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and Wolf Heinrich Reuter

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Paper

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Julia Bachtrögler
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Summarizing Data using Partially Ordered Set Theory: An Application to Fiscal Frameworks in 97 Countries*

Julia Bachtrögler¹, Harald Badinger^{1,2}, Aurélien Fichet de Clairfontaine¹, and Wolf
Heinrich Reuter¹

¹Vienna University of Economics and Business, Department of Economics, Welthandelsplatz 1, 1020 Vienna,
Austria. E-mail: julia.bachtroegler@wu.ac.at, harald.badinger@wu.ac.at, afichet@wu.ac.at,
wolf.reuter@wu.ac.at

²Austrian Institute of Economic Research (WIFO), Arsenal, Objekt 20, 1030 Vienna, Austria.

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Abstract

The widespread use of composite indices has often been motivated by their practicality to quantify qualitative data in an easy and intuitive way. At the same time, this approach has been challenged due to the subjective and partly ad hoc nature of computation, aggregation and weighting techniques as well as the handling of missing data. Partially ordered set (POSET) theory offers an alternative approach for summarizing qualitative data in terms of quantitative indices, which relies on a computation scheme that fully exploits the available information and does not require the subjective assignment of weights. The present paper makes the case for an increased use of POSET theory in the social sciences and provides a comparison of POSET indices and composite indices (from previous studies) measuring the "stringency" of fiscal frameworks using data from the OECD Budget Practices and Procedures survey (2007/08).

JEL Codes. C43, H60, E02, E62

Keywords. Partially Ordered Set Theory, Composite Indices, Index Functions, Fiscal Frameworks, Fiscal Rules, Budgetary Procedures

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1 Introduction

Criteria and methods for measuring objects based on nominal or ordinal properties have always been of interest in the social sciences. Various approaches have been brought forward, such as principal component analysis, correlation, data envelopment analysis or the elaborated usage of dummy variables. Composite indices, computed by means of scoring or index functions, are one of the most common of these methods to rank or measure objects based on different properties. Composite indices are employed in various fields of social sciences, e.g. to measure the quality-of-life in a country, the degree of corruption of governments, industrial competitiveness, environmental sustainability, institutional quality, or economic performance. Both, their practicality and the possibility of aggregating a large amount of information into a single variable that can be used in quantitative analyses, explain the widespread application of such indices.

However, the validity (and the robustness of the results obtained by the use) of composite indices has often been challenged due to unavoidable subjectivity in their calculation. Subjective choices are necessary on various levels: i) a selection of variables due to the scarcity of comparable qualitative data; ii) a choice of weights for each property is necessary, depending on prior knowledge, expert views or beliefs;¹ iii) the treatment of missing values that may limit the number of observations and aggravate the interpretation of the composite indices; and iv) the choice of an aggregation technique (the scoring scheme), the computing process and of the scale. All those shortcomings contribute to the disparities in the conditional ordering of objects and limit their comparability.

To address these issues we advocate the use of partially ordered set theory (POSET), which requires subjectivity only in the choice of the properties to be considered. This methodology is convenient in providing comparable indices or ranks of objects while reducing subjectivity to a minimum. As an application, we consider the measurement of the stringency of fiscal frameworks and compare the results obtained using the POSET approach with those obtained using composite indices (used in previous studies).

The interest in assessing and measuring fiscal frameworks (consisting of fiscal rules, budgetary procedures, fiscal institutions, etc.) and their impact on public finance has been growing in the last decade, especially following the consolidation efforts in the aftermath of the Economic and Financial Crisis and the consequent European debt crisis.² Several studies introduced

¹Sometimes a choice of optimal weights can be theoretically motivated, e.g., when an objective function of the policy maker can be defined.

²As a result, fiscal consolidation became 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.

measures of fiscal rules that allow quantitative analyses of their impact.³ One stream of literature suggests dummy variables that measure the existence and characteristics of fiscal rules⁴, while another one assesses properties of fiscal rules and budgetary procedures by defining categorical characteristics using composite indices.

Our study focuses on the second approach and the different methods used for computing fiscal framework indices. ACIR (1987), Bohn and Inman (1996), Wagner (2003), Alesina et al. (1999), Filc and Scartascini (2004), Debrun et al. (2008), Von Hagen (1992), Gleich (2003) and Schaechter et al. (2012) provide self-assessed and self-defined composite indices. Along with data or indices on fiscal institutions, obtained either via surveys or official documents, they compute measures of the stringency and other aspects of fiscal rules and budgetary systems to compare them across a sample of countries or states (of the US). The variables included in the calculations range from the formulation and legal basis of fiscal rules to the budget decision and execution structure, their transparency and foresight. However, these measures based on index functions often raise the problem of subjectivity in the weighting and assignment of point values to different rule designs. Furthermore, indices extracted from the literature are difficult to compare due to distinct patterns of scoring (different scales). As will be shown in the present paper, POSET theory provides an alternative method for generating indices of fiscal frameworks involving less subjective choice.

In a first step, we replicate indices used in previous studies (using the same index functions) based on data from the OECD Budget Practices and Procedures (OECD BPP) survey 2007/08. Second, we use POSET theory as a novel approach to calculate indices for the stringency of fiscal rules. We then compare the indicators obtained by different methods, analyse their correlation and interpret their discrepancies. In a last step, the data selection process is simplified in a way that all available and applicable information from the OECD dataset is taken into consideration, thereby creating a more general index of fiscal rules and reducing the subjective choice of properties to a minimum.

The remainder of the paper is organized as follows. Section 2 reviews the literature on measures of fiscal rules together with the index functions applied. Section 3 introduces POSET theory as an alternative approach. Section 4 describes the data and variables. Section 5 reports the degree of similarity between indices of the literature obtained by means of index functions and POSET theory as well as those based on all applicable questions of the dataset. The final section 6 summarizes the main results and concludes.

³The nexus between fiscal rules and fiscal performance has been established in theoretical research (Persson et al., 1997; Persson and Tabellini, 2004; Poterba and von Hagen, 2008; Debrun et al., 2008; Ayuso-i Casals et al., 2007), with a focus on the deficit bias as part of the problem of debt profligacy (see *e.g.* Debrun et al., 2008). The design of fiscal rules, *e.g.* their stringency, and its impact on fiscal outcomes empirically showed a positive and significant relation (Fatás and Mihov, 2003). Fatás and Mihov (2003, 2006) argue that fiscal constraints lead to lower volatility of discretionary fiscal policy, lower output volatility and thereby enhanced economic growth.

⁴See *e.g.* Debrun and Kumar (2007), Guichard et al. (2007), Brzozowski and Sivińska-Gorzela (2010), Candelon et al. (2009), Galí and Perotti (2003) and Nerlich and Reuter (2013).

2 Literature Review

We compare the new POSET approach to the common index/scoring function approach for constructing composite indices by applying both methods to the measurement of countries' fiscal rules and budgetary processes based on one data set, namely the OECD BPP dataset 2007/08. This dataset is particularly suitable for our question of interest, given its large number of questions and amount of information, which allows us to replicate indices used in previous studies (that have used different datasets, which are available only for a small number of countries, however) to a large extent. The analysis is related to a stream of literature on fiscal rules, covering various geographical regions (USA, South America, Western and Eastern Europe, IMF countries) as well as distinct aspects of a government's fiscal policy. As we show in the following, the selected properties and index computation schemes for the fiscal rules measures vary significantly across the literature. This section reviews fiscal rules indices used in previous studies and their interpretation. Table 1 gives an overview of the indices considered.⁵

A group of papers concentrated on the sub-national level of the USA. The Advisory Committee on Intergovernmental Relations (ACIR, 1987) analyses differences in implemented restrictions on budget procedures across the 50 US states. It introduces an index on existing balanced budget requirements for the local state governments in 1984 regarding their nature and legal basis, using data collected via a survey of executive and legislative fiscal officers and via the Council of State Governments. The results show that fiscal discipline-mechanisms are correlated with reduced spending and deficits (ACIR, 1987). Bohn and Inman (1996) examine, using a panel of 47 US states for the period 1970-1991, the statutory and constitutional constraints on budget formulation, and provide indices computed from a larger database than previous studies.⁶ Their index of stringency relies on the existence of statutory and constitutional requirements that prevent governments from carrying deficit (thus creating debt) over several years, and on the possibility for a governor to use a line item veto during the budget formulation process. Their results indicate that a constitutional basis guaranteeing an end-of-year balanced budget inherits a larger positive effect on state fund surplus than a statutory one. They also show that a governor line item veto limits deficits. Successively, Wagner (2003) analyses the increasing role of Budget Stabilization Funds (BSF) and their substitutability with general budget funds for the US states.⁷ As BSF are supposed to balance revenue decreases in unforeseen crises, one would assume that the withdrawal and usage of BSF by the government would be restricted. Though, this study concludes that the degree of strictness of the existing withdrawal and deposit rules, which indicate the amount of funds to be saved in the BSF over a time period, differ across the US states.

⁵Note that we leave out sub-indices which could not be replicated using the OECD BPP 2007/08 survey data. We provide a full description of the replication process of indices in Appendix A.3.

⁶Refer to Bohn and Inman (1996) for a complete review of related studies preceding 1996.

⁷States, which implemented these special funds, transfer a fraction of the budget surplus to the BSF, whereas the remaining amount stays in the general fund.

Two papers base their analysis on data from Latin American and Caribbean countries. Alesina et al. (1999) investigate the fiscal frameworks of a group of Latin American countries, classifying them as "collegial" (involving all possible governmental agents for the budget formulation) or "hierarchical" (budget procedures that assign a strong role to only one or few individuals for taking decisions). Their index is based on two questionnaires submitted to 20 Latin American countries. They find that countries having implemented more hierarchical and transparent budget institutions have a better fiscal discipline. Filc and Scartascini (2004) follow the approach of Alesina et al. (1999). They replicate and develop the indices further for eight Latin American countries by using the OECD BPP 2003 database, containing a broader number of questions and data for a bigger sample of countries. The authors calculate indices for the stringency of fiscal rules, depicting the hierarchical structure and the transparency of budgetary procedures, and aggregate them to a new composite index. Empirical analysis reveals that more hierarchical procedures as well as more stringent and enforceable rules are associated with lower fiscal deficits.

Another group of papers investigates the effects of fiscal frameworks using a sample of European countries. Von Hagen (1992) provides indices describing the different phases of the budgeting process: negotiations between ministers, the approval of the budget by the parliament and its execution. Furthermore, he calculates an index containing information about the existence and design of long-term planning constraints. His empirical analysis on the institutions constraining national budgeting procedures in the European Community (EC) builds on data containing assessments of the procedures by the European Commission and some member states, as well as fiscal data of the 1970s and 1980s. Von Hagen (1992) highlights the importance of ensuring fiscal discipline, especially in 12 EC member states for the planned foundation of the European Monetary Union (EMU). According to his results, this fiscal discipline is positively influenced by a powerful minister of finance (relative to other ministers), restrictions on the amendment possibilities of the parliament and by limitations to changes in the budget execution phase.

Gleich (2003) develops an index of fiscal performance for a sample of ten Central and Eastern European countries (CEEC) on the basis of detailed documents and questionnaires summarizing institutional characteristics of the budget process. The index measures to which extent public budgeting relies on coordination and cooperation during its formulation: at the budget preparation, legislative and implementation stage. The role of the constitution, budget law and procedure's rules of the parliament are evaluated for each of the three stages. His findings show that budget procedures characterised by stringent coordination and cooperation have been significantly associated with better fiscal outcomes.

Debrun et al. (2008) only consider fiscal rules fixing targets or ceilings expressed in numeri-

cal terms, *i.e.* numerical fiscal rules in the EU countries over the period 1990-2005.⁸ Those numerical fiscal rules are analysed with respect to their efficiency as instruments of governance to tackle budget deficits and output volatility. The related computed indices aim at measuring the degree of stringency of each fiscal rule (budget rule, expenditure rule, deficit rule and revenue rule), taking into account the statutory basis of the rule, the body (bodies) in charge of monitoring and enforcing it, the functioning of the enforcement mechanism and finally the visibility of the rule (transparency). Results indicate that the countries with the most stringent fiscal rules have the least volatile fiscal outcomes.⁹

The most recent study by Schaechter et al. (2012) analyses the development of national and supranational fiscal rules in IMF countries after the crisis. They provide index functions for fiscal rules indices, based on Kumar et al. (2009), that include the legal basis, coverage and enforcement of the rules. Furthermore, supporting procedures and institutions as well as the flexibility of governments facing fiscal rules are considered. The indices are calculated per type of rule (expenditure, revenue, budget balance and debt rule) and aggregated to an overall fiscal rules index. Analysing their panel dataset of 87 countries from 1985-2012, they find that many new, more complex rules have been implemented and existing ones have been reinforced.

In the present study, the indices mentioned above (ACIR, 1987; Bohn and Inman, 1996; Wagner, 2003; Alesina et al., 1999; Filc and Scartascini, 2004; Von Hagen, 1992, using 2001 data from Hallerberg, 2003; Gleich, 2003; Debrun et al., 2008; Schaechter et al., 2012) are replicated based on data from the broader OECD dataset 2007/08 by choosing the corresponding questions matching most closely the properties used in previous studies. Thereby we obtain composite indices using the method from previous studies and referring to the year 2006, which allows a comparison with corresponding POSET indices calculated from the same database (and the same year).¹⁰ The indices considered for this part of the analysis are summarized in Table 1.

3 Methodology

This section introduces the methodological approaches, which are compared in this paper: index/scoring functions and partially ordered set theory (POSET). Furthermore, Appendix

⁸As defined by Kopits and Symansky (1998), numerical fiscal rules are “a permanent constraint on fiscal policy, expressed in terms of a summary indicator of fiscal performance”.

⁹The criteria for the fiscal rules indices applied by Debrun et al. (2008) have been developed by the European Commission, Directorate-General for Economic and Financial Affairs. Data is collected annually from the EU member states and published here: http://ec.europa.eu/economy_finance/db_indicators/fiscal_governance/fiscal_rules/index_en.htm. They are also used in Foremny (2011), Foremny and Von Hagen (2013), Foremny (2014) and Iara and Wolff (2010) to construct fiscal rules indices.

¹⁰We slightly depart from this approach when we consider the indices used in Schaechter et al. (2012). They do not provide their indices but the underlying data on <http://www.imf.org/external/datamapper/fiscalrules/map/map.htm>, from which we will replicate their index according to the methodology described in their paper. If available, we use the indices of the year 2006 (matching the year of the OECD BPP 2007/08 survey; otherwise we use the year from the period 2004-2008 that is closest to 2006, assuming that fiscal rules have not changed too much over these (maximum period of) two years.

