Estimating the Genuine Progress Indicator (GPI) for Greece:

Opportunities and Prospects for the Transition to the Beyond GDP era

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Contents

List of figures

List of tables

List of Acronyms and Abbreviations

PPP: Purchasing Power Parity
GDP: Gross Domestic Product
GNP: Gross National Product
ISEW: Index of Sustainable Economic Welfare
GPI: Genuine Progress Indicator
WB: World Bank
IMF: International Monetary Fund
UN: United Nations
OECD: Organisation for Economic Co-operation and Development
SNA: System of National Accounts
SDG: Sustainable Development Goals
EC: European Commission
IPCC: Intergovernmental Panel on Climate Change
EU: European Union
WHO: World Health Organisation
EEA: European Environment Agency
APC: Adjusted personal consumption
CCD: Costs of consumer durables
SCD: Services of consumer durables
IE: Informal economy
CU: Cost of underemployment
UW: Value of unpaid work
NDGE: Non-defensive government expenditures
LT: Value of leisure time
NWEHE: Non-welfare enhancing household expenditures
CRA: Cost of road accidents
CC: Cost of crime
CD: Cost of divorces
CNP: Cost of noise pollution
CAP: Cost of air pollution
ECNP: Ecosystem costs of nitrogen pollution
CCB: Cost of climate breakdown
DNRER: Depletion of non-renewable energy resources
W: Loss/ gain of wetlands
F: Loss of forests
NI: Net investment
NB: Net international trade balance
NFA: Net foreign assets

Abstract

The Genuine Progress Indicator (GPI) has emerged as a holistic metric that seeks to address the limitations of Gross Domestic Product (GDP) by integrating economic, social, and environmental dimensions into the assessment of a nation's well-being. While GDP remains the dominant measure of economic performance, it fails to account for critical factors, such as income inequality, environmental degradation, and the depletion of natural resources (Kubiszewski et al., 2013).

Since its development in the 1930s, GDP has been widely used as a proxy for economic success, despite Simon Kuznets' -the architect of national income accounting- explicitly warning that GDP should not be used to measure societal welfare, as it excludes non-market activities and social disparities (Kuznets, 1934). Over time, GDP has prioritized economic expansion at the expense of sustainability, failing to distinguish between activities that enhance well-being and those that generate negative externalities (Cook & Davíðsdóttir, 2021). In response, the GPI emerged as an alternative framework, building upon the Index of Sustainable Economic Welfare (ISEW), introduced by Daly and Cobb (1989), to offer a more comprehensive measure of prosperity. Unlike GDP, which treats all economic activity as a net positive, GPI distinguishes between activities that contribute to well-being and those that impose social or environmental costs. For example, GDP increases both when pollution is created and when it is cleaned up, treating both as economic gains. In contrast, GPI subtracts environmental degradation, healthcare costs from pollution, and crime-related expenditures, providing a more realistic assessment of a country's net economic and social welfare (Talberth et al., 2007, 2014; Kim & Moon, 2024). As concerns over socio-economic disparities and environmental sustainability have intensified, international institutions such as the United Nations, the European Union, and various national governments have increasingly recognized the need for alternative indicators that more accurately capture inclusive and sustainable progress (Jansen et al., 2024). OECD reinforces these concerns, emphasizing that GDP-centric economic assessments overlook key dimensions of well-being, particularly in relation to inequality and environmental sustainability (Stiglitz et al., 2018). The European Commission has promoted Beyond GDP initiatives, supporting the adoption of alternative frameworks that integrate social equity, environmental protection, and economic resilience (Benczur et al., 2024). Towards this direction, the present study aspires to contribute to the beyond GDP movement by estimating the GPI indicator for Greece, covering the period 1995-2022.

Keywords:

- Genuine Progress Indicator (GPI)
- Index of Sustainable Economic Welfare (ISEW)
- Beyond GDP movement
- Alternatives to GDP
- Sustainable Development
- Economic Welfare
- Well-Being

1. Introduction

1.1. The rise and the dominance of GDP. A historical perspective

Efforts for estimating the total aggregate economic welfare produced by national economies date back to the 17th century. Sir William Petty provides one of the first recorded official attempts to estimate the total national income of England (Lepenies and Gaines, 2016). The idea of estimating the aggregate income produced in a national economy was further developed, as economic science and economic theory evolved through the centuries. However, three extraordinary events are recognized as the main cornerstones that set the necessity for the creation of an innovative, contemporary, and well-defined national accounting system that could provide reliable estimates of the national income of a country (Coyle, 2015; Lepenies, 2016):

- The Great Depression period, after Wall Street's crash of 1929.
- The second World War (WWII: 1939-1945), with its devastating consequences in Europe, both at the socio-economic and the political level.
- The engagement of Keynesianism as the macroeconomic "antidote" for confronting the above-mentioned dual crises.

Contemporary Gross Domestic (or National) Product equation is based to the contributions made by Colin Clark in the United Kingdom, during 1920-1930 initially, and mainly to the work of Simon Kuznets in the USA,[1] after the crash of 1929. It is worth mentioning that Kuznets himself had early on raised awareness of the inappropriateness of GD(N)P as a proxy for estimating the socio-economic well-being of a country (Costanza et al., 2014). Since the Bretton Woods agreement and system, back in 1944, until nowadays, the predominance of GD(N)P as an indicator for accounting the progress of a country is unquestionable. Great economists, like Sir John Richard Hicks, proposed the per capita national income (thus, per capita GNP) as an acceptable index for quantifying the social welfare produced by the economic process (Islam and Clarke, 2002). Gross National Product (GNP) gradually replaced by Gross Domestic Product (GDP) and adopted by international statistics and the reports provided by prestigious national, international and transnational organizations, such as the World Bank (WB), the International Monetary Fund (IMF), the United Nations (UN), the Organisation for Economic Co-operation and Development (OECD), to name a few representative examples.

1.2. Literature review of the alternative indicators to GDP. The beyond GDP movement

Evidently, already back in the 1930s Simon Kuznets himself raised questions about the misuse of GDP as a proxy for measuring socio-economic welfare and human well-being, as economic growth per se is not explicit evidence of improvement (Kuznets, 1962). Similarly, the famous English economist Arthur Cecil Pigou, well-known for his contributions on welfare economics, remained critical over the capability of GDP to perform as an adequate indicator measuring total social welfare of a

[1] The economic report of the US Congress, back in the early '30s, consists of the historical deposition of the first ever GNP estimation: https://fraser.stlouisfed.org/title/national-income-1929-1932-971 (Retrieved in 25/10/2024).

country (Pigou, 1962). The early roots of the "beyond GDP" movement (Rasmussen, 2004; Goossens et al., 2007; Costanza et al., 2007, 2009, 2014; European Commission, 2013) could be already traced in various early studies (see e.g.: Zolotas, 1981; Max-Neef, 1995; Michalos, 1997) (see also the time-line presented in Fig. 1). In a nutshell, the main shortcomings of GDP, as an inappropriate welfare/well-being indicator, could be summarized into the following ones (Coyle, 2016; van den Bergh, 2009, 2022):

1. It does not count income inequalities and the poverty level of a country
2. It does not count value created outside markets, such as household works, social and volunteering work, own production of agriculture and other products, as well as the so-called shadow economy which represents a substantial part of the total economic activity that is not captured by GDP.[2]
3. It does not count the environmental externalities, the raising scarcity of natural resources, the declining carrying capacity of ecosystems services, the biodiversity loss, and the degradation of various ecosystems.
4. It does not consider demographic dynamics and various other socio-economic varia bles, such as changes in the quality of health system's services, access in the educa tional system, and so on.
5. It does not account for technological progress, as well as innovation and new-know-l edge spillovers.

However, GDP does count the so-called "defensive" and/or "positional" expenditures, even though these categories are not contributing to further welfare (Jackson 2011, p.76). [3]Moreover, it is worth mentioning here that there are studies providing empirical evidence for many developed countries that, beyond a certain level of increase in GDP per capita, there seems to be some kind of threshold beyond which more consumption of goods and services does not lead to further increases in well-being; on the contrary, in some cases, more growth in income is translated into a decreasing satisfaction, thus a declining welfare/utility (Max-Neef, 1995; Daly, 2000; Jackson, 2009; Victor, 2010; Clarke and Islam, 2005).

According to Hoekstra, (2019) four milestones of the long-lasting influence of GDP in economic history, could be perceived:

- (1929-1944): The rise
- (1944-1973): The golden era
- (1973-2008): The hegemony under question
- (2008-2030): The decadence and the forthcoming end

[2] Source: https://www.worldeconomics.com/National-Statistics/Informal-Economy/Greece.aspx (Retrieved in 08.03.2024)

[3] The so-called "defensive" expenditures are utilized as compensation for the damages caused by economic growth, according to Latouche (2008, - p. 369). In general, the defensive expenditures are the result of the need for "defense" against activities taking place into other sectors of the economy, such as the cost of car accidents. The positional expenditures are critical to support certain aspects of the social status of citizens. Yet, according to Jackson (2011, p.76), it remains a paradox why these expenditures are considered in the GDP estimates.

Indeed, the first dedicated efforts to construct an alternative to GDP accounting framework are traced in the late-1980s – early-1990s, while at the political arena the beyond GDP movement gains ground after 2007 (For example, the international conference "Beyond GDP" that was held on the premises of the European Commission (EC). "It's time to go beyond GDP" was the moto of the former EC president José Manuel Barroso) (Cassiers, 2007). [4]At about the same time, the prestigious committee consisted of Joseph Stiglitz, Amartya Sen, and Jean Paul Fitoussi publish the "Measurement of Economic Performance and Social Progress" report endorsing the need to move beyond GDP (Stiglitz et al., 2009). Furthermore, in 2009, the EC adopted the roadmap for action, "GDP and beyond — measuring progress in a changing world", while in 2013 a relevant study is published, focusing on alternative to GDP accounting frameworks and indicators (European Commission, 2013).

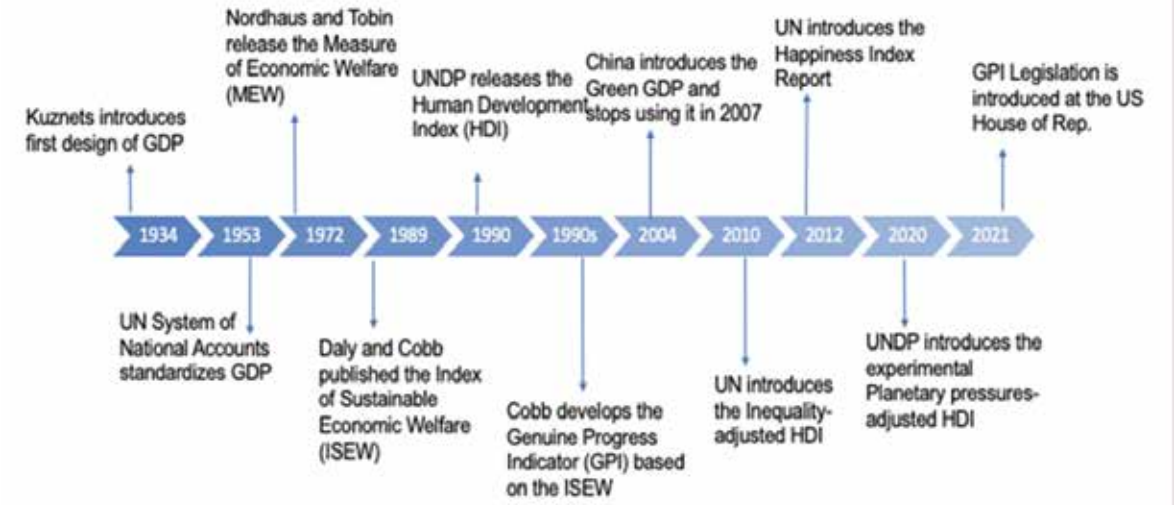

Figure 1: Timeline of GDP and its main alternatives (Source: https://www.ecologicaleconomicsforall.org/gdp-and-its-alternatives).

