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Measurement of Fiscal Rules: Introducing the Application of Partially Ordered Set (POSET) Theory[☆]

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Abstract

Data on (economic) institutions are often available only as observations on ordinal, inherently incomparable properties, which are then typically aggregated to a composite index in the empirical social science literature. From a methodological perspective, the present paper advocates the application of partially ordered set (POSET) theory as an alternative approach. Its main virtue is that it takes the ordinal nature of the data seriously and dispenses with the unavoidably subjective assignment of weights to incomparable properties, maintains a high standard of objectivity, and can be applied in various fields of economics. As an application, the POSET approach is then used to calculate new indices on the stringency of fiscal rules for 81 countries over the period 1985 to 2012 based on recent data by the IMF (2012). The derived measures of fiscal rules are used to test their significance for public finances in a fiscal reaction function and compare the POSET with the composite index approach.

Keywords: Partially ordered set theory (POSET), Index functions, Fiscal rules, Public finances

JEL-Codes: C43, H60, E62

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1. Introduction

The recent financial and economic crisis, in highlighting the fiscal profligacy of many governments during the pre-crisis period, has led to a revival of both the public and academic debate on whether policy makers should be constrained in their discretion. The political-economic rationale underlying the present discussion is well understood:

‘Fiscal profligacy occurs because politicians find it politically optimal given the constraints and pressures they face. It will continue as long as the same pressures and constraints are in place. Restoring fiscal discipline therefore requires . . . adopting institutions that bind the budgetary process.’ (Wyplosz, 2010, p. 35)

From a theoretical perspective it is well established that (fiscal) institutions affect (fiscal) policy outcomes (Persson et al., 1997, 2004; Poterba and von Hagen, 1999; Debrun and Kumar, 2007). And while there is also some evidence on the effects of fiscal rules on fiscal policy (e.g., Fatás and Mihov, 2006; Krogstrup and Wälti, 2008; IMF, 2009), an open issue and key difficulty in the empirical literature is the lack of an objective, widely accepted approach to measure (the stringency of) fiscal rules.

Fiscal rules can be described by numerous properties in terms of both legislative acts and informal agreements, which are typically ordinal in nature and not comparable with each other. This requires a choice of which characteristics to use and – if they are aggregated into one composite index as it is common in this strand of the literature – how to assign (cardinal) values and weights to particular properties. The unavoidably high degree of subjectivity and wide variety of measures used is likely to be one key reason for the partly conflicting results in the literature and the lack of consensus on the optimal design of fiscal rules.

The present paper suggests, as an alternative approach to construct measures of fiscal rules, the use of partially ordered set (POSET) theory, which is well established in the natural and technical sciences, but has – to the best of our knowledge – not been applied in the empirical economics literature so far.¹ The attractiveness of the POSET approach is that it builds on well-established mathematical concepts, fully exploits all information contained in the data and reduces the need for subjective choice to a minimum.

In particular, the purpose of this paper is threefold. First, it introduces POSET theory as an alternative to the widely used index function approach. Although this choice is motivated by the subject of the present paper and the nature of (data on) fiscal rules, we argue that the POSET approach is a useful alternative in other applied fields of the social sciences as well.

¹ In the economics literature POSET theory has been employed in very different contexts, e.g., for the computation of winning strategies in game theory (Soltys and Wilson, 2011) or for the derivation of supermodularity and preferences in utility theory (Chambers and Echenique, 2009).

Second, the POSET approach is used to construct various measures of numerical fiscal rules based on data from IMF (2012), which contains information on the properties of fiscal regimes for 81 countries dating back to 1985. Third, these POSET indices are used to investigate the effect of fiscal frameworks on public finances and thereby compare fiscal rules indices derived by the composite index and the POSET approach, respectively.

The remainder of the paper is organized as follows. Section 2 provides a brief review of the literature on fiscal rules with a focus on the measurement of fiscal frameworks. Section 3 discusses issues in constructing measures of fiscal rules and makes the case for the use of partial order set (POSET) theory to rank countries according to their (stringency of) fiscal rules. Section 4 makes use of recent IMF data to calculate POSET indices of fiscal rules for 81 countries over the period 1985-2012. Section 5 uses the indices of fiscal rules as explanatory variable in a fiscal reaction function and compares the results from the POSET approach with those from a composite index approach. Section 6 summarizes the results and concludes.

2. Measures of Fiscal Rules: Previous Studies

There is a large theoretical literature, motivating the need for constraining fiscal policy discretion by fiscal rules. The main arguments relate to market failures and incentive structures that create a deficit bias of policy makers (common pool problem, information asymmetry, short-sightedness of policy makers, political competition and outside pressures). Another argument for binding the budgetary process has been put forward by Fatás and Mihov (2003, 2006), who argue that fiscal constraints lead to lower volatility of discretionary fiscal policy, lower output volatility and thereby enhanced economic growth.

Regarding the potential downsides of (possibly too stringent) fiscal rules, Blanchard and Giavazzi (2004) and Beetsma and Debrun (2007) point to the tradeoff between sufficient government investment (spending) and the requirement of low deficits imposed by budgetary rules. Manasse (2005) discusses the tradeoff between reducing the deficit bias and the cost of foregone stabilization.

There is also large empirical literature, investigating the effects of fiscal rules on fiscal outcomes. The interest in assessing the effects of alternative fiscal institutions and their impact on public finance has been growing in the last decade, following the consolidation efforts in the aftermath of the economic and financial crisis and the subsequent European debt crisis. As a result, fiscal consolidation has become a major objective of governments and the European Union (EU) institutions that took measures like the re-formulation of the Stability and Growth Pact and the implementation of the Fiscal Compact in order to regulate and strengthen the stability of the member countries' budgets.

The present paper does not aim at providing a comprehensive survey of the voluminous theoretical and empirical literature.² Rather, we review a few well known papers that are also representative of the approaches that have been used in previous studies for the measurement of fiscal frameworks.

Some of the studies use dummy variables indicating the existence of (specific features of) fiscal rules (e.g., Guichard et al., 2007; Brzozowski and Siwinska-Gorzalak, 2010; Galí and Perotti, 2003). These studies use binary variables to indicate if a country has a specific type or design of rule (balanced budget rule, golden rule, debt rule in law or constitution, etc.) in force and/or test for structural breaks at the year of the introduction of the fiscal rule. In most studies, the dummy variables indicating the existence of fiscal rules turn out to be significant in various empirical settings using fiscal performance measures as dependent variable (such as the primary balance, fiscal policy volatility, or the debt level). While these results are suggestive and binary variables are valuable tools in econometric analyses, their informational content (and the number of dummy variables that can be included) is limited and they might be prone to capture the effects of other (omitted) variables.

Most studies on fiscal rules rely on an index function approach, where alternative properties related to the stringency of fiscal rules are numerically evaluated (ranked) and aggregated into a composite index, typically by calculating a weighted average (e.g., Advisory Council on Intergovernmental Relations, 1987; Alesina et al., 1999; Debrun et al., 2008).³ This strand of studies typically calculates indices using data from surveys among practitioners or officials of international organisations. Indices can be based on five different questions (properties) as, e.g., in Debrun et al. (2008), or on more than 20 properties as, e.g., in von Hagen (1992); the selection and weighting of the various categories (groups of questions) is based on by the judgment of the authors. And while these studies are suggestive and point to a significant role of fiscal rules indices on public finances, the composite index approach has some limitations that will be discussed in the next section.

3. Measuring Fiscal Rules: Methodological Issues

As indicated in Section 2, there is a large variation in the measures of fiscal rules employed in the literature, reflecting the difficulties to quantify institutional arrangements. This is a shortcoming, and a more widely accepted approach to measure fiscal

² A review of the theoretical arguments for and against fiscal rules is given by Wyplosz (2012) and IMF (2009). A descriptive overview of fiscal regimes and rules is given by Schaechter et al. (2012).

³ Such an index function approach is widely used in economics to consolidate information and to allow numerical analyses; examples are composite indices measuring corruption, economic freedom, the rule of law, central bank independence, or the degree of federalism.

rules seems warranted to estimate their determinants (and their effects on fiscal performance), to enable a comparison of alternative studies, and to derive policy conclusions on the optimal, i.e., most effective and efficient design of fiscal rules.

3.1. General Considerations

There are several issues in the construction of composite indices.⁴ Generally, there are three stages which need subjective decisions: i) the selection of the objects and the relevant properties, ii) the assignment of weights to each of the properties, and iii) the aggregation technique used to combine the individual properties.

