Araştırma Makalesi / Research Article

Measuring Multidimensional Growth in Turkey: Sustainable and Inclusive Economic Growth (SIEG) Index

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Abstract

This study develops a multidimensional index that includes sustainability and inclusiveness as well as quantitative measures to assess Türkiye's growth performance. The Sustainable and Inclusive Economic Growth (SIEG) Index brings together economic, social and sustainability indicators in a holistic framework. The index is built on ten variables, including education level, income inequality, labour force participation of women and youth, R&D expenditures, labour productivity and the share of renewable energy. The SIEG index created by using Principal Component Analysis was constructed with data covering the years 1992-2023. The results show that Türkiye's long-term growth has faced significant disruptions in terms of sustainability and inclusiveness, with a more pronounced structural transformation emerging after 2010. The study suggests that growth policies should emphasise qualitative and inclusive approaches rather than focusing solely on GDP. The SIEG Index provides a powerful decision support tool for policymakers.

Keywords*: Sustainable Economic Growth, Inclusive Economic Growth, Principal Component Analysis*

JEL Codes: *044, C38, C43*

Türkiye'de Çok Boyutlu Büyümenin Ölçülmesi: Sürdürülebilir ve Kapsayıcı Ekonomik Büyüme (SKEB) Endeksi

Öz

Bu çalışma, Türkiye'nin büyüme performansını değerlendirmek için nicel ölçütlerin yanı sıra sürdürülebilirlik ve kapsayıcılığı da içeren çok boyutlu bir endeks geliştirmektedir. Sürdürülebilir ve Kapsayıcı Ekonomik Büyüme (SKEB) Endeksi ekonomik, sosyal ve sürdürülebilirlik göstergelerini bütüncül bir çerçevede bir araya getirmektedir. Endeks, eğitim seviyesi, gelir eşitsizliği, kadın ve gençlerin işgücüne katılımı, Ar-Ge harcamaları, işgücü verimliliği ve yenilenebilir enerjinin payı dahil olmak üzere on değişken üzerine inşa edilmiştir. Temel Bileşenler Analizi kullanılarak yaratılan SKEB endeksi 1992-2023 yıllarını kapsayan verilerle oluşturulmuştur. Sonuçlar, Türkiye'nin uzun vadeli büyümesinin sürdürülebilirlik ve kapsayıcılık açısından kayda değer kesintilerle karşı karşıya kaldığını ve 2010 yılından sonra daha belirgin bir yapısal dönüşümün ortaya çıktığını göstermektedir. Çalışma, büyüme politikalarının yalnızca GSYH'ye odaklanmak yerine niteliksel ve kapsayıcı yaklaşımları vurgulaması gerektiğini önermektedir. SKEB Endeksi, politika yapıcılar için güçlü bir karar destek aracı sunmaktadır.

Anahtar Sözcükler: *Sürdürülebilir Ekonomik Büyüme, Kapsayıcı Ekonomik Büyüme, Temel Bileşenler Analizi*

JEL Kodları: *044, C38, C43*

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1. Introduction

The Brundtland Report, published in 1987 under the title *Our Common Future*, conceptualized sustainable development as a model that fulfills current needs without compromising the ability of future generations to meet theirs. It introduced this model as a comprehensive development paradigm that encompasses environmental, social, and economic pillars (World Commission on Environment and Development, 1987). This framework emphasised that economic growth should not be limited to quantitative increase but should be integrated with social inclusion and environmental sustainability. The Growth Report (Commission on Growth and Development, 2008) and its sequel Inclusive Green Growth: The Pathway to Sustainable Development, respectively published by the World Bank (2012), argued that sustainable growth can only be possible in the long run through strategies that include all segments of society and take into account environmental pressures.

Similarly, the Sustainable Development Goals (SDGs) adopted by the United Nations in 2015 emphasise that economic growth should create "decent work" opportunities, reduce inequalities and be environmentally sound (United Nation Development Programme (UNDP), 2025). Currently, however, growth performance is often assessed only in terms of single indicators such as GDP growth or per capita income. This neglects important qualities such as whether growth is inclusive or whether it contributes to environmental sustainability. Therefore, the fact that the qualitative aspects of economic growth are not analysed in a sufficiently holistic and multidimensional manner creates an important gap in both academic evaluations and policy design.

In this study, the long-term growth performance of the Turkish economy is analysed through a multidimensional index on the axis of sustainability and inclusiveness. Based on the methodology developed by Hamilton and Xi (2022; 2024), the Sustainable and Inclusive Economic Growth (SIEG) Index provides a three-dimensional (economic, social, environmental) framework that assesses the structural nature of economic growth. The index holistically reflects the course of human capital, income inequality, gender and youth inclusion, technological capacity, environmental impact and financial stability over time in Türkiye's growth process. In this respect, the study goes beyond traditional growth indicators and aims to provide a strong analytical basis for policymakers on the quality of growth. This study is one of the first applications such as the Inclusive Green Growth Index (Asian Development Bank, 2015), The Inclusive Development Index (World Economic Forum, 2018), The Green Growth Index (Global Green Growth Institute, 2022) to systematically perform a multidimensional and structural-based growth analysis for the Turkish economy. While economic growth is generally evaluated with single indicators (GDP growth, per capita income, etc.) in the literature, in this study, sustainability and inclusiveness factors are directly considered as components of the index. In this respect, the study approaches Türkiye's growth process not only through

