



Measuring fiscal sustainability: A novel multidimensional index from a developed country perspective

Susantha Dissanayake^{*} , Priyantha Mudalige, Nam Hoang, Shawn Leu

University of New England, Australia

ARTICLE INFO

JEL classification:

C38
E62
H63
H68

Keywords:

Fiscal sustainability
Fiscal sustainability index
OECD countries

ABSTRACT

Persistent fiscal risks in advanced economies highlight the need for comprehensive tools to assess fiscal sustainability. We develop a multidimensional Fiscal Sustainability Index (FSI) comprising nine key fiscal and macroeconomic indicators, including government expenditure, external debt, government revenue, and real GDP growth rate, to evaluate fiscal sustainability across 37 OECD countries from 1995 to 2023. Using principal components analysis, the FSI captures the complex, dynamic interactions among fiscal flows, debt accumulation, and growth performance, offering a more comprehensive and timely assessment than conventional single-ratio indicators. Our results reveal substantial fiscal deterioration during the Global Financial Crisis and even greater vulnerabilities during the COVID-19 pandemic, especially in economies with high external debt. The FSI's multidimensional framework also captures feedback mechanisms and evolving fiscal pressures, enabling policymakers to monitor fiscal resilience effectively and formulate responsive macroeconomic policies amid global shocks. This study advances fiscal surveillance by highlighting the multifaceted nature of fiscal sustainability and providing insights to support adaptive fiscal strategies in advanced economies.

1. Introduction

Fiscal sustainability, a government's ability to finance expenditures, meet debt obligations, and maintain macroeconomic stability without resorting to unsustainable borrowing, is fundamental to the long-term stability of advanced economies and the credibility of public finances (Barro, 2023). In recent decades, rising sovereign debt, fiscal imbalances, and inefficiencies in public spending have heightened concerns about sustainability, especially amid unprecedented global shocks (Afonso and Coelho, 2024). The 2007–08 Global Financial Crisis (GFC) and the COVID-19 pandemic have exposed structural vulnerabilities in fiscal frameworks, triggered expansive fiscal responses, and increased sovereign risk, revealing the limitations of traditional fiscal indicators that rely on single metrics (Auerbach et al., 2022).

Fiscal sustainability is multidimensional, influenced by the interplay of fiscal policy, economic growth, and financial market conditions. These dimensions shape solvency, intertemporal budget balance, and macroeconomic stability (Mamatzakis, 2024). The fiscal reaction function framework suggests that governments tend to increase primary surpluses in response to rising debt to restore solvency. However,

empirical evidence shows significant variation in such adjustments owing to differences in institutional quality, political economy factors, and crisis characteristics (Afonso et al., 2021; Gootjes et al., 2021). Moreover, the interest rate-growth differential ($r-g$) plays a central role in debt dynamics and fiscal risks. For example, low or negative differentials can provide temporary relief but also foster policy complacency (Heimberger, 2023).

Despite advances in theory and empirical modeling, researchers often measure fiscal sustainability using simple indicators such as debt-to-GDP ratios or primary balances (Furceri et al., 2022). These unidimensional metrics fail to capture the complex, dynamic nature of fiscal health, particularly during economic stress. Recent research highlights that a comprehensive understanding of fiscal vulnerabilities requires integrating diverse fiscal, macroeconomic, and financial indicators, drawing inspiration from composite indices used to measure poverty, inequality, and financial distress (Alkire et al., 2022; Johns et al., 2022).

However, the field has not yet produced a theoretically consistent and empirically validated multidimensional Fiscal Sustainability Index (FSI) tailored to advanced economies. Existing multidimensional studies often examine isolated variables or country-specific cases but lack a

^{*} Corresponding author. University of New England UNE Business School, Armidale, NSW, 2351, Australia.

E-mail addresses: mdissan2@myune.edu.au (S. Dissanayake), pmudalig@une.edu.au (P. Mudalige), nam.hoang@une.edu.au (N. Hoang), cleu@une.edu.au (S. Leu).

<https://doi.org/10.1016/j.cbrev.2026.100270>

Received 4 December 2025; Received in revised form 28 July 2026; Accepted 11 August 2026

Available online 14 August 2026

1303-0701/© 2026 The Authors. Published by Elsevier B.V. on behalf of Central Bank of The Republic of Turkey. This is an open access article under the CC BY license (<http://creativecommons.org/licenses/by/4.0/>).

broadly applicable index suitable for real-time risk assessment and cross-country comparisons using advanced statistical techniques (Iorio and Fachin, 2022; Nomo Beyala, 2025).

We address this gap by constructing a novel FSI based on principal components analysis (PCA) of nine fiscal and macroeconomic variables, including government expenditure, external debt stock, revenues, and GDP growth. These variables are obtained from 37 OECD countries between 1995 and 2023. This approach enables a detailed analysis of fiscal resilience and vulnerability, with particular focus on systemic shocks such as the GFC and the COVID-19 pandemic. In this analysis, we pose the following central research questions: (1) How can a multidimensional FSI improve cross-country and temporal assessments of fiscal sustainability relative to traditional single-ratio measures? (2) How do fiscal risk patterns emerge during systemic crises in advanced economies, and what policy lessons can policymakers discern from these patterns?

Our empirical results demonstrate that the FSI effectively captures fiscal deterioration during both the GFC and the COVID-19 pandemic, with vulnerability significantly heightened during the latter. Notably, countries with higher external debt levels face greater fiscal risks and diminished policy space, underscoring the importance of prudent debt management. These findings establish the FSI as a valuable real-time diagnostic tool to inform macroeconomic policymaking, sovereign risk management, and crisis response.

The remainder of this paper proceeds as follows. Section 2 reviews relevant theoretical and empirical literature underpinning fiscal sustainability and the construction of multidimensional indices. Section 3 details the data, variable selection, and PCA methodology used to construct the FSI. Section 4 presents the empirical findings, including case studies and cross-country comparisons. Section 5 concludes with policy implications, limitations of the study, and avenues for future research.

2. Literature review

2.1. Theoretical foundations of fiscal sustainability

Fiscal sustainability evaluates a government's capacity to support its spending, taxation, and debt-servicing policies without default or unsustainable debt accumulation (Barro, 2023; Iorio and Fachin, 2022; Heimberger, 2023). Central to this concept is the intertemporal budget constraint (IBC), which requires that the present value of future primary surpluses exceeds current debt levels, ensuring solvency over time (Barro, 2023). A core element in dynamic fiscal sustainability models is the interest rate-growth differential ($r-g$), which influences debt trajectories and long-run solvency (Barro, 2023).

Bohn's (1998) seminal empirical test provided early evidence of a positive fiscal reaction function (FRF), in which governments raise primary surpluses as debt expands, thus signaling an adjustment towards sustainability. Nevertheless, Bohn's methodology was limited by its focus on a single country and constrained time horizon, highlighting the need to consider heterogeneous responses in broader samples. Debt dynamics frameworks extend this approach by decomposing debt evolution into interest payments, growth effects, primary balances, and stock-flow adjustments (Heimberger, 2023). Notably, substantial heterogeneity in ($r-g$) dynamics emerges across advanced economies, shaped by financial-market factors such as credit spreads and rollover risk. However, political and institutional determinants remain underexplored.

The FRF formalizes a stabilizing feedback loop in which increasing debt ratios induce fiscal surpluses. This relationship is empirically sensitive to model specifications and structural breaks, such as fiscal crises (Iorio and Fachin, 2022). Political economy perspectives emphasize the role of fiscal rules and governance quality in constraining political budget cycles and enhancing fiscal credibility (Gootjes et al., 2021). Additionally, fiscal multipliers tend to vary, generally intensifying

during recessions and in emerging economies, which complicates the fiscal sustainability landscape (Ilzetzki et al., 2013). Taken together, these strands define fiscal sustainability as a government's ability to maintain credible public finance management through prudent expenditure, effective debt control, and sustained growth, which are cornerstones for long-term macroeconomic stability.

2.2. Empirical evidence regarding fiscal sustainability

Recent empirical research has revealed significant heterogeneity in fiscal rule adherence and sustainability dynamics across countries over time. By analyzing 19 OECD countries between 1995 and 2020, Afonso and Coelho (2024) demonstrated that fiscal sustainability improves with economic growth, fiscal balance, and rule compliance, but declines with heightened trade openness, current account deficits, and institutional inefficiencies. Nomo Beyala (2025) examined 97 countries and found that stringent fiscal rules reduce primary deficits and promote sustainability; however, their effectiveness declines in democratic regimes with weak institutional capacity.

Mamatzakakis (2024) examined EU member states' FRFs, uncovering predominantly procyclical patterns with notable countercyclicality during significant output gaps and debt thresholds (75–79% of GDP). The presence of fiscal rules and independent fiscal councils notably enhances sustainability, particularly at lower debt levels.

Historical case studies have provided complementary insights. Papadia (2024) showed that during the Great Depression of the 1930s, countries with greater fiscal capacity implemented less procyclical policies, thereby mitigating the impacts of austerity despite limited effects on borrowing costs beyond crisis peaks. At the national level, Linhares et al. (2021) identified evolving fiscal regimes in Brazil, highlighting improved coordination between revenues and expenditures and recent successes in expenditure control through taxation policies.

Despite the advances in these studies, most of the existing empirical research has focused on individual fiscal variables or single-country contexts. Consequently, the research lacks integrative approaches that combine fiscal and macroeconomic indicators in a coherent multidimensional framework. This fragmentation limits a comprehensive understanding of fiscal dynamics, especially under crisis conditions.

2.2.1. Fiscal policy effectiveness during crises

Additional empirical literature has underscored the pivotal role of targeted fiscal interventions during crises. Auerbach et al. (2022) documented elevated fiscal multipliers for transfers to households and firms during the COVID-19 recession, emphasizing the importance of calibrated, targeted fiscal support. Albonico et al. (2021) used Dynamic Stochastic General Equilibrium (DSGE) modeling to show that moderate fiscal expansions stimulate growth; however, excessive debt burdens can undermine long-run fiscal sustainability. Jalles et al. (2024) demonstrated that early and credible pandemic-related fiscal announcements improved economic confidence and recovery prospects, contingent on available fiscal space and communication effectiveness. Collectively, these findings highlight that fiscal policy success depends critically on responsible debt management and sound policy messaging.

Furthermore, Tkačevs and Vilerts (2019) found that higher government borrowing costs incentivize fiscal discipline, whereas prolonged low interest rates may weaken it, especially in Eurozone periphery countries. Australia's responses to the GFC and COVID-19 illustrated best practices, with substantial fiscal stimuli combined with accommodative monetary policy effectively stabilizing the economy (Auerbach et al., 2022; Reserve Bank of Australia, 2021). This coordination underscores the importance of integrated policy during systemic shocks.

2.2.2. Socioeconomic index literature

Composite indices have proven valuable for measuring complex, multidimensional socioeconomic phenomena such as poverty, gender inequality, financial stress, and well-being (Alkire et al., 2022; Johns

et al., 2022; Lind, 2019; Santos and Villatoro, 2020). These indices typically apply principal component analysis (PCA) or factor analysis to reduce dimensionality and derive objective weights, preserving complex variable interrelationships (Illing and Liu, 2006; Michalek and Zarnekow, 2012). Examples include the Multidimensional Poverty Index (Alkire et al., 2022), the Financial Stress Index in Canada (Illing and Liu, 2006), and the Sub-national Gender Inequality Index in Great Britain (Schmid et al., 2023). These advances demonstrate the superior explanatory power and nuanced insights that multidimensional approaches offer over univariate metrics (see Table A1 in Appendix A).

2.3. Identified gaps and study positioning

Despite examples of multidimensional indices, fiscal sustainability measurement predominantly relies on single-ratio indicators, such as debt-to-GDP or the primary balance. These measures fail to capture the interconnected fiscal and macroeconomic dynamics that are critical in turbulent economies (Panizza and Presbitero, 2014; Reinhart and Rogoff, 2010). A theoretically robust, empirically validated, and widely accepted multidimensional fiscal sustainability index that systematically integrates fiscal and macroeconomic variables is conspicuously absent in the research. Addressing this gap by developing a novel FSI based on PCA of nine key variables grounded in fiscal solvency and debt dynamics theory could significantly advance both academic research and pragmatic policymaking.

3. Methodology

3.1. Data and variable selection

Our empirical analysis employs an unbalanced panel dataset covering 37 OECD countries from 1995 to 2023. We select nine macroeconomic variables that theory and prior empirical work identify as critical determinants of fiscal sustainability and risk (Afonso and Coelho, 2024; Barro, 2023; Heimberger, 2023). These variables collectively capture fiscal flows, debt dynamics, growth, and macro-financial conditions that underpin fiscal sustainability.

The data for this analysis were sourced from the World Bank's World Development Indicators (WDI), the Federal Reserve Economic Data (FRED), and the International Monetary Fund's World Economic Outlook (WEO), ensuring high-quality, comparable datasets. Table A2 in Appendix A provides a summary of the data sources, while Table A3 details the definitions of the variables used.

3.1.1. Variable selection

The selection of variables for constructing the FSI is grounded in both rigorous theoretical frameworks and robust empirical evidence linking macroeconomic indicators to fiscal health and sovereign risk. To capture the multidimensional nature of fiscal sustainability, we incorporate nine key fiscal and macroeconomic variables: government expenditure, external debt stock, government revenue, real GDP growth rate, inflation rate, gross domestic savings, interest rate, broad money supply, and exchange rate. Each variable represents a critical dimension of fiscal stress, sustainability, or macro-financial stability, collectively ensuring a comprehensive analysis of fiscal dynamics.

Government expenditure and revenue are the foundational fiscal flows shaping budget balance and fiscal discipline. Government consumption financed through efficient resource allocation can support economic growth. However, excessive or inefficient spending suppresses growth and heightens fiscal vulnerabilities (Ghouchian and Yilmazkuday, 2020). Conversely, effective revenue mobilization underpins sustainable debt servicing and long-term fiscal health (Afonso and Coelho, 2024; Bohn, 1998). Thus, including both expenditure and revenue is imperative for capturing the critical interplay of fiscal flows within the FSI framework.