Table 1: Overview of Indices from Literature

Paper	Index name	Definition	Country Coverage	Period	#	Index Scale	
						Min	Max
ACIR (1987)							
	Category I	Legal basis of balanced budget requirements	US* States (50)	1984	1	1	2
	Category II	Nature of balanced budget requirements	US States (50)	1984	1	1	8
Bohn and Inman (1996)							
	No Carry Over	Possibility of carrying a deficit over	US States (47)	1970-1991	1	0	2
	Governor Veto	Presence of a governor veto by line item	US States (47)	1970-1991	1	0	1
Wagner (2003)							
	Deposit Rule	Budget Stability Funds deposit	US States (50)	2001	1	1	4
	Withdrawal Rule	Withdrawal of Budget Stability Funds	US States (50)	2001	1	1	4
Alesina et al. (1999)							
	Borrowing Constraint	Borrowing constraints	Latin American (20)	1980-1992	5	0	10
	Agenda Setting	Agenda setting constraints	Latin American (20)	1980-1992	5	0	10
	Total	Property of budget procedure (hierarchical or collegial budget procedure)	Latin American (20)	1980-1992	10	0	10
Filc and Scartascini (2004)							
	Fiscal Rules	Stringency of fiscal rules	Latin-American (11)	2004	10	0	10
	Hierarchical Procedures	Hierarchicalness of the procedures	Latin American (11)	2004	9	0	10
	Transparency	Transparency of the fiscal rules	Latin American (11)	2004	3	0	10
Von Hagen (1992)							
	Negotiations Structure	Impact of institutions during budget negotiations	EC** Countries (15)	2001	4	0	4
	Budget Approval	Impact of institutions during budget approval	EC Countries (15)	2001	5	0	4
	Budget Implementation	Impact of institutions during budget implementation	EC Countries (15)	2001	6	0	4
	Budget Rules	Impact of budget rules on fiscal process and discipline	EC Countries (15)	2001	4	0	4
	Total	Impact of institutions on fiscal process and discipline	EC Countries (15)	2001	19	0	4
Gleich (2003)							
	Preparation	Degree of centralization during preparation phase	CEEC*** Countries (10)	2003	4	0	10
	Legislation	Degree of centralization during legislation phase	CEEC (10)	2003	5	0	10
	Implementation	Degree of centralization during implementation phase	CEEC (10)	2003	4	0	10
	Total	Degree of centralization	CEEC (10)	2003	13	0	30
Debrun et al. (2008)							
	Expenditure Rule	Index of strength of numerical expenditure rules	EU**** Countries (25)	2006	6	1	10
	Revenue Rule	Index of strength of numerical revenue rules	EU Countries (25)	2006	6	1	10
	Budget Balance Rule	Index of strength of numerical budget balance rules	EU Countries (25)	2006	6	1	10
	Debt Rule	Index of strength of numerical debt rules	EU Countries (25)	2006	6	1	10
Schaechter et al. (2012)							
	Expenditure Rule	Design of expenditure rules and supporting procedures and institutions	IMF***** Countries (87)	1985-2013	10	0	5
	Revenue Rule	Design of revenue rules and supporting procedures and institutions	IMF Countries (87)	1985-2013	10	0	5
	Budget Balance Rule	Design of budget balance rules and supporting procedures and institutions	IMF Countries (87)	1985-2013	10	0	5
	Debt Rule	Design of debt rules and supporting procedures and institutions	IMF Countries (87)	1985-2013	10	0	5
	Overall Fiscal Rules Index	Design of fiscal rules and supporting procedures and institutions	IMF Countries (87)	1985-2013	25	0	5

Notes: #: Number of underlying properties for the index construction. * US: United States, ** EC: European Community, *** CEEC: Central and Eastern European Countries, **** EU: European Union, ***** IMF: International Monetary Fund

A.2 reviews the correlation measures used for the comparison of the indices obtained by the two methods.

3.1 Composite Indices and their Shortcomings

Composite indices are often used to summarize, measure and rank objects conditional on a set of properties (such as the fiscal performance of a country or an institution) (Jacobs et al., 2004). Their focus on policy achievement and performance, their efficiency for facilitating communication with the public and promotion of accountability are seen as the best arguments in favour of composite indices (Smith, 2002). Examples include, among others, the Human Development Index (UN), the Economic Freedom of the World Index (Economic Freedom Network) or the Corruption Perception Index (Transparency International).

A typical composite indicator is defined by Freudenberg (2003) as $I_i = \sum_{k=1}^K w_{k,i} X_{k,i}$, where w_k is the weight assigned to the k -th property and $X_{k,i}$ is the value (score) assigned for the k -th property to object i .¹¹

As discussed in Freudenberg (2003), the shortcomings of composite indices are widely related to their construction framework. Their sensitivity to the choice of endogenous variables (properties) and the assignment of scores and weights raises questions about their interpretation and relevance. To simplify, the construction framework of composite indices inherits five shortcomings where subjective decisions can negatively influence the relevance of the computed measure. The first is the selection of relevant properties (variables) underlying the definition of the composite index. They are chosen along criteria of analytical solidity, relevance and measurability (Freudenberg, 2003). Nonetheless, omitting or purposefully discarding relevant factors can mask data shortcomings and therefore bias the interpretation of the resulting index. Secondly, the lack of relevant data, so that properties might not be comparable across objects (*i.e.* countries), can be an issue that may drive the selection of properties. The third shortcoming relates to the subjectivity in designation of the scores and weights for each property to compare distinct objects, whereas the latter is often tackled with the use of regressions, correlation analysis, or principal component analysis. Fourthly, the issue of missing answers in the data harms the reliability of the composite index (Freudenberg, 2003). Finally, the aggregation technique used to map elementary factors into a composite index is a further source of subjectivity. Indeed, properties (variables) are rarely homogeneous and the aggregation process could be misleading when ordinal variables are combined with numerical weights (Maggino and Fattore, 2011).

¹¹The composite index I_i of an object i has a scale depending on the score (points) attributed to each k 'th property $X_{k,i}$. Obviously, the scaling of the scores assigned to the properties also affects the relative weights attributed to them. Often it will be convenient to re-scale an index (or the scores of the properties), improving its comparability with other indices and giving it a clear minimum and maximum value (for instance, zero for the lowest and one for the largest value).

3.2 POSET Theory

POSET theory is presented in this paper as an alternative approach to construct aggregate indices and ranks of objects. While employed in natural sciences, where it has proven as a reliable methodology for computing robust indices and reducing the requirements for subjective choice to a minimum, it has to the best of our knowledge not been applied in the social sciences so far.¹² The application of POSET theory is advocated also for practical reasons by reducing the subjectivity in the assessment of indices and fully exploiting the available information. According to Brüggemann and Patil (2011) and De Loof et al. (2008) partially ordered set theory offers the possibility of ordering objects conditional on their characteristics. It is considered as an efficient alternative to composite indicators computed by index functions since the assignation of scores to each property is reduced to an ordinal rank. There are also established methods for checking the sensitivity of POSET indices with respect to the selection of properties (the remaining subjective choice) (Brüggemann and Patil, 2011).

In the following, we outline the construction of POSET indices, following Brüggemann and Patil (2011) and De Loof et al. (2008). Consider a set O of $i = 1, \dots, N$ objects (depicted by $x_i \in O$) with J corresponding properties as $q(x_i) = (q_1(x_i), q_2(x_i), \dots, q_J(x_i))$. These properties are ordered in a set Q as $q(x_i) \in Q_j \forall j$. Keeping this in mind, we define a partially ordered set as a set of objects ordered alongside their properties by the following relation:

An object $x_i \in O$ is written as $x_i \leq_O x'_i$ if $q_j(x_i) \leq_Q q_j(x'_i)$ where \leq_O is the binary partial order relation between objects x and \leq_Q is the linear order relation between properties of these objects. The ranking of objects that are only characterised by one property is straightforward. However, more than one property could lead to different linear relations between two objects and the problem of uncomparability arises.

Objects that are not comparable are written as $x_i \parallel_O x'_i$ and POSET theory treats them by adding a linear extension approach, thus attributing a rank r to every object $x_i \in O$. For two objects x_i and x'_i , the linear extension is defined such that $x_i \leq_O x'_i$ implies $r_i < r'_i$. The set of all linear extensions of the POSET (O, \leq_O) is denoted as $\varepsilon(O)$. The set of linear extensions contains all the possible rankings of objects $x_i \in O$ obeying POSET theory. Assuming that all linear extensions have the same probability and are uniformly distributed on an interval $[0, |\varepsilon(O)|]$, each rank of an object can be associated with an assigned rank probability. Indeed, the expected value of the rank of an object $x_i \in O$ is given by

$$p_i(r) = |\varepsilon_i^r(O)| / |\varepsilon(O)| \quad (1)$$

for $r \in [1, n]$ where $|\varepsilon_i^r(O)|$ is the number of linear extensions in $\varepsilon(O)$ and $|\varepsilon(O)|$ is the

¹²POSET theory has been used, for example, in order to rank chemicals according to environmental hazards (Halfon and Reggiani, 1986), or for the ranking of near-shore sediments (Brüggemann and Patil, 2011). 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).

cardinality of the set of linear extensions (i.e., the number of elements contained in the set). By construction, the sum of all expected probabilities for an object x_i is equal to one:

$\sum_{r=1}^N p_i(r) = 1$. Therefore, the expected rank of an object $x_i \in O$, also referred to as averaged rank \bar{r}_i is written as follows:

$$\bar{r}_i = \frac{\sum_{r=1}^N [r \cdot p_i(r)]}{N} \quad (2)$$

The POSET approach of ranking objects and, analogously, generating index values depends on the number of objects contained in O and on their properties contained in Q . However, the rank probability $p_i(r)$ relies only on the linear extensions between observable objects (contained in O) that cover a sample of the entire population.

In applied work, particularly in social sciences, there might be further unobserved objects, and hence further possible linear extensions, such that the average 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. We rewrite Eq. (1) by substituting the set of observable objects O with a set G of all existing (observable and unobservable) objects and define their relation as $O \subseteq G$, thus O being a subset of G . Objects $g \in G$ (alike object $x \in O$) have L corresponding properties ordered in the set Q , i.e. $G = g \mid q(g) = \{(q_1(g), q_2(g), \dots, q_L(g) \text{ with } q_l(g) \in Q \forall l)\}$. The rank probability of element x_i on rank r in all linear extensions, written $\varepsilon(G)$, is defined as

$$p_i(r) = |\varepsilon_i^r(G)| / |\varepsilon(G)| \quad (3)$$

and its corresponding expected value of the rank \tilde{r}_i is given by

$$\tilde{r}_i = \frac{\sum_{r=1}^N [r \cdot \tilde{p}_i(r)]}{N} \quad (4)$$

The latter distinguishes itself from the former by the fact that at least one possible linear extension contained in $\varepsilon(G)$ corresponds to any ranking obtained by a weighting scheme in an index function (Brüggemann et al., 2001). As shown in Brüggemann et al. (2004), the computation of the approximate rank probabilities of more than $n = 25$ objects exceeds today's computer capacities. We therefore apply the approach of Brüggemann et al. (2004) that addresses this issue by calculating the approximate averaged rank of objects using Local Partial Order Model techniques.¹³

¹³For further research on alternative ways to calculate the approximate rank probabilities and averaged ranks, see Lerche and Sørensen (2003) (random sampling) and De Loof et al. (2006) (lattice theory). Further details are provided in Appendix A.1.

4 Data

The OECD BPP survey 2007/08 provides data on many aspects of fiscal frameworks for a wide range of countries. Thus we base our comparison of methodologies on indices constructed by using this database. First we replicate indices used in the literature to describe fiscal frameworks as exact as possible with the OECD dataset and then compare those to our POSET measures based on the same underlying selection of data. The OECD dataset was collected during 2006 and 2007, as a revised version of the 2003 survey, using an on-line questionnaire for senior budget officials of 97 countries. It contains 89 questions (split into 227 sub-questions) on the countries' fiscal frameworks. The questionnaire is divided into six parts, namely "General Information" (concerning the central budget authority), "Budget Formulation" (procedure), "Budget Approval", "Budget Execution", "Accounting and Audit" and "Performance Information", which are outlined in Table 2.¹⁴

In general, each category contains questions with a given set of prescribed answers, containing information on i) whether fiscal rules, restrictions, transparency or other requirements on the fiscal authority in the budgetary process exist, and ii) if so, how stringent they are, and iii) which legal basis (constitution, law, informal rule) they have. In the first part of our analysis, we choose those questions matching as close as possible the ones included in the calculation of fiscal indices in previous studies.¹⁵ We code all answers on an ordinal scale, such that the response options are ranked higher with increasing stringency, increasing hierarchy of the legal foundation (with constitution being the highest level) or increasing independence of the budget authority. POSET theory then offers an attractive approach for the computation of rank indices for the stringency of fiscal frameworks without the need to set further assumptions.

Table 2: Overview of Questions in OECD Budget Survey 2006/2007

Part*	Chapter	Description**
1	General Information	Location and structure of budget authority, legal foundations of fiscal and budget procedures rules in place. 4 (14) questions
2	Budget Formulation	Actors involved in formulating and reviewing the budget, legal foundations, time frames and forecasting, characteristics of fiscal rules in place, budget negotiations, expenditure limits. 27 (62) questions
3	Budget Approval	Roles and the relative power of executive and legislative, off-budget expenditures. 17 (38) questions
4	Budget Execution	Authority of the executive for increases in spending, restrictions on amendments after approval, borrowing constraints, supplementary budgets, reserve funds. 13 (22) questions
5	Accounting and Audit	Reporting to legislative, internal and external auditing by supreme audit institutions, public availability of auditing results. 9 (16) questions
6	Performance Information	Setting performance targets, links to budget formulation and execution, evaluation of performance, potential consequences of evaluation results. 19 (75) questions

Notes: * Chapter of OECD Budget Survey Questionnaire. ** Number of questions including sub-questions in parentheses.

¹⁴See Appendix A.4 for some descriptive statistics of responses to the questionnaire 2007/08. It turns out that there is substantial variation in the properties of fiscal framework across countries that provides a valuable source of variation that can be exploited the empirical analyses.

¹⁵In a final step, we calculate POSET indices based on all information provided in the the OECD BPP survey. However, not all questions allow a clear ordinal coding relating to the stringency, transparency, legal status of the budgetary process or the independence of the budget authority. Thus, the baseline dataset will be made up of 26 questions (including 70 sub-questions).

5 Index Computation

This section compares the two methods to construct indices of fiscal frameworks: index/scoring functions (for composite indices) and POSET theory (introduced in Section 3). As a first task, preceding the computation of POSET indices and testing their similarity with their composite counterparts, the suitability of the OECD dataset for the calculation of the indices used in the literature and the measurement of fiscal frameworks has to be established. To this end, composite indices from the literature are matched as closely as possible by using information in the OECD dataset and compared using the same country sample as in the original studies. Large coefficients of correlation between newly calculated and original indices (from Alesina et al. (1999); Filc and Scartascini (2004); Von Hagen (1992); Gleich (2003); Debrun et al. (2008) and Schaechter et al. (2012)) suggest that the OECD dataset contains (roughly) the same information as the sources used in previous studies. The first subsection therefore shows the comparability of the indices from the literature by means of the particular index function. As a next step, the second subsection shows the correlation analysis of the composite indices based on the information in the OECD dataset and the newly computed POSET indices, based on the same properties and the full country sample provided in the OECD dataset. Finally, the third subsection suggests a construction scheme of POSET indices with no prior selection of properties, thereby reducing the need for subjective choice further. These indices are compared with the POSET ones calculated in the section before.