the question of "how much it has grown" but also "how it has grown" and bases this assessment on the methodological framework proposed by Hamilton and Xi (2022; 2024). Moreover, the fact that the index is constructed as a time series for the period 1992-2023 provides the opportunity to periodically monitor Türkiye's structural transformation and make comparative analyses. Through these attributes, the study aspires to offer valuable insights for both academic discourse and the formulation of effective policy.

In this study, the existing literature was first comprehensively reviewed in order to establish the theoretical background of the research. Subsequently, under the heading **Methodology, Variables and Data**, the methodological framework employed in the study was elaborated and the variables used in the analysis were introduced. In the following section, **Findings, Analyses and Evaluation**, the empirical results were systematically presented and subjected to critical evaluation. Finally, in the **Conclusion** section, the main findings were discussed, and policy recommendations were developed based on these results.

2. Literature

In the literature, the concept of sustainable and inclusive economic growth has similarly been extended to include the social and environmental dimensions of economic growth. Jackson (2009), in his book Prosperity Without Growth, discusses the limits of economic growth and the necessity of sustainable development, arguing that it is insufficient to focus only on the quantitative increase in economic growth. This study emphasises that economic growth should be redefined to include environmental and social dimensions. The World Bank (2012) published "Inclusive Green Growth: The Pathway to Sustainable Development" published by the World Bank (2012) argued that inclusive and environmentally friendly growth strategies should be adopted to achieve sustainable development goals. This report states that economic growth should be assessed not only by GDP growth, but also by environmental and social indicators. A report published by McKinsey and Company (2021) emphasised that sustainable and inclusive growth requires economic growth to be compatible with the principles of environmental sustainability and social inclusion. This report states that economic growth should be assessed not only by GDP growth, but also by social and environmental indicators.

In recent years, the concept of sustainable and inclusive economic growth has been further deepened by studies examining the effects of factors such as economic complexity, green finance and social inclusion. The study by Stojkoski et al. (2022) proposes a multidimensional approach of economic complexity to understand sustainable and inclusive economic growth. While traditional measures of economic complexity are usually based on trade data, this study develops a more comprehensive model by combining trade data with patent applications and research publications. The study

analyses trade, patent and research data of various countries, making cross-country comparisons at the global level. In this way, the relationships between different countries' levels of economic complexity and their sustainable and inclusive growth performance are analysed. The combination of complexity measures based on trade, patents and research publications provides higher accuracy in explaining indicators such as economic growth and income inequality. Countries with high scores in these three areas generally have lower emissions intensity and perform better in terms of sustainable and inclusive growth. The results highlight the interconnected roles of trade, technological advancement, and research distribution in shaping patterns of sustainable and inclusive economic growth. Additionally, the influence of the digital economy on these growth dimensions has been the subject of empirical inquiry. For instance, evidence from China indicates that the expansion of the digital economy plays a significant role in fostering both sustainability and inclusivity (Xin et al., 2023). A panel data analysis conducted across 270 Chinese cities from 2011 to 2021 examined the impact of digital financial inclusion on these growth outcomes. According to this study, digital inclusive finance significantly and positively affects sustainable and inclusive growth. Digital finance supports growth by promoting green technology innovation. Entrepreneurial activities strengthen economic inclusion by increasing the level of entrepreneurship. Industrial structure development improves environmental sustainability by promoting the development of the industrial structure. The impact of digital inclusive finance varies across regions. While its impact is more pronounced especially in the eastern, central and western regions, no statistically significant effect is observed in the northeast region. The study suggests that policymakers should strengthen digital infrastructure, increase financial access and support environmental regulations to enhance the potential of digital inclusive finance to promote sustainable and inclusive growth. Using panel data analysis for the period 2011-21 across 31 provinces in China, the positive impact of green finance on inclusive economic growth is identified. While this effect is more pronounced in the east, central and west, no significant effect was observed in the northeast region (SCIRP, 2020). Rusu and Oprean-Stan (2025) examined the effects of digitalisation and sustainability on inclusive growth in the period 2000-2021 for 32 European countries and found that economic growth, industrial development, electricity consumption, digitalisation and governance quality have positive effects on inclusive growth, while CO_2 emissions and inflation have negative effects.

Although empirical studies on sustainable and inclusive economic growth in the Turkish context are limited, existing research has developed different approaches that take into account the social, environmental and structural dimensions of growth. In a study conducted by the OECD, the contribution of structural transformation in the business sector to inclusive growth in Turkey was analysed, with particular emphasis on the share of low-productivity enterprises and the importance of the formal-informal sector divide (Gönenç, Röhn, & Koen, 2014). More recently, Akagündüz (2022) presented an empirical analysis of sustainable development in Turkey from a green economy

perspective and drew attention to the relationship between environmental indicators and growth. Naimoğlu (2024), on the other hand, evaluated the effects of labour, trade, financial and monetary freedoms on green growth in Turkey using ARDL approach in his study covering the period 1995-2022. Taken together, these studies show that Turkey's sustainable and inclusive growth performance has improved in terms of both environmental sustainability and inclusiveness, but problems such as labour market inequalities, informality and regional disparities persist.