External debt stock is indispensable as a direct indicator of sovereign

indebtedness and solvency risk. It reflects exposure to refinancing challenges, currency risk, and global financial shocks characteristic of open economies (Panizza and Presbitero, 2014; Reinhart and Rogoff, 2010). Elevated external debt is associated with higher sovereign risk premiums and constrained fiscal space, thereby increasing default probabilities (Jeanne and Rancière, 2011; Neumeyer and Perri, 2005). Moreover, trade deficits, while not directly included, are structurally linked to external indebtedness because they reflect ongoing reliance on foreign capital, thereby increasing sovereign risks (Yilmazkuday, 2021a). By encompassing external debt stock, the FSI captures these systemic vulnerabilities within interconnected global fiscal regimes.

The real GDP growth rate is a pivotal macroeconomic driver influencing the debt-to-GDP ratio and fiscal resilience. Higher growth rates expand the nominal tax base and alleviate debt burdens, thus improving fiscal sustainability (Barro, 2023). Alongside growth, indicators of macroeconomic stability, specifically the inflation rate and broad money supply, are incorporated to capture monetary dynamics that affect fiscal outcomes. Inflation volatility disrupts revenue predictability and fiscal planning, while unchecked monetary expansion risks inflationary pressures that raise real debt-service costs (Heimberger, 2023). Including these variables ensures that the FSI reflects critical macro-financial conditions that influence fiscal trajectories.

Gross domestic savings signal a country's internal financing capacity for investment and external debt repayments, which is particularly vital during external shocks when access to foreign capital may be constrained (Eberhardt and Presbitero, 2015). Higher savings enhance fiscal space and buffer sudden fiscal stresses, thereby stabilizing debt dynamics.

Interest rates directly affect fiscal sustainability by determining debt service costs. Elevated interest rates exacerbate fiscal burdens, compelling adjustments in fiscal policy to maintain solvency (Tkačevs and Vilerts, 2019). Incorporating interest rates into the FSI captures these cost dynamics, which are critical for sovereign risk assessment, especially in volatile global financial conditions.

Finally, exchange rate fluctuations influence the cost of servicing foreign-currency-denominated debt. Currency depreciation increases repayment obligations, amplifying fiscal vulnerabilities in countries with substantial external debt exposure (Asonuma and Trebesch, 2016). This variable thus completes the macro-financial dimension of the FSI by accounting for currency risk endemic in open economies.

Together, these nine variables offer a comprehensive, theory-informed, and empirically validated suite that captures the multifaceted fiscal pressures governing sustainability. This integrated approach advances measurement beyond traditional unidimensional metrics by accounting for fiscal flows, debt dynamics, growth performance, and macro-financial vulnerabilities, which are critical for robust fiscal risk monitoring (Afonso and Coelho, 2024; Ghouchian and Yilmazkuday, 2020).

3.1.2. Data preparation and quality control

Prior to empirical analysis, rigorous data cleaning procedures were implemented to ensure the accuracy, consistency, and reliability of the dataset, in line with best practices in economic research (Hair et al., 2010; Saisana and Tarantola, 2002). We systematically converted variables stored in non-numeric formats into appropriate numerical data types to maintain computational precision and enable robust statistical processing (Hair et al., 2010). We thoroughly screened the dataset for missing values and substantial data gaps, excluding observations with incomplete essential information to prevent bias and preserve sample integrity (Little and Rubin, 2019).

To mitigate the influence of outliers, particularly extreme fiscal or macroeconomic observations that could disproportionately skew results, we applied winsorization at the 1st and 99th percentiles, a commonly endorsed technique in macro-financial empirical studies (Lun et al., 2006; Wilcox, 2012). This approach preserves the central distributional properties while curbing the effects of extreme values.

Sensitivity analyses, including alternative winsorization thresholds and imputation methods for missing data, confirmed that the primary empirical findings remained stable and robust across various data treatment specifications (Hair et al., 2010; Saisana and Tarantola, 2002).

Overall, these data preparation and quality control measures enhance the validity and reliability of the subsequent statistical analyses, which are crucial for developing a credible and informative FSI.

3.2. FSI pyramid

Fig. 1 illustrates the FSI pyramid, which comprises three main dimensions: 1) expenditure, 2) revenue, and 3) others. We further divide the expenditure dimension into two sub-indices. The revenue dimension specifically concentrates on tax revenue sub-indices, while the ‘Other’ dimension includes six sub-indices.

3.3. Model specification

The expressions for the data vector in the context of PCA, which is used to construct the FSI, are given in Equation (1) (Schmid et al., 2023).

Let $X = (x_1, x_2, \dots, x_9)$ denote the vector of observed fiscal variables. PCA derives principal components ($PC_1, PC_2, \dots, PC_9$) as a linear combination expressed as Equation (1).

$$PC_n = \sum_{i=1}^9 w_i \cdot X_i \quad (1)$$

Where:

- PC_n = the n th principal component (score),
- w_i = the weight (loading) corresponding to the i th variable,
- X_i = the i th observed variable in the data vector.

The first principal component (PC_1) in Equation (2) is identified as a linear combination of the selected variables in the PCA. The second principal component (PC_2) is represented by Equation (3), and the n th principal component (PC_n) is represented by Equation (4). Note that $PC_1, PC_2, \dots$, and PC_n are mutually uncorrelated.

$$PC_1 = w_{11}.Exp + w_{12}.Eds + w_{13}.Rev + w_{14}.GDP + w_{15}.Sav + w_{16}.Inf + w_{17}.Int + w_{18}.Exr + w_{19}.Msb \quad (2)$$

$$PC_2 = w_{21}.Exp + w_{22}.Eds + w_{23}.Rev + w_{24}.GDP + w_{25}.Sav + w_{26}.Inf + w_{27}.Int + w_{28}.Exr + w_{29}.Msb \quad (3)$$

$$PC_n = w_{n1}.Exp + w_{n2}.Eds + w_{n3}.Rev + w_{n4}.GDP + w_{n5}.Sav + w_{n6}.Inf + w_{n7}.Int + w_{n8}.Exr + w_{n9}.Msb \quad (4)$$

3.4. Methodological approach to constructing the FSI

Saisana and Tarantola (2002) validated PCA's fit for constructing composite indices because it reduces dimensionality while preserving the important variance structure among variables. The construction process of composite indicators, as described by Saisana and Tarantola (2002), is structured around a five-step methodology consisting of (1) detecting and handling outliers, (2) assessing intervariable correlations, (3) normalizing data for comparability purposes, (4) assigning objective weights to indicators, and (5) aggregating measures into a composite indicator. Such methodological consistency yields a rigorous, valid index that enables thorough screening of fiscal sustainability within the sample.

Fig. 2 shows a flowchart of the FSI construction, which highlights crucial methodological options for normalization, weighting, and aggregation (Mazziotta and Pareto, 2013). Our study combines its index components using a linear aggregation technique, consistent with prior work (Michalek and Zarnekow, 2012).

The optimal aggregation method depends on the study's aim and the stakeholders or researchers involved. Aggregation approaches fall into two categories: “simple” and “complex.” Simple methods employ basic mathematical functions, such as the arithmetic mean used in the Human Development Index (Lind, 2019). In contrast, complex techniques require sophisticated models or multivariate methods such as PCA.

Moreover, comparisons over time can be absolute or relative. Asymptotic comparisons reveal that the composite index values at time (t) depend on predetermined external parameters and do not involve rankings or standardization. After weighting the variables, we apply min–max normalization. In this scenario, the minimum and maximum bounds are set independently of the data distribution or any external reference (Saisana and Tarantola, 2002).

3.5. The FSI construction

We computed the FSI as the weighted average of the nine selected variables, using PCA to estimate endogenous weights that effectively

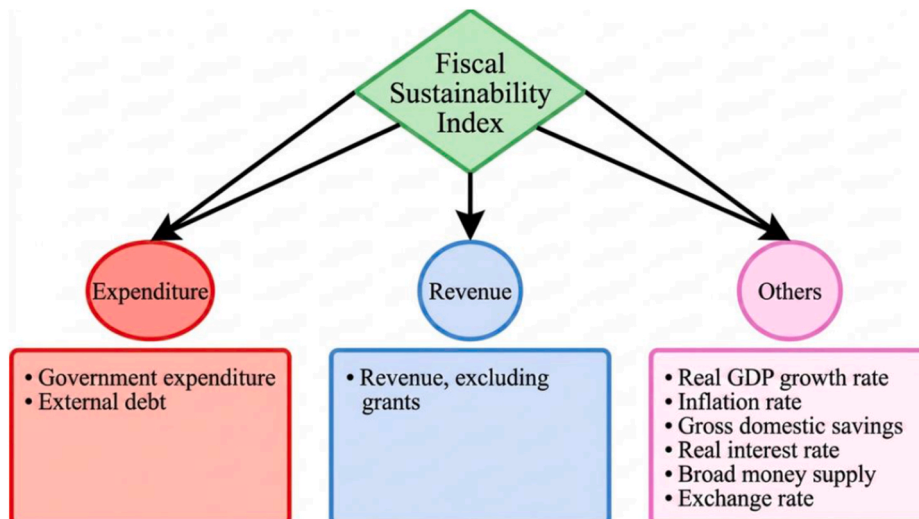


Fig. 1. Fiscal sustainability index pyramid.

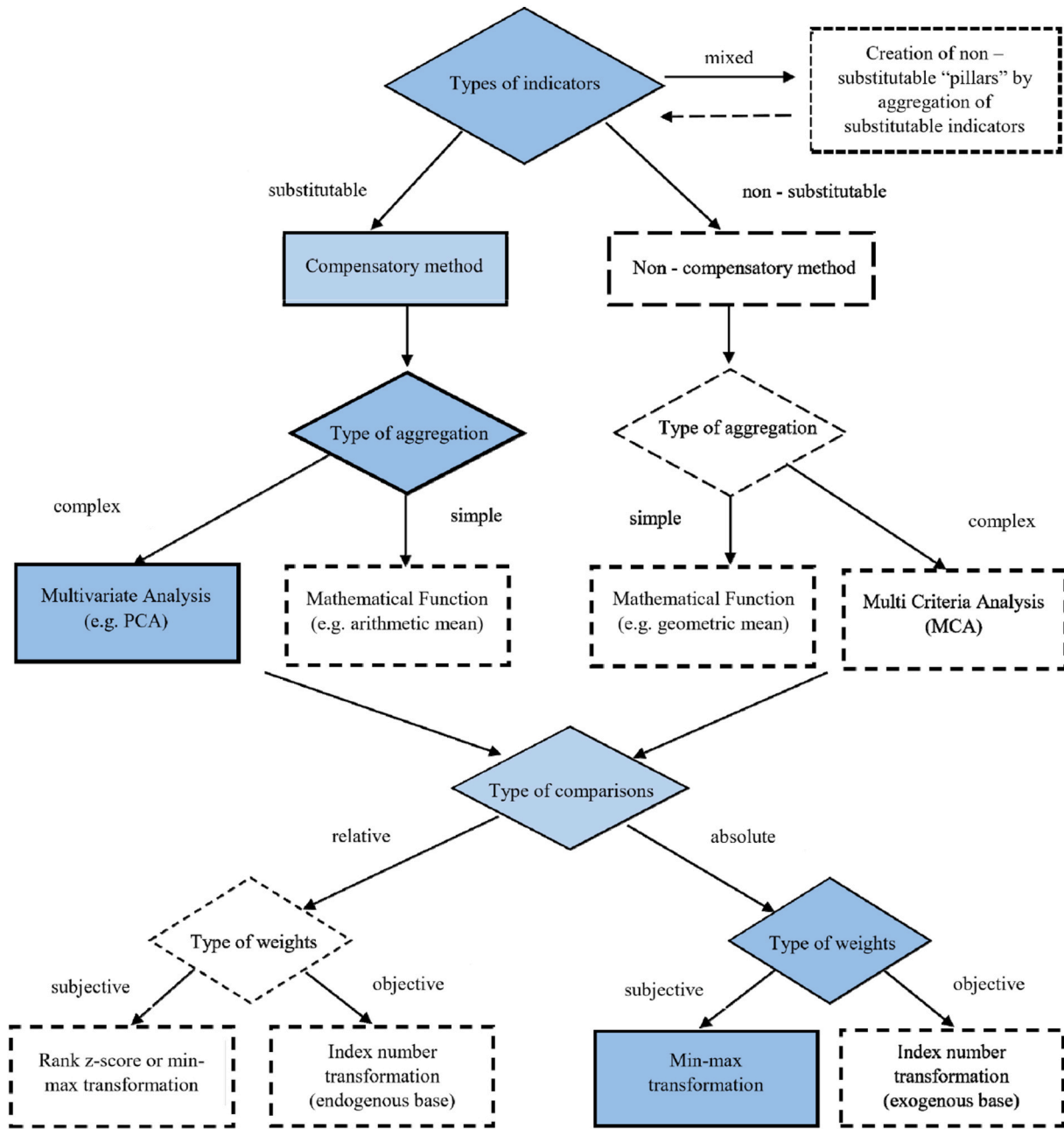


Fig. 2. The path of the fiscal sustainability index.

capture the data's underlying variance structure (Hair et al., 2010).

3.5.1. The average component score (ACS)

The ACS is the mean of the individual component scores. A component score, also known as a factor score, is a numerical estimate that summarizes the relationships among the observed variables by expressing them as a linear combination. This score helps identify the variables most affected by each underlying factor and the relative importance of each factor. Researchers typically derive principal components from the correlation matrix of the observed data. The first principal component (PC1) captures the most significant variance in the dataset and provides the best linear fit to the data distribution (Hair et al., 2010).