The choice of objects and properties is less controversial; it often arises directly from economic theory and is typically also determined by (restrictions on) data availability. Assigning weights to and thereby judging the relative importance of specific properties is more critical.⁵ Moreover, the numerical valuation properties (that are often ordinal in nature) and their scaling are more or less arbitrary and different approaches can imply very different outcomes (Maggino and Fattore, 2011). Finally, the aggregation process is problematic since it assumes the existence of compensations and trade-offs among (typically) incomparable properties.

These arguments do often apply to empirical studies in the social sciences and they do specifically apply to the measurement of fiscal rules, which can be described by numerous properties in terms of both legislative acts and informal agreements, which are difficult or impossible to quantify and can typically only be expressed in ordinal terms.

To overcome these difficulties, the present paper suggests the use of partially ordered set (POSET) theory as an alternative approach that has not been used in the construction of measures of fiscal rules so far. Its virtue is that it fully exploits all the available information, takes the ordinal nature of the data seriously and does not require a subjective choice of weights and the aggregation technique.

The use of POSET theory is well established in the natural and technical sciences. It has been employed, e.g., in order to rank chemicals according to environmental hazards (Halfon and Reggiani, 1986), for the ranking of near-shore sediments (Brüggemann et al., 2001), to evaluate the quality of air pollutant monitoring systems (Voigt et al., 2004) or to explore patterns of habitat diversity across US landscapes (Myers et al., 2006). In the next section we outline the theoretical concepts underlying the POSET approach.

⁴ Freudenberg and Nardo (2003) provide a critical review of the construction and use of composite indices in the social science literature.

⁵ Sometimes such a choice can be theoretically motivated, e.g., when an objective function of the policy maker can be defined. To reduce the degree of arbitrariness in the choice of weights, techniques like correlation, principal component, or data envelopment analysis have been used.

3.2. Partially Ordered Set (POSET) Theory

3.2.1. Basic Definitions

In the following we outline the construction of ranking indices using partial order set theory, based on Brüggemann and Patil (2010) and De Loof et al. (2008).

Definition 1. *The set O consists of $i = 1, \dots, N$ objects ($x_i \in O$) which can be described by $j = 1, \dots, J$ properties: $q(x_i) = (q_1(x_i), q_2(x_i), \dots, q_J(x_i))$, where $q_j(x_i) \in Q_j \forall j$. On each set of different properties Q_j a linear order relation \leq_{Q_j} is defined. A linear order relation is reflexive, anti-symmetric, transitive and every two elements are comparable.*

Definition 1 formalizes that an object $x_i \in O$, e.g., a country, can be described by J ordinal properties $q_j(x_i)$. Without loss of generality, we assume that the sets of possible properties Q_j are subsets of the integer values, since any property, on which a linear order relation is defined, can be mapped into a set of integer values, as long as the integer values are interpreted strictly in ordinal terms.

For illustration, consider an example with seven objects (x_1, \dots, x_7), which are all described by three different properties $q_1(x_i)$, $q_2(x_i)$, and $q_3(x_i)$. In the context of the present paper, which considers the measurement of the stringency of fiscal rules as an application, the objects could be countries (or states); property $q_1(x_i)$ could be a binary variable indicating whether enforcement mechanisms or transparency requirements monitored by an independent body do exist (2) or do not exist (1). Property $q_2(x_i)$ could refer to the legal foundation, i.e., whether the fiscal rule is embedded in the constitution, whether it is statutory, or just provisional in terms of an informal agreement among or commitment by policymakers. Finally, property $q_3(x_i)$ might reflect a numerical limit on some fiscal performance measure, e.g., the (cyclically adjusted) deficit in % of GDP. Properties $q_1(x_i)$ and $q_2(x_i)$ are measured on an ordinal scale, whereas property $q_3(x_i)$ is measured on an interval scale. Nevertheless, on each set of the properties a linear order relation (relating to the stringency of the fiscal rule) can be defined as follows:

$$\begin{aligned} Q_1 & \dots & 1 \leq_{Q_1} 2, \\ Q_2 & \dots & \text{provisional} \leq_{Q_2} \text{legal} \leq_{Q_2} \text{constitutional}, \\ Q_3 & \dots & 3\% \leq_{Q_3} 1\% \leq_{Q_3} 0\%. \end{aligned}$$

Within each of the properties the ordering of the objects is clear, but when institutions (such as fiscal frameworks) of the objects are described by more than one property, the problem arises that different properties (per se) may imply different rankings. Let the seven objects considered have the following values for the three properties:

$$\begin{aligned} q(x_1) &= (2, \text{legal}, 0\%) & q(x_2) &= (2, \text{constitutional}, 1\%) & q(x_3) &= (2, \text{legal}, 1\%) \\ q(x_4) &= (2, \text{provisional}, 1\%) & q(x_5) &= (1, \text{legal}, 3\%) & q(x_6) &= (1, \text{provisional}, 1\%) \\ q(x_7) &= (1, \text{provisional}, 3\%) \end{aligned}$$

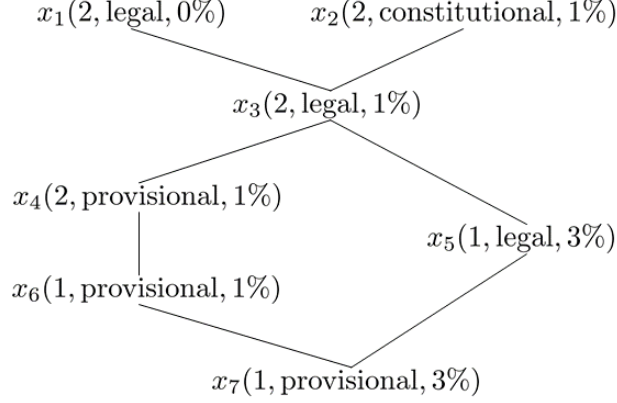


Figure 1: Hasse Diagram of POSET Example

While it is clear that there is no country with a fiscal regime that is less stringent than the one of country x_7 (regardless, which of the three properties is considered), country x_1 is less stringent than country x_2 in terms of property q_2 , whereas in terms of property q_3 , the order is reversed; hence; countries x_1 and x_2 are incomparable.

To address the problem of incomparable objects, the POSET approach uses the notion of a partially ordered set and the concept of a linear extension of a set:

Definition 2. A partially ordered set (POSET) is a couple (O, \leq_O) of a set of objects O with a corresponding binary partial order relation \leq_O . Object $x_i \in O$ is said to be ‘smaller than or equal to’ object $x_{i'} \in O$, written as $x_i \leq_O x_{i'}$, if $q_j(x_i) \leq_{Q_j} q_j(x_{i'}) \forall j$. Otherwise the objects are said to be ‘incomparable objects of the POSET’, written as $x_i ||_O x_{i'}$.

According to Definition 2 an object can only be said to be smaller than (or equal to) another object if all properties of the first object are smaller than (or equal to) all properties of the second object (in their respective ordinal ranking).

A partially ordered set (O, \leq_O) can be depicted using a so called Hasse diagram. The diagram connects objects by lines such that if $x_i \leq_O x_{i'}$ there has to be a sequence of connected objects upwards from x_i to $x_{i'}$, otherwise the objects are incomparable (and hence unconnected in the diagram). In the present example, the Hasse diagram for the seven objects is illustrated in Figure 1.