5.1 Composite Indices: Comparing Previous Studies with the OECD Dataset

Replicating the indices of fiscal frameworks allows testing the degree of equivalence between the content of the OECD dataset and the data used in the respective studies. Therefore, we attempt to match the properties suggested in the literature with the questions in the OECD survey 2007/08. The originally computed indices of fiscal frameworks for the sample of countries investigated in each study (Latin American countries in Alesina et al. (1999) and Filc and Scartascini (2004); European Union countries in Hallerberg (2003), using the method of Von Hagen (1992), and in Debrun et al. (2008); Central and Eastern European countries in Gleich (2003); IMF countries in Schaechter et al. (2012)) are compared with the corresponding replicated indices based on the OECD dataset but using exactly the same index function approach and weights as in the original study. It is worth mentioning that three index sets from the literature, namely ACIR (1987), Wagner (2003) and Bohn and Inman (1996) cannot be replicated using the OECD data, since the 50 US States are not covered in the dataset. For the purpose of this analysis, we attempt to construct and compare an index for the United States as a whole, based on similar questions in Section 5.2.

Table 3 contains Spearman's correlation coefficients and Kendall taus between all fiscal rules indices vectors originating from the literature and the suggested replicated indices sets using the OECD dataset. Additionally, descriptive statistics of the differences between the two vectors of indices are given as well as information about time discrepancies between the original

Table 3: Indices Replication

Indices	Spearman's coefficient	Kendall tau	Differences [†]			Year of survey	Matching questions	Country coverage
			Mean (Std.Dev.)	Min	Max			
Alesina <i>et al.</i>								
Borrowing Constraints	0.45	0.41	-0.27 (1.35)	-3.12	1.45	1996	5/5	9/20
Agenda Setting	0.30	0.25	1.25(1.87)	-2.30	4.23	-	3/5	9/20
Total	0.58	0.40	0.41 (1.11)	-1.77	2.73	-	8/10	9/20
Filc and Scartascini								
Fiscal Rules	0.78**	0.62**	0.89 (1.41)	-0.98	3.43	2003	6/10	8/11
Hierarchical Procedures	-0.46	-0.40	-1.33 (3.08)	-5.19	4.23	-	3/9	8/11
Transparency	0.18	0.15	-1.38 (1.83)	-3.50	2.00	-	2/3	8/11
Von Hagen ^{††}								
Negotiations Structure	0.26	0.24	-2.56 (0.45)	-3.00	-1.75	2001	1/4	15/15
Approval	0.24	0.19	-0.13 (0.28)	-0.50	0.40	-	5/5	15/15
Execution	-0.05	-0.02	-0.04 (0.28)	-0.39	0.47	-	5/6	15/15
Budget Rules	0.26	0.22	-0.30 (0.38)	-0.88	0.10	-	3/4	15/15
Total	0.46*	0.33*	-0.14 (0.11)	-0.32	0.04	-	14/24	15/15
Gleich								
Preparation	0.77	0.69	0.11 (1.61)	-2.00	3.00	2003	3/4	9/10
Legislation	0.62*	0.47*	-0.06 (1.66)	-1.90	2.93	-	5/5	9/10
Implementation	0.42	0.27	0.94 (1.06)	-0.55	2.67	-	3/4	9/10
Total	0.42	0.33	-0.90 (0.98)	-2.79	0.38	-	11/13	9/10
Debrun <i>et al.</i> ^{†††}								
Expenditure Rule	0.74**	0.57**	-0.60 (1.30)	-2.66	1.00	2003	5/7	13/25
Budget Balance Rule	0.24*	0.15*	-0.23 (2.66)	-3.33	5.00	-	5/7	9/25
Debt Rule	0.97**	0.94**	-1.13 (1.53)	-3.33	1.00	-	5/7	5/25
Schaechter <i>et al.</i> ^{††††}								
Expenditure Rule	0.58**	0.40*	0.17 (0.41)	-0.50	0.83	2012	7/10	13/87
Budget Balance Rule	0.48*	0.37*	0.33 (0.66)	-0.67	1.67	-	7/10	13/87
Debt Rule	0.11	0.12	0.20 (0.91)	-0.92	2.25	-	7/10	9/87
Overall Fiscal Rules Index	0.27	0.21	0.36 (0.62)	-0.94	1.58	-	19/25	28/87

Notes: [†] Mean differences and standard deviation between the replicated indices and the original indices from the literature as well as the minimum and maximum difference value. Year of the original data collection. Number of questions available in both original and OECD dataset over the total number of questions for an index. Country coverage in terms of number of countries covered in both original and OECD dataset for an index. The scales of the indices are given in Table 1. ^{††} Indices based on methodology by Von Hagen (1992) taken from Hallerberg (2003). ^{†††} Revenue rule is taken out of the dataset because of the lack of observations. ** and * denote statistical significance at the 5 % and 10 % level. ^{††††} As the index values of Schaechter *et al.* (2012) are not available on the individual country level, we build the indices following the methodology in Schaechter *et al.* (2012) and the database on <http://www.imf.org/external/datamapper/fiscalrules/map/map.htm>, which suffers from much missing information. If values from 2006 are not available in the time series provided, but one from 2004 to 2008, we use the value of the year nearest to 2006 for the index computation. For the comparison, we just consider those countries, which have the specific rule in question in place. As we do not consider the Revenue Rule due to lack of observations, we divide the sum of the available rule-specific index results per country by three for the computation of the Overall Fiscal Rules Index.

survey/database and the OECD dataset and the share of properties (questions) for the indices construction present in both databases. To go more into detail, the mean and standard deviation of differences between the two sets of indices are useful indicators for the magnitude of variation.¹⁶ The minimum and maximum distances are provided for the ease of interpretation.¹⁷ The year of the data collection (via survey or analysis) gives insights towards the possibility of discrepancy between original and replicated indices since it can be expected that the characteristics of fiscal rules and budgetary procedures change over time. Column nine of Table 3 (Country Coverage) demonstrates that not all countries in the data samples in the literature could be considered for the correlation analysis, since some countries are not covered in the OECD dataset.¹⁸

¹⁶It is computed by subtracting the n -by-1 vector of original indices from the n -by-1 vector of replicated indices, with n being the number of countries. The mean and standard deviation are computed using the difference vector.

¹⁷Note that the replicated indices based on the index functions and the original ones are not equally scaled. Therefore, the means, standard deviations and minimum/maximum of the differences in Table 3 depend on the original scale suggested by the literature.

¹⁸The indices suggested in Schaechter *et al.* (2012) are not provided by the authors. As the underlying data, available on <http://www.imf.org/external/datamapper/fiscalrules/map/map.htm>, contains many missing answers, the country coverage is relatively low.

The results in Table 3 reveal mostly positively correlated relationships between the original and the replicated indices. However, few differences remain for Filc and Scartascini (2004) and Von Hagen (1992), where some correlation coefficients approximate zero or are even negative.

The replication of the indices constructed in Alesina et al. (1999) for 20 Latin American countries are positively correlated with the original indices (coefficients range from Spearman 0.30/Kendall 0.25 to 0.58/0.40). The correlation is small, notwithstanding the high proportion of questions in the OECD dataset matching the original survey of 1996. An explanation for this discrepancy could be the large time difference between the original and new dataset (eleven years) and the possible changes in fiscal frameworks of the investigated countries. The correlation between the original and replicated Agenda Setting sub-index may be smaller due to two properties from the original data that do not have a match in the OECD dataset.¹⁹

The correlation between the replicated and original indices of Filc and Scartascini (2004) (that are based on a 2003 version of the OECD BPP survey) is high and positive for the Fiscal Rules sub-index. As visible in Table 4, the replicated Hierarchical Procedures and the Transparent Procedures sub-indices and the original ones from Filc and Scartascini (2004) have low or even negative correlation. The explanation may be twofold. Firstly, the matching of questions building the indices is an issue here, as some questions and response options of the OECD survey version 2003 have been reformulated or even deleted (see Appendix A.3 for more information). Secondly, the countries' fiscal frameworks between the OECD survey 2003 and 2007/08 may have been changed.²⁰

For the indices provided for 2001 in Hallerberg (2003), who uses the index function introduced in Von Hagen (1992), we find positive correlations with the exception of the Budget Execution sub-index. Although we were only able to match one of four questions with the OECD dataset, we find a positive correlation of 0.26/0.24 for the first sub-index regarding the Negotiations Structure. However, question matching issues seem to be the reason for the negative correlation between the original and the replicated Budget Execution sub-index.²¹ Nevertheless, the average of all replicated sub-indices is positively correlated (0.46/0.33) with the Total index in the literature.²²

Concerning the indices of Gleich (2003), the high proportion of matching questions (75%, 84%

¹⁹See Appendix A.3 for a detailed explanation of the matching.

²⁰For the Hierarchical Procedures, one would suggest that the countries would have converged towards a stricter regulation and more hierarchical budget procedure (point values would increase), but this only applies for Bolivia and Suriname. Unfortunately, Filc and Scartascini (2004) only provide the value of the aggregated sub-indices and not the points' assignment to the individual sub-questions, which would allow investigating the varying values in detail.

²¹See Appendix A.3 for a detailed discussion.

²²Note that Von Hagen (1992) suggested 5 sub-indices (Structure of Negotiations within parliament, Structure of parliamentary process, Informativeness of the budget draft, Flexibility of budget execution, Long-term planning constraint). There are no questions in the OECD BPP dataset that match the third sub-index. Thus, it is not included in the replicated Total index. See Appendix A.3 for further details.

and 100%) allows for high correlation coefficients. This may result from the relative simplicity of the index functions (only four to five questions per index). The smallest Spearman's correlation coefficient corresponds to the Budget Implementation index and is 0.42 while the largest one amounts to 0.77 for the Budget Preparation index.

All replicated indices from Debrun et al. (2008) are positively correlated with the ones in the literature, and only the Revenue Rule yields correlation coefficients is close to zero. Due to the extremely small number of countries having a revenue rule in place, it has been discarded from the analysis. The Debt Rule index yields the largest correlation coefficient (0.97/0.94), followed by the Expenditure Rule index (0.74/0.57). Only the Budget Balance Rule index is poorly correlated with its original counterpart (0.24/0.15) which could related to the small country coverage (only nine out of 19 countries were covered in both datasets). We take this, however, as a cautious hint that our replicated index conveys the same information as the one by Debrun et al. (2008). These findings reflect the high degree of similarity between the original survey and the OECD dataset.

Also for the indices from Schaechter et al. (2012), we do not consider the Revenue Rule index in this section as we could just compare only four country observations. The Expenditure and Budget Balance Rule index show relatively high correlation with those calculated on the basis of the original data. However, the correlation of the Debt Rule indices (0.11/0.12) appears to be less strong due to a lower country coverage. The IMF Fiscal Rules dataset referred to in Schaechter et al. (2012) and the OECD BPP 2007/08 data contain partly contradictory information regarding the existence and design of the rules as well as many missing answers to the relevant questions in this case, which may be the reason for the relatively small correlation coefficients of the Overall Fiscal Rules index (0.27/0.21).²³

To summarize, most of the correlation coefficients are positive and vary between 0.11 and 0.97. Few exceptions demonstrate that matching the properties used in the literature indices with questions from the OECD survey is not always straightforward. Furthermore, the time passed between the data collection can influence the index replication negatively. In spite of that, we consider these discrepancies to be structure-specific and not directly related to the appropriateness of the dataset for the measurement of fiscal rules. Thus we conclude that the OECD BPP survey 2007/08 can be an approximate substitute for the different original datasets used in the literature.

5.2 Composite Indices versus POSET Indices based on OECD Data

As a second step, corresponding indices related to fiscal frameworks are computed by means of POSET theory. As outlined in Section 3, this methodology does not require an explicit scoring of each property, but instead reduces subjectivity by assigning an ordinal rank and equal weight to each objects' property. For the purpose of comparability with the replicated indices,

²³See Appendix A.3 for details on the matching of properties underlying the indices with the OECD dataset.

Table 4: Correlation of Composite Indices and POSET Indices

Index		Spearman's coefficient	Kendall tau	Mean (Std. Dev.)	Differences*	
					Min	Max
ACIR	Category I	0.60	0.60	0.35 (0.18)	0.00	0.75
	Category II	-0.52	-0.54	0.59 (0.18)	0.00	0.69
Bohn and Inman	No Carry Over	0.99	0.96	-0.00 (0.11)	-0.45	0.53
	Governor Veto	0.91	0.89	-0.02 (0.10)	0.00	0.48
Wagner	Deposit Rule	0.96	0.95	0.40 (0.14)	0.25	1.13
	Withdrawal Rule	0.64	0.58	0.76 (0.19)	0.38	0.88
Alesina <i>et al.</i>	Borrowing Constraint	0.62	0.52	-0.11 (0.25)	-0.77	0.66
	Agenda Setting	0.92	0.79	0.04 (0.14)	-0.44	0.36
	Total	0.59	0.46	0.22 (0.23)	-0.46	0.85
Filc and Scartascini	Fiscal Rules	0.65	0.47	0.26 (0.12)	0.00	0.68
	Hierarchical Procedures	0.81	0.70	0.56 (0.20)	0.06	1.00
	Transparency	0.38	0.32	0.37 (0.19)	-0.02	0.95
Von Hagen**	Negotiations Structure	1.00	1.00	0.75 (0.00)	0.75	0.75
	Budget Approval	0.69	0.57	0.72 (0.05)	0.64	0.81
	Budget Implementation	0.85	0.68	0.78 (0.04)	0.67	0.85
	Budget Rules	0.89	0.75	0.77 (0.07)	0.66	1.13
	Total	0.84	0.65	0.78 (0.07)	0.63	0.86
Gleich	Preparation	0.80	0.66	-0.06 (0.21)	-0.26	0.26
	Legislation	0.82	0.68	-0.00 (0.22)	-0.79	0.79
	Implementation	0.79	0.67	-0.05 (0.20)	-0.63	0.63
	Total	0.77	0.59	-0.08 (0.20)	-0.44	0.44
Debrun <i>et al.</i>	Expenditure Rule	0.73	0.57	-0.22 (0.27)	-0.73	0.25
	Revenue Rule	0.36	0.29	-0.15 (0.37)	-0.62	0.52
	Budget Balance Rule	0.69	0.55	0.03 (0.24)	-0.55	0.38
	Debt Rule	0.44	0.34	0.14 (0.34)	-0.66	0.60
Schaechter <i>et al.</i> ***	Expenditure Rule	0.90	0.79	-0.09 (0.19)	-0.42	0.23
	Revenue Rule	0.94	0.87	-0.09 (0.19)	-0.33	0.27
	Budget Balance Rule	0.91	0.80	-0.10 (0.18)	-0.42	0.27
	Debt Rule	0.92	0.81	-0.11 (0.19)	-0.42	0.27
	Overall Fiscal Rules index	0.65	0.49	-0.32 (0.33)	-0.80	0.25

Notes: * Mean differences and standard deviation of these differences between the replicated indices and the POSET indices from the literature as well as the minimum and maximum difference value. Composite indices are divided by maximum index scale (see Table 1) in order to be standardized between zero and one. All correlation coefficients contained in Table 4 are significantly different from zero (at the 5 % level). ** Replicated indices based on methodology by Von Hagen (1992), data taken from Hallerberg (2003). *** For the comparison, we just consider those countries, which have the specific rule in question in place. The composite indices following Schaechter *et al.* (2012) are divided by four (not by maximum scale five given in Table 1) because we do not consider the properties regarding flexibility. For more details see Appendix A.3.

the computation is based on the same set of questions from the OECD dataset, matching as closely as possible those from previous studies. We refer to these newly obtained measures as POSET indices.