To construct the FSI, the ACS is calculated as a weighted average of principal component scores, reflecting the contributions of expenditure, revenue, and other fiscal variables (Schmid et al., 2023). The

weighted-average equation is given in Equation (5), and PC_j denotes the selected principal components.

$$ACS = \sum_{j=1}^n w_j \cdot PC_j \quad (5)$$

$$ACS = \left(\frac{\lambda_1}{\lambda_1 + \lambda_2 + \dots + \lambda_n} \right) PC_1 + \left(\frac{\lambda_2}{\lambda_1 + \lambda_2 + \dots + \lambda_n} \right) PC_2 + \dots + \left(\frac{\lambda_n}{\lambda_1 + \lambda_2 + \dots + \lambda_n} \right) PC_n \quad (6)$$

where $\lambda_1, \lambda_2, \lambda_3, \dots, \lambda_n$ are eigenvalues.

The compensatory linear aggregation mechanism (Equation (6)) requires complete substitutability among components, which is appropriate for capturing gross fiscal health and facilitating its interpretation (Mazziotta and Pareto, 2013). We also examined other aggregation techniques (e.g., geometric means) but found them inadequate due to

their sensitivity to differences among components.

3.5.2. Normalization using min-max scaling

To make the raw variables and PCA scores comparable across countries and over time, we rescale them using min-max scaling to the [0, 1] range. This technique, frequently used in the construction of composite indicators, preserves relative distances and constrains extreme values (Lind, 1993; Lun et al., 2006; Saisana and Tarantola, 2002).

Subsequently, we normalize the ACS using the min-max transformation formula to derive the FSI indicators. For each indicator, the formula is calculated as follows:

$$FSI_i = \frac{ACS_i - ACS_{\min i}}{ACS_{\max i} - ACS_{\min i}} \quad (7)$$

FSI_i = Normalized value of the FSI indicator i

ACS_i = Actual value of the ACS indicator i

$ACS_{\max i}$ = observed minimum value of the ACS indicator i

$ACS_{\min i}$ = observed maximum value of the ACS indicator i where $i = 1, 2, \dots, 29$.

Next, the FSI_i indicator is generated over 29 years, from 1995 to 2023.

$$FSI_i = \begin{bmatrix} FSI_1 \\ FSI_2 \\ \vdots \\ FSI_{29} \end{bmatrix} = \begin{bmatrix} FSI_{1995} \\ FSI_{1996} \\ \vdots \\ FSI_{2023} \end{bmatrix}$$

3.6. Policy relevance and application

The FSI supports detailed monitoring of fiscal sustainability by combining various macro-fiscal aspects into a single, understandable metric. This metric allows policymakers to identify emerging fiscal pressures, compare fiscal resilience across countries, and evaluate the impact of policies during shocks.

The classification thresholds set for the FSI scores offer the following practical interpretations:

$0 < FSI < 0.4$ = Strong fiscal sustainability.

$0.4 < FSI < 0.6$ = Moderate vulnerability.

$0.6 < FSI < 0.8$ = Substantial vulnerability.

$0.8 < FSI < 1.0$ = Weak fiscal sustainability.

This gradation enables a real-time fiscal risk evaluation and targeted policy responses.

3.7. Temporal considerations and dynamic interpretability

As the dataset was longitudinal, PCA was performed on the pooled data across all time points to obtain a stable, consistent factor structure. While PCA is conventionally a static tool (Bai and Ng, 2002), we conducted robustness tests (split-sample validation) to ensure that factor loadings did not change significantly across sub-periods. This approach allows meaningful temporal comparisons of fiscal sustainability trends and the potential impact of structural breaks in these trends resulting from economic shocks, consistent with the approaches applied in other reputable economic modeling studies (Forni et al., 2000; Stock and Watson, 2002).

Future investigations might exploit dynamic PCA or time-varying factor models to account for the evolving interrelationships evident in the fiscal data (Bańbura et al., 2010). However, pooled PCA offers a strong and informative baseline framework for this study.

3.8. Methodological considerations: composite indices and causal inference

Composite indices, such as the FSI, serve as powerful tools for consolidating multidimensional fiscal and macroeconomic data into interpretable metrics for monitoring and comparison (Alkire et al., 2022; Illing and Liu, 2006). However, their use as explanatory variables in causal econometric models entails significant methodological challenges. Specifically, employing such indices as regressors can introduce omitted-variable bias and simultaneity issues, commonly referred to as the “bad-controls” problem (Angrist and Pischke, 2009). This problem arises because composite indices encapsulate multiple underlying factors, some of which may be endogenous or correlated with omitted determinants of the outcome variable.

Consequently, the FSI is designed and best used as a descriptive and diagnostic indicator that summarizes overall fiscal health, enabling timely cross-country and temporal comparisons. The index does not serve as a causal regressor for estimating the direct impact of fiscal policies on macroeconomic outcomes. Recognizing this limitation helps guide researchers and policymakers in interpreting and applying the index appropriately in both academic studies and policy analysis.

4. Empirical analysis and discussion

4.1. Australia case study: PCA and FSI construction

We examine the empirical construction of the FSI in Australia for several reasons. First, the country is a typical example of a developed economy with well-established fiscal and institutional arrangements, making it an ideal setting for analyzing changes in fiscal sustainability spanning multiple economic cycles (Heimberger, 2023). Second, Australia's experience of significant economic shocks, such as the GFC and the COVID-19 pandemic, provides a crucial backdrop for examining fiscal resilience and policies to ameliorate fiscal pressure (Reserve Bank of Australia, 2021). Third, rich data, including consistent fiscal and macroeconomic series over a long period, also enable a robust empirical analysis of the FSI framework (Barro, 2023). By focusing on Australia, this study provides a contextually rich perspective that is relevant not only to policymakers in the region but also to other advanced economies facing similar fiscal dilemmas. Furthermore, it contributes to the literature on fiscal sustainability under uncertainty (Afonso and Coelho, 2024).

4.1.1. Data verification and preparation

The initial data preparation involved checking the variable storage types in STATA to ensure computational accuracy. Generally, we proceeded only with variables stored as floats in the analysis, following standard data management protocols (Table A4.1 in Appendix A).

4.1.2. Sample adequacy assessment via Kaiser-Meyer-Olkin (KMO) measure

The KMO measure assesses sampling adequacy for factor analysis. Following Hair et al. (2010), we applied a Minimum Sampling Adequacy (MSA) threshold of 0.5. As shown in Table A4.2 (Appendix A), the variable “exchange rate” had the lowest MSA ($Exr = 0.303$), falling well below the threshold. Therefore, it was removed, and the KMO measure was recalculated for the remaining variables. This iterative process continued until all remaining variables had MSA values above 0.5, as presented in Table A4.3 (Appendix A). During this process, the variables “revenue” (Rev) and “savings” (Sav), with MSAs below 0.5, were also removed. The final set of six variables met the adequacy criterion (Table A4.3 in Appendix A). This iterative variable selection ensured the validity of the subsequent factor analysis.

4.1.3. Determination of factor components: Horn's parallel analysis

Horn's parallel analysis identified the optimal number of principal

components to retain. The unadjusted eigenvalues showed that the first two components accounted for sufficient variance (Hair et al., 2010) (see Table A4.4 in Appendix A). The unrotated factor-loading matrix demonstrated acceptable uniqueness (<0.5) and no cross-loading, confirming the factor extraction (Table A4.5 in Appendix A).

4.1.4. Factor rotation using the orthogonal varimax method

We employed orthogonal varimax rotation, a method that simplifies data by producing uncorrelated factors and clarifying variable loadings (Hair et al., 2010). According to accepted criteria, all variables had uniqueness values below 0.5. They also exhibited no significant cross-loadings (see Table A4.6 in Appendix A), confirming the validity of the factor rotation.

The rotated factor loadings indicate that government expenditure, GDP growth rate, and external debt load significantly influence separate factors (≥ 0.40), suggesting a primary impact on fiscal sustainability. The interest rate and broad money growth loadings are below the threshold, implying limited relevance. We excluded inflation because it loaded heavily across both factors, reducing each one's distinctiveness. Two factors were labeled: 1) Factor 1: Expenditure, and 2) Factor 2: Others (presented in Table A4.7 in Appendix A). Collectively, these components support the empirical structure of the Australian FSI.

Overall, government expenditure, the GDP growth rate, and external debt emerge as key variables with substantial explanatory power.

4.1.5. Assessment of data suitability: Bartlett's test of sphericity

We performed Bartlett's test of sphericity to assess whether the dataset is suitable for PCA. Table A4.8 in Appendix A indicates that the null hypothesis (H_0) states that the variables are not intercorrelated, while the KMO measure is 0.695. Because the variables show sufficient intercorrelation and the KMO exceeds 0.6, we conclude that the data meet the PCA criteria.

4.1.6. Component selection and normalization for index construction

Following the KMO measure's criterion, we retained only principal components with eigenvalues greater than one (Hair et al., 2010). Table A4.9 in Appendix A shows that the first two components account for 73% of the total variance, and both have eigenvalues greater than one. Consequently, these two components form the basis for index development and predictive analysis.

Cattell's scree test, illustrated in Figure A1.1 in Appendix A, visually confirmed that retaining the two components was appropriate. Figure A1.2 (Appendix A) presents a scatter plot and normalized component scores, further supporting the methodological approach (Hair et al., 2010).

4.1.7. Calculation of the average component score

The next step in constructing the FSI is to calculate the ACS, which is obtained by summing the scores of the first and second principal components, as specified in Equation (8).

$$ACS_i = \left(\frac{0.4441}{0.7272} \right) * pc_1 + \left(\frac{0.2830}{0.7272} \right) * pc_2 \quad (8)$$

where: $i = 1, 2, 3, \dots, 29$.

The values of ACS range from -2.170549 to 2.728777 .

4.1.8. Construction of the FSI

Finally, we create the FSI by applying the min-max transformation described in Section 3.5.2 and normalizing the index to the range of 0-1 (see Table A4.10 in Appendix A).

$$FSI_i = \begin{bmatrix} FSI_1 \\ FSI_2 \\ \vdots \\ FSI_{29} \end{bmatrix} = \begin{bmatrix} FSI_{1995} \\ FSI_{1996} \\ \vdots \\ FSI_{2023} \end{bmatrix} = \begin{bmatrix} 0.0000 \\ 0.0388 \\ \vdots \\ 0.6240 \end{bmatrix}$$

According to the analysis, Australia's FSI was zero in 1995, indicating strong fiscal sustainability (Table B1, Appendix B). This result reflects lower government expenditure, reduced external debt, and robust GDP growth. In contrast, the FSI rose to 1 by 2020, indicating a significant deterioration in fiscal sustainability (Table B1, Appendix B). This decline was primarily attributed to increased government expenditure, a substantial rise in external debt, and a contraction in GDP growth caused by the COVID-19 pandemic (Auerbach et al., 2022; Reserve Bank of Australia, 2021).

4.2. Fiscal sustainability dynamics in Australia

4.2.1. Impact of the Global Financial Crisis on Australia, 2009

The 2007–08 GFC, originating in the US, led to a significant tightening of liquidity in world markets. While Australia managed to avoid a deep recession during the GFC, its growth slowed markedly, and uncertainty increased. However, according to OECD standards, the Australian financial system appears relatively robust (Reserve Bank of Australia, 2010). Our study examines fiscal sustainability during the GFC period, when the FSI was 0.6923 in 2009 (Table B1, Appendix B). The increase in government spending to 26.47% of GDP, the increase in external debt to 104.67% of GDP, and the slowdown in growth to 1.89% were among the factors that led to a deterioration in fiscal sustainability. These indicators show moderate fiscal fatigue, consistent with the relatively minor impact of the GFC on Australia's fiscal architecture (Reserve Bank of Australia, 2010).

4.2.2. Impact of the COVID-19 pandemic on Australia, 2020

Authorities declared the COVID-19 pandemic a global public health emergency in 2020, triggering unprecedented economic disruptions worldwide. In Australia, real GDP contracted sharply by approximately 7% in the second quarter of 2020, marking the most severe quarterly decline since World War II (Reserve Bank of Australia, 2021). Correspondingly, our FSI for Australia increased dramatically to its maximum value of 1.0000 in 2020 (Table B1, Appendix B), signaling a pronounced deterioration in fiscal sustainability.

Driving this fiscal stress were the surge in government expenditure to 30.25% of GDP, and the marked increase in external debt to 123.28% of GDP. Meanwhile, real GDP growth turned negative, at -0.12% . These developments position Australia's fiscal stance during the pandemic as considerably more strained than during the GFC in 2009. Such findings are consistent with the Reserve Bank of Australia's (2021) official assessment of pandemic-induced fiscal vulnerabilities, reinforcing the FSI's efficacy in capturing fiscal pressure during systemic shocks.

Complementing this national perspective, Yilmazkuday (2022) documented the global macroeconomic ramifications of COVID-19, highlighting widespread disruptions to transport networks and supply chains that precipitated steep declines in economic activity. This global context enlarges the scope of external shock factors that underpin the fiscal deterioration observed in our FSI analysis.

Collectively, the evidence indicates that the constraints imposed by the COVID-19 pandemic had a more severe impact on Australia's fiscal

sustainability than those experienced during the GFC. These insights affirm the critical need for dynamic, multidimensional fiscal risk metrics, such as the FSI, capable of monitoring fiscal resilience under profound international economic shocks.

4.2.3. Policy implications for Australia

Australia's fiscal erosion during the COVID-19 pandemic underscores the importance of maintaining a healthy check on public finances and sound debt management to secure sustainability in times of crisis (Afonso and Coelho, 2024). The FSI provides a timely signal to guide a calibrated fiscal policy, balancing stimuli with long-run solvency (Jalles et al., 2024).

4.3. Cross-country fiscal sustainability analysis of OECD economies

This section presents the empirical findings of the FSI analysis for 37 OECD countries over the period 1995 to 2023. Table 1 provides descriptive statistics of the FSI across countries, while detailed annual FSI values for each country are available in Appendix B (Tables B1–B37). Our analysis of FSI values from 1995 to 2023 indicates a marked deterioration in fiscal sustainability for most OECD countries following the COVID-19 pandemic, with 28 countries exhibiting increased FSI values that reflect heightened fiscal vulnerabilities. Additionally, seven countries experienced fiscal weakening primarily during the Global Financial Crisis (GFC), and five of these sustained fiscal stress through both crises (see Tables B1–B37, Appendix B). These findings underscore the significant fiscal challenges OECD economies face amid both isolated and successive economic shocks.