Various indices that address sustainable and inclusive economic growth together have also been developed. Global Green Growth Institute (2022) has created The Green Growth Index values with 4 main dimensions such as efficient and sustainable resource utilisation, conservation of natural capital, green economic opportunities and social inclusion. As of 2022, Türkiye is close to the world average with a score band of 50-55 points and has made progress in the areas of energy efficiency and agricultural and water efficiency, while carbon intensity and air pollution and regional inequalities are identified as weaknesses. The World Economic Forum (2018) created the Inclusive Development Index with three main dimensions: growth and development, inclusion and intergenerational equity and sustainability. Türkiye is ranked in the 0.50-0.55 band, indicating a moderate performance, while Türkiye is found to be advanced in the areas of public debt and education infrastructure, but weak in the areas of income inequality, youth unemployment, median income and carbon intensity. The Asian Development Bank (2015) has created the Inclusive Green Growth Index with 3 main dimensions such as environmental sustainability, social equity and economic growth. While improvements in environmental sustainability alone are not sufficient, green growth in developing countries has progressed independently of social equality, and green transformation has been more permanent in countries that prioritise social inclusion. Türkiye, on the other hand, has been in the position of countries seeking balance; carbon intensity, female labour force participation rate, water and soil management, income inequality and regional disparities have stood out as weaknesses, while it has made progress in renewable energy, hydroelectricity and solar investments. United Nations Environment Programme (2018) found Inclusive Wealth Index values by considering 3 main types of capital such as productive capital (infrastructure, machinery, etc.), human capital (education, health), natural capital (forests, water resources, etc.). While Türkiye shows a positive trend in the productive capital dimension, it has improved in the human capital dimension, but has not reached its full potential due to regional differences. Factors such as deforestation, over-exploitation of water resources and loss of biodiversity have led to a decline in natural capital, while rapid urbanisation and industrialisation have put pressure on environmental resources, threatening the sustainability of natural capital. The Social Progress Imperative (2021) has created the Social Progress Index by addressing the main dimensions of basic human needs such as nutrition and basic health, housing, security, the foundations of well-being such as access to information and communication, environmental quality, and opportunities such as personal rights, personal freedoms,

access to advanced education. Türkiye received an average score of 66.59 out of 100. It performed strongly in the area of basic human needs, moderately in the area of the basis of well-being, and weakly in the areas of opportunities, environmental quality, personal rights and freedoms, and inclusion. In particular, it needs to reduce air and water pollution, promote freedom of expression and social inclusion, and develop programmes to increase labour force participation of women and disadvantaged groups. The creation of an economic growth index that addresses Türkiye's social and economic structure in a holistic manner from the perspective of sustainability and inclusiveness will contribute to the analytical evaluation of the country's economic growth. With this motivation, this study aims to develop a sustainable and inclusive growth index by taking into account Türkiye's trends.

3. Methodology, Variables and Datas

3.1. Methodology

3.1.1. Principal Component Analysis

Principal Component Analysis (PCA) is a method for constructing the correlation structure between observed variables with fewer variables (factors) (Tabachnick and Fidell, 2007). In other words, factor analysis, which is a multivariate statistical technique, aims to explain the variables that are related to each other through a smaller number of unobservable factors (Hair et al., 2010). The data matrix can be expressed as n observations and p variables (Jolliffe, 2002:1-5).

$$\begin{pmatrix} x_{11} & \cdots & x_{1p} \\ \vdots & \ddots & \vdots \\ x_{n1} & \cdots & x_{np} \end{pmatrix} \tag{1}$$

Standardization of variables (z-score) should be performed before PCA. If the variables have different scales (integer, percentage, dummy). With z-score normalization, all variables can be brought to the same scale. In this way, by bringing all variables to the same scale range, weight imbalance is prevented in the analysis, and factor loadings are more reliable. If the mean of the jth variable is the standard deviation of the jth variable, the standardization equation is shown as follows (Hair et al, 2010:104-106).

$$z_{ij} = \frac{x_{ij} - \bar{x}_j}{s_j} \tag{2}$$

PCA can be applied to the correlation (R) or covariance (S) matrix. The correlation matrix is preferred if the variables contain different units, and the covariance matrix is preferred if they contain the same units (Abdi and Williams, 2010; Jolliffe 2002: 19-20).

$$S = \frac{1}{n-1} Z^T Z \quad \text{or } R = cor(X) \tag{3}$$

PCA also solves the eigenvalue problem. If λ is the eigenvalue and v is the

eigenvector, it is expressed as follows (Abdi and Williams, 2010: 437; Hair et al, 2010:106).