Let us now define the concept of a linear extension of a set, which is crucial in the treatment of incomparable objects:

Definition 3. A linear extension of the set O is one permutation of the objects of $O \equiv (x_1, x_2, \dots, x_n)$, such that $x_i <_O x_{i'}$ implies $r_i < r_{i'}$, where r_i and $r_{i'}$ are the ranks

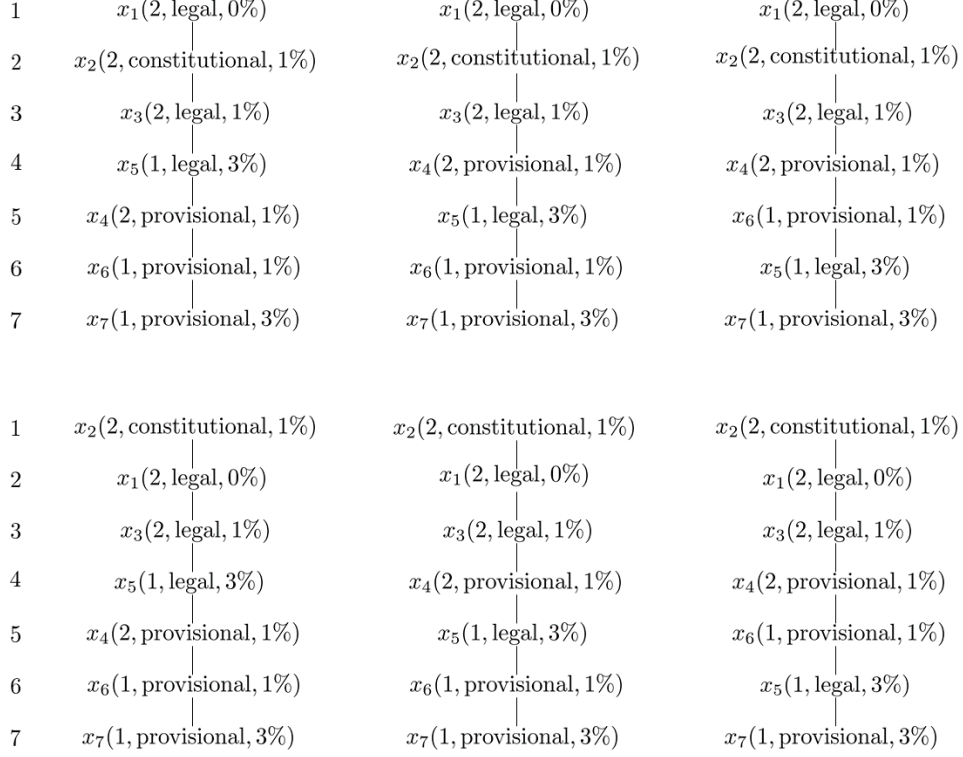


Figure 2: *Linear Extensions of POSET Example*

of objects x_i and $x_{i'}$ respectively. The set of all linear extensions of the POSET (O, \leq_O) is denoted as $\varepsilon(O)$.

Hence, every linear extension represents one possible ranking of the objects which obeys the POSET, i.e., each permutation changes the positions of incomparable objects but preserves the ordering of comparable objects. All six possible linear extensions of the above example are illustrated in Figure 2. As can be seen, country x_7 , the least stringent one, always appears on the bottom. In contrast, countries x_1 and x_2 , the two most stringent ones, always appear on top. However, since x_1 and x_2 are incomparable, both orderings have to be considered, i.e., x_1 above x_2 (upper panel), and x_2 above x_1 (lower panel). Analogous arguments yield the alternative arrangements of the other countries in the six linear extensions.

The set of all linear extensions is the set of all possible rankings (obeying the POSET) of the objects under examination. Without further information, it is natural to assume that all linear extensions have the same probability and are thus uniformly distributed

over the interval $[0, |\varepsilon(O)|]$.⁶ This allows us to define a rank probability for each rank of an object.

Definition 4. *The number of linear extensions in $\varepsilon(O)$ with the specific object $x_i \in O$ on rank $r \in [1, n]$, referred to as $|\varepsilon_i^r(O)|$, divided by the cardinality of $\varepsilon(O)$ (the number of its elements) is called the rank probability of object x_i on rank r : $p_i(r) = |\varepsilon_i^r(O)|/|\varepsilon(O)|$. By construction, it holds that $\sum_{r=1}^N p_i(r) = 1$. The expected value of the rank of an object $x_i \in O$, also referred to as averaged rank (\bar{r}_i), is given by*

$$\bar{r}_i = \sum_{r=1}^N [r \cdot p_i(r)] \quad (1)$$

For convenience, and w.l.o.g. for our empirical analysis, the averaged ranks, ranging from potentially 1 to N , will be normalized to take values between zero and one. Relating the POSET to the index function approach, the latter is a very special case of the former in the sense that each ranking implied by a particular weighting scheme in an index function corresponds to exactly one particular linear extension of the POSET (Brüggemann et al., 2001).⁷

In the above example the averaged ranks for each of the objects are $\bar{r}_1 = 1.5$, $\bar{r}_2 = 1.5$, $\bar{r}_3 = 3$, $\bar{r}_4 = 4.33$, $\bar{r}_5 = 5$, $\bar{r}_6 = 5.66$, $\bar{r}_7 = 7$, which gives normalized indices of $\bar{r}_1^I = 0.21$, $\bar{r}_2^I = 0.21$, $\bar{r}_3^I = 0.43$, $\bar{r}_4^I = 0.62$, $\bar{r}_5^I = 0.71$, $\bar{r}_6^I = 0.81$, $\bar{r}_7^I = 1$.

Essentially, the only subjective choice in the POSET framework is the set of properties considered. As a consequence, it is of particular interest to assess the stability of the POSET indices against excluding or adding properties. To identify the most influential properties, summary measures for the implied changes in terms of the average ranks (Brüggemann and Patil, 2010) and the implied change in the number of incomparabilities (Brüggemann and Voigt, 1996) have been suggested in the literature. Elaborating on the alternative approaches available is beyond the scope of the present paper; a discussion is given in Brüggemann and Patil (2010).

Another important advantage of the POSET approach is related to the handling of missing values or uninformative data (such as answers in the categories ‘other’ in survey data). On the one hand, excluding objects where information on one (or a few properties) is missing would significantly reduce the sample size; on the other hand, excluding properties where data is available only for a subset of objects would imply a substantial loss of information. The POSET approach - unlike an index function approach - allows to account for properties (e.g., a particular question in a survey) where information (the answer) is missing for a subset of the countries. In this sense the

⁶ $|\cdot|$ stands for the cardinality of a set, i.e., the number of its elements.

⁷ More precisely, the POSET is related by an order preserving map to the ordered set implied by the index function.

POSET approach fully exploits and makes best use of the available information provided by the (sub)set of observed properties and dispenses with the need to drop objects (or properties) where part of the information is missing.

The reason is that the POSET approach is based on a pair-wise comparison of countries. E.g., if two countries A and B have responded to a question, this question is used for the comparison of the two countries. If one of the countries (e.g., A) has not responded (or responded uninformatively), this question is dropped for the comparison of country A with country B (and other countries), but the question is still used for comparing country B with other countries (which have also responded to the respective question).⁸

3.2.2. A Simple Extension

The standard approach in the POSET literature is to calculate the averaged rank of the objects, given the set of observed objects. A drawback of this approach is that it depends on the particular sample of objects at hand. In other words, the interpretation of the averaged rank as expected value rests on the assumption that the set of linear extensions from a given sample corresponds to the population.

In applied work, in particular in the social sciences, there might be further unobserved objects, and hence further possible linear extensions, such that the averaged rank defined above is then based on a subset of the population only, and may thus be interpreted as a (possibly biased) estimate of the expected value, given the set of all possible objects.

To address this (possible) selection bias of the standard approach, under which the ranking of each object depends on the sample of objects (which could be only a subset of existing objects, e.g., due to data availability), we suggest a straightforward extension of the calculation of the averaged rank that takes into account all possible objects (even those which might not be observed in a particular application).

Definition 5. Let G be the ‘full’ (hypothetical) POSET, including objects $g \in G$ with all combinations of values of the properties $q_j(g)$ from the set of possible values Q_j , i.e., $G = \{g | q(g) = (q_1(g), q_2(g), \dots, q_J(g), \text{ with } q_j(g) \in Q_j \forall j\}$.⁹ The rank probability of element x_i on rank r in all linear extensions of this full POSET $\varepsilon(G)$ is defined as

⁸ As outlined in Section 3.2.3, object x_1 ‘is smaller or equal than’ object x_2 with the properties $q(x_i) = (q_1(x_i), q_2(x_i), \dots, q_J(x_i))$ if $q_j(x_1) \leq_{Q_j} q_j(x_2), \forall j$. In case of missing observations this definition is slightly augmented in the sense that it needs to hold only for the set of properties on which data is available for both countries, i.e. $\forall j : \exists q_j(x_1) \wedge \exists q_j(x_2)$.

⁹ Obviously, the set of objects under consideration O is a subset of G , i.e. $O \subseteq G$. Also notice, that we make the reasonable assumption that the set of all possible values Q_j is the set of values actually observed for each property q_j . On an ordinal scale, there would be arbitrarily many additional values (below, above, and in between the observed values), yielding a (useless) ‘full’ POSET with an infinite number of elements.

$\tilde{p}_i(r) = |\varepsilon_i^r(G)|/|\varepsilon(G)|$, and the corresponding expected value of the rank (\tilde{r}_i) is given by

$$\tilde{r}_i = \sum_{r=1}^N [r \cdot \tilde{p}_i(r)] \quad (2)$$

Again the averaged ranks will be rescaled to an index between zero and one w.l.o.g. for our empirical analysis.