Table 1
Descriptive statistics of FSI values for 37 OECD Countries, 1995–2023.

Country	Mean	Std. Dev.	Min.	Max.	Obs.
Australia	0.443	0.247	0	1	29
Austria	0.614	0.245	0	1	29
Belgium	0.510	0.314	0	1	29
Canada	0.573	0.289	0	1	29
Chile	0.490	0.265	0	1	29
Colombia	0.485	0.263	0	1	29
Costa Rica	0.566	0.268	0	1	29
Czech Republic	0.457	0.325	0	1	29
Denmark	0.575	0.280	0	1	29
Estonia	0.786	0.248	0	1	29
Finland	0.666	0.235	0	1	29
France	0.383	0.327	0	1	29
Greece	0.450	0.296	0	1	29
Hungary	0.414	0.336	0	1	29
Iceland	0.333	0.234	0	1	29
Ireland	0.528	0.326	0	1	29
Israel	0.278	0.274	0	1	29
Italy	0.531	0.247	0	1	29
Japan	0.346	0.288	0	1	29
South Korea	0.546	0.269	0	1	29
Latvia	0.685	0.302	0	1	29
Lithuania	0.668	0.303	0	1	29
Luxembourg	0.567	0.296	0	1	29
Mexico	0.604	0.296	0	1	29
Netherlands	0.505	0.314	0	1	29
New Zealand	0.453	0.278	0	1	29
Norway	0.370	0.219	0	1	29
Poland	0.478	0.289	0	1	29
Portugal	0.506	0.250	0	1	29
Slovakia	0.596	0.288	0	1	29
Slovenia	0.632	0.308	0	1	29
Spain	0.496	0.297	0	1	29
Sweden	0.315	0.306	0	1	29
Switzerland	0.499	0.305	0	1	29
Turkey	0.520	0.265	0	1	29
United Kingdom	0.531	0.302	0	1	29
United States	0.497	0.313	0	1	29

Notes: Std. Dev.: Standard deviation; Min.: minimum value; Max.: maximum value; Obs.: number of observations.

The descriptive statistics in Table 1 reveal substantial heterogeneity in fiscal stability and temporal volatility across countries. For example, Israel records the lowest average FSI (0.278), reflecting generally stronger fiscal resilience, whereas Estonia exhibits the highest average (0.786), suggesting comparatively greater fiscal vulnerability over the study period. Most countries lie within a moderate FSI range of 0.4 to 0.65. Year-to-year variability is evident in standard deviations ranging from 0.219 (Norway) to 0.336 (Hungary), highlighting the impact of country-specific economic fluctuations and policy responses. The full range of minimum and maximum values confirms episodes of both fiscal stability and stress throughout the timeframe, underscoring diverse fiscal stability trajectories within advanced economies.

4.3.1. Impact of the GFC on OECD countries in 2009

The GFC precipitated a severe economic downturn across OECD economies, with aggregate output declining by approximately 4.7% between Q1 2008 and Q2 2009 (Lane, 2012). This shock exposed fiscal fragilities, particularly in parts of Europe, where sovereign debt difficulties culminated in financial market volatility and banking-sector distress, notably the near-collapse of Iceland's banking system. Sovereign debt crises spread across Portugal, Greece, and Ireland during 2009, heightening regional fiscal concerns.

Table 2 reports FSI scores across OECD countries for 2009, illustrating a broad spectrum of fiscal sustainability conditions. Countries such as Italy (FSI = 0.000) and Japan (FSI = 0.020) displayed strong fiscal positions, whereas the Czech Republic (FSI = 0.417) and Luxembourg (FSI = 0.441) faced moderate fiscal stress. Several economies evidenced significant fiscal vulnerability, including Poland (0.602), Slovenia (0.778), and notably, the United States (0.820), Iceland (0.848), Latvia (0.895), and Denmark (1.000). These results align with observed sovereign stress episodes and confirm the FSI's effectiveness in distinguishing fiscal risks during economic crises (Reinhart and Rogoff, 2010).

4.3.2. Impact of the COVID-19 pandemic on OECD countries in 2020

The COVID-19 pandemic precipitated unprecedented fiscal expansions alongside sharp economic contractions across OECD countries, constituting a severe and sudden shock that fundamentally reshaped fiscal sustainability profiles globally (Furceri et al., 2022). Table 3 presents FSI scores for 2020, revealing significant heterogeneity in fiscal strength among advanced economies. For instance, countries such as Israel (FSI = 0.019), Sweden (FSI = 0.062), and Ireland (FSI = 0.063) maintained relatively robust fiscal positions despite the shock. In contrast, Finland, France, Greece, Lithuania, Mexico, Norway, Canada, Australia, Slovenia, Colombia, and the United States exhibited pronounced fiscal vulnerabilities, each reaching the maximum normalized FSI value of 1. Japan's score of 0.672 signals a moderate fiscal impact relative to its OECD peers.

Our analysis reveals that the COVID-19 pandemic induced a more severe and widespread deterioration in fiscal sustainability across the OECD compared with that caused by the GFC. This pattern highlights the critical need for enhanced fiscal transparency and responsiveness. In addition, it signals opportunities for targeted policy interventions to improve expenditure efficiency and strengthen fiscal resilience (Aizenman and Marion, 2011; Furceri et al., 2022). The FSI emerges as a powerful real-time tool for detecting and comparing fiscal vulnerabilities across countries, enabling policymakers to navigate complex and rapidly evolving fiscal environments.

The heterogeneity detected at the national level is echoed at the subnational level, as demonstrated by Yilmazkuday (2021b), who documents significant variation in the welfare costs of COVID-19 across the United States. This spatial and economic disparity aligns with the cross-country fiscal sustainability divergences captured by the FSI, underscoring the uneven nature of pandemic-related fiscal shocks.

By integrating these macro- and micro-level insights, our discussion situates observed fiscal vulnerabilities within a broader context of global

Table 2

FSI scores for OECD Countries, 2009.

Country	FSI	Country	FSI	Country	FSI	Country	FSI
Italy	0.000	Finland	0.382	Mexico	0.598	US	0.820
Japan	0.020	Czechia	0.417	Turkiye	0.599	Iceland	0.848
Canada	0.091	Luxembourg	0.441	Poland	0.602	Latvia	0.895
France	0.185	Chile	0.449	Costa Rica	0.624	Estonia	0.944
Israel	0.212	Portugal	0.458	Lithuania	0.656	New Zealand	0.969
Sweden	0.229	Austria	0.473	Australia	0.692	Ireland	0.986
Hungary	0.284	Belgium	0.555	Slovak Rep.	0.697	Denmark	1.000
Netherlands	0.290	Switzerland	0.555	Korea, Rep.	0.731		
Colombia	0.320	Greece	0.576	UK	0.736		
Spain	0.341	Norway	0.596	Slovenia	0.778		

Table 3

FSI scores for OECD Countries, 2020.

Country	FSI	Country	FSI	Country	FSI	Country	FSI
Israel	0.019	Denmark	0.872	Portugal	0.968	France	1.000
Sweden	0.062	Netherlands	0.872	Spain	0.970	Greece	1.000
Ireland	0.063	Austria	0.875	Slovak Rep.	0.994	Lithuania	1.000
Belgium	0.147	Latvia	0.876	Australia	1.000	Mexico	1.000
Italy	0.207	Turkiye	0.885	Canada	1.000	Norway	1.000
Switzerland	0.278	Hungary	0.893	Colombia	1.000	Slovenia	1.000
Iceland	0.294	Luxembourg	0.912	Costa Rica	1.000	US	1.000
Poland	0.463	United Kingdom	0.942	Czechia	1.000		
Japan	0.672	Korea, Rep.	0.948	Estonia	1.000		
New Zealand	0.863	Chile	0.942	Finland	1.000		

economic disruption and asymmetric pandemic impacts, thus enriching the robustness and policy relevance of our findings.

OECD countries exhibited divergent fiscal trajectories over the two major crises examined, with the multidimensional FSI effectively distinguishing varying degrees of fiscal resilience and vulnerability. This index not only captures episodic fiscal shocks but also illuminates underlying structural fiscal risks, providing policymakers with invaluable guidance as they manage dynamic fiscal challenges amid unprecedented uncertainty.

4.4. Sensitivity analysis of PCA

To ensure the robustness and reliability of the PCA used to construct the FSI, we conducted a comprehensive sensitivity analysis across five critical aspects. We first evaluated whether the sample size of 261 observations met the statistical criteria necessary for stable and reliable factor extraction (Bai and Ng, 2002; Stock and Watson, 2002). Second, we evaluated the impact of the normalization method, applying min-max scaling, to confirm consistent results across scaling approaches. Third, we examined the effect of excluding certain variables to reduce multicollinearity and enhance factor clarity. Fourth, we implemented orthogonal varimax rotation to improve factor interpretability by maximizing the variance of loadings across factors. Finally, we determined the appropriate number of principal components to retain, restricting the analysis to the first two factors using eigenvalue and parallel analysis criteria (Bai and Ng, 2002).

This systematic examination strengthens the credibility of the PCA results and supports the assertion that the extracted components accurately represent the underlying data structure. Collectively, these sensitivity tests reinforce confidence in the FSI's construction and its suitability as a robust multidimensional measure of fiscal sustainability.

4.5. Robustness and sensitivity of the FSI

4.5.1. Subsample definition

To examine the robustness of the FSI, we classify countries into high- and low-debt groups based on their average external debt stock (EDS) over the entire sample period. Adopting thresholds grounded in

established fiscal research (Reinhart and Rogoff, 2010), we designate countries with average EDS above 90% of GDP as high-debt economies. This group includes nations with persistent fiscal vulnerabilities, such as Greece, Iceland, Italy, Spain, and Portugal. Conversely, countries with average EDS below 60%, including fiscally strong economies such as Korea, Luxembourg, Switzerland, and Norway, are classified as low-debt countries. This bifurcation facilitates nuanced assessments of fiscal risk profiles across debt regimes.

To interrogate further the impact of major macroeconomic shocks, we partition the dataset into pre- and post-crisis subperiods, delineating 2008 as the cutoff for the GFC and 2020 for the COVID-19 pandemic. This temporal segmentation enables an evaluation of fiscal sustainability trends in relation to distinct systemic shocks.

4.5.2. Fiscal sustainability trends by debt level

Over the 29 years of the study period, high-debt countries consistently exhibited greater volatility and higher FSI scores than their low-debt counterparts. High-debt economies have experienced an upward trajectory in fiscal stress since the early 2000s, culminating in near-maximum FSI values (FSI = 1) during the COVID-19 pandemic in 2020. In contrast, low-debt countries maintained relatively low and stable fiscal stress indicators.

These pronounced peaks in the high-debt group during crisis periods signal intensified fiscal pressures linked to heavy debt burdens, rendering these countries especially vulnerable to external shocks (Afonso and Coelho, 2024; Reinhart and Rogoff, 2010). The FSI's sensitivity to such dynamics supports its validity as an incisive tool for capturing both episodic fiscal stress and underlying structural fragilities.

4.5.3. Impact of crisis periods on fiscal sustainability

The GFC precipitated a marked rise in average FSI levels, particularly among high-debt countries, reflecting acute financing constraints and deteriorating fiscal balances (Furceri et al., 2022). While low-debt countries also experienced heightened fiscal stress, these changes were comparatively moderate and more stable. During the COVID-19 pandemic, FSI values surged broadly across OECD countries in 2020. Subsequently, most high-debt economies sustained elevated fiscal stress, whereas several low-debt countries demonstrated signs of stabilization

or partial fiscal recovery. These patterns underscore a strong interplay between fiscal stability, crisis resilience, and sovereign debt profiles, echoing findings from earlier empirical studies (Eberhardt and Presbitero, 2015; El-Shagi and von Schweinitz, 2021).

4.5.4. Robustness of the FSI as a fiscal sustainability indicator

The persistent increases in fiscal stress detected by the FSI during major crises affirm its robustness and reliability as a comprehensive measure of fiscal sustainability. The index's responsiveness to distinct shocks, particularly its capacity to discriminate between the heterogeneous experiences of high- and low-debt countries, enhances its practical utility for real-time fiscal risk monitoring and policy formulation.

Moreover, the contrasting fiscal dynamics observed across debt groups align with fundamental economic principles governing solvency and fiscal resilience, thereby reinforcing confidence in the FSI's broad applicability and interpretive coherence (Afonso and Coelho, 2024).

Subsample analyses confirm that highly indebted economies bear greater fiscal vulnerability, as evidenced by larger and more volatile FSI values during and following crisis episodes. Both the GFC and COVID-19 pandemic thus serve as rigorous stress tests for the index, highlighting its ability to capture increased sovereign fiscal strain transparently. Conversely, low-debt countries display superior fiscal stability and attenuated stress responses, consistent with theoretical expectations (Reinhart and Rogoff, 2010).

4.5.5. Theoretical and empirical basis for debt thresholds

The debt thresholds employed to define high- and low-debt groups rest on well-established theoretical and empirical foundations. Reinhart and Rogoff (2010) identified a critical 90% EDS level beyond which fiscal pressures intensify sharply, increasing sovereign risk and depressing growth prospects. The 60% threshold corresponds to the prudent fiscal criterion articulated in the Maastricht Treaty and widely endorsed by international financial institutions. These benchmarks facilitate transparent categorizations of fiscal regimes, improving the interpretability and policy relevance of the FSI's performance across heterogeneous country contexts (Eberhardt and Presbitero, 2015).