Investigating the degree of similarity between POSET theory and index functions, indices yielded by both methods are compared. Correlation coefficients are reported in Table 4. It is worth mentioning that measures of fiscal rules and budgetary procedures are replicated not only for the country samples investigated in the literature²⁴ but for the entire sample of 97 countries covered in the OECD dataset. Note that in contrast to the previous analysis of subsection 5.1, indices are normalized to the range from zero to one.

The results reveal interesting features of the interrelationship between composite and POSET indices: the large majority of correlation coefficients reported in Table 4 are high, indicating that the POSET indices are approximating their counterparts based on an index function approach (or vice versa). Moreover, all correlation coefficients (for both Spearman's correla-

²⁴US states in ACIR (1987), Bohn and Inman (1996) and Wagner (2003); Latin American countries in Alesina *et al.* (1999) and in Filc and Scartascini (2004); Central and Eastern European countries in Gleich (2003), European Union countries in Hallerberg (2003) following Von Hagen (1992) and in Debrun *et al.* (2008); IMF countries in Schaechter *et al.* (2012).

tion coefficient and Kendall tau) are statistically significant. The highest similarity can be shown for the indices picturing the No Carry Over rule and Governor Veto (Bohn and Inman, 1996), the Deposit Rule (Wagner, 2003), the Agenda Setting (Alesina et al., 1999), Hierarchical Procedures (Filc and Scartascini, 2004) and the Negotiations Structure and Budget Rules (Von Hagen, 1992). Their very large coefficients might result from the fact that the construction of these indices only relies on one or two questions, thus having only a restricted set of possible scores (0, 0.5 and 1). However, also the POSET indices of Schaechter et al. (2012) are highly correlated with their composite counterparts.

Indices with the lowest (positive) correlation coefficients are the Revenue Rule and Debt Rule of Debrun et al. (2008) and the Transparency index of Filc and Scartascini (2004) with values of 0.36, 0.44 and 0.38 (Spearman's) respectively. An explanation for the low correlation of the Revenue Rule and of the Debt Rule of Debrun et al. (2008) could be their high fraction of "not applicable" answers (NA's). For the questions contained in Filc and Scartascini's Transparency composite index we also see a large fraction of NA's, which may distort the composite indices.

For the Category II index of ACIR (1987) regarding the nature of balanced budget requirement, we get a negative correlation between the replicated and the POSET index. The problem lies in matching the considered properties²⁵ and the high amount of NA's. The average Spearman's correlation coefficient comparing the 30 POSET indices and replicated indices in Table 4 is 0.72. As in the previous section, the mean, standard deviation as well as the minimum and maximum of the differences between POSET indices and replicated indices are provided. The partly high values can be explained by (1) the problem of matching the properties of the indices with questions in the OECD dataset (see Appendix A.3) and (2) a high fraction of "not applicable" responses for some questions. However, the "not applicable" responses are an issue only for the composite indices since it harms their reliability towards countries that are not covered or have only limited information available and can corrupt the actual position of all countries in a composite index (Freudenberg, 2003). The POSET approach - unlike an index function approach - allows to include questions where answers are missing for part of the countries, thereby exploiting and making best use of the information provided by the (sub)set of observed answers.²⁶

²⁵Two of five of the possible types of nature of requirements that ACIR (1987) proposed cannot be replicated by the questions in the OECD dataset while the other three can only be approximated indirectly by a combination of two questions. See Appendix A.3.

²⁶The 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). Dropping particular questions is done by assigning a mean value (0.5) to this property, which could be expected to have the consequence of centering of the POSET indices around their mean. However, Table 7 in Appendix A.5 shows that the POSET theory does not systematically reduce the variability of the indices.

The objective of this subsection was to show the difference between indices of fiscal frameworks computed by means of POSET theory and composite indices from the literature. The principal shortcoming of composite indices lies in the assignment of points to particular characteristics of fiscal rules and budgetary procedures and the choice of weights is highly subjective that can lead to large sensitivity in response to varying point schemes and weights. In opposition, POSET theory reduces subjectivity to a minimum. Still, we find that POSET indices are very similar to composite indices if the underlying basis of questions or number of NA's is small, *i.e.* where the subjective choices are not so important due to the small amount of possible weightings or selections. If the datasets and fractions of NA's are larger we do find larger difference between the two approaches as POSET allows considering more information in the index calculation.

5.3 Global Indices vs. Specific Indices

POSET theory offers an index calculation method that reduces subjectivity in the ordering of different properties as compared to composite indices relying on index functions, as it is based on linear extensions of the properties of the objects in question. Furthermore, it allows including all information available in the dataset, even the missing observations. However, the selection of objects' properties for the construction of the indices, in our case the questions in the OECD dataset, remains an issue and a source of subjectivity.

So far in this study, questions from the OECD dataset were chosen conditional on matching the particular properties of fiscal rules and budgetary procedures considered in the literature. In the last step of our analysis, we eliminate this restriction and take advantage of the large information contained in the OECD dataset. Therefore, we suggest a novel construction scheme of indices for fiscal rules and budgetary procedures characteristics by using the whole set of questions in the OECD dataset. Though, as we want to measure the budgetary characteristics of the 97 countries and order them, we can only consider questions, whose responses allow an ordinal ranking.

The OECD dataset has six main chapters: General Information, Budget Formulation, Approval, Execution, Accounting and Audit, and Performance Information.²⁷ For each chapter, an index of fiscal rules characteristics is computed using POSET theory. Note that we leave out the General Information as well as the Performance Information chapters because of their rather restricted number of questions that are fully covered in the indices used in the literature. The focus is therefore put on the remaining four chapters corresponding to the stages of the budgetary process. We refer to these indices as Global indices, and to indices based on the restrained questions set by the literature as specific indices. We investigate whether the global indices correlate with specific indices considering similar properties, thus if the prior selection of questions in the OECD dataset is crucial for the measurement of fiscal frameworks.

²⁷See Section 4 and Appendix A.4 for a detailed description of the dataset.

The significant correlation coefficients for the relationship between the four global indices with the 30 specific indices from the literature (ACIR, 1987; Bohn and Inman, 1996; Wagner, 2003; Alesina et al., 1999; Filc and Scartascini, 2004; Debrun et al., 2008; Von Hagen, 1992; Gleich, 2003; Schaechter et al., 2012) are shown in Table 5.

Table 5: Global vs. Specific Indices

	Budget Formulation		Budget Approval		Budget Execution		Accounting Audit	
	Spearman's coefficient	Kendall tau						
ACIR								
Category I	0.41**	0.33**	–	–	–	–	–	–
Bohn and Inman								
No Carry Over	–	–	–0.19*	–0.16*	0.36**	0.30**	–	–
Governor Veto	–	–	–0.26**	–0.21**	–	–	–	–
Wagner								
Withdrawal Rule	–	–	0.32**	0.26**	–	–	–	–
Alesina <i>et al.</i>								
Borrowing Constraint	0.17*	0.12*	–	–	0.34**	0.25**	–	–
Total	0.22**	0.15**	–	–	0.30**	0.21**	–	–
Filc and Scartascini								
Fiscal Rules	0.71**	0.53**	–	–	–	–	0.24**	0.16**
Transparency	–	–	0.28**	0.23**	–	–	–	–
Von Hagen								
Budget Implementation	–	–	–0.26**	–0.18**	0.39**	0.27**	–	–
Budget Rules	–	–	–	–	–	–	–0.18*	–0.13*
Total	–	–	–0.22**	–0.14**	0.24**	0.17**	–	–
Gleich								
Preparation	0.28**	0.22**	–0.24**	–0.19**	0.17*	–	0.26**	0.20**
Legislation	–	–	0.24**	0.17**	–	–	–	–
Implementation	–	–	–	–	0.41**	0.31**	–	–
Total	–	–	–	–	0.34**	0.23**	–	–
Debrun <i>et al.</i>								
Expenditure Rule	0.26**	0.19**	0.22**	0.16**	–	–	0.32**	0.25**
Revenue Rule	–	–	0.23**	0.18**	–	–	0.21**	0.16**
Budget Balance Rule	0.51**	0.38**	0.17*	0.12*	–	–	0.26**	0.18**
Debt Rule	0.32**	0.24**	–	–	–	–	0.21**	0.16**
Schaechter <i>et al.</i>								
Expenditure Rule	0.45**	0.35**	0.19*	0.13*	–	–	–	–
Revenue Rule	0.36**	0.27**	0.24**	0.19**	–	–	–	–
Budget Balance Rule	0.54**	0.40**	–	–	–	–	–	–
Debt Rule	0.38**	0.28**	0.27**	0.19**	–	–	–	–
Overall Fiscal Rules Index	0.71**	0.54**	–	–	–	–	–	–

Notes: All correlation coefficients contained in Table 5 are significantly different from zero. ** and * denote statistical significance at the 5 % and 10 % level. We consider all 97 countries of the OECD dataset for the comparison.

In summary, the correlation analysis reveals significant interdependencies between most specific and the global indices (24 of the 30 specific indices). The global index based on the first chapter of the OECD dataset, “Budget Formulation”, yields the largest correlation coefficients and shows a positive relationship with the measurement of fiscal rules of Filc and Scartascini (2004), Debrun et al. (2008), Schaechter et al. (2012), and the Preparation index of Gleich (2003).

The correlation between global and specific indices depends positively on the proportion of underlying questions from an OECD dataset chapter, setting the basis for the construction of the global index, that are also used for the computation of a specific index. Specific indices focusing on a specific part of the budget process, *i.e.* formulation, legislation, execution or

audit (such as those of Gleich (2003)), are therefore expected to be significantly similar to the corresponding global indices.

The index related to the “Budget Approval” (by the legislation) is, as expected, significantly correlated with the Transparency index by Filc and Scartascini (2004), the Legislation index of Gleich (2003) and the measures of Debrun et al. (2008) and Schaechter et al. (2012). Though, it shows a negative correlation with the Budget Implementation index by Von Hagen (1992) and the Preparation index of Gleich (2003), which can be explained by the fact that just one question in the replication of each originates from the Budget Approval chapter. The third part of the dataset, “Budget Execution”, yields an index highly correlated with Alesina et al. (1999), with the No Carry Over index of Bohn and Inman (1996) and of course the Implementation indices of Von Hagen (1992) and Gleich (2003). Finally, the “Accounting and Audit” index shows a significant positive correlation with all Debrun and Kumar (2007)’s indices, mainly due to the budget monitoring aspect covered by these indices. It also has a positive relationship with the Fiscal Rules index of Filc and Scartascini (2004) and Gleich (2003)’s preparation measure due to the same reasons. The negative correlation coefficient related to Von Hagen (1992)’s Budget Rules index again represents the fact that no question considered for its replication is part of this chapter.

The selection of data and of relevant variables underlying the construction of a composite index has often been described as very subjective. Comparing such indices may be misleading since prior knowledge, expert views or beliefs toward the right set of properties and weights strongly influence the computation process (Freudenberg, 2003; Maggino and Fattore, 2011). Addressing this failure, our global indices take into account all available and orderable properties for the index construction, minimizing the chance of omitting valuable information.²⁸

6 Concluding Remarks

Composite indices are widely used in applied science to quantify qualitative aspects of objects in an understandable and easy way. However, their shortcomings originate from their construction scheme, relying on a subjective selection of relevant properties and on assignation of weights that make it hard to compare their values. Driven by the idea that the need for subjective choices in the computation of rank indices can be avoided or at least reduced, this study advocates the use of POSET theory, a methodology that has not been fully exploited in social sciences so far. POSET theory relies on a linear extension framework for ordering objects conditional on given properties. It does not require any prior assignation of weights for the properties and is able to take into consideration all available information. It therefore helps to reduce subjectivity to a minimum and yields comparable indices that may serve as benchmark that can be compared with more specific composite indices.

²⁸Global indices computed with the POSET methodology also consider the presence of NA’s for some observations. For more information on this topic, see Section 3 or Brüggemann and Patil (2011).

This paper uses the measurement of governments' fiscal frameworks as a case study to investigate the applicability of POSET theory. As a first step, replication of indices from the literature has been successfully performed using the OECD BPP survey 2007/08 dataset, providing information on budgetary procedures for 97 countries. The dataset is shown to be suited to replicate many fiscal rules measures from the literature and therefore enables a comparison of the composite indices with indices based on POSET theory. As a second step, we compare POSET and composite indices of fiscal rules (using the same set of questions as previous studies but the full country sample) and find partly large similarities between indices obtained by POSET theory and composite indices. Of course, the large correlation for part of the indices does not necessarily imply that the use of these two kinds of indices in econometric analyses yields the same results. Overall, we argue that POSET indices can serve as a (more) objective benchmark for the measurement of performance and ranking analyses. Finally, global indices, computed by taking into account all available and applicable information provided by the dataset, show significant and positive correlations with many of corresponding specific indices that are confined to smaller sets of questions. We take this result as a hint that the selection of relevant properties seems not to be too crucial for the indices computation (in the present setting).

To summarize, POSET theory has been shown to be a well suited alternative to composite indices. It allows to fully exploit available information for the ordering of objects conditional on their properties, yields measures that are less sensitive to subjective decisions, improves comparability, and simplifies the calculation of rank indices by making designation of properties, assignment of weights and deletion of objects with missing data unnecessary.

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Appendix

A.1 Appendix - Closed Formula for averaged Ranks of a POSET

Brüggemann et al. (2004) introduce a closed form solution to calculate the (approximate) averaged rank of objects of a POSET, using 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: $r(x_i) \in [P + 1, P + 1 + U]$, where P 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 the number of incomparable objects 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 cases $r(x_i) = P + 1$ all the incomparable objects are placed among the successors of (objects ranked below) object x_i , and for $r(x_i) = P + 1 + U$, all the incomparable objects are placed among the predecessors. For ranks in-between, we see that if $r(x_i) = P + 1 + k$ then k objects are placed among the predecessors and $U - k$ objects are placed among the successors. This rank is realized $\binom{U}{k} (P + 1)^k (S + 1)^{U-k}$ times, which counts all possibilities to place k objects among the predecessors and $U - k$ objects among the successors of x_i . Using this we can formulate the following formula for the averaged rank of an object:

$$\bar{r}(x_i) = \frac{\sum_{k=0}^U (P + 1 + k) \cdot \binom{U}{k} \cdot (P + 1)^k \cdot (S + 1)^{U-k}}{\sum_{k=0}^U \binom{U}{k} \cdot (P + 1)^k \cdot (S + 1)^{U-k}} \quad (5)$$

In Brüggemann (2004) this formula is empirically tested and furthermore it is shown that Formula 5 is numerically²⁹ the same as Formula 6, which treats the incomparable objects, as one block:

$$\bar{r}(x_i) = \frac{(P + 1 + U)(P + 1) + (P + 1)(S + 1)}{S + 1 + P + 1} \quad (6)$$

One can think of several examples where the above introduced approximation formulas do not perform well. This is especially the case if the POSET is very asymmetric or includes objects, which are incomparable to all other objects. Nevertheless, in POSET with a sufficient amount of objects and a symmetrical structure, which is especially given if we consider a POSET of all possible objects, the formula gives a good approximation of the real averaged rank.