Van den Bergh (2022) proposed the establishment of an international panel, like the Intergovernmental Panel on Climate Change (IPCC),[5] as an official United Nation's (UN) body for addressing the demanding accounting transition beyond the realms of GDP. Indeed, this proposal seems to be already a work in progress, within the System of National Accounts (SNA), an internationally agreed standard set of recommendations on how to compile measures of economic activity in accordance with strict accounting conventions, based on economic principles. The recommendations are expressed in terms of a set of concepts, definitions, classifications and accounting rules that comprise the internationally agreed standard for measuring such items, as GDP, the most frequently quoted indicator of economic performance. The draft 2025 SNA[6] report is available online, and the final evaluation is pending by the United Nations Statistical Commission at its 56th Session, in order to be incorporated into the officially approved statistics. Especially, the Chapter 34: "Measuring well-being", provides substantial information about the measuring of well-being, including many variables already proposed by the GPI literature (see Fig. 2).

[4] More information about the conference is available here: https://ec.europa.eu/environment/beyond_gdp/2007_conference_en.html. The minutes of the conference are available here: https://ec.europa.eu/environment/beyond_gdp/proceedings/bgdp_proceedings_full.pdf (Retrieved in 23.11.2024).
[5] More info for IPCC here: https://www.ipcc.ch/ (Retrieved 29.03.2025).
[6] Available here: https://unstats.un.org/unsd/nationalaccount/SNAUpdate/2025/chapters.asp (Retrieved 29.03.2025).

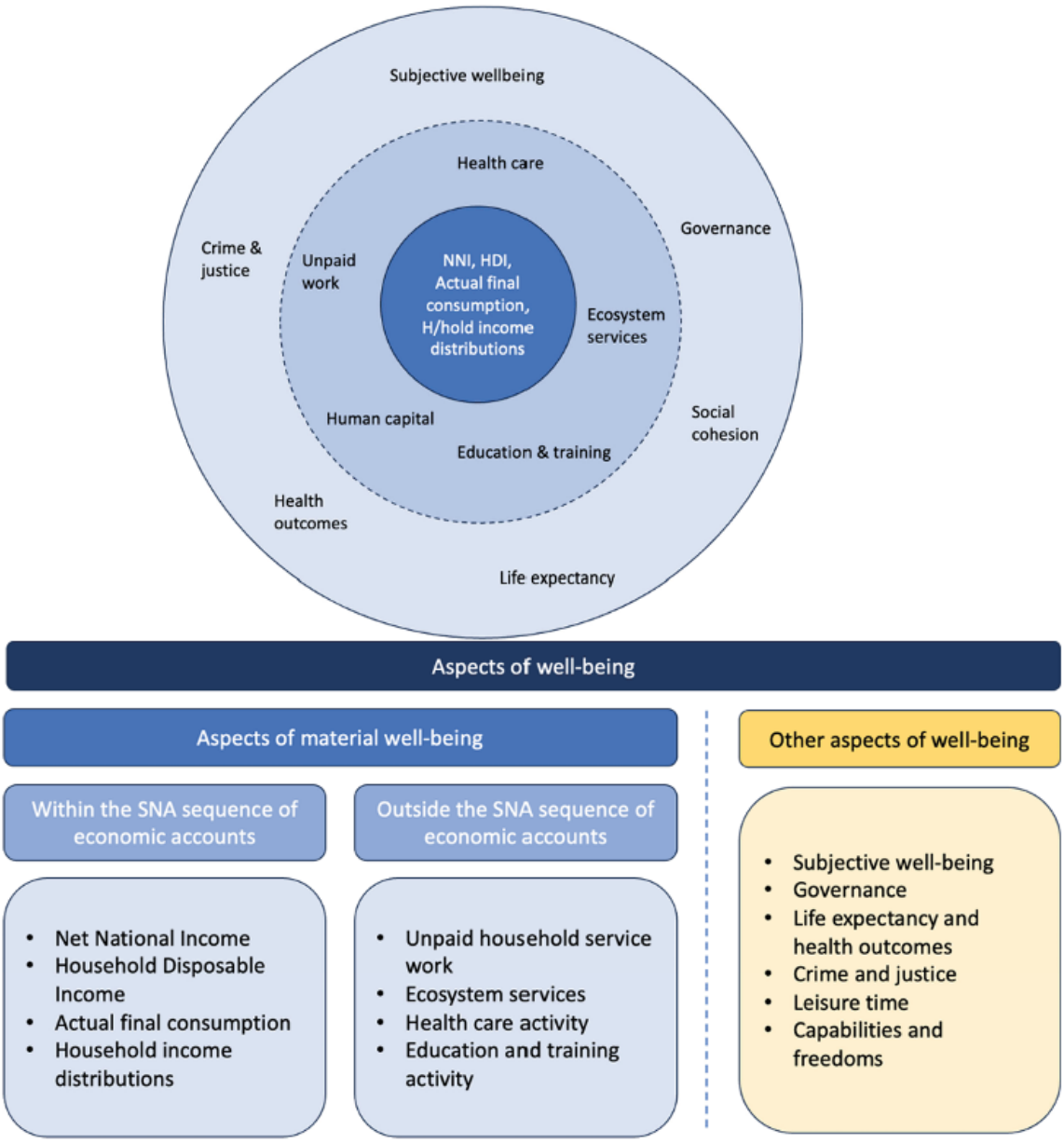

Figure 2: Aspects of well-being, according to the 2025 SNA draft report (Source: https://unstats.un.org/unsd/nationalaccount/SNAUpdate/2025/2025SNA_CH34_V11.pdf).

There are various extensive literature reviews shedding light to the beyond GDP research, providing different classifications and fruitful comparisons among studies, proposed frameworks, and empirical analysis, (e.g. Offer, 2000; Goosens et al., 2007; Van den Bergh, 2009; Bleys, 2012; Singh et al., 2012; Kalimeris et al., 2023 – see also Table 1; Jansen et al., 2024) even raising criticism (see for example: Peterson, 2014; Bleys and Whitby, 2015).

Table 1: The most representative alternative to GDP frameworks, based on Kalimeris et al., (2023).

No.	Indicator	Source	Description
1.	Index of Sustainable Economic Welfare (ISEW)	Scientific publications	Measures economic welfare by adjusting GDP to include environmental and social factors.
2.	Genuine progress indicator (GPI)	Scientific publications	Like ISEW, adjusts economic activity to reflect real social and environmental progress.
3.	Quality of Life Index (QLI)	World Population Review (independent organization)	Countries rank based on living conditions, health, safety, and well-being.
4.	Human Development Index (HDI)	UN	Combines life expectancy, education, and income to measure human development.
5.	Index of Economic Well-Being (IEWB)	Centre for the Study of Living Standards (Canada)	Evaluates economic well-being using consumption, wealth, equality, and economic security.
6.	Social Health Index (SHI)	Institute for Innovation in Social Policy (USA)	Evaluates economic well-being using consumption, wealth, equality, and economic security.
7.	Sustainable Society Index (SSI)	Dutch Sustainable Society Foundation	Measures sustainability through human, environmental, and economic dimensions.
8.	Fragiled States Index (FSI)	Fund for Peace	Ranks countries by political risk and social stability.
9.	Legatum Prosperity Index (LPI)	Legatum Institute	Evaluates prosperity using factors like economy, health, education, and personal freedom.
10.	Social Progress Index (SPI)	Nonprofit Social Progress Imperative	Measures how well countries meet basic human needs and improve quality of life.
11.	Ecological Footprint (EF)	Global Footprint Network	Calculates how much nature a population uses compared to what Earth can renew.
13.	Happy Planet Index (HPI)	New Economics Foundation	Combines well-being and environmental impact to assess sustainable happiness.
14.	World Happiness Report	Sustainable Development Solutions Network	Ranks countries by happiness based on surveys and factors like GDP, social support, and life expectancy.
15.	Gini Coefficient	Eurostat	Measures income inequality within a country (0 = perfect equality, 1 = total inequality).
16.	Life Satisfaction	Eurostat	Reflects how individuals rate their overall happiness with life.
17.	Adjusted net savings	Word Bank	Shows true savings by including investment in people, natural resources, and pollution.
18.	Better life Index (BLI)	OECD	Compares well-being across countries in areas like housing, income, and work-life balance.
19.	SDG	UN	The 17 Sustainable Development Goals (SDGs), adopted by all United Nations Member States in 2015, as a shared blueprint for peace and prosperity for people, the planet, and future generations.
20.	Inclusive Wealth Index	UN (UNEP)	Measures wealth by including natural, human, and produced capital.

Evidently, the most recent three-dimensional approach analyzed 65 Beyond GDP metrics, shown in Fig. 3, provides in the cross-section of the three triangles, namely the core triangle, the most important alternative to GDP frameworks fulfilling all three dimensions of wellbeing, inclusion, and sustainability (Jansen et al., 2024). GPI is depicted in the center of these core indicators, as a dashboard. This recent publication at the prestigious Lancet-Planetary Health journal justifies the choice made by the authors of the present study to estimate the GPI for the Greek economy.

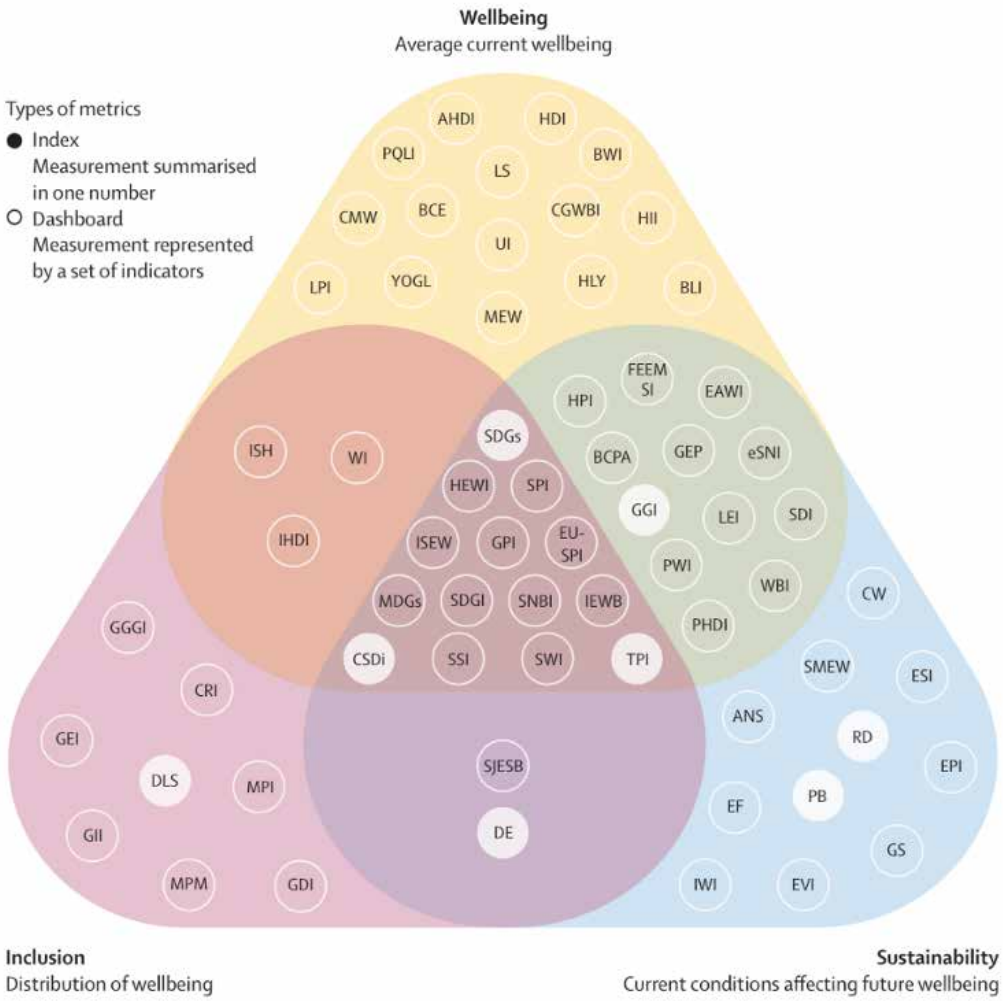

Figure 3: WISE database classification of alternative to GDP Indicators. The triangle shows an overview of 65 Beyond GDP metrics that are plotted based on the dimension they relate to: wellbeing, inclusion, or sustainability, or a combination of two or three of these dimensions. (Source: https://beyond-gdp.world/wise-database/wise-metrics and Jansen et al., 2024 – p. e700).