4.5.6. External debt and trade imbalance dynamics: implications for FSI robustness

Although we do not explicitly incorporate trade deficits into the FSI construction, extensive research has documented their role in driving external debt accumulation (Yilmazkuday, 2021a). Persistent external imbalances necessitate foreign borrowing, thereby augmenting sovereign exposure to rollover risk, exchange rate fluctuations, and liquidity constraints. All these stress factors are embedded within the EDS component of the FSI (Arellano and Ramanarayanan, 2012).

Empirical studies further associate elevated external debt with macroeconomic instability and amplified fiscal fragility, particularly in OECD countries (El-Shagi and von Schweinitz, 2021; Reinhart and Rogoff, 2010). By implicitly capturing the fiscal implications of trade imbalances through its external debt dimension, the FSI offers a nuanced reflection of sovereign vulnerability in an increasingly interconnected global economy.

These insights highlight the imperative for policymakers to manage external sector imbalances alongside debt levels to bolster fiscal sustainability (Aizenman and Marion, 2011).

4.5.7. Summary of robustness checks

The multifaceted robustness checks performed, including subsample stratification, crisis-period evaluation, and theoretical benchmark validation, corroborate the FSI's reliability as a comprehensive fiscal sustainability indicator. The index's sensitivity to diverse fiscal regimes, crisis episodes, and underlying structural factors affirms its value as a tool for economic modeling, policy development, and sovereign risk assessment across varied macroeconomic environments.

4.6. The FSI's superiority over conventional fiscal indicators

Traditional fiscal indicators, such as the general government gross debt-to-GDP ratio and the primary deficit, have long been favored for their simplicity and intuitive appeal in assessing fiscal sustainability (Bohn, 1998). However, these conventional measures exhibit critical limitations. Their narrowly focused scope often fails to capture the complex, multidimensional nature of a country's fiscal performance, thereby providing an incomplete picture of fiscal health (Debrun et al., 2009). By contrast, the FSI integrates multiple fiscal and macroeconomic dimensions, directly addressing these shortcomings.

First, the FSI encompasses key determinants of fiscal health, including government expenditure patterns, external debt stock, and real GDP growth rates, thus reflecting both debt dynamics and fiscal policy responses over time. This multidimensionality aligns with insights from the external debt crisis literature, which emphasized not only the magnitude of sovereign debt, but also the evolution of fiscal policy responses and their interplay with economic growth (Reinhart and Rogoff, 2010). Consequently, the FSI serves as a more comprehensive and realistic proxy for fiscal sustainability than any single-ratio metric.

Second, the continuous construct of the FSI, in which higher values denote weaker fiscal sustainability, facilitates nuanced cross-country and intertemporal comparisons without reliance on arbitrary fixed thresholds. This continuity offers a marked advantage over ratio-based indicators, which rely on preset benchmarks that often disregard country-specific structural differences and temporal fiscal dynamics (Hatchondo et al., 2022). By aggregating diverse fiscal variables, the FSI enhances early detection of fiscal stress and recovery signals, a capability especially crucial in periods of systemic shocks, such as the COVID-19 pandemic and the GFC (Furceri et al., 2022).

Third, the FSI is rigorously grounded in established fiscal sustainability theory, encapsulating the core concepts of the government intertemporal budget constraint, debt dynamics, and fiscal risk exposure (Barro, 2023). This theoretical underpinning ensures that the FSI transcends the role of a mere statistical construct; it meaningfully reflects both fiscal solvency and vulnerability. Empirical analyses corroborate that the FSI exhibits superior explanatory power for sovereign fiscal vulnerabilities compared with traditional indicators, thereby enhancing its utility for researchers and policymakers seeking rigorous fiscal surveillance tools (Afonso and Coelho, 2024; Ghourchian and Yilmazkuday, 2020).

In sum, the FSI represents a significant advance in fiscal sustainability measurement, combining theoretical rigor, multidimensional comprehensiveness, and empirical robustness. It is also a framework for formulating balanced fiscal strategies that harmonize prudent debt management, expenditure discipline, and growth promotion. Employing this tool enhances macroeconomic stability and helps secure long-term fiscal health (Alkire et al., 2022; Reinhart and Rogoff, 2010). Moreover, its capacity to provide timely, accurate assessments of fiscal health renders it an indispensable instrument for policymaking and academic inquiry in an increasingly complex fiscal landscape.

5. Conclusion

5.1. Summary of key findings

Our analysis demonstrates that fiscal sustainability across OECD countries deteriorated more sharply during the COVID-19 pandemic than during the GFC. While both crises imposed substantial fiscal pressures, the pandemic-induced shock was more severe, particularly in Australia, where each event precipitated pronounced fiscal deterioration. We further establish that countries with higher external debt levels face significantly greater fiscal vulnerabilities when confronted with such economic shocks. Significantly, the FSI developed in this study exhibits superior empirical performance and robustness relative to

traditional, unidimensional fiscal indicators. By synthesizing multiple fiscal and macroeconomic dimensions, the FSI equips policymakers with a comprehensive, real-time framework for monitoring fiscal risks and informing the development of adaptive macro-fiscal policies.

Methodologically, this study bridges theoretical fiscal sustainability frameworks with empirical composite index techniques, providing policymakers with a multidimensional measurement tool. The FSI supports the design of countercyclical fiscal policies, improves sovereign risk monitoring, and promotes long-term macroeconomic stability (Iorio and Fachin, 2022; Gootjes et al., 2021). Fiscal shocks do not remain isolated; they can spread through global trade and financial linkages, amplifying international risks (Yilmazkuday, 2024). The FSI's comparative and multidimensional approach helps uncover these cross-border vulnerabilities, aiding coordinated policy efforts.

5.2. Policy implications and recommendations

The FSI highlights external debt, government expenditure, and real GDP growth as pivotal determinants shaping a country's fiscal sustainability profile (Afonso and Coelho, 2024; Barro, 2023). Grasping the interplay of these factors is crucial for formulating fiscal policies that ensure the long-term stability and sustainability of public finances.

Countries with high external debt consistently register elevated FSI scores, signaling higher debt servicing costs and refinancing vulnerabilities that constrain fiscal space and amplify sovereign risk (Panizza and Presbitero, 2014; Reinhart and Rogoff, 2010). The COVID-19 pandemic has further exposed these fiscal fragilities, as rapid debt accumulation intensified pressures in many advanced economies (Auerbach et al., 2022). For such countries, targeted debt stabilization strategies are imperative. Recommended interventions include imposing borrowing constraints, extending debt maturities, and strengthening debt management frameworks to mitigate rollover risks and reduce interest expenses (Heimberger, 2023; Nomo Beyala, 2025).

Beyond debt management, careful moderation of government expenditure growth, especially non-productive and recurrent spending, is crucial to restoring fiscal balance without undermining essential investments and social safety nets. This approach aligns with the fiscal reaction function, which suggests that primary surpluses tend to rise in response to rising debt to preserve fiscal sustainability (Bohn, 1998; Linhares et al., 2021).

Simultaneously, robust and sustained economic growth plays a vital role in improving fiscal positions by expanding nominal GDP, thus lowering debt-to-GDP ratios and easing fiscal tensions. Structural reforms fostering innovation, labor market flexibility, and institutional quality have demonstrated efficacy in driving growth and enhancing fiscal resilience (Furceri et al., 2022; Ilzetzki et al., 2013).

5.3. Limitations and future directions

The FSI breaks new ground in assessing fiscal sustainability by incorporating multiple macroeconomic dimensions within a unified theoretical framework. Nonetheless, acknowledging several limitations is essential to contextualize its applicability and to guide future research directions.

First, we base the FSI on a fixed set of nine macro-fiscal variables that primarily capture contemporaneous fiscal and economic conditions. Therefore, it may not adequately reflect the full complexity of fiscal sustainability, particularly in contexts in which factors such as contingent liabilities, structural reforms, or exposure to exogenous shocks, such as commodity price volatility in resource-dependent or emerging economies, play a critical role (McHugh et al., 2011). The omission of these elements could constrain the index's comprehensiveness and reduce its predictive accuracy in specific country contexts.

Second, the FSI relies on realized fiscal outcomes and lacks

incorporation of forward-looking or risk-sensitive components such as fiscal projections, forecast errors, and measures of macroeconomic uncertainty (Davig and Leeper, 2007). Incorporating such dynamic indicators would enhance the FSI's capacity to detect fiscal stress early and improve its utility as a proactive policy instrument, aligning with recent advances in fiscal risk assessment methodologies (Kraay and Nehru, 2006).

Third, applying a uniform composite metric across heterogeneous OECD economies risks obscuring important institutional and structural differences, including variations in fiscal frameworks, governance quality, and budgetary rules that shape fiscal performance and sustainability (Debrun et al., 2009). Developing region- or country-specific adaptations of the FSI could better capture these nuances, improving its granularity and policy relevance.

Importantly, the FSI serves as a descriptive and diagnostic tool; it does not function as an explanatory variable in causal econometric frameworks. Including the FSI as a regressor can introduce endogeneity and omitted-variable bias, undermining causal inference (Angrist and Pischke, 2009). Hence, its primary role remains comparative assessment across countries and over time, as well as the provision of near-real-time early warning signals of fiscal vulnerability.

Future research should incorporate forward-looking, probabilistic, and risk-sensitive indicators, such as fiscal stress testing, contingent liability modeling, and macroeconomic scenario analysis, to augment the FSI's predictive accuracy and policy utility (International Monetary Fund, 2021). By doing so, the FSI can evolve into an even more robust tool that effectively supports sustainable fiscal policy formulation and fiscal surveillance in an increasingly uncertain global economic environment.

In summary, the FSI offers central banks and fiscal authorities a timely, comprehensive, and practical measure of fiscal vulnerability. As uncertainties continue to challenge global economies, this tool enhances the capacity to detect fiscal risks early and design policies that safeguard economic stability and sustainable public finances (Auerbach et al., 2022; Barro, 2023).

Data statement

The processed datasets and replicable code for constructing the Fiscal Sustainability Index (FSI) are available upon reasonable request from the corresponding author.

Author contributions

The corresponding author conceptualized the study, developed the methodology, and wrote the initial draft. All other authors critically revised the manuscript, providing necessary comments and thorough reviews. All authors have read and approved the final version of the manuscript.

Funding

The authors declare that no funding was received for this study.

Declaration of interest statements

The authors declare no conflicts of interest related to the content of this manuscript.

Acknowledgements

We thank the University of New England, Armidale, for valuable support and resources. We also appreciate the constructive feedback from colleagues and reviewers, which greatly improved this manuscript.

Appendix A. Additional Tables

Table A1
Summary of key socioeconomic indices

Index	Author and Year	Data	Methodology	Key Findings
Multidimensional Poverty Index (MPI – Global)	Alkire et al. (2022)	105 countries, 2006–2016, using household survey datasets.	Alkire-Foster (AF) method	The study identified 1.3 billion people in multidimensional poverty using refined MPI indicators.
Child-Sustainable Human Development Index (CSHDI)	Biggeri and Ferrone (2022)	Children's well-being indicators linked to sustainability (datasets not specified).	Capability approach framework for index construction	CSHDI captures links between child welfare, environmental sustainability, and intergenerational equity.
Financial Stress Index	Illing and Liu (2006)	Canada's financial and economic data, including multi-year stock market returns.	Principal component analysis and other multivariate methods	Tracks episodes of financial market turmoil in Canada; useful as an early warning tool for policymakers and market participants.
Subnational Gender Development Index	Johns et al. (2022)	Sub-national gender indices in 702 regions across 57 countries, 2010–2019.	Ecological analysis with fractional logistic regression	Gender equality is positively associated with childhood immunization coverage.
Human Development Index (HDI) and Index H	Lind (2019)	Global comparison, baseline year 2000 (income, health, education indicators).	Reformulated HDI as Index H with adjusted constants.	The reduced influence of income on human development allows for ordinal and cardinal comparisons across countries.
'Il Sole 24 Ore' Quality of Life Index	Lun et al. (2006)	Quality of life indicators covering Italian regions or cities over multiple years.	Sensitivity analyses on weighting, normalization, and aggregation	Methodological choices substantially affect the stability of rankings; provide guidance to improve robustness and transparency.
Rural Development Index	Michalek and Zarnekow (2012)	Regional data, including socio-economic, environmental, and infrastructure variables.	Multivariate statistical techniques (PCA/FA)	The report highlights regional disparities, key rural development drivers, and composite index effectiveness.
Multi-dimensional Poverty Index for Latin America (MPI-LA)	Santos and Villatoro (2020)	17 Latin American countries; 13 indicators across five dimensions.	Construction of the regional multidimensional poverty index	Improved poverty measurement in Latin America enhances policymaking and improves accuracy beyond previous measures.
Sub-national Gender Inequality Index (GII)	Schmid et al. (2023)	Great Britain, sub-national domains and indicators (dataset not detailed).	Principal component analysis	This index measures sub-national gender inequality, resolving measurement disagreements.
Financial Development Index (FDI)	Sviryzdenka (2016)	183 countries, 1980–2013, with nine variables linked to financial institutions and markets.	Principal component analysis	Substantial differences in financial development exist across advanced, emerging, and low-income countries.

Table A2
Data sources

Category	Indicator	Data source
Expenditure	Government expenditure (as a % of GDP)	WDI, FRED
	External debt stock (as a % of GDP)	WDI, FRED
Revenue	Revenue, excluding grants (as a % of GDP)	WDI, FRED
Others	Broad money supply (as a % of GDP)	WDI, FRED
	Exchange rate (US dollar exchange rate index)	WEO, FRED
	Gross domestic savings (as a % of GDP)	WDI, FRED
	Inflation, consumer prices (as annual %)	WDI, FRED
	Real GDP growth rate (as annual %)	WDI, FRED
	Real interest rate (as annual %)	WDI, FRED

Table A3
Variable definition

Code	Selected variables	Code	Selected variables
Rev	Revenue, excluding grants (% of GDP)	Inf	Inflation, consumer prices (annual %)
Exp	Expenses (% of GDP)	Int	Lending interest rate (%)
Eds	External debt stocks (% of GDP)	Exr	Exchange rate (USD exchange rate index)
GDP	GDP growth (annual %)	Msb	Broad money supply (% of GDP)
Sav	Gross domestic savings (% of GDP)		

Table A4.1
Identifying the storage type of variables

Variable name	Storage type
Rev	float
Exp	float
Eds	float
Exr	float
GDP	float
Sav	float
Inf	float
Int	float
Msb	float

Notes: observations: 29; variables: 9; size: 1044.