A.2 Appendix - Correlation Measures

This study aims to achieve a comparison of sets of indices computed with the two methodologies introduced above, (1) index functions yielding composite indices and (2) POSET theory. Aggregated statistical measures such as correlation coefficients offer a clear view on the degree of dependence and similarity of numerical vectors and can also be applied to ordinal measures such as indices and rankings. The literature often relies on two aggregates, namely the Spearman's rank correlation and the Kendall tau, as well as on the use of a correlation

²⁹The formal proof of the equivalence of the formulas is not available yet.

test to assess the probability of two ranking vectors to be fully independent.

Spearman's Rank Correlation

The Spearman's rank correlation coefficient is appropriate for discrete values, and therefore for ordinal measures. Let two vectors of numerical variable R_1 and R_2 be converted in ranks $r^{(1)}$ and $r^{(2)}$, their Spearman's rank correlation coefficient is defined as

$$\rho = \frac{\sum_i (r_i^{(1)} - \bar{r}^{(1)}) (r_i^{(2)} - \bar{r}^{(2)})}{\sqrt{\sum_i (r_i^{(1)} - \bar{r}^{(1)})^2 \sum_i (r_i^{(2)} - \bar{r}^{(2)})^2}} = \frac{\text{Cov}(r^{(1)}, r^{(2)})}{\sigma_{r^{(1)}} \sigma_{r^{(2)}}} \quad (7)$$

The problem of ranking ties (presence of rank duplicates) is addressed by Spearman's rank correlation coefficient formula. Spearman's rank correlation test is also satisfactory for testing a null hypothesis of independence between two variables, but it is difficult to interpret when the null hypothesis is rejected. Kendall's rank correlation (Kendall tau) improves upon this by reflecting the strength of the dependence between the variables being compared.

Kendall tau

The second measure of the degree of interdependence between two ordinal variables (rankings) is the Kendall tau. Analogously to the Spearman's rank-order correlation coefficient, Kendall's tau correlation coefficient captures the relation between two ordinal vectors. It is equivalent to Spearman's correlation coefficient but distinct in magnitude. Let $(x_1, y_1), (x_2, y_2), \dots, (x_n, y_n)$ be a set of observations of the joint random variables X and Y respectively, such that all values of (x_i) and (y_i) are unique. Any pair of observations (x_i, y_i) and (x_j, y_j) are said to be concordant if the ranks for both elements have the same order: that is, if both $x_i > x_j$ and $y_i > y_j$ or if both $x_i < x_j$ and $y_i < y_j$. They are said to be discordant, if $x_i > x_j$ and $y_i < y_j$ or if $x_i < x_j$ and $y_i > y_j$. If $x_i = x_j$ or $y_i = y_j$, the pair is neither concordant nor discordant. For a number N of non-reciprocal pairs of observations n , defined as $N = n(n - 1)/2$, the Kendall tau is written as

$$\tau = \frac{n_c - n_d}{N} \quad (8)$$

where n_c is the number of concordant pairs in both ranking vectors, and n_d the number of discordant pairs. However, Eq. (7) does not consider ties (duplicates) and could be therefore biased. A non-biased version of (7), denoted Kendall tau-b, is thus given by

$$\tau_b = \frac{n_c - n_d}{[N - T][N - U]} \quad (9)$$

where T and U are the respective number of non-reciprocal pairs of ties in $r^{(1)}$ and in $r^{(2)}$. Note that if there are no ties, (9) simplifies to (8). Kendall's tau-b is therefore less sensitive

to outliers and is often preferred to the Spearman's correlation coefficient due to its simpler interpretation. Kendall's tau could be interpreted as a probability, *i.e.*, the difference between the probability that the observed data are in the same order (when positive) versus the probability that the observed data are not in the same order (when negative).

A.3 Appendix - Questions

This appendix refers to section 5.1 that contains the results of the correlation analysis of replicated and original composite indices from the literature (ACIR, 1987; Bohn and Inman (1996); Wagner, 2003; Alesina et al., 1999; Filc and Scartascini, 2004; Von Hagen, 1992; Gleich, 2003; Debrun and Kumar, 2007; Schaechter et al., 2012). In the following, we show in detail our procedure of matching the properties of the original indices with the questions in the OECD BPP survey 2007/08. Note that the scoring schemes are not relevant for the indices calculation using POSET theory (section 5.2) and that the matching is not necessary for the global indices developed in section 5.3.

I. ACIR (1987)

ACIR (1987) calculate indices of stringency of balanced budget requirements. The variables in question are the legal basis and the nature of the requirement:

Category I

Question: "Are balanced budget requirements statutory (= 1 point) or constitutional (= 2)?"

Match: Q15-"Budget Balance rules": d) "Which of the following defines the fiscal rule?" "Constitution" = 2, "Legislation" = 1, otherwise = 0

Category II

Question: "What is the nature of the requirement?"

Answers: "State Cannot Carry Over a Deficit Into Next Fiscal Year" = 8, "State Cannot Carry Over a Deficit into Next Biennium" = 6, "May Carry Over a Deficit but Must be Corrected in Next Fiscal Year" = 4, "Legislature Only has to Pass a Balanced Budget" = 2, "Governor Only has to Submit a Balanced Budget" = 1

Match: Q15-"Budget Balance rules": Combination of b) "What is the time period covered by the fiscal rule?" and f) "In case of non-compliance with the fiscal rule, what are the enforcement procedures?"

15 b) "1 year" and 15 f) "There is an automatic correction mechanism" = 8, 15 b) "2 years" and 15 f) "There is an automatic correction mechanism" = 6, 15 f) "The Government or ministry responsible for the overrun has to implement corrective measures" = 4, otherwise = 2

The assignment of 1 and 2 points according to ACIR (1987) cannot be replicated straight-

forward considering the response options in the OECD BPP survey 2007/08. If two response options are valid in the categories, the higher points are taken for calculating the corresponding index.

II. Bohn and Inman (1995)

Bohn and Inman indices are computed for 44 US states and focus on the possibility for a state government to carry a deficit over a fiscal year and on the existence of an item veto for the governor. The two related questions originally asked by Bohn and Inman and their equivalents in the OECD BPP survey are the following:

No Carry Over

Answers: "There is a constitutional regulation" = 2, "There is a statutory regulation that deficits might not be carried over into the next fiscal year" = 1, "Governments may carry over deficits into next fiscal year" = 0

Match: Q55: "Is it possible for ministries/Government organizations to borrow against future appropriations?" "Yes, without approval" = 2, "Yes, with approval by Legislature" = 1 and "No" = 0

Governor Veto

Answers: "Governor has item veto" = 1, "Governor has no item veto" = 0

Match: Q44: "Does the Executive have the power to veto the budget approved by the Legislature?" "Yes" = 1, "No" = 0

III. Wagner (2003)

Wagner analyses the increasing role of Budget Stabilization Funds (BSF) and their substitutability with general budget funds also for the US states. Three indices concerning the stringency of deposit rules, of withdrawal rules and of fund size were constructed:

Deposit Rule

Answers: "If specific, pre-defined economic conditions are met (*e.g.* growth rate of real personal income exceeds 2.5%) the government has to deposit funds into the BSF." = 4, "There is the obligation to deposit funds into the stabilization funds each year, independently from the budget balance." = 3, "The state is obligated to deposit at least a fraction of a budget surplus into the stabilization funds." = 2, "There is no explicit requirement to deposit funds into stabilization funds." = 1

Match: Q61: "Did the budget for the last fiscal year include any central reserve funds to

meet unforeseen expenditures?" "Yes, to finance new policy initiatives" or "Yes, to meet major forecasting errors in macroeconomic and other assumptions underlying the budget" = 3, "Yes, to meet general unforeseen expenditures" = 2, "No" = 1

As one can see, response options and points assignment cannot be replicated straightforward.

Withdrawal Rule

Answers: "Withdrawals from stabilization funds are permitted if specific, pre-defined economic conditions are met (*e.g.* a declining growth of real personal income)." = 4, "Usage of stabilization funds is only permitted with a supramajority vote of the legislature." = 3, "There is a restriction to just withdraw funds from BSF in the case of a revenue shortfall." = 2, "There is no rule for the withdrawal from the stabilization funds." = 1

Match: Q45-for the types of off-budget expenditure "Emergency/contingency funds" and "Stabilization funds": "What types of off-budget expenditure exist?" If one of two named types "requires legislative authorization" = 2, if one of these types "is applicable" = 1

Fund Size

This index contains information if the US states have implemented size limits for the budget stabilization funds: Definition of size limit by a "Statutory formula" = 4, "No limit on fund size" = 3, "between 5 and 25% of the budget" = 2, "5% of budget or less" = 1

There is no question in the OECD questionnaire about the size limits of the budget stabilization funds, *i.e.*, we are forced to skip that aspect.

IV. Alesina et al. (1999)

This index, scaled from zero to one, is based on two questionnaires submitted to 20 Latin American countries. For each question, countries were assigned a score between zero (more collegial) and ten (more hierarchical). Two sub-indices are suggested by Alesina et al. (1999): the "borrowing constraint sub-index", composed of the answers to the questions 1, 2, 3, 7 and 8 and the "agenda-setting sub-index", composed of the answers to the questions 4, 5 and 6.

Borrowing Constraint

Question 1: "What constitutional constraints are there on the fiscal deficit?"

Answers: "Deficits are not Allowed" = 10, "Budget should include proper financing for deficit" = 5, "No restrictions" = 0

Match: Q14: "In developing the budget, are there any fiscal rules that place limits on fiscal policy?" with Answers "Yes, budget balance (surplus/deficit) rule" = 10, Q35: "In the presentation of Central Government budget documents to the Legislature, which of the following elements are included?" with Answers "Comprehensive annual financial plan encompassing all revenues and expenditures" or "Perspective on total revenue and expenditure" = 5, Otherwise

= 0

Question 2: "Is there a legal requirement for the approval of a macro program to precede the presentation of the budget to Congress? How important is this requirement in practice?"

Answers: "Very important" = 10, "Relatively important" = 5 and "Not important" = 0

Match: Average of Q16: "Does the annual budget documentation submitted to the Legislature contain multi-year expenditure estimates?" and Q24: "What type of information is contained in the annual budget circular/memorandum issued by the Central Budget Authority to guide the preparations of budget proposals/budget estimates?". If more than one answer = 10, one answer = 5 or none = 0.

Question 3: "What kind of borrowing constraints are there on the government?"

Answers: "Congress approves each borrowing operation" = 10, "Ceiling set by the congress" = 6.66, "Ceiling set by the government" = 3.33, "No constraints: Government borrows if shortfall" = 0 (composite score in the case of multiple answers).

Match: Q14: "In developing the budget, are there any fiscal rules that place limits on fiscal policy?" "Yes, debt rule" = 10 and Q37: "Does the Legislature first vote on the total amount of expenditure before it votes on specific appropriations?" "Yes" = 5, Otherwise = 0

Question 7: "Can the budget be modified after Congress approval?"

Answers: "No" = 10, "On Congress' initiative" = 7.5, "On government's initiative without congressional approval" = 5, "On government's initiative with congressional approval" = 2.5, Otherwise = 0

Match: Average of Q51: "Does the Government have the authority to increase spending once the budget has been approved by the Legislature?" - "Is it possible?" with answer "No" and average of Q51 - "Does it require any approval?" with answers "It requires legislative approval prior to the fact" = 10 or "It requires legislative approval after the fact" = 5, Otherwise = 0

Question 8: "Is the government legally empowered to cut spending after the budget has been approved?"

Answers: "At government's discretion on any item" = 10, "At government's discretion for non-earmarked expenditures" = 6.66, "Only when revenues are lower than projected" = 3.33 and "No" = 0

Match: Q52: "Does the Government have the authority to cut/cancel/rescind spending once the budget has been approved by the Legislature?" "Yes, with some restrictions" = 10 and "Yes, without restrictions" = 5, Otherwise = 0

Agenda Setting

Question 4: "Is the authority of the Minister of Finance greater than that of the spending ministers on budgetary issues?"

Answers: "Yes, considerably greater" = 10, "Somewhat greater" = 5, "No" = 10

Match: Q26: "In practice how are disputes between line ministries and the Central Budget Authority in the budget preparation process generally resolved?" "The issue is resolved by the Minister of Finance" = 10, Q23: "Does the Central Budget Authority impose limits (ceilings) for each ministry's initial spending request?" "Yes, for all types" or "Yes, but only for some types" = 5, "Otherwise" = 0

Question 5: "Restrictions on the content of amendments to the budget by Congress: Congress can only pass amendments that..."

Answers: "Do not increase the deficit" = 10, "Do not increase spending" = 7.5, "Do not increase deficit or spending" = 5, "With government approval" = 2.5 and "No restrictions" = 0

Match: Q40: "What are the formal powers of the Legislature to amend the budget proposed by the Executive?" with answer "The Legislature may make amendments but only if it does not change the total deficit/surplus proposed by the Executive" = 10, Q40 with answer "The Legislature may only decrease existing expenditures/revenues (*i.e.* the Legislature cannot increase existing items nor create new ones)" or "Other" = 5. 0 points otherwise.

Question 6: "What happens if Congress rejects the budget, or does not approve it within the constitutionally set time frame?"

Answers: "The government resigns" = 10, "The government submits a new budget" = 7.5, "The budget proposed by government is enacted" = 5, "The previous year's budget is enacted" = 2.5, "Otherwise" = 0

Match: Q43: "If the budget is not approved by the Legislature before the start of the fiscal year which of the following describes the consequences?" with Answer "The Executive's budget proposal takes effect"=10, Q43 with answer "Expenditure without legislative approval are not allowed" or "The Executive's budget proposal takes effect on an interim basis, *i.e.* for a limited period" = 6.66 and Q43 with answer "Last year's budget takes effect on an interim basis, *i.e.* for a limited period" or "Other" = 3.33. 0 points otherwise.

Question 9: "Does the central government typically assume debt originally contracted by other public agencies? Under what circumstances?"

Answers: "Frequently", "Occasionally", "Exceptionally", "Only on guaranteed debt", "Including non-guaranteed debt" with the total score depending on a combination of answers. The more frequent the central government assumes debt from other institutions the lower is the score.

Match: Not available in OECD survey

Question 10: "Can these agencies borrow autonomously?"

Answers: "No" = 10, "Yes without restrictions" = 7.5, "With Congress approval" = 5, "With central government approval" = 2.5, "With local legislature approval" = 0

Match: Not available in OECD survey.

