and rewards for being a member of the EMU and for conducting sustainable macroeconomic policy.

The principal's maximization problem is subject to delivering the agent reservation utility $-$, namely, the boundary utility of being a member of the EMU (W_0):

$$W_0 \leq E \left[r \int_0^\infty (e^{-rt} (u(P_t^*) - h(A_t^*))) dt \right] \quad (4)$$

where $u(P_t^*)$ is agent's utility from the rewards from the Commission and EMU membership in the optimal contract, whereas $-h(A_t^*)$ is the disutility from exerting effort $-$ namely, the political cost of tightening government expenditure.

In addition, the contract needs to be incentive compatible, which means that it must always be profitable for the agent to exert the level of effort envisaged by the principal. So that, for any P_t and A_t :

$$E \left[r \int_0^\infty (e^{-rt} (u(P_t) - h(A_t))) dt \right] \leq E \left[r \int_0^\infty (e^{-rt} (u(P_t^*) - h(A_t^*))) dt \right] \quad (5)$$

The equations (2-5) describing the assumption of the framework depict that the contracts are history dependent. In order to solve the problem, it needs to be reformulated in terms of the expected continuation pay-off. The expected lifetime payoff, as proved by Sannikov using the martingale representation theorem, is the variable that fully describes the contract at any stage. The continuation value accounts for the accumulated future promises of the agent, who expects increased benefits from the EU after it conducts its policy in accordance with the rules, and decreased benefits after the rules are not satisfied.

The optimal control problem takes the form of:

$$F(W_0) = \max E \left[r \int_0^\infty e^{-r(u-t)} (A_u - P_u) dt \right] \quad (6)$$

with respect to A_u and P_u , such that the law of motion of the continuation value is satisfied:

$$dW_t = r(W_t - u(P_t) + h(A_t))dt + r\Omega_t(A_t)(dY_t - A_t)dt \quad (7)$$

where $r\Omega_t(A_t)$ is the sensitivity of the continuation value to output innovation determined by incentive compatibility. $\Omega_t(A_t)$ is set to minimal level since it is costly to expose the agent for risk.

The continuation value denoted by equation (6) decreases in time with every repayment, but at the same time increases as future payoffs become closer at hand. $(r(W_t - u(P_t) + h(A_t)))$ could be regarded as the drift of the continuation value since the innovation-dependent component $r\Omega_t(dY_t - A_t)dt$ with a mean of zero.

As shown by Sannikov, the optimal contract must terminate in specific situations that is, after sufficiently poor performance or sufficiently good performance. The fulfilment of future promises for exerting extra effort might appear to be too costly for the principal ($W = \tilde{W}$) or might be not worth providing any incentives ($W = 0$). Retirement might be associated with the situation when MS abandon EU fiscal arrangements. An example of such a situation might be the exit of the MS from the EMU, which was heavily speculated when Greece encountered severe problems with servicing its debt. In the situation when the agent is retired, the principal provides constant retirement profit of the form:

$$F_0(u(P)) = -p \quad (8)$$

Omitting the time index, the solution of the above- described optimal control problem must satisfy the Hamilton-Jacobi-Bellman (HJB) equation of the form:

$$F''(W) = \min_{C, A > 0} \left[\frac{F(W) - A + C - (W - U(C) + h(A))F'(W)}{r\Omega^2\sigma^2/2} \right] \quad (9)$$

subject to boundary condition $F(0) = 0$, $F(\tilde{W}) = F_0(\tilde{W})$ and $F'(\tilde{W}) = F'_0(\tilde{W})$.

6. Results

6.1. Optimal contract

The key assumption to the model, which makes it solvable, is the assumption of the perfect-commitment of the principal. The agent, assuming its rationality, will always optimize its action at any period, it will decide on the level of effort that maximizes its discounted value of future payoffs.

In a situation when the agent does not believe in the fulfillment of the principals promises (e.g. the imposition of sanctions for breaching the rules), the agent's behaviour would not be optimal. In order to meet the political constraints in imposing the sanctions, it must be ensured that even if the sanctions appear, the agent's reservation utility is met (see equation (3)) – that is, it is still profitable for the MS to continue the contract even if the sanctions appear. Practically, the fear of sanctions will lead to the situation when the rules are breached only in extraordinary situations.