2. The Genuine Progress Indicator (GPI)

2.1. Conceptual Framework and Structure of GPI

The roots of the GPI can be traced on the Measure of Economic Welfare (MEW) developed by Nordhaus and Tobin (1972), representing one of the first systematic attempts to adjust national income, by incorporating environmental costs and non-market household production. Building upon this foundation, Daly and Cobb (1989) introduced the Index of Sustainable Economic Welfare (ISEW), a more refined metric that adjusted personal consumption for income inequality, added the value of unpaid work, and subtracted costs associated with environmental degradation. In the early 1990s, the ISEW evolved further into the GPI, developed as a collaborative initiative within the ecological economics and policy research community (Cobb et al., 1995). Its core objective is to move beyond the narrow economic focus of GDP and reflects the real economic welfare experienced by individuals, by the values of market and non-market activity, the cost of depletion of natural and social capital, offering a more inclusive and policy relevant measure of economic welfare (Lazarus and Brown, 2022).

Unlike GDP, measuring only the market value of goods and services produced in an economy, GPI adjusts for factors that GDP ignores, such as environmental degradation, income inequality, the value of unpaid work, and the costs of social problems like crime and car accidents. It also adds benefits from non-market activities like household labour and volunteer work, which are excluded from GDP but clearly contribute to societal welfare (Talberth et al., 2007; Kubiszewski et al., 2013).

The GPI draws its theoretical basis from foundational concepts in welfare economics and capital theory and, specifically, from the idea of sustainable income, as discussed by Sir John Hicks in 1946. In his well-known book Value and Capital, Hicks defined income not just as the total of money transactions in a given period, but as the maximum amount that someone can spend without reducing their ability to spend the same amount in the future (Hicks, 1946). GPI's foundation also aligns with Irving Fisher's earlier distinction between income and capital. According to Fisher (1906), capital is a stock that produces a flow of benefits (e.g. income), and that true income is only the part of that flow that can be used without reducing the stock. This has strongly influenced ecological economists, focusing on preserving natural resources so they can continue to support well-being in the future (Costanza and Daly, 1992).

According to Van der Slycken (2021), GPI and the related indicators, such as the ISEW, are based on a double theoretical foundation: Hicksian sustainable income and Fisher's concept of psychic or experiential income. These foundations explain why the GPI accounts not only for income inequality and environmental degradation, but also for time-use and subjective well-being.

The components of the GPI are grouped into three categories to reflect the multidimensional nature of sustainable well-being (Lawn, 2005; Kubiszewski et al., 2013; Cook & Davíðsdóttir, 2021). Each component is either added or subtracted depending on whether it contributes to or detracts from genuine progress. These categories, as shown in Fig. 4, are:

- **Economic components** focus on income and production adjusted for inequality and sustainability. They include personal consumption (adjusted for income distribution), the costs and services of consumer durables, underemployment, net capital investment, and the balance of international trade. These variables assess how equitably and efficiently the economy supports individual and collective prosperity.

- **Social components** capture aspects of well-being often omitted from traditional economic indicators. They include the value of unpaid and volunteer work, the cost of crime, family breakdown, lost leisure time, and domestic labour. These elements reflect the quality of life, social cohesion, and time allocation within households and communities.

- **Environmental components** quantify the degradation of natural systems and the depletion of ecological resources. Key indicators include the costs of air, water, and noise pollution, the loss of forests and wetlands, the depletion of non-renewable energy sources, and the long-term effects of climate change. These variables highlight the environmental limits to economic activity and the long-run risks to sustainability.

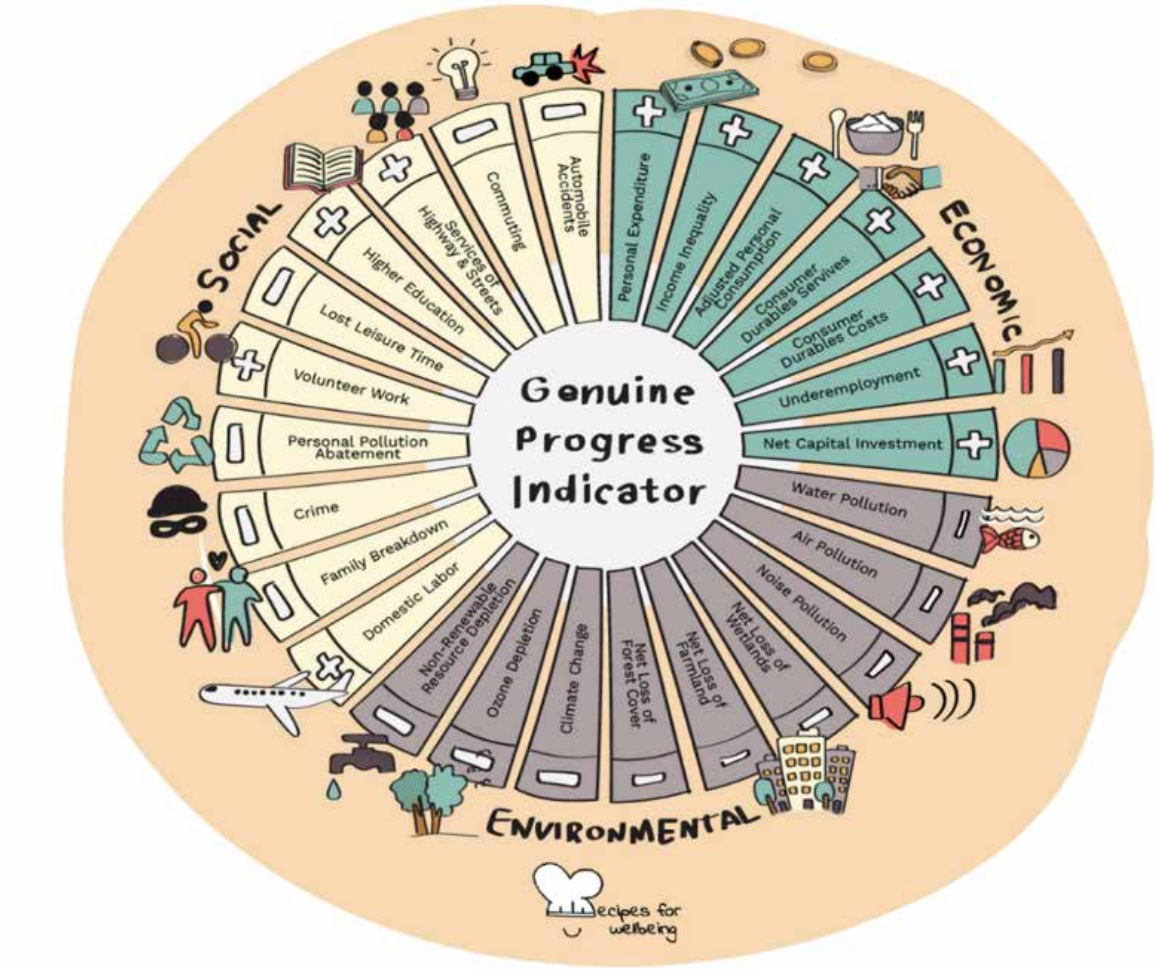

Figure 4: Conceptual Structure of the Genuine Progress Indicator and its Components (Source: https://www.recipesforwell-being.org/genuine-progress-indicator/).

The wide range of economic, social, and environmental components described above can be integrated into a single composite index, allowing for a holistic evaluation of a nation's genuine progress. This aggregation is commonly expressed through a simplified formula that summarizes the fundamental structure of the GPI:

$$\mathbf{GPI=A+B-C-D+I} \qquad \mathbf{(1)}$$

Each letter indicates a specific category of variables that either add to or reduce genuine progress. Specifically:

- A represents the income-weighted personal consumption, reflecting house hold consumption, adjusted by an income distribution index (typically the Gini coefficient).
- B represents the value of non-market services generating welfare, reflecting the benefits not captured in the market economy but which contribute significantly to social welfare, such as unpaid household labour, volunteer work, and the value of leisure time.
- C represents the private defensive cost of natural deterioration, reflecting the costs incurred to defend or repair well-being, often due to social issues or failures in public provision, such as spending on road accidents and crime prevention.
- D represents the cost of deterioration of nature and natural resources, such as air and water pollution, climate breakdown, loss of forests and wetlands, noise pollution, nitrogen emissions, and the depletion of non-renewable energy sources, representing environmental degradation.
- I represents the increase in capital stock and balance of international trade, reflecting the net capital investments, the trade surplus or deficit, and the country's net foreign asset position.

Despite its conceptual strengths, GPI have been the subject of significant criticism. A limitation is the lack of methodological consistency and standardization across studies and regions, which undermines the comparability of results. As Bleys and Whitby (2015) note, variations in the choice of components and valuation techniques often lead to "apples and oranges" comparisons between countries. This problem is even more pronounced at the sub-national/regional level, where there are limited data available and researchers should rely on assumptions (Gigliarano et al., 2014; Clarke & Lawn, 2008). As Tsara et al. (2024) emphasize, there is a "need to support the adoption of [...] measures as superior alternatives to GDP" and to improve valuation methods in order to strengthen their credibility and usefulness for policymaking.

Another critique involves the subjectivity embedded in GPI's construction. The decision about which variables to include or exclude is based on subjective choices, rather than grounded in a universally accepted framework (Neumayer, 1999; Harris, 2007). Additionally, by combining indicators of present welfare with those of long-term sustainability, GPI can create conceptual ambiguity in interpreting its outcomes (Dietz & Neumayer, 2006).

Concerns have also raised about how the GPI treats natural, and human-made capital. GPI often assumes that human-made capital (e.g., infrastructure) can substitute for natural capital (e.g., forests or ecosystems). This assumption is consistent with "weak sustainability" viewpoint underestimating the real impact of environmental loss (Lawn, 2005; Lazarus & Brown, 2022).

Addressing these limitations through better data infrastructure, and a well-stated methodological guidance, would significantly enhance the GPI's usefulness for academic research and policy making.