V. Filc and Scartascini (2004)

We compare the questions Filc and Scartascini (2004) applied from the OECD/World bank Budget Practices and Procedures survey (2003) with the 2007/08 version of the questionnaire and attempt to build the indices the same way to see whether the results are correlated. We expect that the comparison will not just reveal different results due to the different time period analysed, but also due to changes in the formulation of the questionnaire.

Fiscal Rules

This sub-index is composed of the topics Fiscal limits, Medium Term Fiscal Frameworks, Borrowing Limits and Reserve Funds.

1. Fiscal Limits

The questions used by Filc and Scartascini (2004) can be found still in the newer version of the OECD/World Bank questionnaire. Though, the grouping of different types of fiscal rules has changed.

Question 1: "Are there fiscal rules placing limits on Executive fiscal policy discretion?"

Answers: "Yes" = 10, "No" = 0

Match: Q14: "In developing the budget, are there any fiscal rules that place limits on fiscal policy?" "Yes, expenditure rule" or "Yes, revenue rule" or "Yes, budget balance (surplus/deficit) rule" or "Yes, debt rule" = 10, "No" = 0

Question 2: "If yes, where are they regulated?" This question needs to be answered separately for "Broad Qualitative Rules, Limit on Total Debt, Limit on Debt Held by the Public, Limit on Nominal Expenditures, Limit on Expenditures as a Percentage of GDP, Limit on Annual Deficit as Percentage of GDP, Limit on Multi-Annual Deficit".

Answers: "Constitution" = 10, "Budget Law" = 6.66, "Regulation" = 3.33, "No formal basis" = 0

Match: Q15 d): "Which of the following defines the rule?" (Responses are considered separately for Expenditure Rule, Revenue Rule, Budget Balance rules, Debt rule)

"Constitution" = 10, "Legislation" = 6.66, "Formal agreement of parties in Government" = 3.33, "Otherwise" = 0 ("Political Commitment of the government", "It is not explicitly defined")

Question 3: "If there are fiscal limits, can the Executive Branch propose waiving or amending the limits?" (single question, no separation by rule type)?

Answers: "Yes" = 0, "Yes within limits" = 5, "No" = 10

Match: Q15 f): "In case of non-compliance with the fiscal rule, what are the enforcement procedures (Responses are considered separately for Expenditure Rule, Revenue Rule, Budget Balance rules, Debt rule)?" "There is an automatic correction mechanism" or "There are automatic sanctions" = 10, "The Government or ministry responsible for the overrun has to implement corrective measures" or "There is a possibility of sanctions" = 5, "Enforcement procedures are not defined ex ante" or "A proposal with corrective measures must be presented to the legislature" or "Otherwise" = 0

2. Medium Term Fiscal Frameworks

Not available in OECD survey. The current version of the survey contains the medium term dimension just for the expenditures side (Q16-22), whereas there is asked only for long term fiscal projections (Q12-13).

3. Borrowing Limits

Question 1: "Is it possible for managers of ministries/government organization to borrow against future appropriations for operating costs (salaries, etc.)?"

Answers: "No" = 10, "Yes, as approved on a case-by-case basis by the Ministry of Finance/Central Budget Authority" = 6.66, "Yes, up to a maximum percentage" = 3.33, "Yes, without limit" = 0

Match: Q55: "Is it possible for ministries/Government organizations to borrow against future appropriations?" (Responses are considered for Operating expenditures) "No" = 10, "Yes, with approval of the Legislature" or "Yes, with approval of the Central Budget Authority" = 6.66, "Yes, without approval if within a specified sub-limit" = 3.33, "Yes, without approval" = 0

Question 2: "Are there any limits on the borrowing activity of lower levels of government?" This question has been eliminated in the 2007/08 version of the OECD BPP survey.

Question 3: "Does the national government explicitly or implicitly guarantee the borrowing activity of lower levels of government?"

This question has been eliminated in the 2007/08 version of the OECD BPP survey.

4. Reserve Funds

One question can be adopted from the earlier version used in Filc and Scartascini (2004), the second one can be approximated:

Question 1: "Does the annual budget include any central reserve funds to meet unforeseen expenditures?"

Answers: "A large central reserve fund is operated for new policy initiatives" or "A large central reserve fund is operated to meet major forecasting errors in the economic and other assumptions underlying the budget. The fund is only used if such errors occur" or "A large central reserve fund is operated to meet general unforeseen expenditures" = 10, "A small central reserve fund is operated for only limited contingent purposes" = 7.5, "A small central reserve fund is operated for new policy initiatives" or "A small central reserve fund is operated to meet general unforeseen expenditures" = 5, "No" = 0 The answers include the purpose of the central reserve funds and if they are small or large. The latter dimension, as also not defined in detail, is left out in the 2007/08 survey.

Match: Q61: "Did the budget for the last fiscal year include any central reserve funds to meet unforeseen expenditures?" "Yes, to meet major forecasting errors in macroeconomic and other assumptions underlying the budget" = 10, "Yes, to meet general unforeseen expenditures" or "Yes, to finance new policy initiatives" = 5, "No" = 0

Question 2: "Are there laws, regulations or policies which define the permitted uses of the budget reserves and the decision making authorities for approving allocations from the reserves?"

Match: Q4: "What is the legal basis for the following?" - 4.8: Rules for the use of contingency or reserve funds: "Constitution" or "Legislation" or "Internal Rules" = 10; "No formal basis" = 0 The fiscal rules index is calculated by an average of the upper responses.

Hierarchical Procedures

Filc and Scartascini (2004) calculate the Hierarchical Procedures sub-index as the average of three indices: restrictions on the legislature, on the executive and cash management.

1. Restrictions on Legislature

Filc and Scartascini (2004) have averaged the response values of three questions, of which just one has stayed in the OECD BPP survey and even also changed due to fewer and reformulated response options. Due to the latter the direct mirroring of the assigned points is not possible.

Question 1: "Are there any restrictions on the right of the legislature to modify the detailed budget proposed by the executive?"

Answers: "Yes" = 10, "No" = 0

Question 2: "If applicable, what form do these restrictions take?"

Answers: "May not make any changes. Legislature can only approve or reject the budget in whole" = 10, "May not increase or propose new expenditures, *i.e.*, legislature can only decrease funding levels" = 8.88, "May only make changes to aggregate levels of spending or revenue" = 7.77, "May reallocate or increase funding levels for only certain programmes, but only if it

reduces others or approves new revenue sources, *i.e.*, no net change in total deficit/surplus" = 6.66, "May reallocate or increase funding levels, but only if it reduces others or approves new revenue sources, *i.e.*, no net change in total deficit/surplus" = 5.55, "May reallocate and increase funding levels for only certain programmes" = 4.44, "May create new spending items, reallocate or increase funding levels, but only if it reduces others or approves new revenue sources, *i.e.*, no net change in total deficit/surplus" = 3.33, "May reallocate and increase funding levels" = 2.22, "May create new spending items, reallocate and increase funding levels" = 1.11, "The Executive must approve any changes proposed by legislature" = 0

Match: Q40: "What are the formal powers of the Legislature to amend the budget proposed by the Executive?" "The Legislature may not make any changes; it can only approve or reject the budget as a whole" = 10, "The Legislature may only decrease existing expenditures/revenues" = 6.66, "The Legislature may make amendments but only if it does not change the total deficit/surplus proposed by the Executive" = 3.33, Otherwise = 0

Question 3: "If applicable, what is the legal basis of these restrictions?" No question in the OECD BPP 2007/08 survey can certainly match that question.

2. Restriction on Ministries

The questions concerning this dimension of the index are approximately the same in the earlier and current OECD Budget Practices and Procedures survey.

Question 1: "Are there fixed spending limits set for initial Ministry spending plans?"

Answers: "Yes, they are based on the MTEF or forward budget" = 10, "Yes, they are set by the Ministry of Finance/central budget authority" = 7.5, "Yes, other" = 5, "No there are only suggested spending targets" = 2.5, "No, there are no restrictions on initial spending plans from Ministries" = 0

Match: Q23: "Does the Central Budget Authority impose limits (ceilings) for each ministry's initial spending request?" "Yes, for all types of expenditure" = 7.5, "Yes, but only for some types of expenditures" = 5, "No, there are only suggested/indicative limits" = 2.5, Otherwise = 0 The assignment of the points cannot be done directly as response options have changed.

Question 2: "Are there established rules or procedures to guide central budget authority negotiations with line ministries?"

There is no such question in the 2007/08 survey.

Question 3: "Who has the last word? How are disputes between Ministries and the central budget authority resolved?"

Answers: "The minister of finance makes all final decisions" = 10, "The issues are resolved by the President/Prime Minister/Principal Executive" = 7.5, "The issues are sent to a ministerial committee" = 5, "Cabinet" = 2.5, "The issue is sent to parliament for decision" = 0

Match: Q26: "In practice, how are disputes between line ministries and the Central Budget Authority in the budget preparation process generally resolved, *i.e.* issues not resolved at civil servant level?" "The issue is resolved by the Minister of Finance" = 10, "The issue is resolved by the Prime Minister" or "The issue is resolved by the President" = 7.5, "The issue is sent to a ministerial committee" = 5, "The issue is resolved by the Cabinet" = 2.5, otherwise = 0

3. Cash Management

There is no question concerning cash management in the OECD survey 2007/08.

Transparency (Transparent Procedures)

Due to the reformulation and re-definition of the first question regarding the completeness of the budget documents presented to the Legislature we expect a lower correlation between the replicated and the original index by Filc and Scartascini (2004). In the OECD BPP survey 2003, it was just a "Yes/No" question, whereas in the 2007/08 version it is asked explicitly for the parts of the documents.

Question 1: "Is the Budget Document presented to the Legislature comprehensive (does it include all government expenditures)?"

Answers: "Yes" = 10, "No" = 0

Match: Q35: "In the presentation of central Government budget documents to the Legislature, which of the following elements are included?" The 12 response options include the report of fiscal policy objectives in the medium run, budget priorities, macroeconomic assumptions and other methodological information as well as medium and long term perspectives on total revenue and expenditure. As the question in 2003 refers in brackets to the completeness of the public expenditure plan, we first interpreted options "Comprehensive annual financial plan encompassing all revenues and expenditures including off budget expenditures and extra budgetary funds" and "Comprehensive annual financial plan encompassing all revenues and expenditures for all levels of Government (including regional and local)" as a positive answer to the Question in 2003 (=10 points). If one of these options is not ticked, there are considered 0 points ("No"). Though, this version gives as a very low, even negative correlation with the indices calculated by Filc and Scartascini (2004). That is why we consider all answer options of Q35 for the completeness of the budget document presented to the Legislature and level them: More than 8 items ticked = 10 points, more than 4 items ticked = 5, otherwise = 0.

Question 2: "What types of extra-budgetary funds are found?"

Answers: "Countries with no funds" = 10, "Countries with one fund" = 9, ..., "Countries with ten fund" = 0

Match: Q45: "What types of off-budget expenditure exist?" 14 types are given which should be ticked when applicable. Like in the Question from 2003, the number of types found indi-

cates the value assigned. Countries with ten or more types of off-budget expenditure chosen applicable get 0 points.

VI. Von Hagen (1992)

For the index creation, Von Hagen (1992) summarizes various characteristics observed in five groups:

- Structure of negotiations within parliament
- Structure of the parliamentary process of approving or rejecting the budget draft
- Informativeness of the budget draft
- Flexibility of budget execution
- Long-term planning constraint

For each item within these groups, Von Hagen (1992) asserts points from zero to four related to the design of the characteristic. The higher the number, the more he assumes its impact towards greater fiscal discipline. To replicate the results, we use the cited structure above and its sub-characteristics:

Negotiations Structure (Structure of negotiations within parliament)

Question 1: "General constraint"

Answers: "government spending/nominal GDP and deficit/nominal GDP" = 4, "government spending/nominal GDP or Golden Rule" = 3, "public debt/nominal GDP and deficit/nominal GDP" = 2, "public debt/nominal GDP" = 1, "none" = 0

Match: Q14: "In developing the budget, are there any fiscal rules that place limits on fiscal policy?" "Yes, expenditure rule" and "Yes, budget balance (surplus/deficit) rule" = 4, "Yes, expenditure rule" = 3, "Yes, debt rule" and "Yes, budget balance (surplus/deficit) rule" = 2, "Yes, debt rule" = 1, "No" = 0

Question 2: "Agenda setting for budget negotiations" There is no matching question in the OECD BPP survey 2007/08.

Question 3: "Scope of budget norms in the setting of agenda" There is no matching question in the OECD BPP survey 2007/08.

Question 4: "Structure of negotiations" There is no matching question in the OECD BPP survey 2007/08.

Budget Approval (Structure of parliamentary process)

Question 1: "Amendments" by the legislature

Answers: "limited" = 4, "unlimited" = 0

Match: Q40: "What are the formal powers of the Legislature to amend the budget proposed by the Executive?" "The Legislature has unrestricted powers to amend the budget" = 0; otherwise (if applicable) = 4

Question 2: "Amendments are "required to be off-setting" (not changing the budget balance)"

Answers: "yes" = 4, "no" = 0

Match: Q40: "What are the formal powers of the Legislature to amend the budget proposed by the Executive?" "The Legislature may make amendments but only if it does not change the total deficit/surplus proposed by the Executive" = 4, otherwise (if applicable) = 0

Question 3: "Amendments "can cause fall of government"

Answers: "no" = 0, "yes" = 4

Match: Q42: "Notwithstanding the formal powers of the Legislature to modify the budget, is a vote on the budget considered a vote of confidence in the Government?" "Yes" = 4, Otherwise = 0

Question 4: "All expenditures passed in one vote"

Answers: "votes are chapter by chapter" = 4, "mixed" = 2, "yes" = 0

Match: Q40: "What are the formal powers of the Legislature to amend the budget proposed by the Executive?" "The Legislature may not make any changes; it can only approve or reject the budget as a whole" = 0, Otherwise = 4 In this question, the assignment of the points cannot be directly replicated from Von Hagen (1992).

Question 5: "Global vote on total budget size"

Answers: "initial" = 4, "final only" = 0

Match: Q37: "Does the Legislature first vote on the total amount of expenditure before it votes on specific appropriations?" "Yes" = 4, "No" = 0,

Informativeness of the Budget Draft

All characteristics (together with their response options) within this item, which corresponds to the form of the budget draft submitted to the parliament, are not reflected in the OECD Survey: special funds included, budget submitted in one document, assessment of budget transparency by respondents, link to national accounts, government loans to non-government entities included in the budget draft.

Budget Implementation (Flexibility of Budget execution)

Question 1: "Minister of finance can block expenditures"

Answers: "yes" = 4, "no" = 0

Match: Q44: "Does the Executive have the power to veto the budget approved by the Legislature?" "Yes, it has line item veto power" or "Yes, it has package veto power" or "Yes, it has both line item and package veto powers" = 4, "No, it does not have such power" = 0

Question 2: "Spending ministries subject to cash limits"

Answers: "yes" = 4, "no" = 0

Match: Q23: "Does the Central Budget Authority impose limits (ceilings) for each ministry's initial spending request?" "Yes, for all types of expenditure" = 4, Otherwise = 0

Question 3: "Disbursement approval required from minister of finance or controller" There is no question in the OECD BPP survey that matches this topic.