The credibility of fiscal instruments is obtained by the numerical properties from the beliefs about the inevitability of sanctions for breaching the rules. In order to estimate the properties of the rules, we search for the solution of the second-order non-linear equation (see equation (8)). To find the largest slope of $F(W)$, we iterate among potential solutions for different $F'(0)$ and verify whether the boundary conditions are met. As in Thakur

(2015), to solve the differential equation, we use Runge-Kutta numerical method and search for the roots of the non-linear function using the bi-section style method.

The objective is not to show specific values but rather general observations on what the optimal contract looks like. Thus, in order to verify the properties of different contracts, we assume the functional form of the utility function and value of parameters in a manner similar to Sannikov (2008).¹⁰

In the optimal contract, the principal adjusts its payment ($p(w)$) to the agent's continuation value to provide proper incentives for exerting more effort and to ensure that it will be profitable for the agent to continue the contract (see Figure 2). The payment increases more than proportionally with the exerted effort to account for the increasing political costs of a higher fiscal effort. However, in cases of extremely positive tailwinds, it might be unprofitable for the principal to continue the contract. A similar situation may appear when the agent's continuation value drops to 0.

The dynamics of effort across continuation value ($h(W)$) are not trivial and are highly dependent on h 's functional form. In general, the agent will exert more effort when his continuation value is low in the period when the effect-output is low and the current benefits from the commitment are low as well.

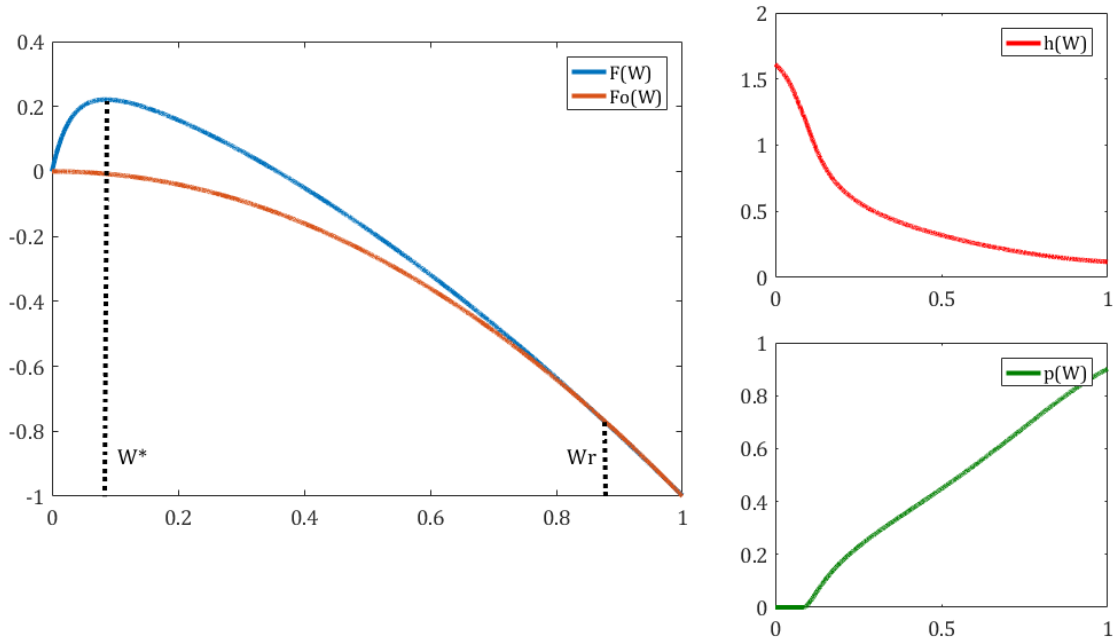
6.2. Current arrangements through the principal-agent lens

Currently, there are a number of differences between the theoretical optimal contract and the practical incentives mechanism provided by the EU. Both under the preventive arm (in the form of MTOs) and the corrective arm (in the form of deficit and debt limits), the effort required by MS is flat (see Figure 3) – namely, the gains from the higher than "sufficient" effort are not incentivised.