2.2. A bibliometric analysis of studies using GPI as a keyword

For the purposes of our initial bibliometric analysis, we first gathered all types of studies and documents for all disciplines, using as keyword the term "Genuine Progress Indicator" and its abbreviation "GPI", searching the Scopus[7] database. The search period was from 2000 until March of 2025 and resulted in 761 documents in total. All data extracted by the Scopus database and were further processed by using the VOSviewer Software Tool (version 1.6.20),[8] developed by the Centre for Science and Technology Studies, in Leiden University, the Netherlands. We estimate three distinct co-occurrence clustering networks. The first co-occurrence network is based on the index of total keywords derived by the VOSviewer, based on the dataset. According to Fig. 5, the most used keywords associated to the GPI literature are "Sustainable Development", "Sustainability", "Economic Growth", "Economics", "Economic Analysis", and "Welfare Economics". A more detailed co-occurrence network is provided in Fig. 6, where data is further filtered according to the specific keywords provided by the authors of the studies themselves.

[7] https://www.scopus.com/ (Retrieved in March 2025).
[8] VOSviewer tool software is freely available here: https://www.vosviewer.com/ (Retrieved in March 2025)

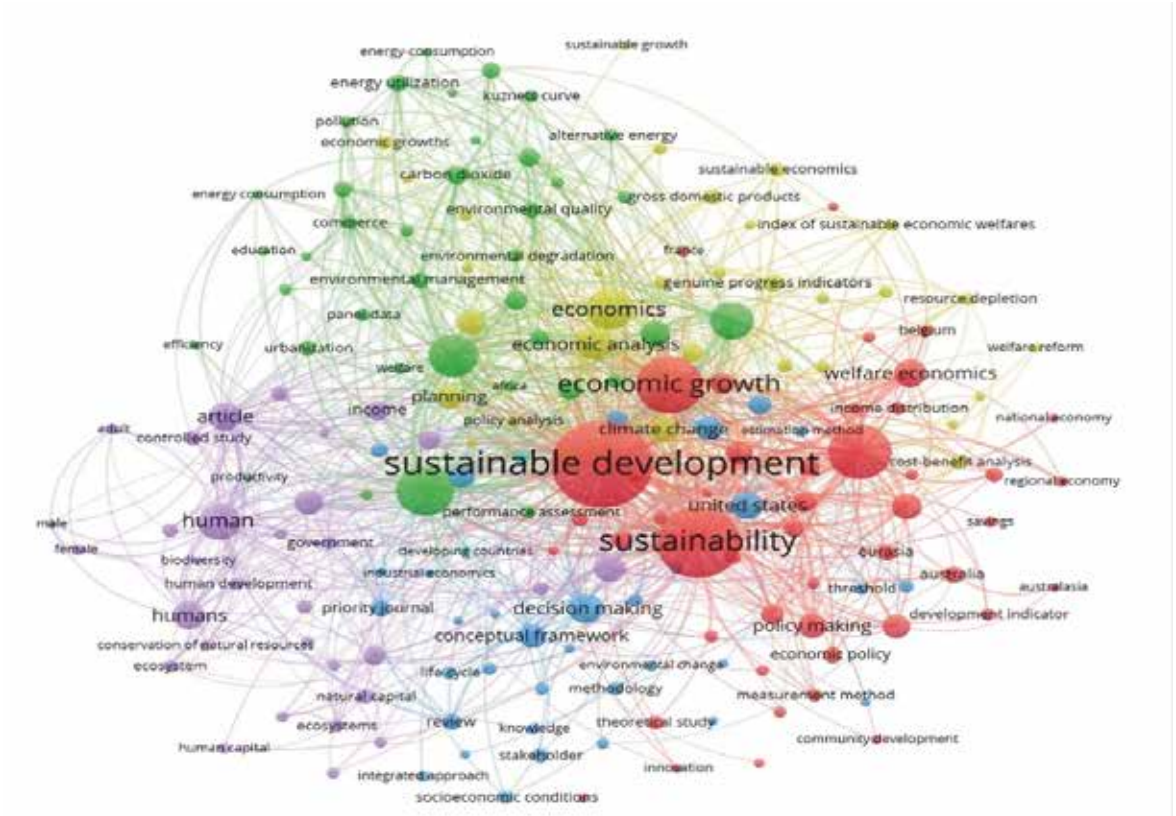

Figure 5: Co-occurrence network of all Index Keywords derived from Scopus bibliometric analysis (2000-2025), weighted by total links' strength (Figure constructed with VOSviewer program).

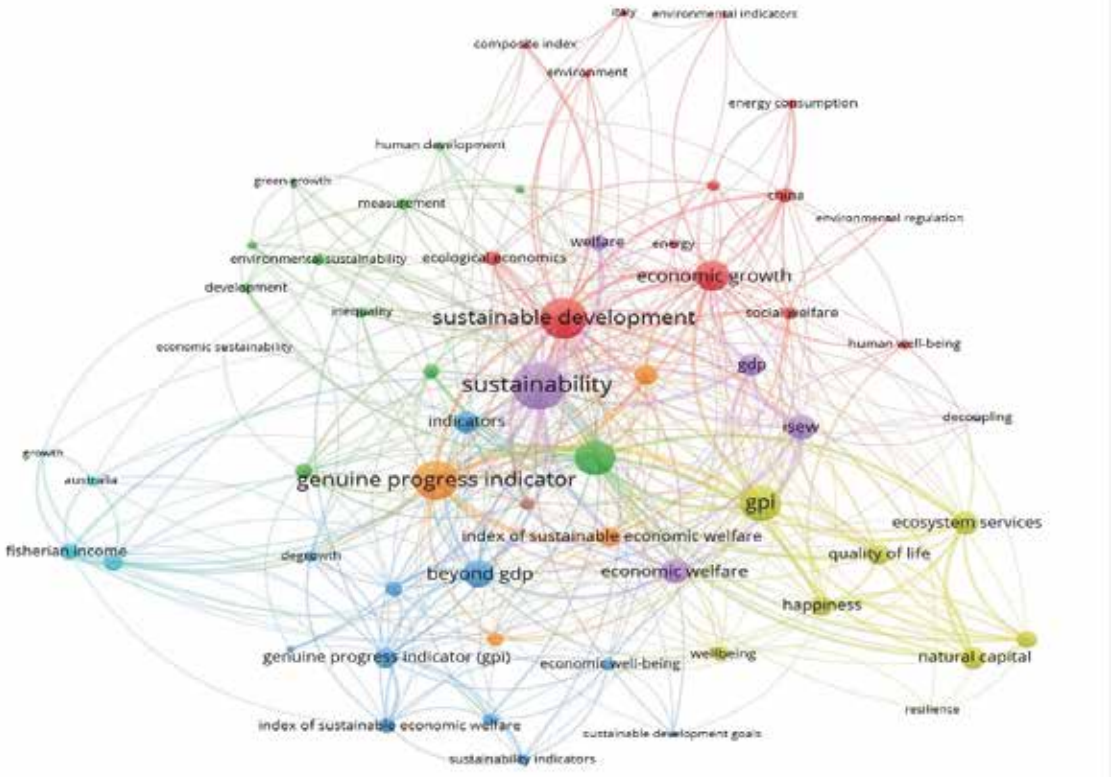

Figure 6: Co-occurrence network of Authors' selected Keywords derived from Scopus bibliometric analysis (2000-2025), weighted by total links' strength (Figure constructed with VOSviewer program).

Finally, Fig. 7 depicts the results of the constructed co-occurrence network based on the authors' names and the citations received by others, by using the modularity clustering method provided by the VOsviewer tool. Evidently, the most fundamental work on GPI is contributed to Costanza and Kubiszewski, affecting an extended universe of clusters constantly populated with new relevant studies (the yellow color denotes the most recent studies), while, there are also some unique independent clusters, a result which needs further research, yet remains beyond the scopes of the present analysis.

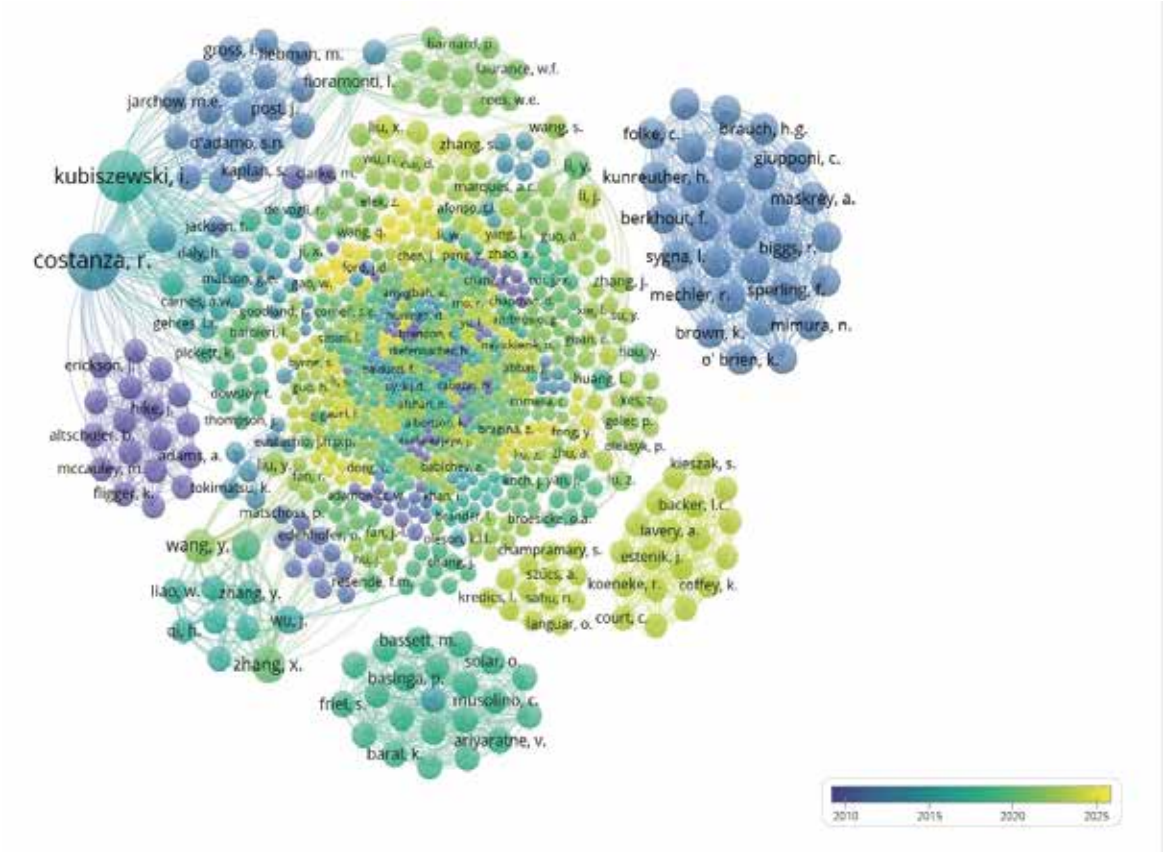

Figure 7: Co-occurrence network of Authors names, derived from Scopus bibliometric analysis (2000-2025), by using the modularity clustering method (Figure constructed with VOSviewer program).