$$Sv=\lambda v \quad (4)$$

Accordingly, if v is the eigenvector and z is the standardized variable, the first principal component is obtained as follows (Jolliffe, 2002: 10-12).

$$PC_1 = v_{11}z_1 + v_{12}z_2 + \cdots + v_{1p}z_p \quad (5)$$

The explained and cumulative variances in the PCA method are expressed as follows (Jolliffe, 2002:14; Hair et al., 2010:107)

$$\text{Explained Variance of } PCA_k = \frac{\lambda_k}{\sum_{j=1}^{p}\lambda_j} \quad (6)$$

$$\text{Cumulative Variance } = \sum_{j=1}^{k}\frac{\lambda_k}{\sum_{j=1}^{p}\lambda_j} \quad (7)$$

PCA is considered a powerful method for index construction. Composite indices can be obtained with PCA (Fabrigar et al., 1999). The factor loadings (v) obtained indicate the contribution of the variables to the index; a unidimensional growth index can be constructed using these weights (Stock and Watson, 2002). PCA has been proposed to construct an index by finding factor loadings through factor analysis (Laeven and Valencia, 2013). The index value is calculated with the following formulation (Abdi and Williams, 2010; Stock and Watson, 2002).

$$Index_i = \sum_{j=1}^{p} v_j . z_{ij} \quad (8)$$

Stock and Watson (2002) find that the first principal component of 85 different measures of real economic activity provides the good inflation forecast. This approach has evolved into the Chicago Fed National Activity Index.

In the literature, there are various arguments in favor of applying an appropriate factor analysis to time series after checking whether they are stationary or not. It has been stated that the traditional PCA applied without difference in non-stationary time series may be misleading and PCA may give spurious results if there are common trends in the series (Stock and Watson, 2002). Bai (2004) suggested caution by using a vague statement that factor loadings obtained by PCA in non-stationary series can represent long-run relationships. Boivin and Ng (2005) stated that traditional PCA can identify common trends, especially in non-stationary series including macroeconomic indicators, but may be insufficient for long-run analysis. Forni et al. (2000) reported that traditional PCA can reveal long-run common factors but may be insufficient for short-run dynamics. That is, non-stationary series generally share trends over time, which may create spurious correlations instead of a real relationship, and the PCA method may capture these spurious correlations and calculate incorrect factor loadings. Indexes calculated with

incorrect factor loadings may lead to instability in long-term analyses. Traditional PCA methods use the interquartile range to identify outliers and take observations that exceed the threshold as missing.

3.1.2. Principal Component Analysis (PCA) for Stationary and Non Stationary

Hamilton and Xi (2022) and Hamilton and Xi (2024) proposed the Principal Component for Non-Stationary Series method for non-stationary series, using the data as is and not taking any special treatment for outliers. The proposed procedure starts with the estimation of the subsequent OLS regression for each variable.

$$y_{it} = \alpha_{i0} + \alpha_{i1}.\, y_{i,t-h} + \alpha_{i2}.\, y_{it,t-h-1} + \cdots + \alpha_{ip}.\, y_{i,t-h-p+1} + c_{it} \quad (9)$$

starts with the estimation of the regression. i = 1, . . . , N represents the index of the variable, p is the number of lags used for the forecast and h is the forecasting horizon. Here (h=24) and (p=12) for monthly, (h=8) and (p=4) for quartely data and also (h=2) and (p=1) for annual. Hamilton and Xi (2022) and Hamilton and Xi (2024) postulate that true cyclical components, ($c_t = (c_{1t}, c_{2t}, \dots, c_{Nt})^t op$), are characterized by a factor structure (r<<N) of the form:

$$c_t = \Lambda\, .\, F_t + e_t \quad (10)$$

We note that c_t, Λ, e_t, and e_t equals Nx1, Nxr, rx1, and Nx1 respectively. Hamilton and Xi (2022) and Hamilton and Xi (2024) also show that even if the cyclical components are not observed and are therefore estimated ($\hat{c}_{it} = c_{it} + v_{it}$), true factors can still be consistently estimated under certain conditions.

PCA for Non-Stationary provides a more reliable method for long-run analysis by taking into account the common trends of stationary series as well as non-stationary common trends and better determining the long-run factor loadings. If short-run analyses are preferred instead of long-run analyses, traditional PCA methods can be used by taking the difference of non-stationary series, but it should be taken into account that long-run trends will be lost. This method aims to reveal the common cyclical factors in all series without the need to know which series are stationary or non-stationary.

Since the Principal Component Analysis (PCA) for the Non-stationary Method used in this study incorporates normalization into its procedure, no internal normalization is used.

3.2. Variables and Datas

Table 1 outlines the primary components of the sustainable and inclusive economic growth index tailored for Türkiye, along with the specific sub-indicators associated with each of these key dimensions: economic growth, inclusion, and sustainability. GDP growth and GDP per capita are known as standard growth indicators. GDP growth, the annual percentage change in GDP, measures the cyclical growth of the economy's total

productive capacity (Mankiw, 2016; Barro and Sala-i Martin, 2004). GDP per capita indicates the average income level. It uses GDP per capita as the main growth indicator in cross-country comparisons (World Bank, 2020).