In the current situation, the effort is constant and the payment is more steep than in the current arrangements (for a comparison, see Figure C7, Appendix). The principal is willing to incentivise the agent to exert more effort. As a result, when the external situation is very not favourable, he promises relatively higher payments for the increase in effort. The increase in expected future payments after good results leads to higher continuation values. With the more flat contract the principal is unable to make the risk-averse agent exert higher effort in the states of nature, when it is more costly to do so. Moreover, the probationary period – that is, the period when the payments equal zero, is longer as, in general, the level of required effort at the beginning of the contractual arrangement is higher in the optimal contract. This objective is to make the situation of low-output relatively less attractive for the agent.

¹⁰Which is $u(P) = p^\alpha$, where $\alpha = 0.5$, and $h(A) = aA^2 + bA$, where $a = 0.5$ and $b = 0.4$. Parameter σ is set to 1, and the rate (r) to 0.1.

Figure 2: Theoretical optimal fiscal contract



Source: own, W^* stands for the optimal continuation value, W_r stands for the retirement value, $F_0(W)$ is retirement profit, $F(W)$ – principal’s profit, $h(W)$ – agent’s effort function, and $p(W)$ – payoff function.

6.3. Impact of better surveillance

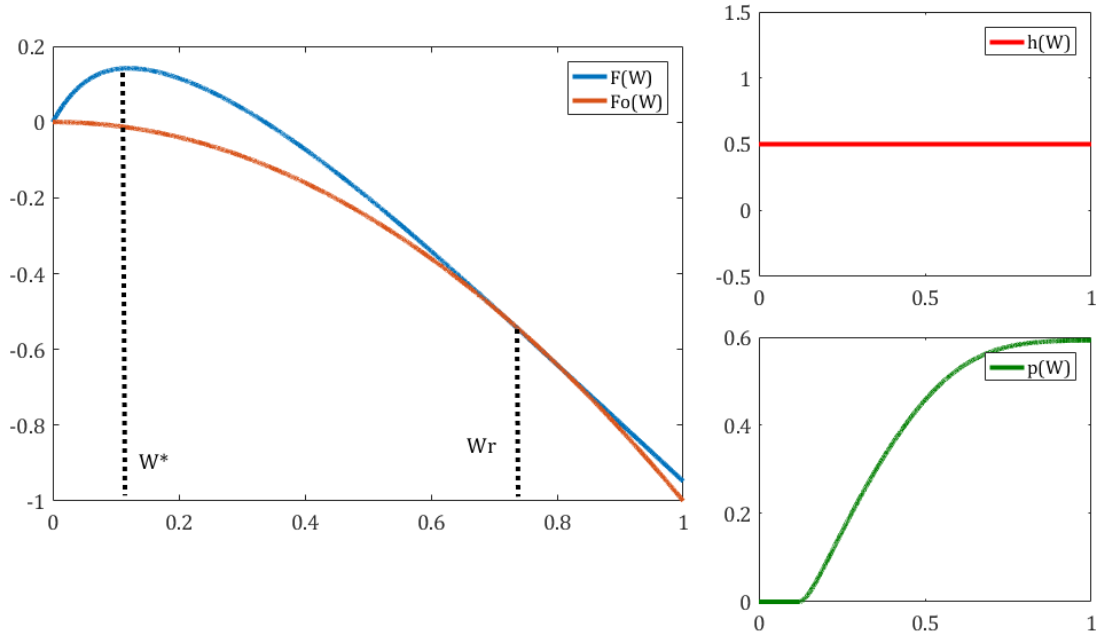
As suggested by the econometric analysis, there are significant gains from the increased monitoring introduced with the introduction of the Six-Pack Directive. Since 2001, well-developed monitoring has been in place in the form of the European Semester and Macroeconomic Imbalance Procedure.

As illustrated by Figure 4, the increased monitoring resulting from the lower value of θ increases the principal’s utility and the sustainability of MS fiscal policy. Since the magnitude of information asymmetry is lower, the payoffs necessary to incentivise the agent can be lower.

6.4. Differentiation of contracts

The econometric analysis also found that fiscal policy has a substantial degree of inertia that is, it is more costly for indebted countries to consolidate their finances. To account for the difference in this cost of exerting effort, the optimal contract for the two types of agents has a different form (see Figure 5).