Figure 3 shows the Hasse diagram for the ‘full’ (hypothetical) POSET of the above example including not only the seven observed objects (underlined in the figure), but additionally all 11 other objects that can be created using (all combinations of) the observed values of the three properties q_1, q_2 , and q_3 . Again the linear extensions for this ‘full’ POSET can be created and then an averaged rank can be calculated for each object in the ‘full’ POSET. It is clear that each of the original objects under investigation in our example is also included in this ‘full’ POSET and the averaged ranks for these can be obtained also for the ‘full’ POSET. In our example the averaged ranks would be: $\tilde{r}_1 = 2.71$, $\tilde{r}_2 = 2.71$, $\tilde{r}_3 = 6.33$, $\tilde{r}_4 = 11.40$, $\tilde{r}_5 = 16.29$, $\tilde{r}_6 = 16.29$, $\tilde{r}_7 = 18$, which gives normalized indices of $\tilde{r}_1^I = 0.15$, $\tilde{r}_2^I = 0.15$, $\tilde{r}_3^I = 0.35$, $\tilde{r}_4^I = 0.63$, $\tilde{r}_5^I = 0.91$, $\tilde{r}_6^I = 0.91$, $\tilde{r}_7^I = 1$. As can be seen, the relative ordering among the objects is preserved under this more general approach, whereas the scaling (i.e., the distances among the objects in the unit interval) is slightly altered depending on how many hypothetical objects ‘enter the picture between’ the observed objects.¹⁰

3.2.3. Computation

A potential complication is that the calculation of POSET indices can be computational cumbersome (or even infeasible). Determining the number of all linear extensions of a POSET and enumerating them has been studied intensively (see De Loof et al., 2008, for a survey). With more than $N = 25$ objects the needed run time of today’s computer programs exceeds any feasible number, since the number of linear extensions increases exponentially with the number of objects (Brüggemann et al., 2004).¹¹ To address this computational issue alternative solutions have been suggested. Lerche and Sorensen (2003) use random sampling, whereas De Loof et al. (2006) develop a method based on lattice theory.

In the present paper, we use the approach by Brüggemann et al. (2004), who derive a closed form solution for the (approximate) averaged rank of objects of a POSET, using

¹⁰In the present example, this is immaterial: the correlation between the two indices amounts to 0.97 (and the rank correlation is 1). More generally (with more objects and properties), there could be larger differences that might be relevant, e.g., if the indices are used in regression analyses.

¹¹De Loof et al. (2006) have shown that enumerating all linear extensions is a complexity problem in the class of counting problems similar to the NP-class for decision problems, from which it follows that the problem can be solved in polynomial time.

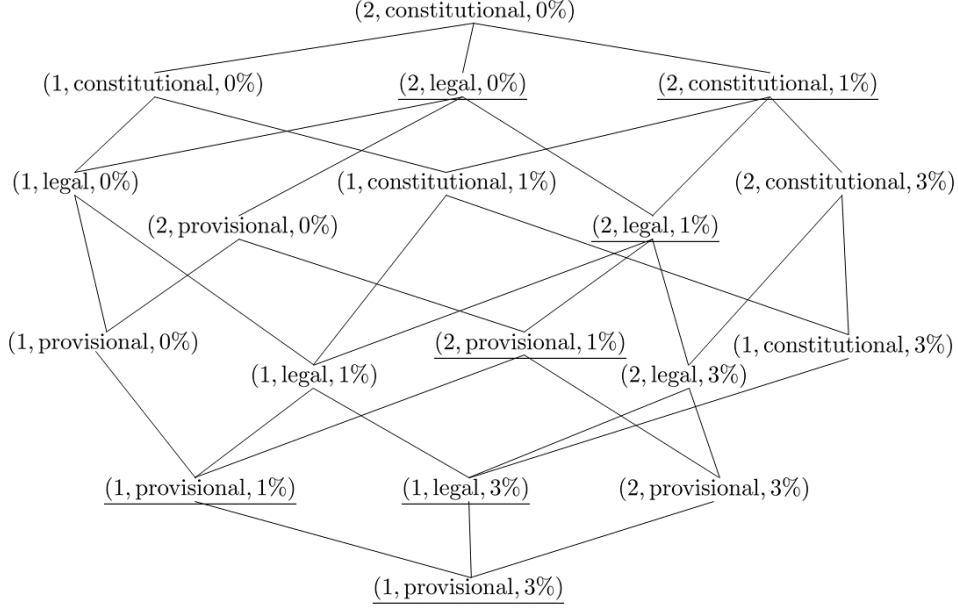


Figure 3: Full POSET Example

Local Partial Order Model techniques. It is derived from the following considerations: The rank of object $x_i \in O$ in any linear extension $\varepsilon(O)$ lies within the closed range: $r_i \in [P_i + 1, P_i + 1 + U_i]$, where P_i is the number of predecessors to (number of objects ranked above) x_i , i.e. the cardinality of the set $\{x_j \in O : x_j >_o x_i\}$, and U_i the number of objects incomparable to x_i , i.e. the cardinality of the set $\{x_j \in O : x_j ||_o x_i\}$.

The actual averaged rank now depends on the distribution of the incomparable objects. In the extreme case $r(x_i) = P_i + 1$ all the incomparable objects are placed among the successors of (objects ranked below) object x_i , and in the other extreme case $r_i = P_i + 1 + U_i$ all the incomparable objects are placed among the predecessors. For ranks in-between, we see that if $r_i = P_i + 1 + k$ then k objects are placed among the predecessors and $U_i - k$ objects are placed among the successors. This rank is realized $\binom{U_i}{k} (P_i + 1)^k (S_i + 1)^{U_i - k}$ times, which counts all possibilities to place k objects among the predecessors and $U_i - k$ objects among the successors of x_i (S_i). This yields the following formula for the averaged rank of an object:

$$\bar{r}_i = \frac{\sum_{k=0}^{U_i} (P_i + 1 + k) \cdot \binom{U_i}{k} \cdot (P_i + 1)^k \cdot (S_i + 1)^{U_i - k}}{\sum_{k=0}^{U_i} \binom{U_i}{k} \cdot (P_i + 1)^k \cdot (S_i + 1)^{U_i - k}} \quad (3)$$

One can think of examples where Equation (3) performs less well, e.g., if the POSET is very asymmetric or includes objects which are incomparable to all other objects. How-

ever, in POSET with a large number of objects and a roughly symmetric structure - as will be the case if we consider the full hypothetical POSET of all possible object (see Section 3.2.2, Definition 5), the formula gives a good approximation of the exact averaged rank.

The calculation of the successor or predecessor object counts (P_i, S_i) , required for implementing Equation (3) is generally cumbersome and time consuming, as the algorithm needs to compare each of the objects with all others to determine the (number of) succeeding and preceding objects. The use of the ‘full’ (hypothetical) POSET with all possible objects facilitates the calculation. To see that, project the ordered set of the properties Q_j on the interval $I_{Q_j} := [1, n_{Q_j}]$ preserving the ordinal ranking, with n_{Q_j} being the number of values in set Q_j for property j and representing the highest value in Q_j . Now the value $q_j(x_i)$ of object x_i for property j has a scalar representation $n_{q_j(x_i)}$ in the interval I_{Q_j} , which is true for every property of object x_i . Hence, in the ‘full’ (hypothetical) POSET, the number of predecessor objects P_i of x_i can be calculated as $P_i = \prod_j (n_{Q_j} - n_{q_j(x_i)} + 1) - 1$ and the number of successor objects can then be calculated as $S_i = \prod_j n_{q_j(x_i)} - 1$. It follows that the number of incomparable objects is $U_{x_i} = \prod_j n_{Q_j} - P_{x_i} - S_{x_i} - 1$.

4. Application I: Measuring Fiscal Rules in 81 Countries

4.1. Data

In the following we calculate POSET indices of fiscal rules, using data from the IMF Fiscal Rules Dataset (IMF, 2012). The data were assembled by the IMF based on primary sources (legislation, published and unpublished country documents, the fiscal rules database of the European Commission, 2010) and interviews with country officials.

The IMF dataset covers 81 countries over the period 1985 to 2012 and provides information on supranational as well as national numerical fiscal rules covering at least the central government. For the most recent period in the sample fiscal rules are included if they have already taken effect or clear transition schemes are specified. In the following we concentrate on national fiscal rules, which have already come into force.