Table 1

Indicators for the Sustainable and Inclusive Economic Growth (SIEG) Index

Indicators	Variables	Codes	Scale	Direction in the index	Source
	Economic Growth indicators				
Economic growth rate	GDP growth	$growth_t$	%	↑	WB
Welfare level	GDP per capita	$gdppp_t$	Number	↑	WB
	Sustainability indicators				
Financial sustainability	Current account balance/GDP(%)	cab/gdp_t	%	↑	IMF
Sustainable human capital	Mean years of schooling	$myos_t$	%	↑	UNDP
Sustainable technological capital	R&D expenditure/GDP	rde_t	%	↑	WB, OECD
Sustainability of energy supply	Share of primary energy consumption from renewables	$specrs_t$	%	↑	Energy Institute*
Environmental sustainability of growth	Carbon emission intensity	$-cei_t$	%	↓	Sources**
Qualified sustainable growth	Labour productivity (output per worker (GDP constant 2015 US $))	lp_t	value	↑	ILO
	Inclusion indicators				
Income inequality	Gini coefficient	$-gc_t$	value	↓	Sources***
Gender equality	Female labour force participation rate (15+)	$flfp_t$	%	↑	ILO
Youth inclusion	Youth labour force participation rate (15-24)	yer_t	%	↑	ILO

Note: Data for 1990-2023 are considered.

*Energy Institute - Statistical Review of World Energy (2024) – with major processing by Our World in Data

**Global Carbon Budget (2024), U.S. Energy Information Administration (2023), Energy Institute - Statistical Review of World Energy (2024) – with major processing by Our World in Data

***For the pre-2017 period, the gini_w dataset, which is most suitable for the methodology of the World Bank, was preferred. https://datacatalog.worldbank.org/search/dataset/0041738

After 2017, the dataset in the relevant link was used.

https://data.worldbank.org/indicator/SI.POV.GINI?locations=TR

Sustainability indicators are selected as current account balance/GDP(%), mean years of schooling, R&D expenditure/GDP, share of primary energy consumption from renewables, carbon emission intensity, labour productivity (output per worker (GDP constant 2015 US $)).

Current account balance/GDP(%) refers to the current account balance. In case of a current account deficit, the financial sustainability of the economy decreases. A current account surplus indicates that the economy provides net financing to the outside world and is financially sustainable. Persistent current account deficits, especially when financed by debt, can signal external vulnerabilities and raise concerns about intertemporal budget constraints (Cubeddu et al. 2013). Current account deficits should remain within limits that can be paid with future revenues. Otherwise, unsustainable external debt is created (Obstfeld and Rogoff, 1995). Consequently, both the magnitude and durability of a country's current account deficit in proportion to its GDP serve as critical indicators of its fiscal sustainability (World Bank, 2009).

Mean years of schooling, as a representative measure of the sustainable human capital dimension, captures the cumulative development of human capital over time. It serves as a fundamental proxy for assessing individual productivity, skill attainment, and potential contributions to labour efficiency (Barro and Lee, 2013). Average years of schooling has been tested as a driver of economic growth and a strong positive relationship has been observed (Hanushek and Woessmann, 2008). This indicator represents the average human capital stock of currently educated individuals in a country (United Nation Development Programme (UNDP), 2020). Duration of education is associated not only with economic output but also with multiple dimensions of sustainability, such as social inclusion, equity, health and democratic participation (OECD, 2001).

R&D expenditures, which are taken as the representative of sustainable technological capital, are the basic input of knowledge production, innovation capacity and technological innovations in the country. According to Romer (1990), sustaining economic growth relies heavily on the accumulation of technological knowledge, often referred to as the stock of knowledge, which is primarily driven by research and development activities. Elevated levels of R&D spending facilitate the generation of innovative outputs and the advancement of efficient technologies. This is necessary for sustainable economic growth and green transformation in the long run (Coe and Helpman, 1995). OECD (2015) emphasises that R&D expenditures are the main indicator for measuring the technological capacity of countries. R&D investments trigger the development of not only machinery-equipment but also qualified labour force, academic production and information systems. Therefore, it covers both the material and human dimensions of sustainable technological capital (Acs and Audretsch, 1990).

The proportion of renewable energy within total primary energy use is widely acknowledged as a key indicator reflecting the sustainability of a country's energy supply. Unlike fossil fuels, renewable energy (solar, wind, biomass, geothermal, etc.) is continuously regenerated by nature. This ensures long-term energy supply security and sustainability (International Energy Agency, 2021). The International Energy Agency (2021) highlights the critical function of renewable energy in maintaining the long-term

viability of global energy infrastructures. Similarly, the World Bank (2022) identifies the proportion of renewables in primary energy consumption as a central metric for monitoring the shift towards sustainable energy systems. Sovacool (2016) states that countries with a high share of renewable energy are more resilient to energy supply shocks and less dependent on energy imports.