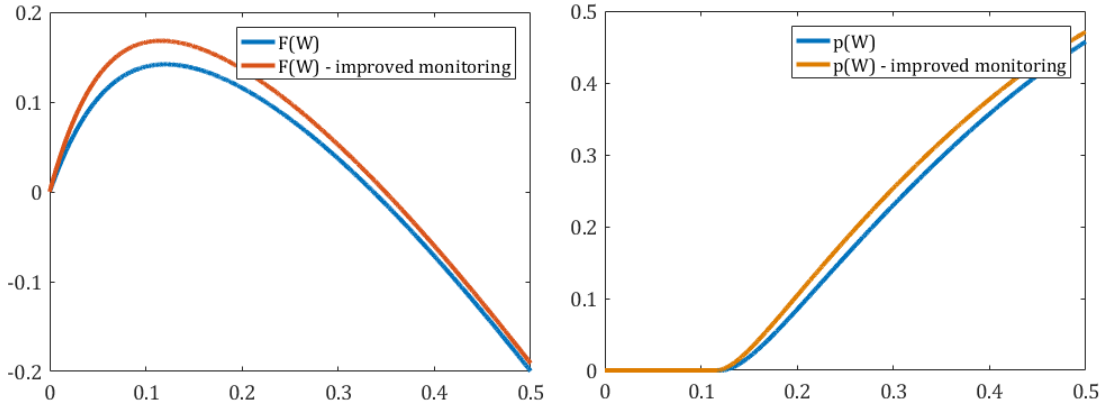
Figure 3: The model of the current EU fiscal contract



Source: own. W^* stands for the optimal continuation value, W_r stands for the retirement value, $F_0(W)$ is retirement profit, $F(W)$ – principal’s profit, $h(W)$ – agent’s effort function, and $p(W)$ – payoff function. Constant effort of 0.5 was assumed.

Firstly, the incentive scheme is more flat. It is not worthwhile for the principal to reimburse the agent for the more costly effort. Therefore, the required level of effort is lower in any circumstance. The principal’s utility is also lower.

Figure 4: The impact of increased monitoring



Source: own. $F(W)$ is principal's profit, $h(W)$ – agent's effort function, and $p(W)$ – payoff function. For the "improved monitoring" case, σ equals 0.9.

7. Conclusion

In this paper, we have addressed the problem of the effectiveness of numerical fiscal rules in the EU using econometric tools, complementing this analysis with formal modeling, through the lens of a dynamic principal-agent framework.

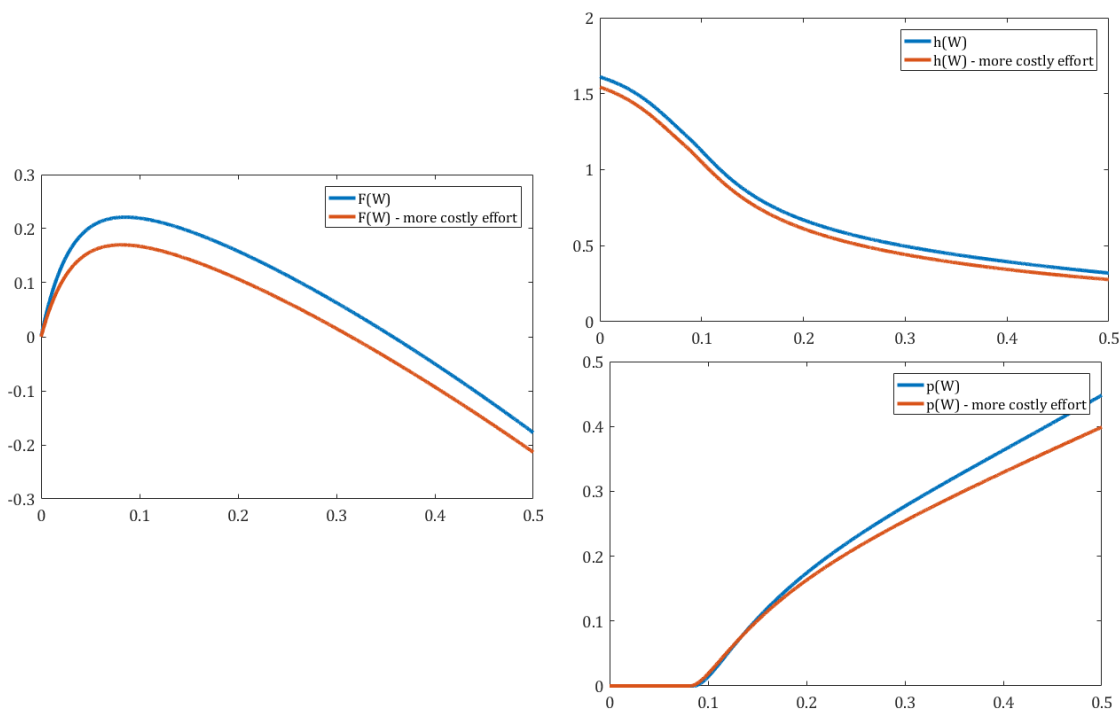
The preliminary study showed that CABs have significantly varied across EU MS between 2003 and 2017, indicating that non-CABs depend on factors other than just the economic cycle. According to the econometric analysis, fiscal policy has a substantial degree of inertia. MS with higher levels of public debt conduct more expansionary fiscal policies. Moreover, the external economic situation matters. During sound times for the world economy, EU MS tend to restrain their cyclical balances, independent of the country's economic situation.