2.3. Literature review of studies estimating the GPI

The bibliometric analysis of the previous section revealed linkages among different fields and studies using the keyword "GPI" and/or "Genuine Progress Indicator". However, the vast majority of these studies do not provide estimates of GPI, thus a more focused literature analysis is required for the purposes of the present study. In that context, a more detailed literature review performed, by using the Scopus database and the Google Scholar tool, which revealed those studies providing estimates and calculation techniques of GPI, for different national levels, as well as some attempts focusing on the state level and the urban, municipality, level. In aggregate, the literature review revealed 51 studies focusing on GPI estimation across the globe (See Fig. 8).

Table 5 (in Appendix A), presents a summary table of the selected GPI studies, indicating the country of examination and the time-period in each case.

The United States has the highest number of studies, with 26 studies, including those focusing on specific regions like San Francisco, Utah, and Vermont (e.g. Berik and Gaddis, 2011; Brown and Lazarus, 2018; Posner and Costanza, 2011; Kubiszewski et al., 2015). China ranks second with 8 studies (e.g. Wen et al., 2007; Thiry, 2015), accounting for various regional studies across provinces and megacities, together with Australia, similarly with 8 studies (e.g. Lawn, 2008a; Karatopouzis et al., 2022), highlighting significant research contributions. Countries like India (Lawn, 2008b), Japan (Makino, 2008), Brazil (Andrade and Garcia, 2015), New Zealand (Lawn and Clarke, 2008), and South Korea (Fenny et al., 2013) also contribute to GPI research, reflecting its growing global adop-

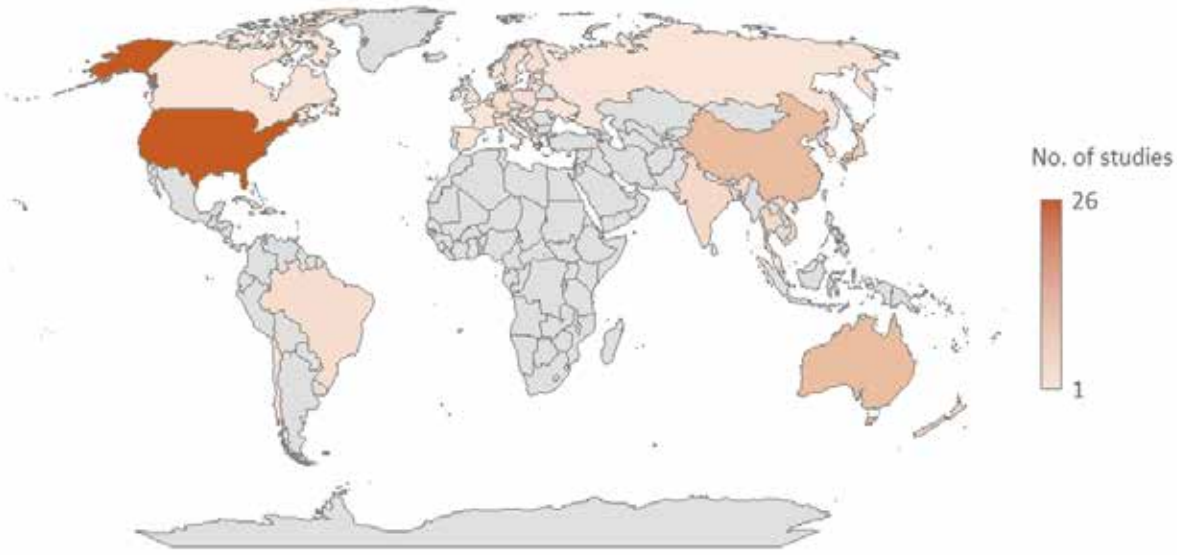

Figure 8: Worldwide Heat Map of GPI Studies by Country.

tion. Finally, on a European level, GPI is estimated for Finland (e.g. Hoffrén, 2019) and other countries such as Austria, Belgium, Netherlands, Sweden, Italy, UK, (e.g. Kubiszewski et al., 2013) and Iceland (e.g. Balafina, 2018) (see Fig. 8).

In relation to Greece, various studies on ISEW have been carried out (e.g. Menegaki & Tsagarakis, 2015; Van der Slycken and Bleys, 2021, 2023; Soupart and Bleys, 2024a, 2024b). However, it is worth noting that Greece is included among the 28 OECD countries in a comparative study by Pais et al. (2019), which estimates GPI for the period 1995–2015. To the best of our knowledge, this is the only GPI estimation for Greece in the relevant literature, although it is conducted within the context of a cross-country comparison. In contrast, the present study is the first to focus exclusively on Greece, providing a GPI estimation that reflects the country's unique economic, social, and environmental context.

3. Estimating the GPI for the Greek Economy

3.1. Assumptions and methodology

To select the most relevant items for GPI calculation in Greece, a comprehensive review of the existing studies on GPI was carried out. One of the basic issues encountered was the fact that each GPI study used a different set of items/variables. This was contingent upon the availability of data and the dimensions that each research aimed at focusing on. For that reason, a number of selection criteria were articulated. These criteria were also based on the fact that it is the first holistic research attempt to evaluate the Greek GPI, apart from the Pais et al. (2019) cross-country GPI evaluation which included Greece. These are the following:

- It should cover as many variables as possible of the GPI indicator.
- It should cover all "sustainability dimensions" i.e., social, environmental and economic.
- The methodology is clearly stipulated, and data sources are publicly available.
- The sum of the studies selected should have broad geographic coverage.

Based on the criteria defined above, 6 GPI studies were selected as most relevant (Table 2)

Table 2: Studies selected for the selection of GPI items.

Title	Author(s)	Year	Country
"Estimating the Genuine Progress Indicator (GPI) for Brazil from 1970 to 2010."	Andrade et al.	2015	Brazil
"An Estimate of the Genuine Progress Indicator for Iceland, 2000–2019."	Cook, D., and B. Davíðsdóttir.	2021	Iceland
"Estimating the Genuine Progress Indicator before and during the COVID Pandemic in Australia."	Karatopouzis, A., et al.	2022	Australia
"Estimates of the Genuine Progress Indicator (GPI) for Oregon from 1960–2010 and Recommendations for a Comprehensive Shareholder's Report."	Kubiszewski, I., et al.	2015	Oregon USA
A Study on the Genuine Progress Indicators in S. Korea	Kim, G. A. and Moon, T. H.	2022	South Korea
Going regional: An index of sustainable economic welfare for Italy.[9]	Gigliarano, C., et al.	2014	Italy

[9] Although an ISEW study, it was selected to the shortlist due to the substantial overlaps/similarities among the provided variables with the GPI equation.

Building upon the selected GPI studies, an analysis was conducted to identify the most frequently used variables across them. To systematically assess variable similarity and frequency, a two-step methodological approach was employed:

- First, a Python-based script was developed to calculate the Levenshtein Distance between variable names. This allowed for the automated detection of semantic simi larities across differently labeled components, helping to cluster variables with minor naming or formatting variations.
- Second, a manual review was performed to refine these groupings, accounting for conceptual overlap and context-specific terminology. This process ensured that variables expressing the same underlying concept, even if labeled differently, were treated consistently.

The results of the first stage are shown in Figure 9. The first stage of processing showed a vast variety of common variables that were used in the 6 selected GPI studies. The results further validated the first two criteria (covering as many variables as possible and looking into all sustainability "dimensions"). However, it was also found that some variables mentioned and measured the same parameter but with different wording e.g., the variable "cost of motor vehicle crashes" is identical as the variable "costs of auto accidents". Based on that, a second processing stage was added. During that stage, the results of the first stage were taken and edited manually to create a more harmonized taxonomy of the variables used in the GPI studies. Results are shown in Figure 10.

The result of the second stage processing was to create a more robust taxonomy of the most common variables that can also be used for the estimation of the Greek GPI. The result is presented in Table 3. All 16 variables are dispersed in all sustainability dimensions and cover numerous aspects the GPI aims to look at.

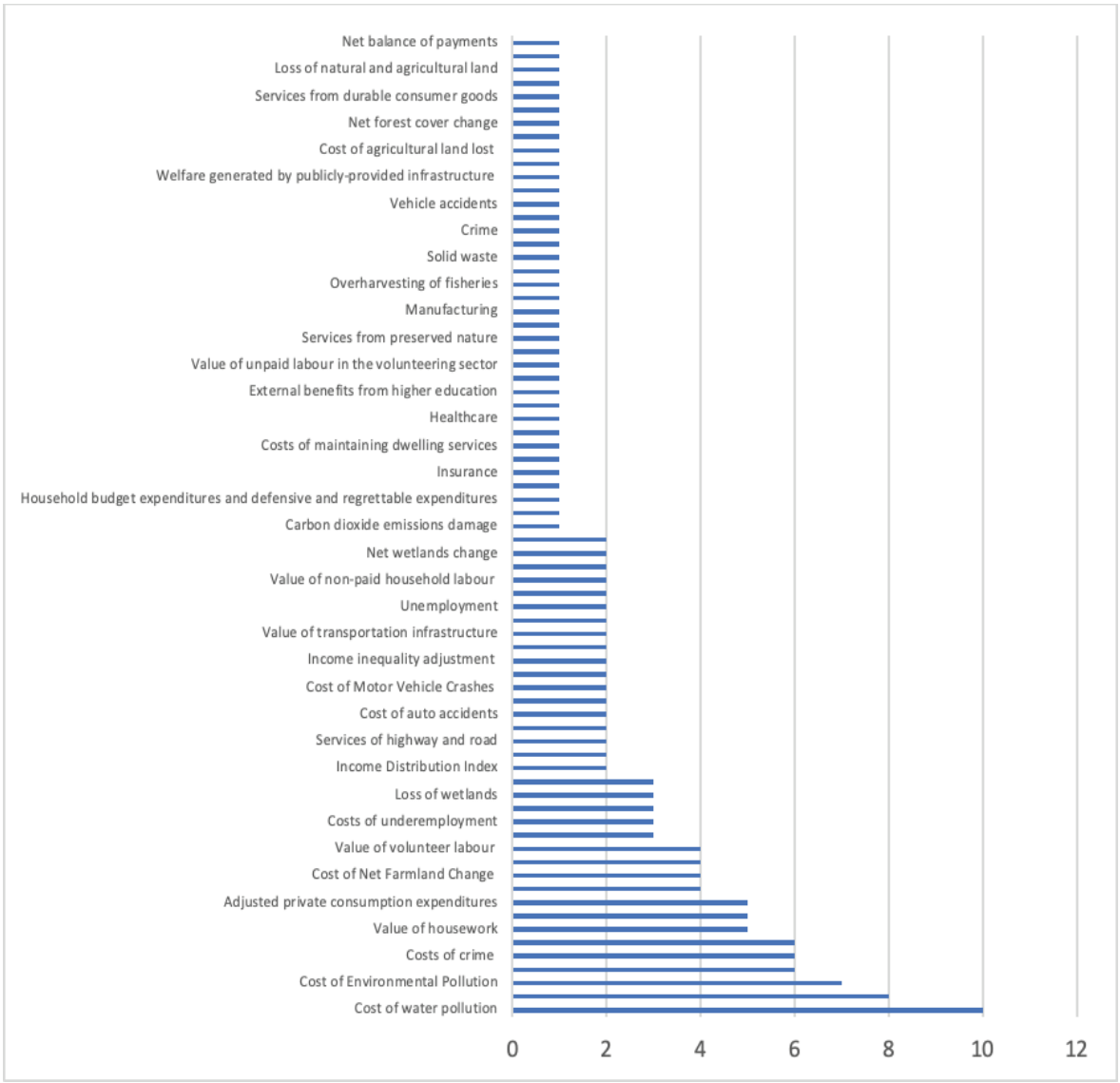

Figure 9: Number of common variables in the selected GPI studies (first stage)