Carbon emission intensity indicates how much CO_2 a country emits when producing a unit of economic output. Low intensity implies a green growth trend, while high intensity implies growth with high ecological burden (Zhang and Da, (2015). Tapio (2005) conceptually justifies that a decline in carbon intensity reflects a transition towards environmental sustainability.

GDP output at constant prices per worker is recognised in the literature as a very strong indicator of qualified (quality) and sustainable economic growth. It is important not only the rate of growth but also how we grow. The increase in output (productivity) per worker represents growth through efficient use of resources. If output increases without increasing inputs, growth is more sustainable and welfare-generating. According to Solow's growth model, sustainable long-term growth is not possible without productivity growth (Solow, 1956). The increase in output per worker is oriented towards increasing productivity through technology and skills rather than increasing working hours. This makes it possible to sustain growth while reducing the environmental burden (World Bank, 2019).

Indicators of inclusion in this study include the Gini coefficient, female labour force participation rate, and youth labour force participation rate. The Gini coefficient, originally formulated by Corrado Gini (1921), provides a mathematical measure of income distribution disparities within a population and remains the most commonly referenced indicator of income inequality (World Bank, 2022). Alesina and Rodrik (1994) employed the Gini coefficient to model how income distribution patterns affect economic growth, highlighting its effectiveness as a measure of distributional inequality. The rate of female participation in the labour market is closely linked to women's economic empowerment, independent income generation, and involvement in decision-making processes (Klasen and Lamanna, 2009). In their study, Klasen and Lamanna (2009) identified female labour force participation as a proxy for both gender and economic equality, while the United Nations (2015) emphasised its importance for reducing gender gaps and promoting inclusive development. Youth labour force participation reflects the extent to which young people are integrated into the economy during their transition from education to employment. It is widely recognised as a foundational element of both inclusiveness and sustainability (Elder and Kring, 2016). Exclusion of youth from the labour force may lead to heightened risks of social marginalisation, detachment, and diminished future prospects. Accordingly, youth participation in the labour market signals not only economic integration but also broader social inclusion (Bynner and Parsons, 2002).

4. Findings, Analyses and Evaluations

Figure 1 presents the evolution of the Sustainable and Inclusive Economic Growth (SIEG) Index covering the years 1992 to 2023. Developed using the methodological framework proposed by Hamilton and Xi (2022, 2024), the index integrates ten normalized variables that together capture key aspects of economic growth, inclusion, and sustainability. The included variables (see Table 1) capture:

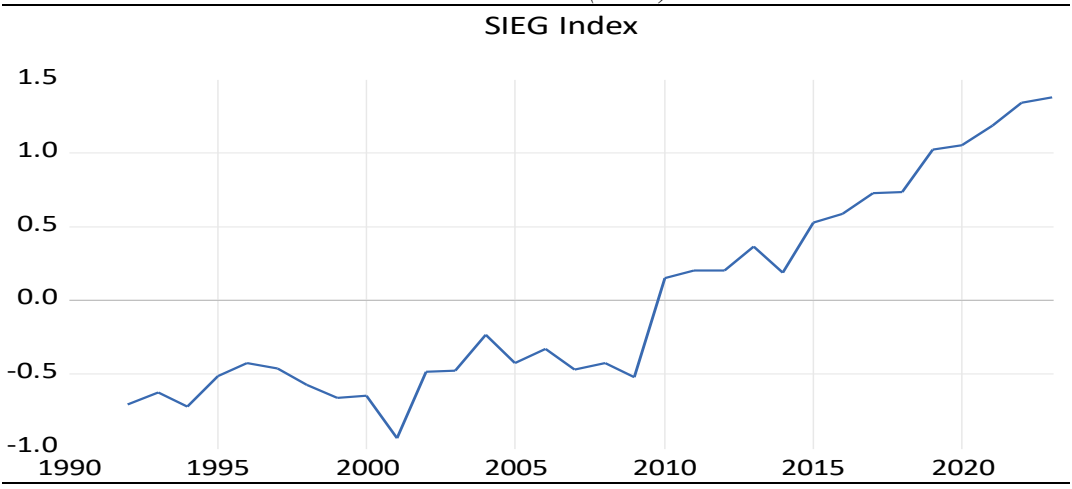
Economic growth: GDP growth and GDP per capita

Sustainability: Current account balance (financial sustainability), mean years of schooling (sustainable human capital), R&D/GDP (sustainable technological capital), renewable energy share (sustainability of energy supply), carbon emission intensity (environmental sustainability of growth), and labour productivity (qualified sustainable growth)

Inclusion: Gini coefficient (income inequality), female labour force participation (gender equality), and youth labour force participation (youth inclusion)

Figure 1

The Sustainable and Inclusive Economic Growth (SIEG) Index.