Institutional factors play a significant role in determining fiscal effort. The existence of numerical fiscal rules, their strong legal entrenchment, surveillance mechanisms, and credible sanctions tie the hands of governments and provide incentives for ensuring anticyclical and prudent fiscal policy. The most influential instruments proved to be the expenditure rules and the external sanctions for breaching the rules.

The econometric analysis has also showed the effectiveness of the Six-Pack Directive, which came into force in 2011, in limiting government profligacy. On the contrary, the reform of the SGP in 2005 proved to be counterproductive.

The relationship between the Commission and EU MS has elements in common with the assumptions of the principal-agent model. Asymmetry of information, moral hazard,

Figure 5: The optimal contract for various effort functions



Source: own. $F(W)$ is principal's profit, $h(W)$ – agent's effort function, and $p(W)$ – payoff function. For the case of a more costly effort, $h(A) = 0.5A^2 + 0.5A$ was assumed.

different objectives, and the ability to reward or punish the principal are the key elements of the framework and exist in the relationship between the EU and national governments.

The sensitivity analysis with the dynamic principal-agent model showed from a theoretical standpoint that, to ensure the credibility of the contract and its best possible output, payment shall be differentiated in line with the exerted fiscal effort. To ensure good fiscal performance, indirect benefits should be envisaged for high fiscal efforts from MS. To decrease the cost of incentivising MS, attention should be focused on monitoring the economic situations of MS. Moreover, to account for the structural differences of MS, it might be worth adjusting the fiscal effort based on the level of indebtedness. To ensure that the recommendations are followed, in general, MS with higher levels of indebtedness prior to a contract agreement should be required to exert less effort. There are obvious problems in executing recommendations based on tailor-made contracts or rewards for implementing fiscal effort. However, differentiation is already present, for instance, in the form of MTOs and country-specific recommendations.