Table A4.2
Kaiser –Meyer –Olkin (KMO) measure of sampling adequacy for nine variables

Variable	KMO
Rev	0.545
Exp	0.701
Eds	0.698
Exr	0.303
GDP	0.720
Sav	0.366
Inf	0.502
Int	0.491
Msb	0.471
Overall	0.522

Table A4.3
Kaiser –Meyer –Olkin (KMO) measure of sampling adequacy for six variables

Variable	KMO
Exp	0.705
Eds	0.730
GDP	0.713
Inf	0.555
Int	0.765
Msb	0.643
Overall	0.695

Table A4.4
Horn's parallel analysis for principal components

Component or Factor	Adjusted eigenvalue	Unadjusted eigenvalue	Estimated bias
1	2.013	3.109	1.096
2	1.452	1.981	0.529

Notes: 210 iterations, using the mean estimate.

Criterion: Retain adjusted components > 1.

Table A4.5
Unrotated factor-loadings matrix and unique variances

Variable	Factor 1	Factor 2	Uniqueness
Exp	0.879	0.148	0.206
Eds	0.822	0.105	0.314
GDP	–0.803	0.334	0.244
Inf	–0.075	0.870	0.238
Int	–0.622	–0.429	0.428
Msb	0.665	–0.660	0.122

Table A4.6

Varimax rotated factor-loadings matrix

Factor analysis/correlation

Method: Principal component factors

Rotation: Orthogonal varimax (Kaiser on)

Factor	Variance	Difference	Proportion	Cumulative
Factor 1	2.737	0.384	0.391	0.391
Factor 2	2.353	.	0.336	0.727

Notes: LR test: Independent vs. saturated: $\chi^2(21) = 97.16$; Prob > $\chi^2 = 0.0000$; Number of observations: 29; Retained factors: 2; Number of params: 13.

Rotated factor-loadings (pattern matrix) and unique variances.

Variable	Factor 1	Factor 2	Uniqueness
Exp	0.804	-0.383	0.206
Eds	0.733	-0.386	0.314
GDP	-0.465	0.735	0.244
Inf	0.438	0.755	0.238
Int	-0.756	0.006	0.428
Msb	0.166	-0.922	0.122

Table A4.7Simplified rotated factor-loadings matrix

Variable	Expenditure	Others
Expenditure	0.804	
Inflation		
GDP growth rate		0.735
External debt	0.733	
Interest rate		
Broad money growth		

Table A4.8

Bartlett test of sphericity

Determinant of the correlation matrix	
Det	= 0.023
Bartlett test of sphericity	
Chi-square	= 93.399
Degrees of freedom	= 21
P-value	= 0.000
H0: variables are not intercorrelated	
Kaiser-Meyer-Olkin measure of sampling adequacy	
KMO	= 0.695

Table A4.9

Principal components /correlation

Component	Eigenvalue	Difference	Proportion	Cumulative
Comp 1	3.109	1.128	0.444	0.444
Comp 2	1.981	1.318	0.283	0.727
Comp 3	0.664	0.134	0.095	0.822
Comp 4	0.380	0.210	0.054	0.952
Comp 5	0.171	0.006	0.024	0.976
Comp 6	0.165	.	0.024	1.000

Notes: Rotation: (unrotated = principal); Number of observations = 29; Number of components = 6; Trace = 6; Rho = 1.0000.

Table A4.10
Generation of FSI indicator

gen ACS	$= (0.444/0.727) * pc1 + (0.283/0.727) * pc2$
gen ACSmin	$= -2.171$
gen ACSmax	$= 2.729$
gen FSI	$= (ACS - ACSmin)/(ACSmax - ACSmin)$

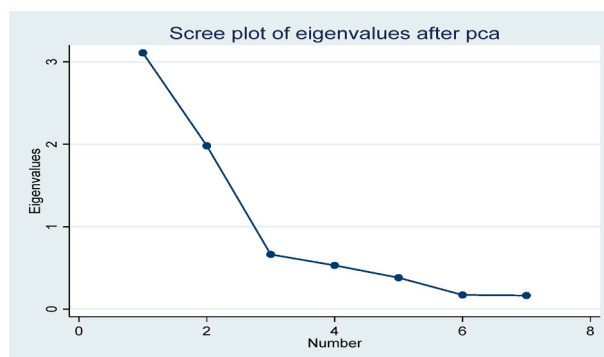


Fig. A1.1. Scree plot of eigenvalues after principal components analysis (PCA).

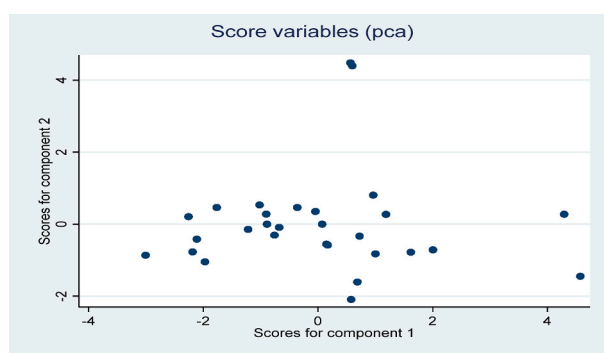


Fig. A1.2. Score variables (PCA).

Appendix B. Thirty-seven OECD countries' fiscal sustainability index (FSI) values: 1995–2023

Table B1
Australia FSI values: 1995–2023

Time	FSI	Time	FSI	Time	FSI	Time	FSI
1995	0.000	2003	0.314	2011	0.561	2019	0.728
1996	0.039	2004	0.280	2012	0.554	2020	1.000
1997	0.164	2005	0.319	2013	0.603	2021	0.936
1998	0.108	2006	0.417	2014	0.635	2022	0.790
1999	0.128	2007	0.379	2015	0.670	2023	0.624
2000	0.137	2008	0.347	2016	0.591		
2001	0.270	2009	0.692	2017	0.670		
2002	0.260	2010	0.552	2018	0.621		

Table B2
Austria FSI values: 1995–2023

Time	FSI	Time	FSI	Time	FSI	Time	FSI
1995	0.000	2003	0.478	2011	0.624	2019	0.813
1996	0.272	2004	0.510	2012	0.764	2020	0.875
1997	0.329	2005	0.440	2013	0.857	2021	0.985
1998	0.436	2006	0.431	2014	0.919	2022	0.975
1999	0.481	2007	0.407	2015	1.000	2023	0.856
2000	0.412	2008	0.451	2016	0.795		

(continued on next page)

Table B2 (continued)

Time	FSI	Time	FSI	Time	FSI	Time	FSI
2001	0.588	2009	0.472	2017	0.749		
2002	0.541	2010	0.598	2018	0.757		

Table B3

Belgium FSI values: 1995–2023

Time	FSI	Time	FSI	Time	FSI	Time	FSI
1995	1.000	2003	0.614	2011	0.585	2019	0.000
1996	0.997	2004	0.468	2012	0.656	2020	0.147
1997	0.935	2005	0.561	2013	0.655	2021	0.049
1998	0.951	2006	0.436	2014	0.589	2022	0.022
1999	0.865	2007	0.452	2015	0.296	2023	0.167
2000	0.776	2008	0.610	2016	0.149		
2001	0.895	2009	0.555	2017	0.114		
2002	0.668	2010	0.454	2018	0.128		

Table B4

Canada FSI values: 1995–2023

Time	FSI	Time	FSI	Time	FSI	Time	FSI
1995	0.828	2003	0.516	2011	0.205	2019	0.717
1996	0.816	2004	0.509	2012	0.360	2020	1.000
1997	0.807	2005	0.482	2013	0.464	2021	0.920
1998	0.793	2006	0.000	2014	0.586	2022	0.903
1999	0.790	2007	0.100	2015	0.622	2023	0.916
2000	0.772	2008	0.055	2016	0.655		
2001	0.667	2009	0.091	2017	0.667		
2002	0.561	2010	0.145	2018	0.671		

Table B5

Chile FSI values: 1995–2023

Time	FSI	Time	FSI	Time	FSI	Time	FSI
1995	0.000	2003	0.564	2011	0.410	2019	0.829
1996	0.012	2004	0.484	2012	0.423	2020	0.942
1997	0.091	2005	0.389	2013	0.492	2021	1.000
1998	0.083	2006	0.321	2014	0.586	2022	0.796
1999	0.258	2007	0.330	2015	0.704	2023	0.812
2000	0.284	2008	0.380	2016	0.695		
2001	0.446	2009	0.449	2017	0.679		
2002	0.642	2010	0.424	2018	0.676		

Table B6

Colombia FSI values: 1995–2023

Time	FSI	Time	FSI	Time	FSI	Time	FSI
1995	0.000	2003	0.527	2011	0.316	2019	0.768
1996	0.120	2004	0.429	2012	0.365	2020	1.000
1997	0.202	2005	0.336	2013	0.479	2021	0.999
1998	0.239	2006	0.320	2014	0.499	2022	0.972
1999	0.388	2007	0.335	2015	0.656	2023	0.922
2000	0.277	2008	0.283	2016	0.671		
2001	0.517	2009	0.320	2017	0.640		
2002	0.496	2010	0.331	2018	0.667		

Table B7

Costa Rica FSI values: 1995–2023

Time	FSI	Time	FSI	Time	FSI	Time	FSI
1995	0.000	2003	0.456	2011	0.597	2019	0.850
1996	0.137	2004	0.447	2012	0.613	2020	0.970
1997	0.128	2005	0.468	2013	0.659	2021	1.000
1998	0.182	2006	0.527	2014	0.695	2022	0.997
1999	0.241	2007	0.607	2015	0.775	2023	0.752
2000	0.274	2008	0.576	2016	0.813		
2001	0.407	2009	0.624	2017	0.752		
2002	0.436	2010	0.590	2018	0.841		

Table B8

Czech FSI values: 1995–2023

Time	FSI	Time	FSI	Time	FSI	Time	FSI
1995	0.047	2003	0.203	2011	0.419	2019	0.859
1996	0.032	2004	0.212	2012	0.517	2020	1.000
1997	0.000	2005	0.218	2013	0.671	2021	0.929
1998	0.006	2006	0.274	2014	0.667	2022	0.812
1999	0.115	2007	0.328	2015	0.729	2023	0.768
2000	0.227	2008	0.332	2016	0.780		
2001	0.231	2009	0.417	2017	0.984		
2002	0.151	2010	0.436	2018	0.888		

Table B9

Denmark FSI values: 1995–2023

Time	FSI	Time	FSI	Time	FSI	Time	FSI
1995	0.390	2003	0.275	2011	0.873	2019	0.701
1996	0.491	2004	0.402	2012	0.910	2020	0.872
1997	0.312	2005	0.499	2013	0.786	2021	0.664
1998	0.415	2006	0.523	2014	0.936	2022	0.286
1999	0.280	2007	0.882	2015	0.739	2023	0.738
2000	0.182	2008	0.798	2016	0.543		
2001	0.000	2009	1.000	2017	0.640		
2002	0.062	2010	0.948	2018	0.531		

Table B10

Estonia FSI values: 1995–2023

Time	FSI	Time	FSI	Time	FSI	Time	FSI
1995	0.000	2003	0.790	2011	0.921	2019	0.929
1996	0.192	2004	0.825	2012	0.949	2020	1.000
1997	0.394	2005	0.848	2013	0.924	2021	0.968
1998	0.502	2006	0.924	2014	0.986	2022	0.807
1999	0.555	2007	0.968	2015	0.975	2023	0.768
2000	0.646	2008	0.839	2016	0.949		
2001	0.653	2009	0.944	2017	0.963		
2002	0.721	2010	0.922	2018	0.931		

Table B11

Finland FSI values: 1995–2023

Time	FSI	Time	FSI	Time	FSI	Time	FSI
1995	0.896	2003	0.641	2011	0.620	2019	0.936
1996	0.876	2004	0.552	2012	0.676	2020	1.000
1997	0.856	2005	0.436	2013	0.633	2021	0.996
1998	0.835	2006	0.238	2014	0.641	2022	0.896
1999	0.744	2007	0.000	2015	0.633	2023	0.885
2000	0.677	2008	0.245	2016	0.641		
2001	0.657	2009	0.382	2017	0.754		
2002	0.631	2010	0.583	2018	0.753		

Table B12

France FSI values: 1995–2023

Time	FSI	Time	FSI	Time	FSI	Time	FSI
1995	0.000	2003	0.078	2011	0.355	2019	0.611
1996	0.133	2004	0.031	2012	0.532	2020	1.000
1997	0.257	2005	0.095	2013	0.758	2021	0.789
1998	0.222	2006	0.100	2014	0.789	2022	0.669
1999	0.292	2007	0.000	2015	0.817	2023	0.154
2000	0.030	2008	0.029	2016	0.794		
2001	0.108	2009	0.185	2017	0.878		
2002	0.050	2010	0.458	2018	0.767		

Table B13

Greece FSI values: 1995–2023

Time	FSI	Time	FSI	Time	FSI	Time	FSI
1995	0.000	2003	0.156	2011	0.712	2019	0.681
1996	0.090	2004	0.180	2012	0.828	2020	1.000
1997	0.064	2005	0.264	2013	0.815	2021	0.832
1998	0.108	2006	0.196	2014	0.663	2022	0.705
1999	0.139	2007	0.261	2015	0.690	2023	0.635
2000	0.139	2008	0.449	2016	0.664		
2001	0.171	2009	0.576	2017	0.651		
2002	0.162	2010	0.572	2018	0.655		