The trajectory of the SIEG index reveals three distinct phases over the 1992–2023 period. During the early years (1990–2010), the index remains relatively stagnant, with occasional negative values, indicating that Türkiye's economic growth lacked sufficient alignment with sustainability and inclusion principles. This stagnation may reflect persistently high income inequality, limited investment in research and development, low renewable energy utilization, and modest gains in education and labor force participation. From 2010 onwards, the index exhibits a marked upward trend, suggesting a shift toward a more integrated and multidimensional development path. Particularly after 2017, the acceleration becomes more pronounced, potentially driven by improvements in renewable

energy share, technological capacity, educational attainment, and greater inclusion of women and youth in the labor market. This upward trend points to a gradual transformation of Türkiye's growth model into one that is more inclusive, environmentally conscious, and structurally resilient. SIEG Index reflects not just how fast the economy is growing, but how well the benefits of growth are shared and whether the path of development is aligned with long-term sustainability objectives. Appendix 1 reports corresponding numerical values of SIEG Index.

Table 2 displays the factor loadings obtained through Principal Component Analysis (PCA), indicating the extent to which each variable contributes to the formation of the composite SIEG Index. These values provide a clearer understanding of the index's internal composition and highlight the dominant influence of specific dimensions such as economic performance, sustainability, or inclusiveness.

Table 2

Factor Loads for the Sustainable and Inclusive Economic Growth (SIEG) Index.

Indicators	Variables	Codes	Scale	Factor Loads
	Economic Growth indicators			
Economic growth rate	GDP growth	$growth_t$	%	0.362028
Welfare level	GDP per capita	$gdppp_t$	Number	0.398326
	Sustainability indicators			
Financial sustainability	Current account balance/GDP(%)	cab/gdp_t	%	-0.366689
Sustainable human capital	Mean years of schooling	$myos_t$	%	1.385600
Sustainable technological capital	R&D expenditure/GDP	rde_t	%	1.396045
Sustainability of energy supply	Share of primary energy consumption from renewables	$specrs_t$	%	0.944915
Environmental sustainability of growth	Carbon emission intensity	$-cei_t$	%	1.387714
Qualified sustainable growth	Labour productivity (output per worker (GDP constant 2015 US $))	lp_t	value	-0.366689
	Inclusion indicators			
Income inequality	Gini coefficient	$-gc_t$	value	1.359116
Gender equality	Female labour force participation rate (15+)	$flfp_t$	%	0.993794
Youth inclusion	Youth labour force participation rate (15-24)	yer_t	%	-0.231400

Note: Choose the normalization method was selected demean and standardize. Number of lags for detrending was used 1 due to having annual dataset. Forecasting time horizon was used 2 due to having annual dataset. Apply the method to was "levels". A number of factors to be estimated was used 1 due to wanting to create only one index value. To construct the Sustainable and Inclusive Economic Growth (SIEG) Index, the study applied Principal Component Analysis (PCA) designed for stationary and nonstationary time series, as recommended by Hamilton and Xi (2022, 2024), utilizing EViews 13 software.

*In order to make the created the Sustainable and Inclusive Economic Growth (SIEG) Index more consistent, all variables were switched to the upward direction. For this purpose, variables in the downward direction are multiplied by -1.

The results indicate that sustainability-related variables exhibit the highest factor loadings, particularly those associated with long-term development capacity. Among these, R&D expenditure/GDP (1.396), labour productivity (1.388), and mean years of schooling (1.386) show exceptionally strong loadings, suggesting that technological capital, human capital, and qualified growth are the most influential pillars of sustainable and inclusive growth in the Turkish context. These variables likely act as structural drivers of long-term resilience and upward mobility within the index. In contrast, the economic growth indicators—GDP growth (0.362) and GDP per capita (0.398)—display moderate factor loadings, implying that while growth is necessary, its contribution to sustainability and inclusion is comparatively limited unless accompanied by broader structural and distributional improvements. Within the inclusion dimension, the Gini coefficient (1.359) and female labour force participation (0.994) emerge as strong contributors, indicating that income equality and gender inclusion play a vital role in shaping inclusive economic growth. However, the youth labour force participation rate (-0.231) has a negative and weak loading, potentially reflecting structural challenges in youth integration or mismatches between education and employment.

One notable finding is the negative loading for the current account balance (-0.367), suggesting that while external balance is a component of macroeconomic sustainability, its short-term fluctuations may counteract other development dimensions, or that surpluses may coincide with contractionary conditions in the Turkish case. Overall, the factor loading structure highlights a development model increasingly driven by human capital, technological innovation, and social equity, rather than conventional growth metrics alone. This reinforces the multidimensional nature of the SIEG Index and underscores the importance of aligning economic performance with inclusive and sustainable foundations.

5. Conclusion

The main objective of this study is to develop a multidimensional index that can evaluate the growth process of the Türkiye economy not only quantitatively but also qualitatively. The SIEG Index developed in this direction is a composite measure that combines three main axes: economic growth, social inclusion and sustainability. Ten different indicators have been used in the construction of the index, and these indicators include structural elements such as economic growth, welfare level, education level, carbon emission intensity, income inequality, female and youth labour force participation rate, R&D expenditures, renewable energy use, and labour productivity. Through this index, the direction and quality of Türkiye's growth performance in the 1990-2023 period have been analysed periodically. Thus, the stages through which Türkiye's growth process has passed in the dimensions of inclusiveness and sustainability and which structural breaks it has faced have been revealed. The observed upward trend in the SIEG Index—particularly after 2010—suggests that Türkiye's growth trajectory has gradually incorporated more sustainable and inclusive elements. Improvements in energy

composition, education, technological investment, and labour market inclusion appear to be the key drivers of this transformation. Nevertheless, the index's historical volatility underscores the importance of structural continuity and policy stability in fostering quality-driven and equitable growth.