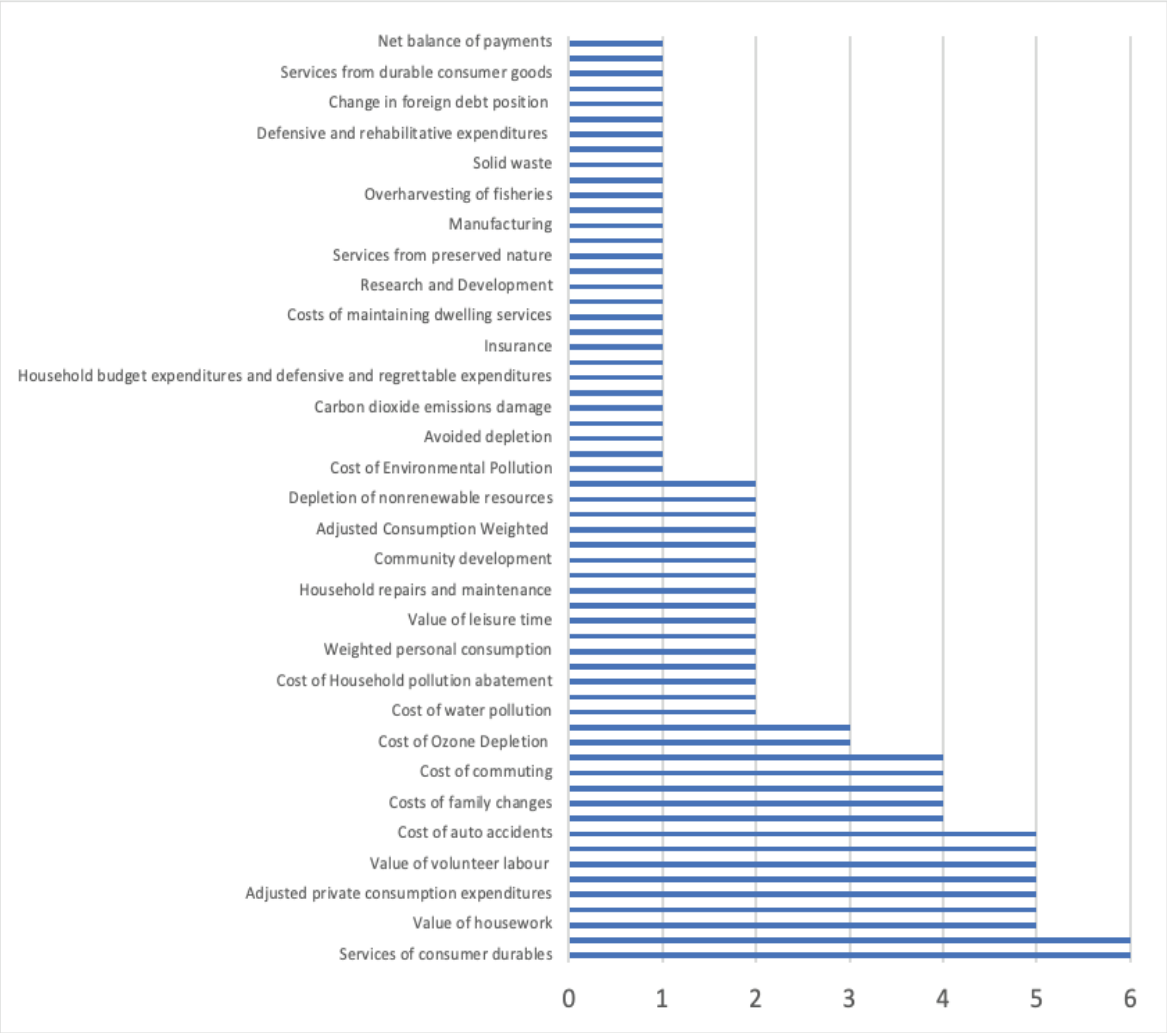

Figure 10: Number of common variables in the selected GPI studies (second stage)

Table 3: List of most common variables in the selected GPI studies.

Economy	Society	Environment
Services of consumer durables	Costs of crime	Cost of Net Farmland Change
Personal Consumption Expenditures	Value of housework	Cost of Air Pollution
Adjusted private consumption expenditures	Value of volunteer labour	Cost of Nonrenewable Energy Resource Depletion
Costs of underemployment	Cost of auto accidents	Cost of ozone Depletion
Public expenditure on health and education	Costs of family changes	
Value of higher education	Cost of commuting	

3.2. Selection of GPI Variables

The analysis in 3.1 section revealed a variety of different variables that can be used in the calculation of the Greek GPI. The final selection of variables was guided not only by the frequency of use across international GPI studies but also by the specific socioeconomic, environmental, and institutional characteristics of the Greek economy, and the availability of consistent and reliable data sources. Based on that, 22 variables were finally selected and included, as summarized in Table 4.

Table 4: Summary of the selected GPI variables and their economic interpretation

Variable	Effect	Description
Adjusted personal consumption (APC)	+	Household consumption adjusted to reflect income inequality in society.
Costs of consumer durables (CCD)	–	Spending on long-lasting household goods such as vehicles, appliances, and furniture.
Services of consumer durables (SCD)	+	Annual value derived from the continued use of household durable goods.
Informal economy (IE)	+	Economic value of legal activities not captured in official GDP due to lack of formal market transactions.
Cost of underemployment (CU)	–	Economic losses resulting from unemployment and temporary or irregular employment.
Value of unpaid work (UW)	–	The estimated contribution of unpaid household and caregiving work to the economy.
Non-defensive government (NDGE) expenditures	+	Public spending that enhances well-being, such as education, cultural services, and environmental protection.
Value of leisure time (LT)	+/–	Economic value of changes in leisure time, depending on whether average working hours decrease or increase.
Non-welfare enhancing household expenditures (NWEHE)	–	Household spending on necessary goods and services that maintain current living standards but do not directly improve well-being. Includes food, beverages, insurance, maintenance, personal care, and similar expenses.

Variable	Effect	Description
Cost of road accidents (CRA)	–	Estimated economic losses due to road traffic accidents.
Cost of crime (CC)	–	Government spending on public safety, including law enforcement, courts, and prisons.
Cost of divorces (CD)	–	Economic impact of legal and administrative expenses associated with divorces.
Cost of noise pollution (CNP)	–	Social cost of exposure to environmental noise in residential areas.
Cost of air pollution (CAP)	–	Total economic cost from air pollution, including both domestic pollution and pollution embedded in imported and exported goods.
Ecosystem costs of nitrogen pollution (ECNP)	–	Environmental damage caused by nitrogen emissions and use in agriculture and industry.
Cost of climate breakdown (CCB)	–	Costs related to the long-term effects of climate change, including carbon emissions.
Depletion of non-renewable energy resources (DNRER)	–	Economic costs associated with the use and exhaustion of fossil fuel resources.
Loss/ gain of wetlands (W)	+/–	Monetary value of the ecological benefits lost or gained from changes in wetland areas.
Loss of forests (F)	–	Economic loss from reduced forest cover, including impacts on biodiversity and ecosystem services.
Net investment (NI)	+/–	The difference between Gross Fixed Capital Formation and Consumption of Fixed Capital.
Net international trade balance (NB)	+/–	The difference between the value of exports and imports of goods and services.
Net foreign assets (NFA)	+/–	The difference between foreign assets and foreign liabilities held by monetary authorities and banks.

3.3. Analysis of the components of GPI

Before presenting and analyzing the individual components of the GPI, it is important to outline some general methodological assumptions that were applied consistently across all variables. All monetary variables were adjusted for inflation using the GDP deflator (2015 = 100) from the World Bank[10] and are expressed in millions of euros (€). Per capita values were calculated using annual population data, also sourced from the World Bank[11] and are expressed in euros (€). Finally, GDP data sourced from Eurostat.[12]

[10] Source World Bank: https://data.worldbank.org/indicator/NY.GDP.DEFL.ZS (Retrieved 09.03.2025).
[11] Source World Bank: https://data.worldbank.org/indicator/SP.POP.TOTL (Retrieved 09.03.2025).
[12] Source Eurostat: https://doi.org/ 10.2908/nama_10_gdp (Retrieved 09.03.2025).

3.3.1. Adjusted personal consumption

The adjusted personal consumption (APC) variable was calculated as the ratio of Actual Individual Consumption (AIC) to the Gini index:

$$\text{APC} = \frac{\text{AIC}}{\text{Gini index}} \quad (2)$$

AIC represents the total consumption of goods and services by individuals, encompassing not only purchases made directly by households but also services provided by non-profit institutions and general government, such as healthcare and education. Due to this broader scope, AIC offers a more suitable metric for international comparisons than simple household consumption. AIC data were sourced from Eurostat[13] for the period 1995–2022.

The Gini index measures income (or consumption) inequality among individuals or households within an economy. It is calculated as the area between the Lorenz curve and the line of perfect equality, expressed as a percentage of the maximum possible area. A Gini index of 0 indicates complete equality, while a value of 100 signifies absolute inequality. Due to the lack of Eurostat data for the years 1995–2013, Gini index values for this period were sourced from the World Bank.[14] For the following years, 2014-2022, data retrieved from Eurostat.[15] In cases of missing Gini index data (specifically for the years 1996–1999 and 2001–2002), linear interpolation was applied to estimate the missing values.

The evolution of APC over the period 1995–2022 reveals notable fluctuations. From 1995 to 2008, the indicator exhibits a steady upward trend, reflecting sustained economic growth and rising private consumption. Starting in 2009, however, a sharp decline occurs, driven by the global financial crisis, reduced incomes, and increasing inequality. In more recent years, a gradual recovery has taken shape, largely due to the relative stabilization of the economy and improved consumer spending (see Fig. 11).

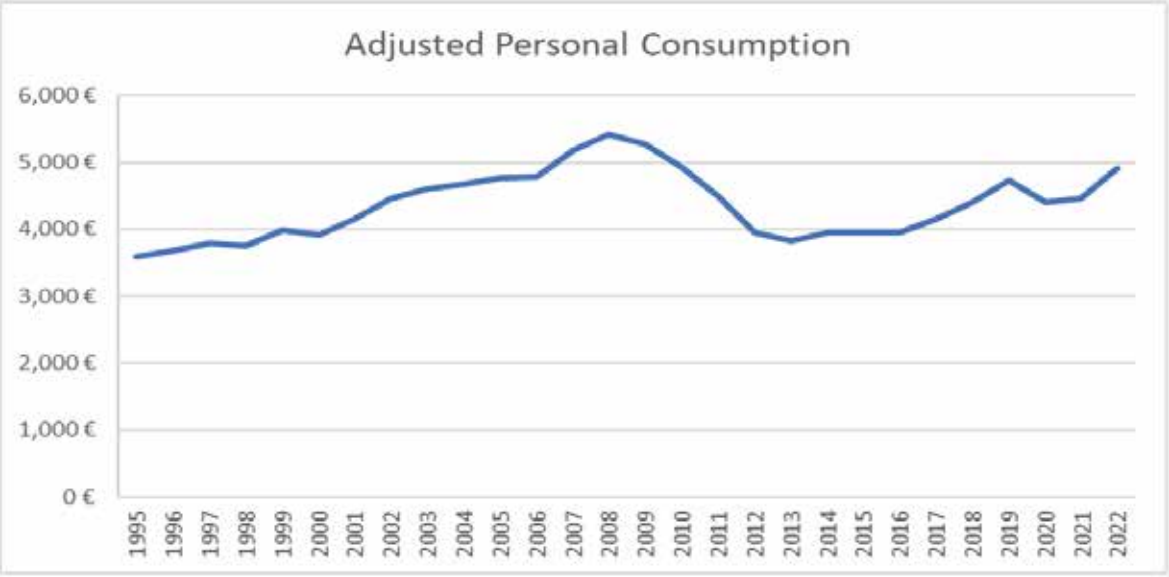

Figure 11: Adjusted personal consumption in Greece, during 1995-2022 (expressed in 2015 real euros)

[13] Source Eurostat: https://doi.org/10.2908/nama_10_gdp (Retrieved 28.02.2025).
[14] Source Word Bank: https://pip.worldbank.org/home (Retrieved 28.02.2025).
[15] Source Eurostat: https://doi.org/10.2908/tessi190 (Retrieved 28.02.2025).