Table B14

Hungary FSI values: 1995–2023

Time	FSI	Time	FSI	Time	FSI	Time	FSI
1995	0.090	2003	0.038	2011	0.378	2019	0.682
1996	0.035	2004	0.029	2012	0.365	2020	0.893
1997	0.179	2005	0.086	2013	0.493	2021	1.000
1998	0.128	2006	0.236	2014	0.813	2022	0.931
1999	0.000	2007	0.280	2015	0.860	2023	0.939
2000	0.135	2008	0.244	2016	0.768		
2001	0.071	2009	0.284	2017	0.733		
2002	0.236	2010	0.344	2018	0.730		

Table B15

Iceland FSI values: 1995–2023

Time	FSI	Time	FSI	Time	FSI	Time	FSI
1995	0.000	2003	0.206	2011	0.509	2019	0.192
1996	0.061	2004	0.255	2012	0.468	2020	0.294
1997	0.000	2005	0.466	2013	0.375	2021	0.266
1998	0.058	2006	0.636	2014	0.360	2022	0.329
1999	0.147	2007	0.556	2015	0.256	2023	0.329
2000	0.169	2008	1.000	2016	0.486		
2001	0.180	2009	0.848	2017	0.221		
2002	0.185	2010	0.555	2018	0.214		

Table B16

Ireland FSI values: 1995–2023

Time	FSI	Time	FSI	Time	FSI	Time	FSI
1995	0.908	2003	0.483	2011	1.000	2019	0.139
1996	0.904	2004	0.383	2012	0.878	2020	0.063
1997	0.777	2005	0.585	2013	0.817	2021	0.000
1998	0.651	2006	0.608	2014	0.632	2022	0.030
1999	0.528	2007	0.657	2015	0.087	2023	0.074
2000	0.580	2008	0.845	2016	0.272		
2001	0.581	2009	0.986	2017	0.147		
2002	0.559	2010	0.953	2018	0.183		

Table B17

Israel FSI values: 1995–2023

Time	FSI	Time	FSI	Time	FSI	Time	FSI
1995	0.976	2003	0.315	2011	0.225	2019	0.040
1996	1.000	2004	0.224	2012	0.154	2020	0.019
1997	0.866	2005	0.247	2013	0.106	2021	0.086
1998	0.525	2006	0.303	2014	0.057	2022	0.152
1999	0.540	2007	0.202	2015	0.012	2023	0.198
2000	0.337	2008	0.270	2016	0.000		
2001	0.295	2009	0.212	2017	0.014		
2002	0.453	2010	0.212	2018	0.031		

Table B18

Italy FSI values: 1995–2023

Time	FSI	Time	FSI	Time	FSI	Time	FSI
1995	0.780	2003	0.563	2011	0.227	2019	0.578
1996	0.695	2004	0.549	2012	0.140	2020	0.207
1997	0.741	2005	0.467	2013	0.187	2021	1.000
1998	0.722	2006	0.499	2014	0.295	2022	0.714
1999	0.696	2007	0.485	2015	0.484	2023	0.691
2000	0.886	2008	0.282	2016	0.561		
2001	0.835	2009	0.000	2017	0.562		
2002	0.785	2010	0.269	2018	0.501		

Table B19

Japan FSI values: 1995–2023

Time	FSI	Time	FSI	Time	FSI	Time	FSI
1995	0.035	2003	0.065	2011	0.093	2019	0.569
1996	0.157	2004	0.099	2012	0.181	2020	0.672
1997	0.381	2005	0.137	2013	0.359	2021	0.683
1998	0.388	2006	0.234	2014	0.732	2022	0.964
1999	0.165	2007	0.193	2015	0.668	2023	1.000
2000	0.156	2008	0.304	2016	0.471		
2001	0.117	2009	0.020	2017	0.534		
2002	0.071	2010	0.000	2018	0.597		

Table B20

Korea, Rep. FSI values: 1995–2023

Time	FSI	Time	FSI	Time	FSI	Time	FSI
1995	0.000	2003	0.448	2011	0.567	2019	0.749
1996	0.084	2004	0.391	2012	0.729	2020	0.948
1997	0.151	2005	0.345	2013	0.682	2021	0.909
1998	0.720	2006	0.335	2014	0.642	2022	0.995
1999	0.158	2007	0.433	2015	0.673	2023	1.000
2000	0.232	2008	0.520	2016	0.693		
2001	0.447	2009	0.731	2017	0.685		
2002	0.385	2010	0.518	2018	0.672		

Table B21

Latvia FSI values: 1995–2023

Time	FSI	Time	FSI	Time	FSI	Time	FSI
1995	0.000	2003	0.594	2011	0.861	2019	0.970
1996	0.049	2004	0.669	2012	0.790	2020	0.876
1997	0.163	2005	0.766	2013	0.776	2021	1.000
1998	0.248	2006	0.813	2014	0.817	2022	0.831
1999	0.244	2007	0.939	2015	0.897	2023	0.847
2000	0.388	2008	0.811	2016	0.914		
2001	0.334	2009	0.895	2017	0.965		
2002	0.547	2010	0.907	2018	0.951		

Table B22

Lithuania FSI values: 1995–2023

Time	FSI	Time	FSI	Time	FSI	Time	FSI
1995	0.000	2003	0.592	2011	0.811	2019	0.969
1996	−0.014	2004	0.609	2012	0.845	2020	1.000
1997	0.218	2005	0.597	2013	0.829	2021	0.972
1998	0.353	2006	0.637	2014	0.839	2022	0.982
1999	0.273	2007	0.765	2015	0.870	2023	0.953
2000	0.249	2008	0.797	2016	0.900		
2001	0.475	2009	0.656	2017	0.999		
2002	0.452	2010	0.770	2018	0.989		

Table B23

Luxembourg FSI values: 1995–2023

Time	FSI	Time	FSI	Time	FSI	Time	FSI
1995	0.000	2003	0.308	2011	0.645	2019	0.873
1996	0.096	2004	0.359	2012	0.745	2020	0.912
1997	0.162	2005	0.511	2013	0.782	2021	0.920
1998	0.245	2006	0.562	2014	0.875	2022	0.783
1999	0.219	2007	0.594	2015	0.959	2023	0.685
2000	0.273	2008	0.540	2016	1.000		
2001	0.306	2009	0.441	2017	0.966		
2002	0.299	2010	0.528	2018	0.868		

Table B24

Mexico FSI values: 1995–2023

Time	FSI	Time	FSI	Time	FSI	Time	FSI
1995	0.000	2003	0.587	2011	0.681	2019	0.853
1996	0.032	2004	0.548	2012	0.685	2020	1.000
1997	0.163	2005	0.531	2013	0.756	2021	0.970
1998	0.156	2006	0.527	2014	0.804	2022	0.953
1999	0.172	2007	0.545	2015	0.872	2023	0.880
2000	0.210	2008	0.645	2016	0.952		
2001	0.479	2009	0.598	2017	0.893		
2002	0.507	2010	0.645	2018	0.870		

Table B25

Netherlands FSI values: 1995–2023

Time	FSI	Time	FSI	Time	FSI	Time	FSI
1995	0.220	2003	0.000	2011	0.366	2019	0.956
1996	0.263	2004	0.058	2012	0.565	2020	0.872
1997	0.197	2005	0.238	2013	0.637	2021	0.986
1998	0.103	2006	0.453	2014	0.602	2022	1.000
1999	0.268	2007	0.400	2015	0.689	2023	0.975
2000	0.320	2008	0.604	2016	0.837		
2001	0.317	2009	0.290	2017	0.903		
2002	0.232	2010	0.388	2018	0.912		

Table B26

New Zealand FSI values: 1995–2023

Time	FSI	Time	FSI	Time	FSI	Time	FSI
1995	0.000	2003	0.135	2011	0.969	2019	0.337
1996	0.160	2004	0.205	2012	0.806	2020	0.863
1997	0.274	2005	0.376	2013	0.515	2021	0.378
1998	0.579	2006	0.478	2014	0.417	2022	0.599
1999	0.186	2007	0.459	2015	0.368	2023	0.616
2000	0.340	2008	1.000	2016	0.354		
2001	0.223	2009	0.969	2017	0.271		
2002	0.140	2010	0.832	2018	0.298		

Table B27

Norway FSI values: 1995–2023

Time	FSI	Time	FSI	Time	FSI	Time	FSI
1995	0.145	2003	0.322	2011	0.427	2019	0.627
1996	0.069	2004	0.138	2012	0.332	2020	1.000
1997	0.000	2005	0.192	2013	0.453	2021	0.481
1998	0.209	2006	0.225	2014	0.490	2022	0.320
1999	0.184	2007	0.327	2015	0.530	2023	0.397
2000	0.051	2008	0.466	2016	0.651		
2001	0.183	2009	0.596	2017	0.555		
2002	0.321	2010	0.473	2018	0.573		

Table B28

Poland FSI values: 1995–2023

Time	FSI	Time	FSI	Time	FSI	Time	FSI
1995	0.244	2003	0.256	2011	0.750	2019	0.501
1996	0.000	2004	0.367	2012	0.843	2020	0.463
1997	0.095	2005	0.465	2013	0.886	2021	0.407
1998	0.114	2006	0.519	2014	0.953	2022	0.367
1999	0.134	2007	0.587	2015	0.938	2023	0.319
2000	0.114	2008	0.596	2016	1.000		
2001	0.134	2009	0.602	2017	0.686		
2002	0.232	2010	0.718	2018	0.563		

Table B29

Portugal FSI values: 1995–2023

Time	FSI	Time	FSI	Time	FSI	Time	FSI
1995	0.000	2003	0.405	2011	0.482	2019	0.722
1996	0.125	2004	0.475	2012	0.318	2020	0.968
1997	0.224	2005	0.376	2013	0.700	2021	1.000
1998	0.242	2006	0.417	2014	0.748	2022	0.924
1999	0.350	2007	0.463	2015	0.740	2023	
2000	0.312	2008	0.462	2016	0.691		
2001	0.328	2009	0.458	2017	0.695		
2002	0.402	2010	0.422	2018	0.729		

Table B30

Slovak Republic FSI values: 1995–2023

Time	FSI	Time	FSI	Time	FSI	Time	FSI
1995	0.000	2003	0.541	2011	0.751	2019	0.908
1996	0.104	2004	0.618	2012	0.712	2020	1.000
1997	0.061	2005	0.657	2013	0.830	2021	0.919
1998	0.126	2006	0.752	2014	0.864	2022	0.667
1999	0.222	2007	0.844	2015	0.886	2023	0.868
2000	0.187	2008	0.779	2016	0.902		
2001	0.295	2009	0.778	2017	0.927		
2002	0.471	2010	0.753	2018	0.909		

Table B31

Slovenia FSI values: 1995–2023

Time	FSI	Time	FSI	Time	FSI	Time	FSI
1995	0.000	2003	0.541	2011	0.751	2019	0.908
1996	0.104	2004	0.618	2012	0.712	2020	1.000
1997	0.061	2005	0.657	2013	0.830	2021	0.919
1998	0.126	2006	0.752	2014	0.864	2022	0.667
1999	0.222	2007	0.844	2015	0.886	2023	0.868
2000	0.187	2008	0.779	2016	0.902		
2001	0.295	2009	0.778	2017	0.927		
2002	0.471	2010	0.753	2018	0.909		

Table B32

Spain FSI values: 1995–2023

Time	FSI	Time	FSI	Time	FSI	Time	FSI
1995	0.000	2003	0.365	2011	0.388	2019	0.846
1996	0.043	2004	0.361	2012	0.435	2020	0.970
1997	0.089	2005	0.395	2013	0.630	2021	1.000
1998	0.175	2006	0.363	2014	0.703	2022	0.982
1999	0.293	2007	0.329	2015	0.748	2023	0.962
2000	0.307	2008	0.279	2016	0.757		
2001	0.322	2009	0.341	2017	0.768		
2002	0.346	2010	0.362	2018	0.816		

Table B33

Sweden FSI values: 1995–2023

Time	FSI	Time	FSI	Time	FSI	Time	FSI
1995	0.939	2003	0.381	2011	0.118	2019	0.072
1996	1.000	2004	0.361	2012	0.148	2020	0.062
1997	0.876	2005	0.328	2013	0.197	2021	0.002
1998	0.876	2006	0.179	2014	0.158	2022	0.000
1999	0.754	2007	0.130	2015	0.135	2023	0.002
2000	0.660	2008	0.128	2016	0.150		
2001	0.439	2009	0.229	2017	0.108		
2002	0.426	2010	0.181	2018	0.094		

Table B34

Switzerland FSI values: 1995–2023

Time	FSI	Time	FSI	Time	FSI	Time	FSI
1995	0.598	2003	0.934	2011	0.528	2019	0.081
1996	0.612	2004	0.957	2012	0.510	2020	0.278
1997	0.656	2005	0.987	2013	0.301	2021	0.177
1998	0.887	2006	0.602	2014	0.246	2022	0.171
1999	0.735	2007	0.580	2015	0.126	2023	0.170
2000	0.756	2008	0.573	2016	0.164		
2001	0.688	2009	0.555	2017	0.061		
2002	1.000	2010	0.542	2018	0.000		

Table B35

Turkey FSI values: 1995–2023

Time	FSI	Time	FSI	Time	FSI	Time	FSI
1995	0.000	2003	0.389	2011	0.503	2019	0.841
1996	0.120	2004	0.400	2012	0.533	2020	0.885
1997	0.120	2005	0.340	2013	0.598	2021	0.933
1998	0.140	2006	0.391	2014	0.638	2022	0.960
1999	0.236	2007	0.362	2015	0.633	2023	1.000
2000	0.207	2008	0.492	2016	0.650		
2001	0.412	2009	0.599	2017	0.736		
2002	0.414	2010	0.555	2018	0.846		

Table B36

United Kingdom FSI values: 1995–2023

Time	FSI	Time	FSI	Time	FSI	Time	FSI
1995	0.267	2003	0.261	2011	0.767	2019	0.669
1996	0.102	2004	0.322	2012	0.740	2020	0.942
1997	0.000	2005	0.398	2013	0.728	2021	0.915
1998	0.088	2006	0.418	2014	0.626	2022	0.916
1999	0.140	2007	0.476	2015	0.632	2023	0.919
2000	0.156	2008	0.692	2016	0.672		
2001	0.191	2009	0.736	2017	0.699		
2002	0.222	2010	1.000	2018	0.718		