We do not explicitly consider supranational rules. To the (often large) extent that these supranational fiscal rules have been transposed into and implemented in national law, they will be included in the information on national fiscal rules anyway. Moreover, the measurement error from ignoring supranational rules would only pose a problem in the empirical models if it was systematically related to other explanatory variables included.¹²

¹²The most relevant set of supranational rules in our sample of 81 countries relates to the EU (Eurozone) countries (a large part of which is implemented in national law). This suggests exploring the sensitivity of the results against including dummies for (EU) euro area countries in empirical models including the POSET indices.

Tables 1 and 2 provide an overview of the data on fiscal rules used in the present paper. A detailed description of the IMF dataset is given by Schaechter et al. (2012).

Table 1: *Numerical Fiscal Rules Across Countries, 1985-2012*

Fiscal Rule(s) in Place	% of countries	% of total observations
BR	44%	27%
DR	31%	16%
ER	35%	12%
RR	9%	7%
BR + DR	19%	6%
BR + ER	17%	6%
BR + RR	2%	1%
DR + ER	11%	3%
DR + RR	4%	2%
ER + RR	7%	2%
BR + DR + ER	5% ¹⁾	1%
BR + DR + RR	1% ²⁾	1%
DR + ER + RR	2% ³⁾	0%
BR + DR + ER+ RR	1% ⁴⁾	0%

Notes: Data source is (IMF, 2012). BR ... Balanced Budget Rule, DR ... Debt Rule, ER ... Expenditure Rule, RR ... Revenue Rule. The first column reports that share of countries where the respective fiscal rule has been in place in at least one year. The second column reports the share of observations (in the total number of observations) where the respective fiscal rule has been in place. ¹⁾ Australia, Bulgaria, Canada, Finland; ²⁾ Australia; ³⁾ Australia, Lithuania; ⁴⁾ Australia.

The database covers four different types of numerical fiscal rules: Balanced budget rules (BR), debt rules (DR), expenditure rules (ER), and revenue rules (RR). Generally, there has been an increase in the use of fiscal rules over time; whereas only 5% of the 81 countries had fiscal rules in place in 1985, this share has increased to 15% in 1995 and 56% in the most recent period (2012). It is worth mentioning that expenditure rules have only been put in place mainly in the most recent years.

As can be seen from Table 1, approximately half the countries in our sample (44%) have some kind of balanced budget rule in place, 35% have an expenditure rule, and 31% a debt rule. Revenue rules are rare and used in only in a small fraction of 9% of the countries (and will thus not be considered separately in our econometric analysis).

Several countries have more than one rule in place; the combination of a balanced budget rule with either a debt or an expenditure rule is most common. Australia is the only country which had (and still has) all four types of rules in place.

For each type of numerical fiscal rule the dataset provides information about the legal basis, coverage, enforcement procedure, monitoring of compliance, and escape clauses. In addition, general information on the fiscal framework in place is available, relating to the existence of multi-year expenditure ceilings, independent bodies for monitoring or assumptions of budget forecasts, and to the transparency and flexibility of the fiscal rules. Table 2 gives an overview of the variables describing the properties of fiscal rules and their sets of possible values, along with their distribution across countries.

Table 2: *Properties of Fiscal Rules, 81 Countries, 1985-2012*

Variable	Characteristics	All	BR	DR	ER	RR
<i>Rule-Type Specific Information</i>						
Legal basis	<i>Constitutional</i>	6%	9%	6%	0%	9%
	<i>Statutory</i>	51%	58%	52%	45%	24%
	<i>Coalition agreement</i>	24%	20%	25%	28%	29%
	<i>Political commitment</i>	20%	13%	17%	28%	38%
Coverage	<i>General government</i>	43%	44%	47%	39%	43%
	<i>Simil. rules for diff. levels</i>	2%	0%	0%	6%	0%
	<i>Central government</i>	55%	56%	54%	55%	57%
Formal enforcement procedure	<i>Exists</i>	24%	23%	19%	28%	40%
	<i>Does not exists</i>	76%	78%	81%	72%	60%
Monitoring of compliance outside government	<i>Exists</i>	27%	26%	31%	25%	26%
	<i>Does not exists</i>	73%	74%	69%	75%	74%
Well-specified escape clause	<i>In place</i>	15%	20%	14%	10%	13%
	<i>Not in place</i>	85%	80%	86%	90%	87%
<i>General Information on Fiscal Framework</i>						
Multi-year expenditure ceilings	<i>By line item</i>	1%				
	<i>By ministry</i>	5%				
	<i>Aggregate</i>	25%				
	<i>None</i>	70%				
Independent body sets budget assumptions	<i>In place</i>	12%				
	<i>Not in place</i>	88%				
Independent body monitors implementation	<i>In place</i>	10%				
	<i>Not in place</i>	90%				
Fiscal responsibility laws (transp., accountability)	<i>In place</i>	29%				
	<i>Not in place</i>	71%				
Budget balance target in cyclically adjusted terms or over the cycle	<i>In place</i>	29%				
	<i>Partly in place</i>	5%				
Rule(s) exclude public investment or other priority items	<i>Do</i>	27%				
	<i>Some rules do</i>	16%				
	<i>Do not</i>	57%				

Notes: Data source is (IMF, 2012). Percentage corresponds to share of total observations where fiscal rule with respective characteristic has been in place.

Only a few countries have constitutional fiscal rules; approximately half of them are enshrined in national law and the other half in coalitional or political agreements. Overall, balanced budget rules do have a stronger legal foundation, while expenditure and revenue rules are only agreed upon in coalitional or political commitments in the majority of the countries (and years). A formal enforcement mechanism or outside monitoring exists for only a quarter of the numerical fiscal rules, well-specified escape clauses are even rarer.

Regarding general institutional arrangements, about a third of the countries has multi-year expenditure ceilings and transparency and accountability rules in place. On the other hand in only approximately 10% of the countries (and years), an independent body sets the budget assumptions or monitors the budgets' implementation. Roughly one third of the fiscal rules are stated in cyclically adjusted or structural terms or exclude priority items like public investment.

For our empirical analysis, we code all variables on an ordinal scale such that the properties are ranked in increasing order of stringency, broadly defined in terms of their hierarchy of the legal basis, coverage, and transparency and accountability. E.g., the variable 'legal basis' takes values of 4 (constitutional), 3 (statutory), 2 (coalition agreement), and 1 (political commitment); corresponding codings are applied to the other variables (properties) listed in the leftmost column of Table 1. Hence the most stringent rules are constitutional, have a wide coverage, involve independent institutions in the budgetary process (setup, implementation, monitoring of enforcement), include multi-year expenditure ceilings, and go along with strong transparency and accountability laws.

For most properties the ranking is straightforward; only for three variables (well defined escape clauses, definition of targets in cyclically adjusted terms, exclusion of public investment), the ranking is unclear a priori. Hence, these properties are reported here for completeness, but they will not be used in the construction of the POSET indices below.

4.2. POSET Indices of Fiscal Rules

In the following, we turn to the calculation of alternative POSET indices (Definition 5, Equation (2)) for our sample of 81 countries, using (subsets of) the variables (properties) listed in Table 1. The choice of the properties and the definitions of the corresponding indices are summarized in Table 3.

Table 3: *Definition of POSET Indices of Numerical Fiscal Rules*

Index	Description	Variables
<i>Rule-Type Specific Indices (same for DR, ER and RR)</i>		
R^{BR}	Information directly associated with Balanced Budget Rules	Legal Basis, coverage, enforcement procedure, monitoring of compliance
R^{BR+}	Adds general information on fiscal framework to R^{BR}	R^{BR} + Multi-year expenditure ceiling, independent body, transparency and accountability
<i>General Index</i>		
R^G	General information about fiscal framework	

We define separate indices for each type of numerical fiscal rule: balanced budget (BR), debt (DR), and expenditure (ER) rules. First, we create a basic index (e.g., R^{BR}) including the legal basis, coverage, enforcement procedures, and monitoring (see the upper panel of Table 2) relating to the respective rule.

To capture the role of general properties of the fiscal framework (see the lower panel of Table 1) with a clear ranking, we augment these basic indices for each type of fiscal rule by adding variables indicating the existence of multi-year frameworks, of independent bodies setting assumptions and monitoring performance, and transparency and accountability laws (e.g. R^{BR+}).

Finally, to separately capture the properties of the general fiscal framework, we define an index (R^G) that is solely based on general information (see the lower panel of Table 2). In sum, this provides us with a total of 9 indices over the period 1985 to 2012, describing the properties of the fiscal framework and the fiscal rules in place for our sample of 81 countries, making a total of 2,268 observations for each index.