Question 4: "Transfers of expenditures between chapters"

Answers: "only within departments and with consent of MF" = 5, "only within departments possible" = 4, "require consent of parliament" = 2.4, "require consent of MF" = 1.6, "limited" = 0.8, "unrestricted" = 0

Match: Q53: "Are ministers allowed to reallocate/vire funds between line items within their responsibility?" "No" = 4, "With the approval of the Legislature" = 2.4, "With the approval of the Finance Minister" = 1.6, "Yes, with restrictions" = 0.8, "Yes, without restrictions" = 0

Question 5: "Changes in budget law during execution"

Answers: "only by budgetary law to be passed under the same regulations as the ordinary budget" = 4, "require consent of MF and parliament" = 3, "at discretion of MF" = 2, "by new law which is regularly submitted during fiscal year" = 1, "at discretion of government" = 0

Match: Q51: "Does the Government have the authority to increase spending once the budget has been approved by the Legislature?" "It requires legislative approval" = 2, "It requires Central Budget Authority approval" = 1, "Approval is not required" = 0 The assignment of the points cannot be done directly for this sub-question.

Question 6: "Carry-over of unused funds to next year"

Answers: "not possible" = 4, "limited and requires authorization by MF or parliament" = 2.66, "limited" = 1.33, "unrestricted" = 0

Match: Q54: "Can ministers carry-over unused funds or appropriations from one year to another?" "No" = 4, "With the approval of the Finance Minister" or "With the approval of the Legislature" = 2.66, "Yes, with restrictions" = 1.33, "Yes, without restrictions" = 0 Question 54 with the response options above has to be answered for Operating expenditures, Investments and Transfers/subsidies each. For the replication of this characteristic by Von Hagen

(1992) we just consider to the responses regarding Operating expenditures.

Budget Rules (Long-term planning constraint)

Question 1: "Multiannual target"

Answers: "total budget size" = 4, "G or T (government expenditure or taxes)" = 2, "none" = 0

Match: Q20: "Are there multi-year expenditure targets or ceilings?" "Yes, there are aggregate targets or ceilings" or "Yes, there are targets or ceilings for each ministry" or "Yes, there are targets or ceilings for line items" = 4, "No, there are no such targets or ceilings" = 0 A levelling of the points assignment like in Von Hagen (1992) is not possible using the question in the OECD BPP survey 2007/08.

Question 2: "Planning horizon (years)"

Answers: "five" = 4, "four" = 3, "three" = 2, "two" = 1

Match: Q21: "How many years do the targets/ceilings cover?" five to ten = 4, four = 3, three = 2, two = 1

Question 3: "Nature"

Answers: "updated on basis of consistent macromodel" = 4, "updated forecast, but not based on consistent macromodel" = 3, "fixed forecast" = 2, "ad hoc forecast" = 1

Match: Q19: "If applicable, from what basis do you extrapolate multi-year expenditure estimates?" "Expenditures in future years are adjusted for the official macroeconomic forecast" = 4, "... are based on anticipated legislative changes" = 3, "... are adjusted for demographic changes" = 2, "... are unchanged in real terms" = 1 As you can see not all response options are directly matchable, therefore we must expect a not too high correlation.

Question 4: "Degree of commitment" In the OECD BPP survey there is no question regarding that aspect.

VII. Gleich (2003)

Gleich (2003) developed an index "on the basis of detailed documents and questionnaires summarizing institutional characteristics of the budget process" (Gleich, 2003, p9). Indeed, constructing an index that measures to which extent public budgeting relies on coordination and cooperation during its formulation: at the budget preparation, legislative and implementation stage. The role of the constitution, organic budget law and the procedure's rules of the parliament were evaluated for each the three stages. A set of questions constructing the index is defined.

Preparation

At the preparation stage, the first question relates to the budget permanent constraints (deficit carry-over, borrowing) and the second exploits information about fiscal targets and ceilings (numerical rules). The third and fourth are referring to the centralization degree of the structure formulating the budget. Question three concerns the role and therefore power of the finance minister in the budget constitution, question four however focuses on the role of the executive in tackling budget discussion matters.

Question 1: "Existence of statutorily mandated fiscal rules"

Answers: "Balanced budget rule" = 4, "Limits on public borrowing" = 2, "No legal limits on borrowing" = 0

Match: Q14: "In developing the budget, are there any fiscal rules that place limits on fiscal policy?" "Yes, budget balance (surplus/deficit) rule" = 4, "Yes, debt rule" = 2, Otherwise = 0

Question 2: "Sequence of budgetary decision-making"

Answers: "Minister of Finance (MF) sets forth aggregate and specific budget targets in initial budget circular" = 4, "MF proposes, cabinet decides on targets for budget aggregates and spending limits are assigned to each ministry before spending ministries develop budget requests" = 3, "MF proposes, cabinet decides on targets for budget aggregates before spending ministries develop budget requests" = 2, "Budgetary targets are set on the basis of preliminary budget requests" = 1, "No budget targets are determined" = 0

Match: Q23: "Does the Central Budget Authority impose limits (ceilings) for each ministry's initial spending request?" "Yes, for all types" = 4, "Yes, but only for some types" = 2, Otherwise = 0

Question 3: "Compilation of the draft budget"

Answers: "Finance ministry holds bilateral negotiations with each spending ministry" = 4, "Finance ministry only collects budget requests and compiles summary for cabinet session" = 0

Match: Not included in OECD survey.

Question 4: "Members of executive responsible for reconciling conflicts over budget bids"

Answers: "MF or PM can veto or overrule cabinet decision" = 4, "Senior cabinet committee, then whole council of ministers or cabinet" = 2, "Executive collectively (*e.g.* council of ministers or cabinet)" = 0

Match: Q26: "In practice how are disputes between line ministries and the Central Budget Authority in the budget preparation process generally resolved?" "The issue is resolved by the Prime Minister" or "The issue is resolved by the President" = 4, "The issue is resolved by the Minister of Finance" or "The issue is sent to a ministerial committee" = 2, Otherwise = 0

Legislation

Turning to the legislative stage, question five addresses the relative power of the upper house (of parliament) vis-a-vis the lower house (of parliament) [the more fragmented the worse]. Question six concerns budget amendment possibility, question seven the sequence of votes and question eight and nine respectively the relative power of the executive vis-a-vis the parliament and the authority of the national president in the budget procedure.

Question 5: "Relative power of the upper house vis-a-vis the lower house"

Answers: "No budgetary power vested in upper house or unicameral parliament" = 4, "Lower house has prerogatives" = 2, "Both houses have equal rights (*e.g.* joint sittings)" = 0

Match: Q32: "If there is more than one chamber in the Legislature, how would you describe their relative powers over the budget?" "The Legislature is unicameral" or "There are two chambers but only the lower chamber is involved in the budget process" = 4, "Both chambers are involved in the budget process but the lower chamber can overrule the upper chamber" = 2, Otherwise = 0

Question 6: "Constraints on the legislature to amend the government's draft budget"

Answers: "Deficit provided in the draft budget cannot be exceeded, or individual amendments have to indicate offsetting changes" = 4, "No restrictions" = 0

Match: Q40: "What are the formal powers of the Legislature to amend the budget proposed by the Executive?" "The Legislature may make amendments but only if it does not change the total deficit/surplus proposed by the Executive" or "The Legislature may only decrease existing expenditures/revenues (*i.e.* the Legislature cannot increase existing items nor create new ones)" or "The Legislature may not make any changes; it can only approve or reject the budget as a whole" = 4, Otherwise = 0

Question 7: "Sequence of votes"

Answers: "Initial vote on total budget revenues, expenditures, and the deficit" = 4 or "Final vote on budget aggregates" = 0

Match: Q37: "Does the Legislature first vote on the total amount of expenditure before it votes on specific appropriations?" "Yes" = 4, "No" = 0

Question 8: "Relative power of the executive vis-a-vis the parliament"

Answers: "Cabinet can combine a vote of confidence with a vote on the budget", "Draft budget is executed if parliament fails to adopt the budget before the start of the fiscal year", "Parliament can be dissolved if it fails to adopt the budget in due time" with 4 points per question.

Match: Sum of Q42 and Q43. Q42: "Notwithstanding the formal powers of the Legislature to modify the budget, is a vote on the budget considered a vote of confidence in the Government?" "Yes" = 2, Otherwise = 0. Q43: "If the budget is not approved by the Legislature

before the start of the fiscal year which of the following describes the consequences?" "The Executive's budget proposal takes effect" = 2, "Otherwise" = 0

Question 9: "Authority of the national president in the budget procedure"

Answers: No special authority, "President has veto right (president elected by parliament)"=4, "President has veto right (president directly elected by citizens)"=2.67 and "President has veto right (qualified majority required to override veto)"=1.33. 0 points otherwise.

Match: Q44: "Does the Executive have the power to veto the budget approved by the Legislature?" "No" = 4, Otherwise = 0

Implementation

Finally, the questions for the last stage, namely the budget implementation stage, are those referring to budget change flexibility during the period of execution, expenditures transfers from ministries budgets, the allowance of carrying-over unused funds to the next fiscal year as well as to the reaction of the budget voting structures toward a possible deficit deterioration.

Question 10: "Flexibility to change budget aggregates during execution"

Answers: "Any increase in total revenues, expenditures and the deficit needs to be approved by the parliament in a supplementary budget" = 4, "Revenue windfalls can be used to increase expenditure without the approval of the parliament as long as the deficit is not increased" = 2.67, "Simultaneous changes in revenues and expenditures allowed without approval of parliament if budget balance is not changed" = 1.33, "At discretion of government" = 0

Match: Q56: "Can overspending occur before a supplementary appropriation law/budget is approved by the Legislature?" "No" = 4, "Yes, but only up to a certain limit, please specify below" = 2, Otherwise = 0

Question 11: "Transfers of expenditures between chapters (*i.e.* ministries' budgets)"

Answers: "Require approval of parliament" = 4, "FM or cabinet can authorize transfers between chapters" = 2.67, "Limited" = 1.33, "Unrestricted" = 0

Match: Q53: "Are ministers allowed to reallocate funds between line items within their responsibility?" "With the approval of the Legislature" = 4, "With the approval of the Finance Minister" = 2.67, "Yes, with restrictions" = 1.33, Otherwise = 0

Question 12: "Carry-over of unused funds to next fiscal year"

Answers: "Not permitted" = 4, "Only if provided for in initial budget or with finance ministry approval" = 2.67, "Limited" = 1.33 and "Unlimited" = 0

Match: Q54: "Can ministers carry-over unused funds or appropriations from one year to another?" "No" = 4, "With the approval of the Legislature" or "With the approval of the Finance Minister" = 2.67, "Yes, with restrictions" = 1.33, Otherwise = 0

Question 13: "Procedure to react to a deterioration of the budget deficit"

Answers: "MF can block expenditures" = 4, "The cabinet can block expenditures" = 2.67, "Approval of the parliament necessary to block expenditures" = 1.33 and "No action is taken" = 0

Match: Not included in OECD survey

VIII. Debrun et al. (2008)

Indices in Debrun et al. (2008) aim at measuring the degree of stringency of each fiscal rule (budget balance rule, expenditure rule, debt rule and revenue rule), taking into account the statutory basis of the rule, the body in charge of monitoring and enforcing the rule (may be distinct institutions), the functioning of the enforcement mechanism and finally the visibility of the rule (transparency). In order to avoid that the weight of the features in the overall index is affected by the score scale, scores are re-normalized such that the maximum score equals to 10 for each feature. In the absence of a strong prior regarding the weight to be given to each feature, the Index of Strength was computed using equal weights. We create a similar index of strength of numerical fiscal rule using the following questions of the OECD Survey: Question 15.1 "Expenditure Rule", 15.2 "Revenue Rule", 15.3 "Budget Balance Rule", 15.4 "Debt Rule", 15.5 "Other Fiscal Rule"

Question 1: "Statutory or legal basis of the rule"

Answers: "The rule has a constitutional basis" = 4, "the rule is based on a legal Act (*e.g.* Public Finance Act, Fiscal Responsibility Law)" = 3, "the rule is based on a coalition agreement or an agreement by different general government tiers" = 2 and "political commitment by a given authority (central or local government, Minister of Finance)" = 1

Match: Q15 d): "Which of the following defines the fiscal rule?" "Constitution" = 4, "Legislation" = 3, "Formal agreement of parties in Government" = 2, "Political commitment of the Government" or "Otherwise" = 1

Question 2: "Room for setting or revising objectives"

Answers: "there is no margin for adjusting objectives (they are encapsulated in the rule)" = 3, "there is some but constrained margin in setting or adjusting objectives" = 2, "there is complete freedom in setting objectives (the statutory basis of the rule only contains principles)" = 1

Match: Q52: "Does the government have the authority to cut/cancel/rescind spending once the budget has been approved by the Legislature?" "No" = 3, "Yes with restrictions" = 2, "Yes without restrictions" = 1

Question 3: "Body in charge of monitoring respect of the rule"

Answers: "Monitoring by an independent authority (Fiscal Council, Court of Auditors,...) or national Parliament" = 3, "Monitoring by the Ministry of Finance or any other government

body" = 2 and "no regular public monitoring of the rule (there is no report systematically assessing compliance)" = 1

Match: Q15 e): "Who is in charge of monitoring compliance with the fiscal rule?" "Independent body" or "Supreme Audit Institution" = 3, "Central Budget Authority" or "Legislature or other legislative body" = 2, Otherwise = 1

Question 4: "Body in charge of enforcement of the rule"

Answers: "enforcement by an independent authority (Fiscal Council or any Court) or the national Parliament" = 3, "enforcement by the Ministry of Finance or any other government body" = 2, "no specific body in charge of enforcement" = 1

Match: Q1: "Where is the function of the Central Budget Authority located?" "Independent Agency" or "President's office" or "The Central Budget Authority is split between two or more agencies" = 3, "Ministry of Finance" or "Prime Minister's office" or "Office of the Chief Executive" = 2, Otherwise = 1

Question 5: "Enforcement mechanism of the rule"

Answers: "automatic correction and sanction mechanisms in case of non-compliance"=4, "automatic correction mechanism in case of non-compliance and the possibility of imposing sanctions" = 3, "obligation to present corrective proposals to the relevant authority" = 2, "there is no ex-ante defined actions in case of non-compliance" = 1

Match: Q15 f): "In case of non-compliance with the fiscal rule what are the enforcement procedures?" "There are automatic sanctions" = 4, "There is an automatic correction mechanism" or "There is a possibility of sanctions" = 3, "A proposal with corrective measures must be presented to the Legislature" = 2, "The Government or ministry responsible for the overrun has to implement corrective measures" or Otherwise = 1

Question 6: "Media visibility of the rule"

Answers: "if the rule observance is closely monitored by the media, and if non-compliance is likely to trigger a public debate" = 3, "for high media interest in rule-compliance, but non-compliance is unlikely to invoke a public debate" = 2 and "for no or modest interest of the media" = 1

Match: Q69: "Are the findings of the Supreme Audit Institution available to the public?" "Yes, always" = 3, "Yes in most cases but with some exceptions" or "Rarely" = 2, "Never" or Otherwise = 1

XI. Schaechter et al. (2012)

Schaechter et al. (2012) create a fiscal rules index, based on Kumar et al. (2009), that is composed by four sub-indices for the particular rules: Expenditure Rule, Revenue Rule, Budget Balance Rule and Debt Rule. Every sub-index contains the same rule-specific or general properties (see questions below) that are summed and standardized to range from zero to five. Due to data availability and to the fact that Question 10 is just covered for the budget

balance rule in the OECD survey, we skip both questions regarding flexibility characteristics of the rule (Question 9 and 10) for our comparison.