The findings of this study are significantly in line with the general trends in the literature on sustainable and inclusive economic growth. According to the findings, variables related to the inclusiveness dimension of sustainability in the Turkish context have the highest factor loadings; especially the share of R&D expenditures in GDP and average years of education stand out as strong determinants. This result is in line with Jackson's (2009) emphasis that economic growth cannot be limited to quantitative increase and that structural transformations based on human and technological capital are necessary for long-term sustainability. Similarly, it is consistent with the findings of the World Bank (2012) and McKinsey (2021) reports that economic performance should be evaluated together with social and environmental indicators.

Recent studies examining the effects of factors such as economic complexity, green finance and digital economy on inclusive growth (Stojkoski et al., 2022; Xin et al., 2023; Rusu & Oprean-Stan, 2025) emphasise the importance of technological progress and human capital. The fact that the highest burdens belong to human capital and innovation capacity in the index calculated for Turkey is in line with this global literature. The findings also reveal that income distribution (Gini coefficient) and female labour force participation rate emerged as strong determinants of inclusive growth, while youth labour force participation exhibited a negative and weak factor loading. This is in line with OECD findings pointing to the high share of low-productivity enterprises and the formal-informal divide in the Turkish labour market (Gönenç, Röhn & Koen, 2014) and with assessments in the literature suggesting that youth unemployment has become chronic. The fact that youth employment is the weak link of sustainable and inclusive growth in Turkey is a concrete reflection of the skills mismatch and structural employment problems frequently mentioned in the literature. Another striking finding of the study is that the current account balance has a negative factor loading. This result can be explained by the fact that in the Turkish context, the external balance surplus is often accompanied by a contraction in domestic demand and a slowdown in growth. In the literature on Turkey (Naimoğlu, 2024), it has been emphasised that there is a contradictory relationship between external balance and growth in the short run. Finally, the findings of this study reveal that sustainable and inclusive growth in Turkey is increasingly shaped around human capital, technological innovation and social equity indicators. This is consistent with both multidimensional approaches in the international literature and Turkey-specific studies such as OECD, Akagündüz (2022) and Naimoğlu (2024). However, the negative effect of the young labour force and the inverse finding in the current account balance provide a new contribution to the literature and highlight Turkey's unique structural vulnerabilities.

Nevertheless, the findings regarding the sustainable and inclusive growth performance of the Turkish economy should be analysed not only through technical analyses but also in a structural context. Although the post-2010 index increase signals a positive transformation on the surface, the permanence and depth of this rise are open to question. In particular, the relatively flat course of income inequality and the structural stagnation in female and youth labour force participation rates indicate that permanent improvements in these areas remain limited. Despite the increase in R&D expenditures, fluctuations in the labour productivity index indicate that technological transformation has not been sufficiently internalised. Moreover, although the improvement in environmental indicators is largely due to the acceleration of renewable energy investments, it should be kept in mind that this improvement is overshadowed by structural problems such as the high share of fossil fuels in energy consumption. All these findings suggest that Türkiye's economic growth model needs to be re-evaluated and that holistic policies that focus not only on the growth rate but also on the composition, distribution and environmental costs of growth are needed. In this context, the SIEG Index provides an alternative assessment ground for policymakers and serves as a more in-depth monitoring tool for the quality of growth.

The limitation of this study is that the index could only be calculated for a limited time period. The lack of long-term, uninterrupted and reliable data sets on sustainable and inclusive economic growth indicators in the Turkish context has prevented the index from being extended over a wider period. Future research may contribute to overcome the limitations of this study by enabling the SIEG index to be calculated over longer time series as more comprehensive data sets become available. As well as this based on the obtained SIEG index, it is recommended that different indices be created by preferring different variables and different samples in future studies.

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Appendix A.

Year	Sustainability and inclusive economic growth (SIEG) index
1992	-0.704632
1993	-0.62880
1994	-0.72616
1995	-0.51694
1996	-0.42668
1997	-0.46532
1998	-0.57302
1999	-0.66377
2000	-0.65019
2001	-0.93453
2002	-0.48395
2003	-0.47528
2004	-0.23224
2005	-0.42722
2006	-0.33239
2007	-0.46885
2008	-0.42454
2009	-0.52446
2010	0.15142
2011	0.20315
2012	0.20223
2013	0.36507
2014	0.18839
2015	0.52996
2016	0.58775
2017	0.72533
2018	0.73625
2019	1.02114
2020	1.05050
2021	1.18226
2022	1.33738
2023	1.37815