Table B37

United States FSI values: 1995–2023

Time	FSI	Time	FSI	Time	FSI	Time	FSI
1995	0.000	2003	0.404	2011	0.777	2019	0.657
1996	0.026	2004	0.393	2012	0.728	2020	1.000
1997	0.024	2005	0.352	2013	0.674	2021	0.970
1998	0.004	2006	0.340	2014	0.667	2022	0.818
1999	0.027	2007	0.400	2015	0.641	2023	0.836
2000	0.028	2008	0.583	2016	0.665		
2001	0.207	2009	0.820	2017	0.641		
2002	0.334	2010	0.751	2018	0.638		

References

- Afonso, A., Coelho, J.C., 2024. Fiscal sustainability, fiscal reactions, pitfalls and determinants. *Appl. Econ.* 57, 560–571. <https://doi.org/10.1080/00036846.2024.2337808>.
- Afonso, A., Jalles, J.T., Venâncio, A., 2021. Taxation and public spending efficiency: an international comparison. *Comp. Econ. Stud.* 63, 356–383. <https://doi.org/10.1057/s41294-021-00147-2>.
- Aizenman, J., Marion, N., 2011. Using inflation to erode the US public debt. *J. Macroecon.* 33, 524–541. <https://doi.org/10.1016/j.jmacro.2011.09.001>.
- Albonico, A., Ascari, G., Gobbi, A., 2021. The public debt multiplier. *J. Econ. Dynam. Control* 132, 104204. <https://doi.org/10.1016/j.jedc.2021.104204>.
- Alkire, S., Kanagaratnam, U., Nogales, R., Suppa, N., 2022. Revising the global multidimensional poverty index: empirical insights and robustness. *Rev. Income Wealth* 68 (Suppl. 1), S347–S384. <https://doi.org/10.1111/roiw.12573>.
- Angrist, J.D., Pischke, J.-S., 2009. *Mostly Harmless Econometrics: an Empiricist's Companion*. Princeton University Press. <https://doi.org/10.1515/9781400829828>.
- Arellano, C., Ramanarayanan, A., 2012. Default and the maturity structure in sovereign bonds. *J. Polit. Econ.* 120, 187–232. <https://doi.org/10.1086/666589>.
- Asonuma, T., Trebesch, C., 2016. Sovereign debt restructurings: preemptive or post-default? *J. Eur. Econ. Assoc.* 14, 175–214. <https://doi.org/10.1111/jeea.12156>.
- Auerbach, A.J., Gorodnichenko, Y., McCrory, P.B., Murphy, D., 2022. Fiscal multipliers in the COVID19 recession. *J. Int. Money Finance* 126, 102669. <https://doi.org/10.1016/j.jimonfin.2022.102669>.
- Bai, J., Ng, S., 2002. Determining the number of factors in approximate factor models. *Econometrica* 70, 191–221. <https://doi.org/10.1111/1468-0262.00273>.
- Bańbura, M., Giannone, D., Reichlin, L., 2010. Nowcasting. In: Clements, M.P., Hendry, D.F. (Eds.), *The Oxford Handbook of Economic Forecasting*. Oxford University Press, pp. 439–470.
- Barro, R.J., 2023. r minus g . *Rev. Econ. Dynam.* 48, 1–17. <https://doi.org/10.1016/j.red.2022.10.001>.
- Biggeri, M., Ferrone, L., 2022. Child sustainable human development index (CSHDI): monitoring progress for the future generation. *Ecol. Econ.* 192, 107226. <https://doi.org/10.1016/j.ecolecon.2021.107266>.
- Bohn, H., 1998. The behavior of U.S. public debt and deficits. *Q. J. Econ.* 113, 949–963. <https://doi.org/10.1162/003355398555793>.
- Davig, T., Leeper, E.M., 2007. Generalizing the Taylor principle. *Am. Econ. Rev.* 97, 607–635. <https://doi.org/10.1257/aer.97.3.607>.
- Debrun, X., Hauner, D., Kumar, M.S., 2009. Independent fiscal agencies. *J. Econ. Surv.* 23, 44–81. <https://doi.org/10.1111/j.1467-6419.2008.00556.x>.
- Eberhardt, M., Presbitero, A.F., 2015. Public debt and growth: heterogeneity and non-linearity. *J. Int. Econ.* 97, 45–58. <https://doi.org/10.1016/j.jinteco.2015.04.005>.
- El-Shagi, M., von Schweinitz, G., 2021. Fiscal policy and fiscal fragility: empirical evidence from the OECD. *J. Int. Money Finance* 115, 102292. <https://doi.org/10.1016/j.jimonfin.2020.102292>.
- Forni, M., Hallin, M., Lippi, M., Reichlin, L., 2000. The generalized dynamic factor model: identification and estimation. *Rev. Econ. Stat.* 82, 540–554. <https://doi.org/10.1162/003465300559037>.
- Furceri, D., Loungani, P., Ostry, J.D., Pizzuto, P., 2022. Will COVID-19 have long-lasting effects on inequality? Evidence from past pandemics. *J. Econ. Inequal.* 20, 811–839. <https://doi.org/10.1007/s10888-022-09540-y>.
- Ghouchian, S., Yilmazkuday, H., 2020. Government consumption, government debt and economic growth. *Rev. Dev. Econ.* 24, 589–605. <https://doi.org/10.1111/rode.12661>.
- Gootjes, B., de Haan, J., Jong-a-Pin, R., 2021. Do fiscal rules constrain political budget cycles? Public Choice 188, 1–30. <https://doi.org/10.1007/s11127-020-00797-3>.
- Hair, J.F., Black, W.C., Babin, B.J., Anderson, R.E., 2010. *Multivariate Data Analysis*, seventh ed. Pearson, New York.
- Hatchondo, J.C., Martinez, L., Roch, F., 2022. Fiscal rules and the sovereign default premium. *Am. Econ. J. Macroecon.* 14, 244–273. <https://doi.org/10.1257/mac.20170479>.
- Heimberger, P., 2023. Public debt and $r-g$ risks in advanced economies: eurozone versus stand-alone. *J. Int. Money Finance* 136, 102877. <https://doi.org/10.1016/j.jimonfin.2023.102877>.
- Illing, M., Liu, Y., 2006. Measuring financial stress in a developed country: an application to Canada. *J. Financ. Stab.* 2, 243–265. <https://doi.org/10.1016/j.jfs.2006.06.002>.
- Ilzetzki, E., Mendoza, E.G., Végh, C.A., 2013. How big (small?) are fiscal multipliers? *J. Monet. Econ.* 60, 239–254. <https://doi.org/10.1016/j.jmoneco.2012.10.011>.
- International Monetary Fund, 2021. Strengthening the Credibility of Public Finances. International Monetary Fund, USA. <https://doi.org/10.5089/9781513584104.089>.
- Iorio, F.D., Fachin, S., 2022. Fiscal reaction functions for the advanced economies revisited. *Empir. Econ.* 63, 1021–1044. <https://doi.org/10.1007/s00181-021-02119-y>.
- Jalles, J.T., Battersby, B., Lee, R., 2024. Effectiveness of fiscal announcements: early evidence from COVID-19. *Open Econ. Rev.* 35, 623–658. <https://doi.org/10.1007/s11079-023-09735-4>.
- Jeanne, O., Rancière, R., 2011. The optimal level of international reserves for emerging market countries: a new formula and some applications. *Econ. J.* 121, 905–930. <https://doi.org/10.1111/j.1468-0297.2011.02435.x>.
- Johns, N.E., Kirkby, K., Goodman, T.S., Heidari, S., Munro, J., Shendale, S., Hosseinpour, A.R., 2022. Subnational gender inequality and childhood immunization: an ecological analysis of the subnational gender development index and DTP coverage outcomes across 57 countries. *Vaccines* 10, 1951. <https://doi.org/10.3390/vaccines10111951>.
- Kraay, A., Nehru, V., 2006. When is external debt sustainable? *World Bank Econ. Rev.* 20, 341–365. <https://doi.org/10.1093/wber/lhl006>.
- Lane, P.R., 2012. The European sovereign debt crisis. *J. Econ. Perspect.* 26, 49–68. <https://doi.org/10.1257/jep.26.3.49>.
- Lind, N.C., 1993. A compound index of national development. *Soc. Indic. Res.* 28, 267–284. <https://doi.org/10.1007/BF01079021>.
- Lind, N.C., 2019. A development of the human development index. *Soc. Indic. Res.* 146, 409–423. <https://doi.org/10.1007/s11205-019-02133-9>.
- Linhares, F., Nojosa, G., Bezerra, R., 2021. Changes in the revenue–expenditure nexus: confronting evidence with fiscal policy in Brazil. *Appl. Econ.* 53, 5051–5067. <https://doi.org/10.1080/00036846.2021.1915463>.
- Little, R.J.A., Rubin, D.B., 2019. *Statistical Analysis with Missing Data*, third ed. John Wiley & Sons, Hoboken, NJ. <https://doi.org/10.1002/9781119482260>. Wiley Series in Probability and Statistics.
- Lun, G., Holzer, D., Tappeiner, G., Tappeiner, U., 2006. The stability of rankings derived from composite indicators: analysis of the “Il Sole 24 Ore” quality of life report. *Soc. Indic. Res.* 77, 307–331. <https://doi.org/10.1007/s11205-005-4505-z>.
- Mamatkakis, E., 2024. Dynamic panel analysis of the EU's fiscal reaction function with threshold effects. *Kyklos* 77, 520–545. <https://doi.org/10.1111/kykl.12377>.
- Mazziotta, M., Pareto, A., 2013. Methods for constructing composite indices: one for all or all for one? *Demografia e Statistica*. 67, 67–80.
- McHugh, M.J., Petrova, I., Baldacci, M.E., 2011. Measuring Fiscal Vulnerability and Fiscal Stress: a Proposed Set of Indicators. International Monetary Fund. IMF Working Paper No. 2011/094.
- Michalek, J., Zarnekow, N., 2012. Application of the rural development index to analysis of rural regions in Poland and Slovakia. *Soc. Indic. Res.* 105, 1–37. <https://doi.org/10.1007/s11205-010-9765-6>.
- Neumeyer, P.A., Perri, F., 2005. Business cycles in emerging economies: the role of interest rates. *J. Monet. Econ.* 52, 345–380. <https://doi.org/10.1016/j.jmoneco.2004.04.011>.
- Nomo Beyala, B., 2025. (Advance online publication). Do fiscal rules enhance states' fiscal capacity? *Kyklos* 78, 1539–1566. <https://doi.org/10.1111/kykl.70005>.
- Panizza, U., Presbitero, A.F., 2014. Public debt and economic growth: is there a causal effect? *J. Macroecon.* 41, 21–41. <https://doi.org/10.1016/j.jmacro.2014.03.009>.
- Papadia, A., 2024. Fiscal policy under constraints: fiscal capacity and austerity during the Great Depression. *Econ. Hist. Rev.* 77, 90–118. <https://doi.org/10.1111/ehr.13253>.
- Reinhart, C.M., Rogoff, K.S., 2010. Growth in a time of debt. *Am. Econ. Rev.* 100, 573–578. <https://doi.org/10.1257/aer.100.2.573>.
- Reserve Bank of Australia, 2010. Statement on monetary policy. <https://www.rba.gov.au/publications/smp/2010/nov/>. November 2010.
- Reserve Bank of Australia, 2021. Statement on monetary policy. <https://www.rba.gov.au/publications/smp/2021/aug/>. August 2021.
- Saisana, M., Tarantola, S., 2002. State-of-the-art report on current methodologies and practices for composite indicator development. EUR 20408 EN. European Commission, Joint Research Centre, Institute for the Protection and the Security of the Citizen, Technological and Economic Risk Management Unit, Ispra, Italy.

- Santos, M.E., Villatoro, P., 2020. The importance of reliability in the Multidimensional Poverty Index for Latin America (MPI-LA). *J. Dev. Stud.* 56, 1784–1789. <https://doi.org/10.1080/00220388.2019.1663177>.
- Schmid, C.B., Cook, R., Jones, L., 2023. Measuring gender inequality in Great Britain: proposal for a subnational gender inequality index. *Soc. Polit.* 30, 580–606. <https://doi.org/10.1093/sp/jxac005>.
- Stock, J.H., Watson, M.W., 2002. Forecasting using principal components from a large number of predictors. *J. Am. Stat. Assoc.* 97, 1167–1179. <https://doi.org/10.1198/016214502388618960>.
- Svirydzhenka, K., 2016. Introducing a New Broad-based Index of Financial Development. International Monetary Fund, Washington, DC. <https://doi.org/10.5089/9781513583709.001>. IMF Working Paper No. 16/5.
- Tkačevs, O., Vilerts, K., 2019. The impact of government borrowing costs on fiscal discipline. *Kyklos* 72, 446–471. <https://doi.org/10.1111/kykl.12207>.
- Wilcox, R.R., 2012. *Introduction to Robust Estimation and Hypothesis Testing*, third ed. Academic Press, New York.
- Yilmazkuday, H., 2021a. Accounting for trade deficits. *J. Int. Money Finance* 115, 102385. <https://doi.org/10.1016/j.jimonfin.2021.102385>.
- Yilmazkuday, H., 2021b. Welfare costs of COVID-19: evidence from US counties. *J. Reg. Sci.* 61, 826–848. <https://doi.org/10.1111/jors.12540>.
- Yilmazkuday, H., 2022. Coronavirus disease 2019 and the global economy. *Transp. Policy* 120, 40–46. <https://doi.org/10.1016/j.tranpol.2022.03.003>.
- Yilmazkuday, H., 2024. Drivers of international fiscal spillovers. *Econ. Polit.* 36, 1491–1536. <https://doi.org/10.1111/ecpo.12300>.