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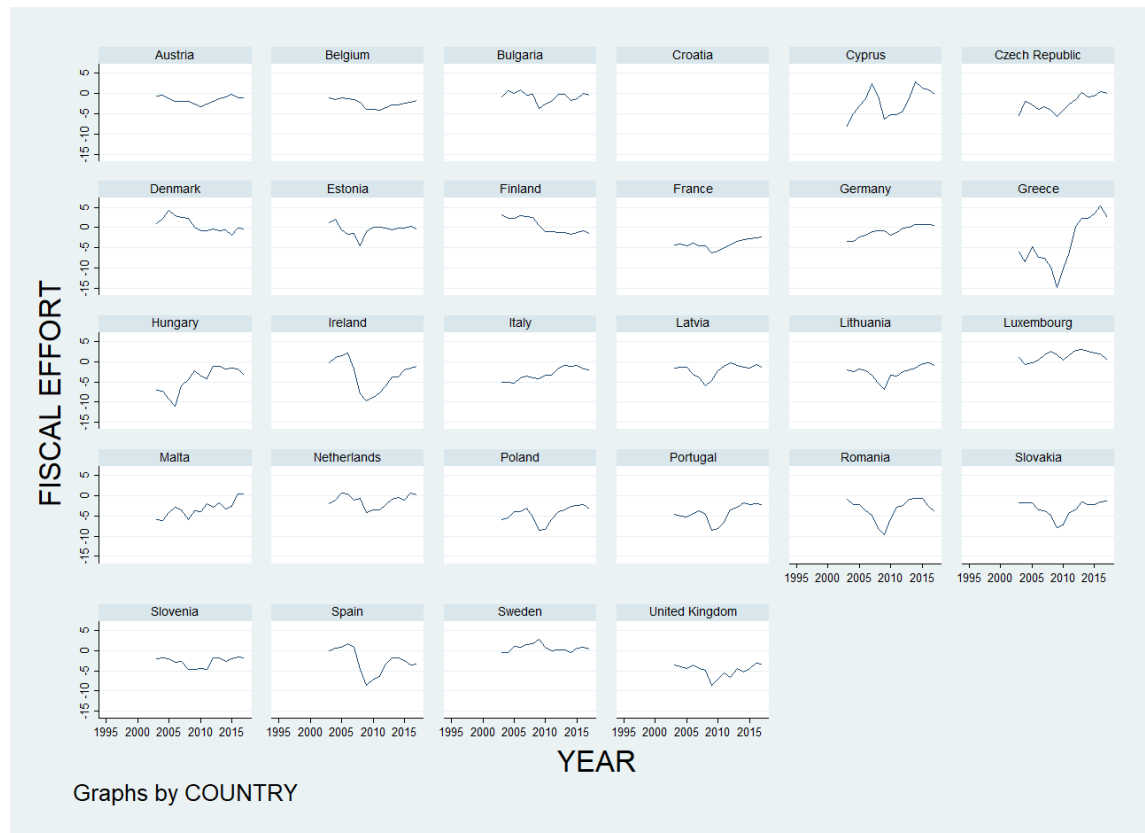
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Appendix A. Fiscal effort by MS

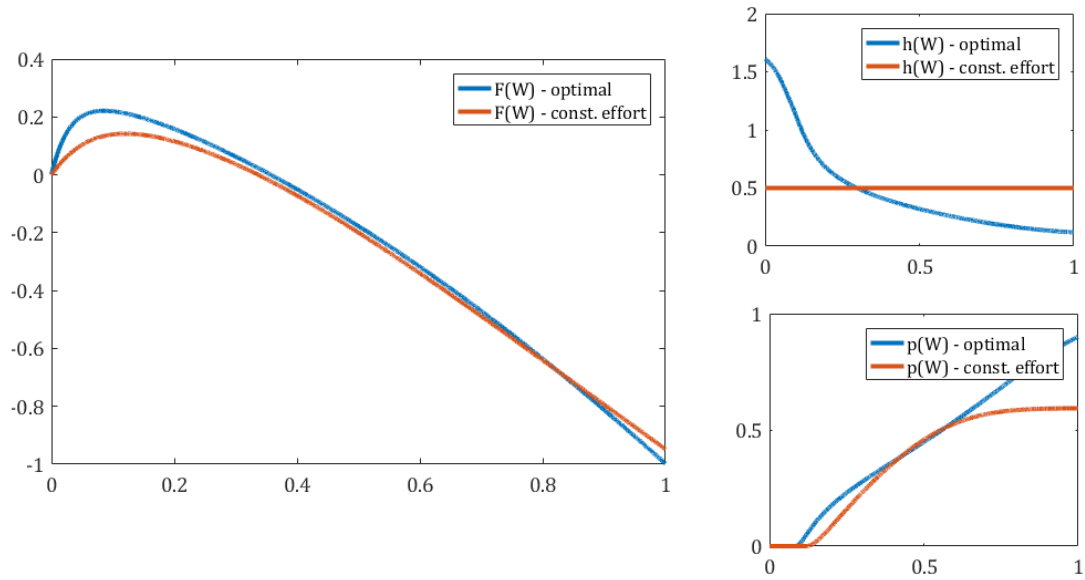
Figure A.6: Fiscal effort by MS



Source: own elaboration, based on AMECO. Ex-post CAB with the oldest available vintages. Six-year lag for years 2005-2011, five-year for 2012, four-year for 2013, three-year for 2014, two-year for 2015, one-year for 2016, and ex-ante assessment for 2017.