Furthermore, we do not consider the Revenue Rule because we could just compare four observations available in both datasets in Section 5.1. However, it is included in the Overall Fiscal Rules index that is computed by summing the four sub-indices and normalization to the scale from zero to four (not five like suggested in Schaechter et al. (2012), as we skip the properties regarding flexibility). Schaechter et al. (2012) exclude flexibility as well in their Overall Index.

Expenditure Rule, Revenue Rule, Budget Balance Rule and Debt Rule

Question 1: "Legal basis (national rules only): What is the highest legal basis of the rule?"

Answers: "Constitutional" = 4, "Statutory" = 3, "Coalition agreement" = 2, "Political commitment" = 1

Match: Q15 d): "Which of the following defines the rule?" (Responses are considered separately for Expenditure Rule, Revenue Rule, Budget Balance rules, Debt rule)

"Constitution" = 4, "Legislation" = 3, "Formal agreement of parties in Government" = 2, "Political commitment of the government" = 1

Question 2: "Coverage: Which sector of the government is covered by the rule?"

Answers: "General government or wider public sector" = 2, "Central government" = 1

Match: Q15 c): "Which parts of the general Government are covered by the fiscal rule?" (Responses are considered separately for Expenditure Rule, Revenue Rule, Budget Balance rules, Debt rule)

"The entire Government sector" = 2, "Central Government", "Regional Government", "Local Government", "Extra-budgetary funds" or "Other" = 1

Question 3: "Enforcement: Are these enforcement mechanisms in place?" - "Formal enforcement procedure"

Answers: "Yes" = 1, "No" = 0

Match: Q15 f): "In case of non-compliance with the fiscal rule, what are the enforcement procedures?" (Responses are considered separately for Expenditure Rule, Revenue Rule, Budget Balance rules, Debt rule)

"There are automatic sanctions", "There is a possibility of sanctions", "There is an automatic correction mechanism", "The Government or ministry responsible for the overrun has to implement corrective measures", "A proposal with corrective measures must be presented to the Legislature" or "Other" = 1, "Enforcement procedures are not defined ex ante" = 0

Question 4: "Enforcement: Are these enforcement mechanisms in place?" - "Monitoring mechanism of compliance outside the government"

Answers: "Yes" = 1, "No" = 0

Match: Q15 e): "Who is in charge of monitoring compliance with the fiscal rule?" (Responses

are considered separately for Expenditure Rule, Revenue Rule, Budget Balance rules, Debt rule)

"Independent body", "Legislature or other legislative body" or "Supreme Audit Institution" = 1, Otherwise = 0

Question 5: "Supporting procedures and institutions (national rules only): Are these procedures or institutions in place?" - "Multi-year expenditure ceilings"

Answers: "Yes" = 1, "No" = 0

Match: Q16: "Does the annual budget documentation submitted to the Legislature contain multi-year expenditure estimates?"

"Yes, at the aggregate level", "Yes, at the ministry level", "Yes, at line item level" and/or "Other" = 1, "No" = 0

Question 6: "Supporting procedures and institutions (national rules only): Are these procedures or institutions in place?" - "Fiscal responsibility law"

Answers: "Yes" = 1, "No" = 0

Match: Not available in OECD survey.

Question 7: "Supporting procedures and institutions (national rules only): Are these procedures or institutions in place?" - "Independent body setting budget assumptions"

Answers: "Yes" = 1, "No" = 0

Match: Q 5: "Which of the following actors develop the economic assumptions used in the budget?"

"Private sector", "Independent Government body", "Panel of economic experts appointed by the Government", "Legislature or other legislative body" = 1, Otherwise = 0

Question 8: "Supporting procedures and institutions (national rules only): Are these procedures or institutions in place?" - "Independent body monitoring budget implementation"

Answers: "Yes" = 1, "No" = 0

Match: Q6: "Which of the following organizations carry out independent reviews of the economic assumptions used in the budget?"

"Independent panel, or similar", "Supreme Audit Institution", "Legislature or other legislative body" or "Other" = 1, "There are no independent reviews of the economic assumptions" = 0

Question 9: "Are these flexibility characteristics in place?" - "Clearly-defined escape clauses"

Answers: "Yes" = 1, "No" = 0

Match: Not available in OECD survey.

Question 10: "Are these flexibility characteristics in place?" - "Fiscal balances defined in cyclically adjusted terms"

Answers: "Yes" = 1, "No" = 0

Table 6: Overview of Number of Countries with Numerical Fiscal Rules in place (OECD)

	BR	DR	ER	RR
Number of countries*	71 (73%)	53 (55%)	51 (53%)	22 (23%)
Number of countries with additional rules**	60	51	45	22
Budget balance rule (BR)	-	16	6	2
Debt rule (DR)	16	-	1	-
Expenditure rule (ER)	6	1	-	-
Revenue rule (RR)	2	-	-	-
DR + ER	19	-	-	-
ER + RR	5	3	-	5
DR + RR	1	-	3	-
BR + RR	-	1	5	-
BR + DR	-	-	19	1
BR + ER	-	19	-	3

Notes: * Number (share) of the 97 countries in our sample that have (at least) the type of rule given in the corresponding column. ** Number of countries with at least one additional rule in place; the rows below are specific about which additional rules (or combination of rules) are in place.

Match: Q15 a) (Budget Balance rules): "What is the target of the rule?"

"The rule targets a given improvement of the structural or cyclically-adjusted budget balance (as a % of GDP)" or "The rule targets a specific budget balance as a percentage of GDP in cyclically-adjusted or structural terms" = 1, Otherwise = 0

A.4 Appendix - Description of the OECD BPP Survey Results

Appendix A.4 summarizes the analysis results of given responses to the OECD BPP survey 2007/08:

None of the countries has completely delegated fiscal policy to an independent council. But in 59% of the countries the head of the central budget authority is a senior civil servant (which normally does not leave with a change of government) instead of a political appointee. Regarding the legal foundation, in 25% of all countries (part of) fiscal rules (comprehensively defined) have a constitutional foundation, in 53% of the countries they are only based on simple laws. In 20% of the countries there exist internal rules and for 2% there is no formal basis. In 42 of the 97 countries there is some independent review of the assumptions underlying the budget. 29 countries have a specialized budget research office or unit attached to the legislative. The central budget authority imposes limits for all (at least some) types of expenditure at line item or chapter level of the initial spending request of the ministries in 49% (66%) of the countries.

Of four types of numerical fiscal rules defined in the OECD Budget Survey (budget balance, debt, expenditure, and revenue rule), 83 countries have at least one rule in place, only 14 countries have none of these rules at all. The budget balance rule is most widely used. A more detailed overview of the number and combinations of numerical fiscal rules in our sample of 97 countries is given in Table 6.

In only 47% of the countries these types of numerical fiscal rules have a legal foundation, mainly based on simple laws; in only 8% of those they are constitutional. In 36% of the countries there exists some more or less formal agreement or political commitment of the government and in 17% of the countries the rules are not explicitly defined.

Implications in case of non-compliance with the numerical fiscal rules are generally weak: In only 7% of the countries, the possibility of sanctions is foreseen; in 8% of the countries a violation of the rules triggers automatic correction or sanction mechanisms (automatic sanctions are only implemented in Portugal). In 41% of the countries the government (or responsible ministry) has to work out the corrective measures (in 20% of the countries this new measures have to be presented to the legislative) and a large share of the countries cases (36%) the enforcement procedures are not defined *ex ante*.

In 48 of the 97 countries, capital budgets (*e.g.*, for long-term investment projects) and operating budgets are split. In 63% of the countries' capital projects are funded incrementally from year to year until the project is completed, whereas in 12% of the countries the funding for the entire cost is appropriated up-front. In the rest of the countries (25%) the funding is determined through other procedures, *e.g.* on a case by case basis.

In 55% of the countries having two chambers of the legislative (42 countries), the upper chamber is not involved in the budget process or can be overruled by the lower chamber; in the other 45% of the countries with two chambers the upper and lower chamber have equal power in the budget process. In 73% of the countries the legislative can change the budget proposed by the executive; in 27% the legislative cannot make any changes and may only approve or reject the budget proposal. In 26% of the countries the executive can veto (parts of) the budget approved by the legislative (such as in the United States), in 74% of the countries the executive has no such power.

Once the budget has been approved by the legislative, the executive is allowed to increase the mandatory (discretionary) spending without restrictions in 14 (11) countries, in 43 (38) countries with restrictions. 40% of the countries report that the (parliamentary) vote on the budget is also considered as a vote of confidence in the government.

In 48% of the countries the budget of the previous year takes effect on interim basis if the Legislature does not approve the proposal before the start of the new fiscal year. Only in 6 countries (Liberia, Luxembourg, Mongolia, Papua New Guinea, Switzerland, United Arab Emirates) no expenditures are possible until the new budget is passed. In the rest of the countries (45%) interim measures are taken by the executive or legislative.

88 of the 97 countries do have at least one type of off-budget expenditure, 41 have five types or more, 7 have ten or more. For most countries (79%), off-budget expenditures are below

15% of the total expenditures of the central government. In 5 countries (Belgium, France, Lithuania, Slovak Republic, Ukraine) the off-budget expenditures are above 30%. On average over all the various off-budget expenditure items, 44% of the countries require legislative authorization and 36% report them in the budget documentation.

85 of 97 countries allow the government to carry over some sort of unused funds from one year to another, of which 32 require the approval of the legislature. However, only 4 countries (Canada, Denmark, Iceland and Sweden) allow the executive to borrow against expected future revenues for some type of expenditure without the approval of the legislature; in 15 countries this is possible with the approval of the legislature. These rules are mainly foreseen for public investment, in a small subset of countries they also apply to operating expenditure and transfers or subsidies.

70% of the countries' budgets include a central reserve funds to meet unforeseen expenditures, of which in 66% of the countries are reserved to meet general unforeseen expenditures, 13% to finance new initiatives, and 12% to correct major errors in forecasts or assumptions underlying the planned budget.

In 62% of the countries almost all line ministries have internal audit units, which are prescribed by law in 81% of the cases; 26% of the countries have internal audit units in less than 80% of the line ministries and 11 countries do not have any internal audit units in the line ministries.

In most countries (83%) the findings of the supreme audit institution are always made available to the public (with some minor exceptions, *e.g.* military audit); 16% of the countries only rarely make the findings available to the public. Only in one country (Suriname) the findings of the supreme audit institution are never made available to the public.

In 43 of the 97 countries more than 40% of the expenditures are linked to some sort of performance targets. The formal responsibility for setting the performance targets rests with the relevant cabinet or minister in 50% of the cases, in 26% with the finance minister (together with relevant minister) or administrative head of the ministry and in 24% with other institutions (like the president, prime minister, international organization, etc.). In practice, however, performance target are set by the finance minister (together with relevant minister) or administrative head in 40% of the cases.

Only 12 countries (Belgium, Congo, Czech Republic, Indonesia, Kyrgyzstan, Lesotho, Mauritius, Morocco, Nigeria, Solomon Islands, Ukraine, Zimbabwe) having performance targets do not report the performance against them to the public or present the performance to the legislature. If performance targets are not met the consequence with the highest probability is increased monitoring of the program or ministry in the future (68% of the countries) and

a decreased budget in the following period (38%); almost never (*i.e.* rendering the lowest probability for the consequences) the program is eliminated or are there consequences for the payment or career opportunities of the head of ministry. Only in South Korea and Denmark the consequence with a probability of 80 to 100% is a negative impact on the payment or future career opportunities of the ministry head.

Interestingly for almost all questions there is no significant difference between developed or developing countries as well as between rich and poor countries . Notable exceptions are:

In 54% of the rich countries, fiscal rules have a legal foundation (compared with 47% in the full sample), of which 13% (8%) are constitutional. Among the rich countries, 46% did not define the enforcement procedures in case of non-compliance with the fiscal rules *ex-ante* (compared with 36% in the full sample), resulting in a lower share of 30%, where the government has to work out corrective measures (compared with 41% in the full sample). In the sample of developing countries the share of countries where the central budget authority imposes limits for all types of expenditure at line item or chapter level of the initial spending request of the ministries is higher (59% compared with 49%). In the sample of developing countries the vote on the budget is less often expected to be considered as a vote of confidence in the government (33% compared with 40% in the full sample); in the sample of rich countries this share is higher than in the full sample with 40%. In fewer of the developing countries (57% compared with 66%) and more of the rich countries (80% compared with 66%) it is possible for the government to increase mandatory spending after the budget is approved by the legislative; the same is true for discretionary spending (43% in developing countries, 69% in rich countries, compared with 57% in the full sample). In 75% of the rich countries, the budget includes a central reserve to meet unforeseen expenditures (compared with 70% in the full sample). Rich countries have more internal audit units in almost all line ministries (84% compared with 74%) and do more often make public the findings of the supreme audit institution (94% compared with 83% of the countries). In only five (Belgium, Czech Republic, Mauritius, Russian Federation, Venezuela) of the rich countries (*i.e.*, 9% compared with 19% in the full sample) performance against targets is not presented to the legislative.

A.5 Appendix - Variance of POSET Indices and Composite Indices

Table 7: Variance of POSET Indices and Composite Indices

Index		Composite Indices	POSET indices
ACIR	Category I	0.10	0.08
	Category II	0.03	0.03
Bohn and Inman	No Carry Over	0.09	0.07
	Governor Veto	0.16	0.16
Wagner	Deposit Rule	0.04	0.11
	Withdrawal Rule	0.04	0.11
Alesina <i>et al.</i>	Total	0.05	0.11
	Borrowing Constraint	0.05	0.07
	Agenda Setting	0.07	0.09
Filc and Scartascini	Fiscal Rules	0.02	0.12
	Hierarchical Procedures	0.05	0.11
	Transparency	0.04	0.02
Von Hagen	Total	0.00	0.12
	Negotiations Structure	0.01	0.17
	Budget Approval	0.00	0.07
	Budget Implementation	0.00	0.06
	Budget Rules	0.01	0.17
Gleich	Total	0.03	0.08
	Preparation	0.06	0.09
	Legislation	0.04	0.07
	Implementation	0.06	0.05
Debrun <i>et al.</i>	Expenditure Rule	0.03	0.07
	Revenue Rule	0.04	0.05
	Budget Balance Rule	0.03	0.07
	Debt Rule	0.05	0.05
Schaechter <i>et al.</i>	Expenditure Rule	0.03	0.09
	Revenue Rule	0.03	0.09
	Budget Balance Rule	0.03	0.09
	Debt Rule	0.03	0.09
	Total Fiscal Rules Index	0.02	0.14

Notes: Variance computed for each fiscal rule index obtained with the POSET approach or the composite indices approach.