4.2.1. Basic results

Adopting the notation introduced above, we consider (up to) $N = 81$ countries, which are to be ranked by (up to) $J = 11$ properties, i.e., ordinaly coded values of the characteristics of fiscal regimes summarized in Table 3. The set of possible values Q_j for the properties is a subset of the integer values that varies across variables depending on the number of possible values, ranging from the set $[1, 2]$ up to $[1, 2, 3, 4, 5]$. We emphasize once more that the properties have only an ordinal interpretation and are

increasing in the ‘stringency’ of fiscal rules, broadly defined in terms of the hierarchy of their legal basis, their coverage, enforcement procedures, and monitoring as well as the existence of multi-year frameworks, of independent bodies setting assumptions and monitoring performance, and transparency and accountability laws.

Table 4 provides summary statistics of the 9 POSET indices over the period 1985 to 2012 for our sample of 81 countries, which are calculated according to Equation (2) based on the sets of properties in Table 3.

Table 4: *Summary Statistics for POSET indices*

	Mean	Std. Dev.	Min	Max		Mean	Std. Dev.	Min	Max
R^{BR}	0.162	0.335	0	0.996	R^{RR}	0.028	0.151	0	0.996
R^{BR+}	0.157	0.325	0	1.000	R^{RR+}	0.028	0.150	0	0.993
R^{DR}	0.087	0.254	0	1.000	R^G	0.147	0.252	0	0.989
R^{DR+}	0.088	0.256	0	1.000					
R^{ER}	0.097	0.264	0	0.996					
R^{ER+}	0.099	0.268	0	0.999					

Correlations

	R^{BR}	R^{DR}	R^{ER}	R^{RR}	R^G
R^{BR}	1.00				
R^{DR}	0.30	1.00			
R^{ER}	0.28	0.15	1.00		
R^{RR}	0.07	0.11	0.42	1.00	
R^G	0.67	0.54	0.64	0.33	1.00

As can be seen from Table 4, all POSET indices show substantial variation across countries and time and span almost the full range of possible values from 0 to 1. Figure 4 illustrates the cross-sectional variation across the POSET indices, using as two representative examples the balanced budget rule index (R^{BR+}) and the index of the general framework (R^G) for the year 2010. In light of the fact that only roughly half of the countries have a fiscal rule in place, we show both the distribution of the full sample and the corresponding plots excluding observations equal to zero.

Descriptive statistics by country group (see Table A6 in Appendix A.1) show that emerging and especially low-income countries do not have any or not very stringent fiscal rules in place. In general the strongest rules can be found in form of balanced budget rules in advanced countries¹³ and the EU27 member states. In particular, Australia, the

¹³Classification according to IMF.

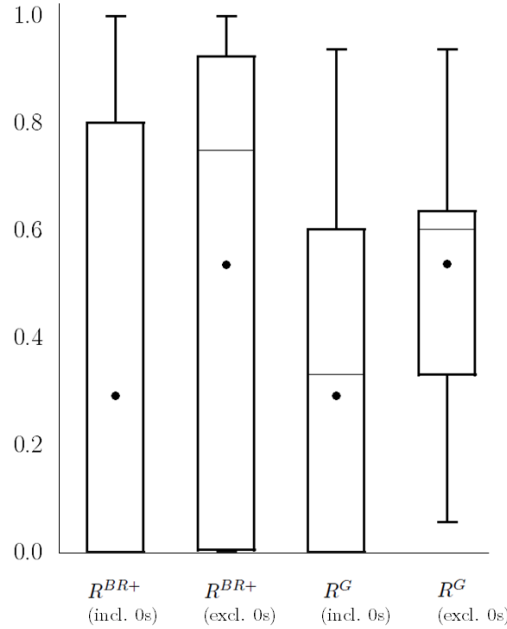


Figure 4: *Boxplots of Selected POSET Indices, 2010*

Netherlands, and Germany have the most stringent fiscal rules¹⁴; they are weakest in Armenia, Russia and Slovakia (apart from the 28 countries for which the indices are close to (< 0.01) or equal to zero).

Figure 5 illustrates, using averages across countries, the development of the POSET indices over time and shows a general trend towards an increased use and stringency of fiscal rules in the last one and a half decade.

The lower panel of Table 4 shows the correlation between selected indices: the average correlation between POSET indices based on the same information categories, i.e. comparing the basic indices for several types of rules, is 0.22, and between the POSET indices for the same type of rule (i.e., comparing basic and augmented index for the same type of rule) is 0.95.¹⁵ These numbers show that the indices constructed in this paper overall do in fact measure different aspects of the budgetary process, and that a high stringency in one type of rule does not necessarily imply a high degree of stringency in other rules. Hence, apart from the large variation in the stringency of rules across countries, there is also large variation within the set of countries with relatively stringent rules. Finally, the average correlation between the rule specific indices and the index

¹⁴Measured as average over the full sample period (1985-2012) and over the indices for the four types of rules R^{BR+} , R^{ER+} , R^{DR+} , and R^{RR+} .

¹⁵This is not too surprising, since the set of questions for the basic and augmented indices overlap to a large extent.

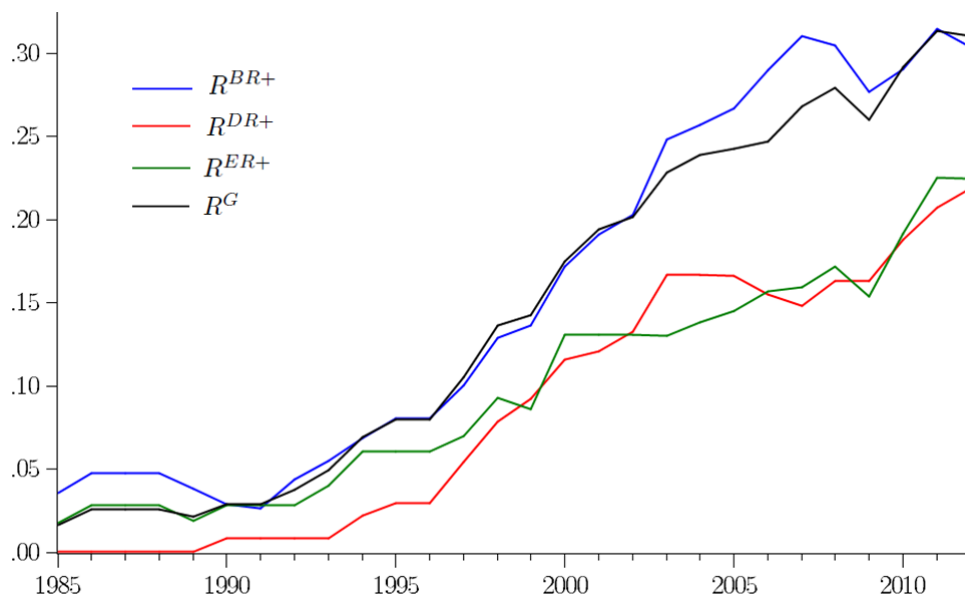


Figure 5: *Evolution of Fiscal Rule Indices, 1985-2012 (Country Averages)*

covering the general framework is 0.64.

5. Application II: Effects of Fiscal Rules

In the following, we compare the results from an estimation of the effects of fiscal rules on fiscal outcomes using the POSET indices calculated in Section 4 with those replicated from a previous study using a composite index approach. Given the quite recent release of the IMF data on fiscal rules in 2012, there are hardly any econometric studies that build exactly on this database.¹⁶

In the following, we focus on the paper by Debrun et al. (2008), a recent and often cited paper, which is - to our knowledge - also the study employing the largest panel in an econometric study on fiscal rules. They investigate the effect of fiscal rules on public finances of the EU25 over the period 1990 to 2005, using a composite index based on (unpublished) IMF data that matches the information contained in the IMF Fiscal Rules Dataset very closely. Their measure of the stringency of fiscal rules is based on five

¹⁶There are several studies looking at EU countries (European Commission, 2006; Deroose et al., 2006; Debrun and Kumar, 2007) or emerging countries (Kopits, 2004; Corbacho and Schwartz, 2007). These studies, however, are not well suited for a comparative analysis, since they are based on other databases that do not match the information in the IMF dataset, typically use only a small sample of countries, and refer to earlier time periods.

properties, which are assigned values ranging from 1 to 4 and then rescaled and summed up to a composite index.¹⁷

In a first step, we replicate the results of Debrun et al. (2008) for their sample of the EU25 countries over the period 1990 to 2005. Since the data underlying their indices are not available, we use the composite fiscal rules indices by Schaechter et al. (2012). These are based on the published IMF Fiscal Rules Dataset and constructed in the same way as the ones in Debrun et al. (2008), using essentially the same properties.