3.3.2. Cost of consumer durables

The variable of cost of consumer durables (CCD) reflects total household expenditure on durable goods such as vehicles, furniture, electrical appliances, and other long-lasting consumer items. Data for the period 1995–2020 were sourced from Eurostat.[16]

For the years 2021 and 2022, due to the unavailability of official data, estimates were produced based on the average annual growth rate observed over the preceding five years. Specifically, the 2020 value was projected forward by applying this average rate to estimate values for 2021 and 2022.

The variable shows an increase until 2008, reflecting the rise in consumption of durable goods in the pre-crisis period. It then follows a sharp downward trend until 2013, mainly due to the economic downturn and limited household purchasing power. From 2014 onwards, a gradual stabilisation with small fluctuations is recorded (see Fig. 12).

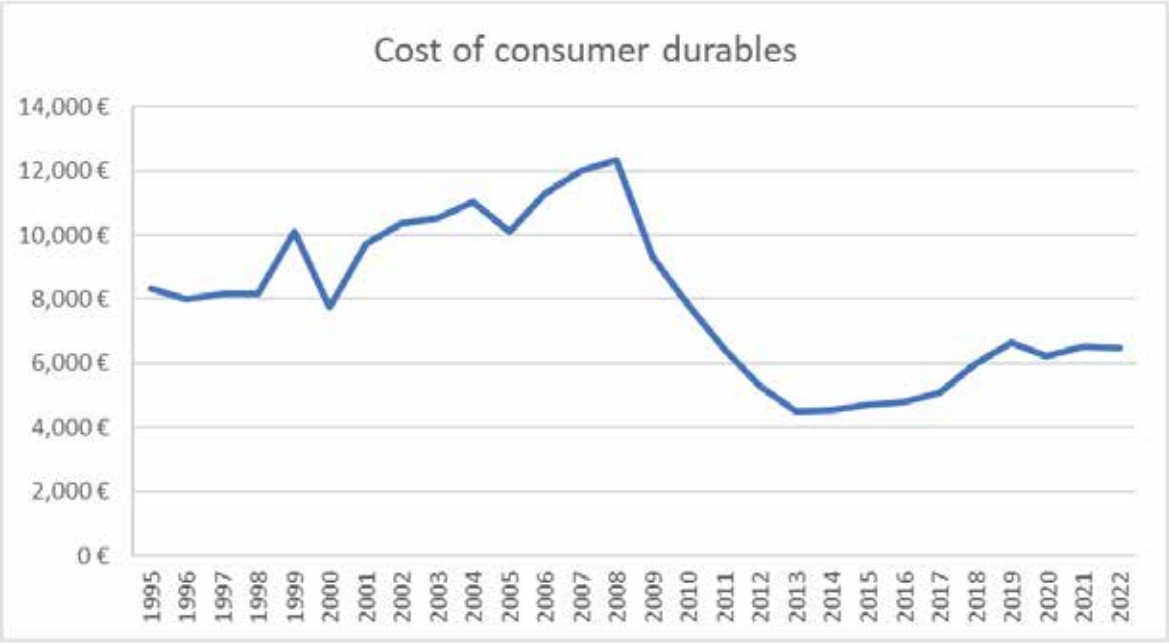

Figure 12: Cost of consumer durables in Greece, during 1995-2022 (expressed in 2015 real euros)

3.3.3. Services of consumer durables

The services of consumer durables (SCD) variable show the yearly value of services provided by durable goods that households already own. Unlike GDP, which treats the full value of these goods as spent at the time of purchase, the GPI considers the ongoing benefits these goods provide over time. The calculation follows most of the literature (Pais et al., 2019) and the formula applied is:

$$\text{SCD} = \text{Cost of Durable Consumer Goods} \times 0.1 \quad (3)$$

[16] Source Eurostat: https://doi.org/10.2908/nama_10_fcs (Retrieved 28.02.2025).

This assumes that each year, 10% of the value of durable goods represents the services they provide. For 2021 and 2022, due to missing data, estimates were made by applying the average growth rate from the previous five years, following the same approach used for the Cost of Consumer Durables variable.

The pattern of this variable is very similar to that of the cost of durable goods. Specifically, it rises up to 2008 and falls sharply during the years of the economic crisis with gradual stabilization in recent years. (see Fig. 13)

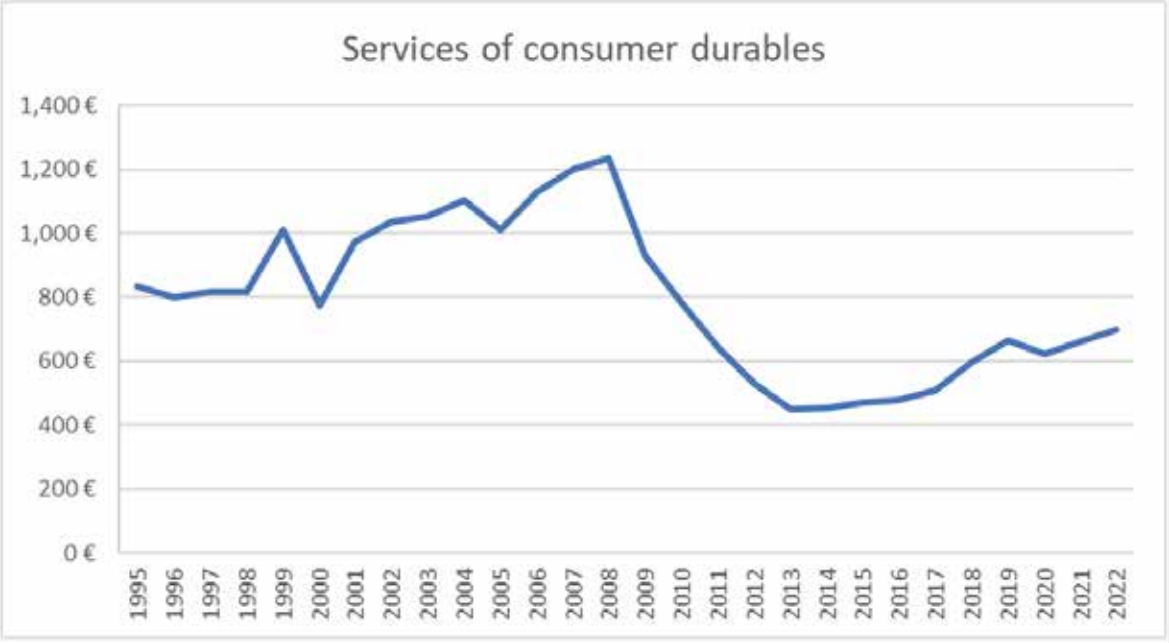

Figure 13: Services of consumer durables in Greece, during 1995-2022 (expressed in 2015 real euros)

3.3.4. Value of informal economy

The variable of the value of the informal economy (IE) captures the economic value of legal but unrecorded activities that are not reflected in official GDP figures. It was calculated by using the following formula:

IE=Size of Informal Economy x GDP (4)

Data on the size of the informal economy was sourced from Elgin et al. (2021). Specifically, estimates from the Multiple Indicators Multiple Causes (MIMIC) model were used, focusing on the variable code MIMIC_p for Greece. The MIMIC model is an indirect estimation method based on a system of structural equations that incorporates multiple causes (e.g. tax burden, regulatory constraints) and indicators (e.g. unemployment, electricity consumption) of informal activity. It measures legal economic output that remains unrecorded, often due to tax avoidance or bureaucratic obstacles. For 2021 and 2022, in the absence of updated data from the study, values were estimated using the average growth rate of the previous five years.

The variable remains relatively stable until the mid-2000s, when it reaches a peak. It then declines sharply during the economic recession, followed by a period of stabilization and a slight recovery trend towards the end of the timeframe (see Fig. 14).

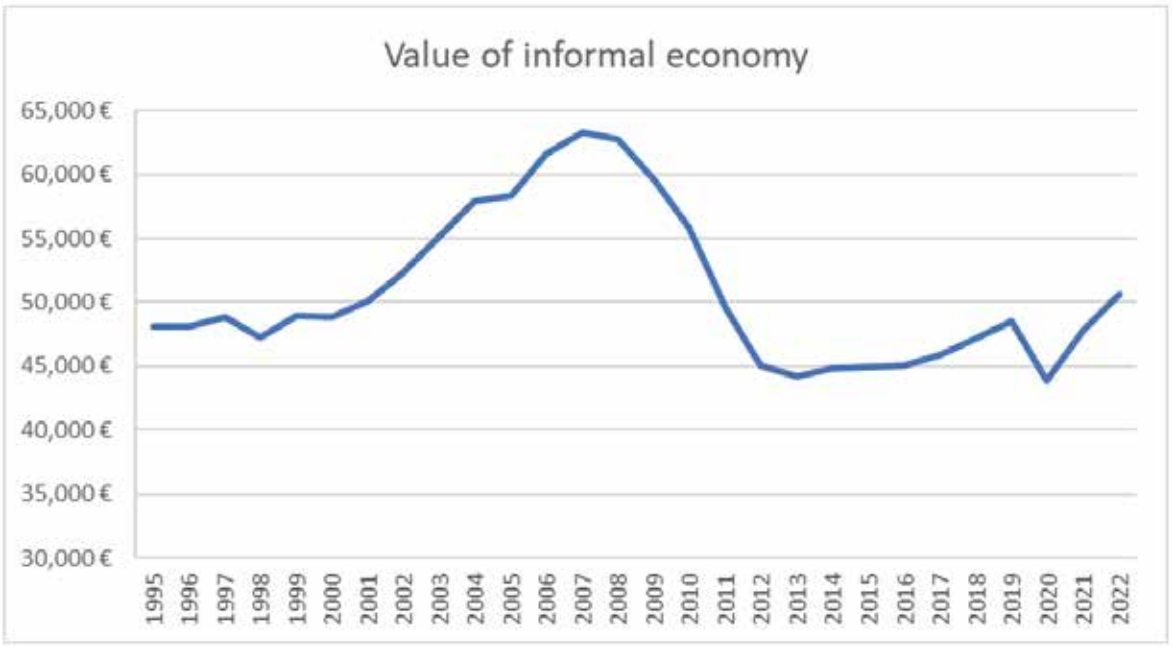

Figure 14: Value of informal economy in Greece, during 1995-2022 (expressed in 2015 real euros)

3.3.5. Cost of underemployment

The variable of the cost of underemployment (CU) represents the economic loss resulting from unemployment and temporary (non-permanent) employment among individuals aged 15 to 74. It is calculated using the following formula, as proposed by Kim and Moon (2024):

$$\mathbf{CU = (Temporary\ Employment + Unemployees) \times Average\ Annual\ Wage} \quad \mathbf{(5)}$$

Due to limited data on underemployment, the study focuses only on the unemployed and temporary workers, excluding the economically inactive population to avoid overestimating the costs. Data on temporary employment was sourced from Eurostat[17] and refers to individuals with fixed-term contracts or other employment arrangements with a predetermined end date. Unemployment data were also retrieved from Eurostat.[18] Average annual wage data was obtained from the OECD,[19] expressed in full-time equivalent units across the entire economy. This measure is based on total earnings divided by the average number of employees and adjusted for average weekly hours worked (both full-time and part-time). As shown in Figures 15 and 16, the variable has followed a steady upward trend since the mid-1990s, peaking in 2013 during a period of rapidly rising unemployment. Since then, it has declined, even as temporary employment and wage levels have remained relatively stable.