Appendix B. Comparison of contracts

Figure B.7: Theoretical optimal contract vs. current contract



Source: own. W^* stands for the optimal continuation value, W_r stands for the retirement value, $F_0(W)$ is retirement profit, $F(W)$ – principal's profit, $h(W)$ – agent's effort function, and $p(W)$ – payoff function.

Appendix C. Variable description, model specification and estimation results

Table C.2: Macroeconomic variables

Variable	Source	Observations	Mean	Standard deviation
Fiscal Effort – CAB	AMECO	405	-2.26	2.81
Debt to GDP	Eurostat	602	55.26	32.37
Debt to GDP – initial level	Eurostat	644	47.79	25.20
Real GDP growth (yoy)	Eurostat	588	0.0256	0.0349
General government deficit to GDP	Eurostat	607	-2.80	3.50
Cost of debt – yield on 10y government bonds	ECB	477	4.48	2.50
Business Climate Index	IFO	644	5.99	13.28

Source: own.

Table C.3: Institutional variables

Variable	Source	Observations	Mean	Standard deviation
Polity index	Polity IV	560	8.76	4.87
Executive constraints index	Polity IV	560	6.24	4.39
Fiscal Rules Index	European Commission	588	0.0613	0.929
Existence of national expenditure rule	Fiscal rules database – FAD	588	0.4013	0.4905
Existence of national balanced budget rule	Fiscal rules database – FAD	588	0.7942	0.4046
Existence of national debt rule	Fiscal rules database – FAD	588	0.8163	0.3875
Existence of national revenue rule	Fiscal rules database – FAD	588	0.0935	0.2917
Excessive Deficit Procedure dummy	Own elaboration based on EC	644	-	-
2005 Reform Compact – dummy	Own elaboration based on EC	644	-	-
2011 Six-Pack – dummy	Own elaboration based on EC	644	-	-
2013 Two-Pack and Fiscal Compact – dummy	Own elaboration based on EC	644	-	-
EMU membership dummy	Own elaboration based on EC	644	-	-
EU membership dummy	Own elaboration based on EC	644	-	-
Existence and applicability of applying financial sanctions	Own elaboration based on EC	644	-	-

Source: own.

Table C.4: Estimation results

Variable	A (RE)	B (RE)	C (RE)	D (RE IV)	E (RE IV)	F (RE IV)
General government debt	-0.015** (0.027)	-0.015*** (0.000)	-0.025*** (0.000)	-0.021* (0.055)	-0.019* (0.058)	-0.021** (0.025)
Business Climate Index (IFO)	0.039*** (0.000)	0.037*** (0.000)	0.041*** (0.000)	0.038*** (0.000)	0.036*** (0.000)	0.041*** (0.000)
Fiscal Rules Index	0.745*** (0.000)	0.780*** (0.000)		0.740*** (0.000)	0.784*** (0.000)	
Sanctions in place	1.567*** (0.000)		1.056*** (0.009)	1.746*** (0.000)		0.950** (0.026)
Expenditure rule			2.057*** (0.000)			2.056*** (0.000)
Debt rule			0.784 (0.440)			0.755 (0.458)
Balanced budget rule			-1.016 (0.236)			-1.033 (0.458)
Revenue rule			-0.011 (0.984)			-0.030 (0.958)
2005 reform		-0.618** (0.037)			-0.604** (0.045)	
2011 reform		1.951*** (0.000)			2.010*** (0.000)	
2013 reform		-0.547 (0.216)			-0.544 (0.223)	
Constant	-2.422*** (0.000)	-2.138** (0.000)	-2.364*** (0.002)	-2.067*** (0.002)	-1.971*** (0.001)	-2.553 (0.001)
no. of observations	351	351	351	351	351	351
R^2						
within	0.1847	0.2316	0.2017	0.1789	0.2296	0.2028
between	0.3865	0.3301	0.5460	0.4007	0.3379	0.5604
overall	0.2505	0.2660	0.3335	0.2612	0.2709	0.3312

Source: own. Note: values in brackets denote p-value ($P > |t|$), * denotes significance at the 10% level, ** denotes significance at the 5% level, while *** denotes significance at the 1% level.