The results obtained using composite indices by Schaechter et al. (2012) serve as a benchmark and will be compared to the corresponding regression results based on the POSET indices introduced in the present paper, which are also based on the IMF Fiscal Rules Dataset. Second, given the larger country and time country coverage of the IMF Fiscal Rules dataset, we extend their regression analysis for the EU25 countries over the period 1990 to 2005 (243 observations) to the largest sample possible, which is made up of 81 countries over the period 1985 to 2012 (851 observations).

Our empirical panel data model follows exactly the (dynamic) specification in Debrun et al. (2008), who regress countries' overall budget balance (bb) on their fiscal rules index and a set of control variables (\mathbf{x}) (and country-specific fixed effects (μ_i)).¹⁸

$$bb_{i,t} = \alpha bb_{i,t-1} + \gamma R_{i,t} + \mathbf{x}_{i,t}\boldsymbol{\beta} + \mu_i + \epsilon_{i,t}, \quad (4)$$

where i is the country index and t is the year index; in Debrun et al. (2008), the cross-section dimension comprises the EU25 countries and the time dimension ranges from 1990 to 2005, yielding a total of 243 observations. As an index for the stringency fiscal rules index (R), we first use the composite fiscal rules index by Schaechter et al. (2012) based on the IMF Fiscal Rules dataset (which is very close to the index used by Debrun et al., 2008), and then compare the results with those obtained using our POSET indices introduced above. In line with Debrun et al. (2008), we focus on balanced budget rules here, i.e., we use the respective composite index and the POSET index R^{BR+} in the regression analysis.

The control variables (\mathbf{x}) included in Equation (4) are: i) lagged real GDP growth (in Debrun et al. (2008) the output gap is used, but this variable is not available for

¹⁷E.g., property 'Statutory base of the rule' assigns a scores of 4 for a constitutional basis, 3 for a legal act, 2 for a coalition agreement, and 1 for political commitment. Another property is the 'body in charge of monitoring the rule' with a score of 3 in case of an independent authority, 2 for the Ministry of Finance and 1 for no public monitoring. The scores for each of the five features are then re-normalized to have the same maximum and afterwards summed up using equal weights. For a detailed description, see Debrun et al. (2008), page 351.

¹⁸Debrun et al. (2008) also use the cyclically adjusted primary balance as dependent variable; for reasons of data availability (especially for countries other than the OECD countries) we consider only the specification with the overall budget balance as dependent variable here.

most of the countries), ii) government stability (index from the International Country Risk Guide by the PRS Group), iii) government fragmentation (sum of squared seat shares of all parties in government), iv) district magnitude (average parliament seats per electoral district), v) ideology (index of conservatism of government), vi) ideological range (difference between extreme ideologies in government), vii) parliamentary election (dummy for legislative election years), viii) run-up to EMU (dummy for the EU15 from 1995 to 1997), ix) monetary union (Debrun et al., 2008 use only a dummy for the Stability and Growth Pact, but in our extended sample there are (will also be) other countries in monetary unions) and x) country size (population). Finally, $\epsilon_{i,t}$ is an idiosyncratic error term. A detailed description of the variables and data sources is given in Appendix A.2.

As in Debrun et al. (2008), all estimations are carried out using the bias corrected LSDV estimator by Kiviet (1995) for unbalanced panels as described in Bruno (2005). The first column of Table 5 shows the estimation results as presented in Debrun et al. (2008) and column (2) the replication using the same sample, i.e. EU countries from 1990 to 2005, and the composite (balanced budget rule) index by Schaechter et al. (2012). In terms of statistical significance, the results of these two specifications are very close in light of the slight difference in the construction of the fiscal rules index. Column (5) estimates the same specification using the POSET (balanced budget rule) index of fiscal rules (R^{BR+}). Comparing, the results in columns (2) and (5), both the IMF index and the POSET index turn out significant at the 5% level, indicating that stronger fiscal frameworks lead to higher overall public balances. This is not too surprising in light of the fact, that the correlation between the IMF balanced budget rule index and the POSET counterpart amounts to 0.97.

Given that the estimation of the effects of fiscal rules on fiscal outcomes might be prone to endogeneity issues (that have to be addressed in future research), we do not wish to overemphasize the quantitative findings. However, for the purpose of the present paper it is of interest to compare the estimates of the specifications using the composite (IMF) index approach and the POSET approach. According to the estimates in columns (2) and (5), a one standard deviation increase in the stringency of fiscal rules, implies a short-run improvement of the budget balance by 0.05 percentage points (IMF index) and of 0.03 percentage points (POSET). The corresponding long-run effects implied by the dynamic specification amount to 0.16 and 0.12 percentage points, respectively. Hence, the point estimate of the specification using the POSET approach, while leading to no change in the statistical significance in the present sample (apparently due to its high correlation with the IMF index) points to a smaller economic significance of fiscal rules as determinants of fiscal outcomes.

Notwithstanding these differences in the point estimates of the effects of fiscal rules, the high correlation of the two indices deserves some discussion. As outlined in Section 3.2.1,

Table 5: Comparison of Fiscal Rules Indices

	Debrun et al. (2008)			IMF Indices		POSET Indices	
		Only EU 1990-2005	Only EU 1985-2012	full 1985-2012	Only EU 1990-2005	Only EU 1985-2012	full 1985-2012
Lagged dependent variable	0.59*** (9.31)	0.68*** (11.44)	0.69*** (18.48)	0.66*** (19.21)	0.68*** (11.46)	0.70*** (18.46)	0.66*** (19.01)
Lagged government debt	0.00 (0.22)	0.02* (1.87)	0.03*** (3.74)	0.01* (1.84)	0.02* (1.81)	0.03*** (3.78)	0.01* (1.84)
Lagged Real GDP Growth ¹	-0.06 (-0.85)	0.09 (1.39)	0.20*** (5.43)	0.18*** (4.96)	0.09 (1.39)	0.19*** (5.32)	0.18*** (5.04)
Fiscal Rule Index	0.52** (2.04)	0.41** (2.13)	0.45*** (3.04)	0.21* (1.71)	0.12** (2.20)	0.13** (2.51)	0.09** (2.11)
Government stability	0.39*** (4.41)	0.24*** (2.79)	0.26*** (3.20)	0.20*** (2.52)	0.25*** (2.83)	0.25*** (3.04)	0.20*** (2.50)
Government fragmentation	0.64 (0.52)	1.89 (0.71)	4.62* (1.71)	-0.32 (-0.21)	1.95 (0.73)	4.54* (1.67)	-0.29 (-0.19)
District magnitude	0.16 (1.15)	0.05 (0.48)	0.03 (0.69)	-0.01 (-1.48)	0.05 (0.48)	0.03 (0.77)	-0.01 (-1.50)
Ideology	0.03 (0.49)	0.02 (0.34)	0.04 (0.79)	0.03 (0.75)	0.02 (0.30)	0.04 (0.87)	0.04 (0.83)
Ideological range	-0.05 (-0.31)	0.16 (1.20)	0.07 (0.71)	0.13 (1.25)	0.16 (1.18)	0.09 (0.85)	0.14 (1.31)
Parliamentary election	-0.65*** (-2.23)	-0.90*** (-3.22)	-0.49** (-2.07)	-0.30 (-1.44)	-0.89*** (-3.22)	-0.49** (-2.05)	-0.30 (-1.44)
Run-up to EMU	-0.02 (-0.05)	0.71* (1.95)	0.42 (0.97)	0.46 (0.85)	0.71* (1.95)	0.38 (0.88)	0.47 (0.87)
Monetary Union ²	0.38 (0.72)	0.69* (1.82)	0.08 (0.26)	-0.12 (0.38)	0.65* (1.74)	0.03 (0.09)	-0.14 (-0.37)
Country size (population)	-9.91 (-0.40)	-28.92 (-1.12)	-43.15*** (-3.09)	-0.26 (4.97)	-26.01 (-1.04)	-39.95*** (-2.90)	-0.36 (-0.07)
N	243	256	429	851	264	429	851
R ² (within from LSDV)	0.700	0.705	0.606	0.486	0.706	0.604	0.487
F-test (fixed effects)	1.87**	2.08***	2.42***	2.57***	1.91***	2.22***	2.59***

Notes: Dependent variable is the budget balance. ¹ In Debrun et al. (2008) Output Gap is used instead of Real GDP Growth, but this variable is not available for full sample. ² In Debrun et al. (2008) Stability and Growth Pact is used instead of monetary union. Country fixed effects included but not reported. z-statistics are in parentheses. *, ** and *** show significance at the 10%, 5% and 1% level.

there is always one weighting scheme that implies equivalence between the composite and the POSET index (Brüggemann et al., 2001). Coincidentally, in the present sample it happens to be the case that the IMF index by Schaechter et al. (2012), using equal weights for the different properties, is quite close to this particular weighting scheme. This provides an additional justification for the use of the IMF index in the sense that it is quite close to the one based on the POSET approach, which has a more general foundation. Of course, this does not imply that composite indices will generally be very close to the corresponding POSET indices.

To demonstrate the sensitivity with respect to alternative weighting schemes, we provide a simple simulation exercise and recalculate the IMF balanced budget rule index using alternative weights; in particular, we calculate 100,000 composite indices using alternative weights for the four main components (legal foundation, coverage, enforcement institution, general framework), where the weights are drawn from the $(0, 1)$ uniform distribution (and then rescaled such that they sum to one). The average correlation between the POSET index R^{BR+} and the simulated indices amounts to 0.42 and spans a range from 0.30 to 0.54. Figure A6 in Appendix A.3 shows the histogram of the correlations.¹⁹ This suggests that the high correlation between the composite and the POSET paper obtained in the present paper is in fact rather the exception than the rule.

In a next step, we extend the time coverage of the sample and reestimate Equation (4) using the full time period for which data are available for the EU25 countries, namely 1985 to 2012. The results turn out to be very similar, the only difference being that one control variable (GDP growth) becomes highly significant. Most interesting here is that the fiscal rules indices remains significant and that the IMF version becomes even more significant. Columns (4) and (7) extend the country coverage further, including all 81 countries (and the full period from 1985-2012) and using the IMF composite index and the POSET version, respectively. First, we observe that all variables other than the fiscal rules index become insignificant, suggesting that the control variables which are standard in the literature on fiscal reaction functions are mostly relevant for developed (EU) countries. Moreover, the much lower R^2 indicates that in a broader country sample there are also additional factors driving public finances. However, both fiscal rules indices remain significant, though the POEST index enters the regression at a higher significance level than the IMF composite index.

¹⁹This issue is pursued further in Bachtrögler et al. (2014), who calculate composite and POSET indices, based on data from the OECD Budget Practices and Procedures survey (2007/2008). This database is not used here; Its main shortcoming for the use in econometric analyses is that it just refers to a single year; on the other hand, its main advantage is that it contains a lot of detailed information on fiscal regimes that allows the replication of other fiscal indices used in previous studies that contain more or different information than the IMF database. Bachtrögler et al. (2014) replicate several composite indices used in previous studies based on the OECD database and calculate the corresponding POSET indices. It turns out that there is substantial variation in the correlation between the composite indices and their POSET counterparts, ranging from 0.3 to (close to) 1.

6. Conclusions

This paper makes use of partially ordered set theory (POSET) to calculate new indices of numerical fiscal rules for 81 countries from 1985 to 2012 based on IMF (2012). We argue that the POSET method is an attractive approach that can be used as an alternative to composite indices. It is applicable in many fields of the social sciences to generate summary indicators of institutional characteristics that can only be described in terms of ordinal and a priori incomparable properties.

The POSET measures of (the stringency) of fiscal rules show that the use of fiscal rules has increased substantially over the last 20 years, though their stringency varies widely among countries. Also, within the group of countries with relatively stringent rules, there is heterogeneity in the type of rule applied. This provides a valuable source of variation to investigate the determinants and the effects of fiscal rules.

As a simple application, the POSET indices are then used to estimate the effects of fiscal rules on fiscal outcomes (in terms of the overall budget balance) for the EU25 countries over the period 1990-2005, following the study by Debrun et al. (2008), who use a composite index approach. The weighting scheme chosen by Debrun et al. (2008) yields a composite index that is quite close to the POSET index; as a consequence, the results using these two alternative measures of fiscal rules produce similar results and point to a positive effect of balanced budget rules on countries' overall fiscal balance. Exploiting the larger country and time coverage of the IMF database used in the present paper, we extend the regression to a sample of 81 countries over the period 1985 to 2012 and show that this result also holds up more generally in this broader sample.

From a policy perspective, an open question relates to the optimal design of fiscal rules for achieving the desired outcomes. Hence, the implications and the effectiveness of alternative types of fiscal rules are important issues that remain to be addressed in future research. The POSET indices of fiscal rules suggested in this paper provide a comprehensive dataset that can be used for that purpose.

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Appendix.

A.1. Summary Statistics by Country Group

Table A6: *Summary Statistics for Full POSET Indices by Country Group*

Index	All	Advanced	Emerging	Low-Income	Resource-Rich	EU27
R^{BR}	0.162	0.272	0.146	0.026	0.154	0.196
R^{BR+}	0.157	0.261	0.147	0.023	0.155	0.192
R^{DR}	0.087	0.093	0.120	0.029	0.061	0.111
R^{DR+}	0.088	0.105	0.118	0.020	0.060	0.117
R^{ER}	0.097	0.178	0.081	0.004	0.081	0.176
R^{ER+}	0.099	0.182	0.083	0.004	0.086	0.177
R^{RR}	0.028	0.063	0.006	0.011	0.000	0.062
R^{RR+}	0.028	0.065	0.007	0.007	0.001	0.062
R^G	0.147	0.237	0.140	0.030	0.139	0.199
Observations	2,268	840	840	588	448	705

Notes: Mean of Indices; Classification according to IMF Fiscal Rules dataset (2012)

A.2. Data Sources

Table A7: *Data Sources for Estimation of Fiscal Reaction Function*

Variable	Explanation	Source
Budget Balance	Surplus of general government (% of GDP)	International Monetary Fund - World Economic Outlook - General government net lending/borrowing
Country Size (Population)	Total population	Worldbank - World Development Indicators - Population total, SP.POP.TOTL
Debt to GDP ratio		International Monetary Fund - World Economic Outlook Database - General government gross debt
District Magnitude	Number of legislators elected in the average district in a country	Worldbank - Database of Political Institutions 2012, Average of Mean District Magnitude (MDM), House and Senate
Gov. Fragmentation	Sum of squared seat shares of all parties in the government	Own calculations with Worldbank - Database of Political Institutions 2012
Government Stability		International Country Risk Guide by the PRS Group
Ideology	Index of conservatism of government	Worldbank - Database of Political Institutions 2012
Ideological Range	Difference between extreme ideologies in government	Worldbank - Database of Political Institutions 2012
Monetary Union	1 if in currency union, 0 otherwise	Authors input
Parliamentary Election	Dummy for legislative election years	Worldbank - Database of Political Institutions 2012
Real GDP Growth	Real Growth of Gross Domestic Product (Percentage change)	International Monetary Fund - World Economic Outlook - Gross domestic product, constant prices, percentage change
Reputation of EMU	Dummy for the EMU15	Authors input

A.3. Comparison of Composite and POSET indices

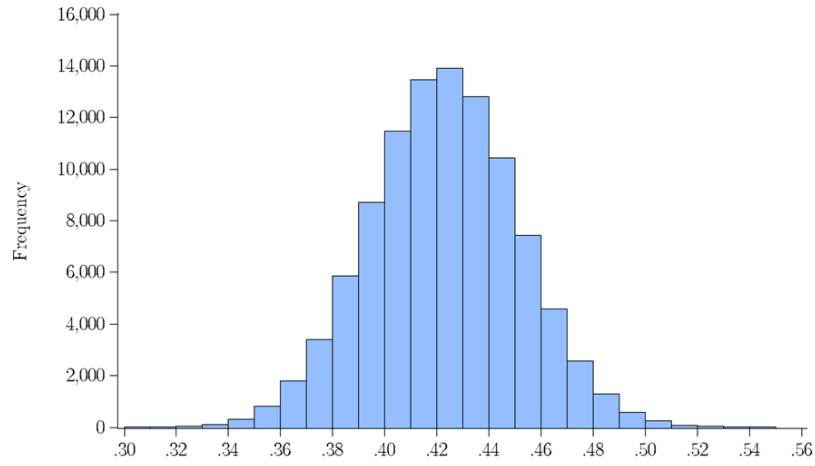


Figure A6: *Correlations between simulated composite indices and POSET index (R^{BR+}).*