[17] Source Eurostat: https://doi.org/10.2908/lfsa_etgaed (Retrieved 24.02.2025).
[18] Both temporary employment and unemployed data refer to individuals aged 15 – 74.
[19] Source OECD: https://www.oecd.org/en/data/indicators/average-annual-wages.html (Retrieved 24.02.2025).

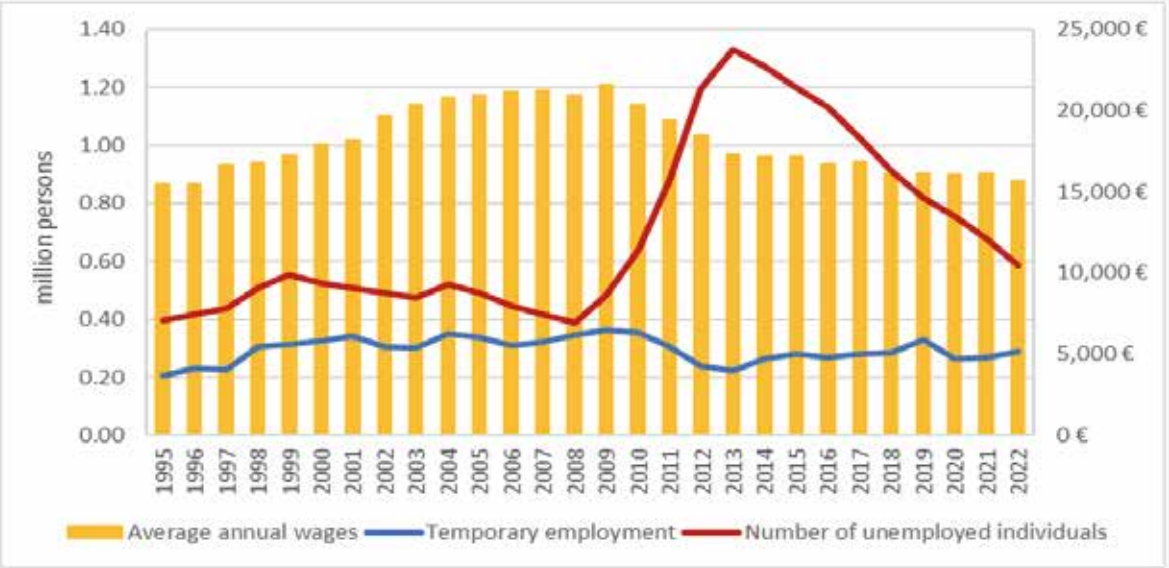

Figure 15: Components of underemployment cost in Greece, during 1995-2022 (temporary employment, unemployment and average annual wages)

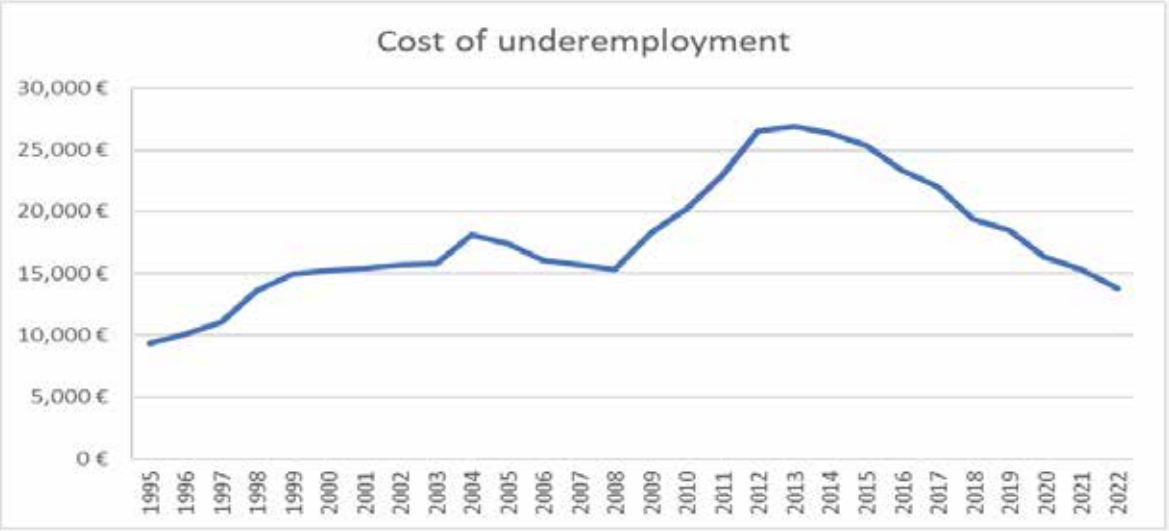

Figure 16: Cost of underemployment in Greece, during 1995-2022 (expressed in 2015 real euros)

3.3.6. Value of unpaid work

The value of Unpaid Work (UW) variable represents the monetary value of unpaid activities carried out by individuals aged 15 to 74 in the context of everyday life. It includes tasks such as housework, caregiving for family members, volunteering, and participation in social or community-based activities. Although this type of work plays a significant role in supporting household well-being and social cohesion, it is not captured in official GDP figures.

Data for this variable is sourced from Soupart and Bleys (2024b).[20] As data are only available up to 2020, estimates for 2021 and 2022 were generated by applying the average annual rate of change from the preceding five years. The value of unpaid work is given by:[21]

$$\begin{aligned} \textbf{UW} &= \textbf{Time Spent on UW per Person} \\ &\times \textbf{Population} \\ &\times \textbf{Replacement Wage} \end{aligned} \qquad \textbf{(6)}$$

As shown in the Fig. 17, the value of unpaid work increased steadily from 1995 to 2010, reflecting both population growth and an increase in time spent on unpaid activities within households. After 2011, a gradual decline followed by relative stabilisation is observed, likely influenced by social and demographic shifts, changes in family structures, and evolving patterns of leisure time.

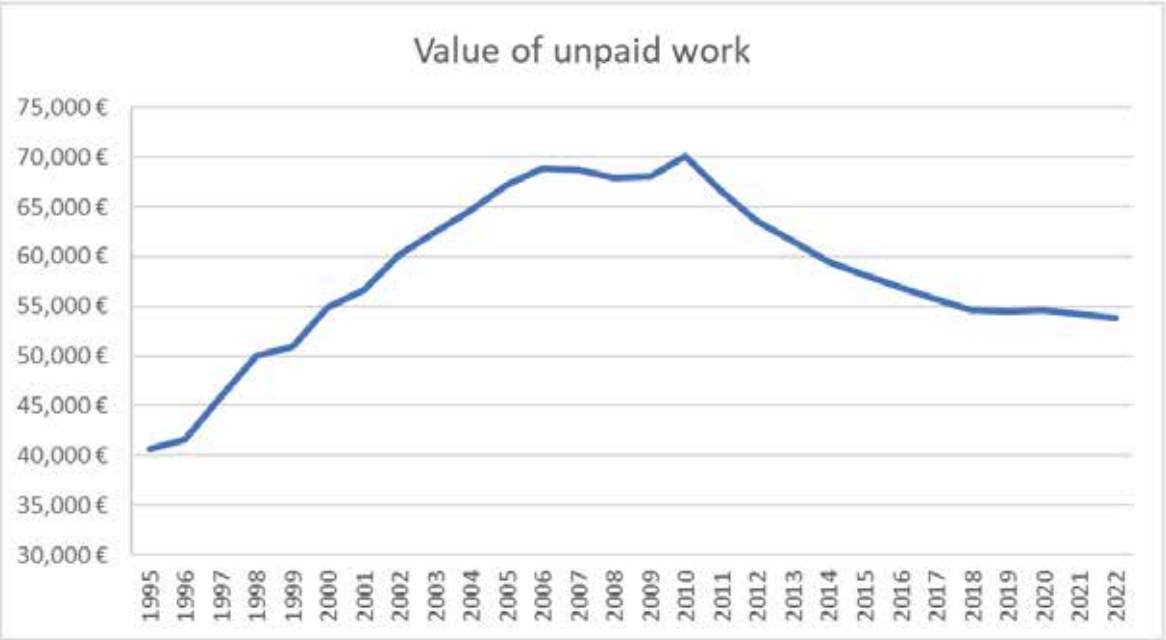

Figure 17: Value of unpaid work in Greece, during 1995-2022 (expressed in 2015 real euros)

3.3.7. Non-defensive government expenditures

The non-defensive government expenditures (NDGE) variable reflects government spending by the general government on goods and services intended for the public, particularly households, but which cannot be linked to specific individuals. This type of spending promotes collective welfare and supports the welfare state. It stands in contrast to defensive expenditures, which are primarily aimed at addressing societal problems such as crime or pollution. To estimate this variable, data from Eurostat[22] were used and specifically, the General Government Expenditure by Function (Classification of the functions of government-COFOG) dataset. This dataset classifies public spending into ten main categories (COFOG Level I). For this analysis, the following categories were aggregated:

[20] Source dataset: 10.5281/zenodo.13365452 (Retrieved 01.03.2025).
[21] For details on the index construction methodology, see Soupart and Bleys (2024, pp. 11–13).
[22] Source Eurostat: https://doi.org/10.2908/gov_10a_exp (Retrieved 03.03.2025).

- **General Public Services:** Includes spending on executive and legislative bodies (excluding spending on public order & safety), budgetary services, external relations, foreign economic aid, general services, public debt-related transactions, basic research, and R&D related to public administration.
- **Housing and Community Amenities:** Covers expenditure for housing develop ment, community improvement, water supply, public lighting, and associated R&D.
- **Recreation, Culture and Religion:** Encompasses cultural services, sports and recrea tion, media, religious and other community activities, as well as research and development in these areas.
- **Environmental Protection:** Includes waste and wastewater management, pollution control, protection of nature and landscapes, and related R&D.
- **Education:** Covers the full range of the education system (across all levels), educa tional support services, and research activities related to education.

Figure 18 presents a breakdown of the individual categories that comprise the variable. As shown, General Public Services consistently account for the largest share of expenditure, followed by Education, which also makes a significant contribution. The remaining categories (i.e., environmental protection, housing & community amenities, and recreation, culture & religion) maintain a smaller yet important role, particularly during periods of strengthened social policy or increased funding through Community programs.

According to Figure 19, NDGE remained relatively stable in the early years of the period, with a notable increase between 2004 and 2010, likely due to financial and administrative preparations for the 2004 Olympic Games, as well as broader investments in social infrastructure. From 2011 onward, the variable shows a downward trend, reflecting the impact of fiscal adjustment measures and reductions in social spending during the economic crisis.

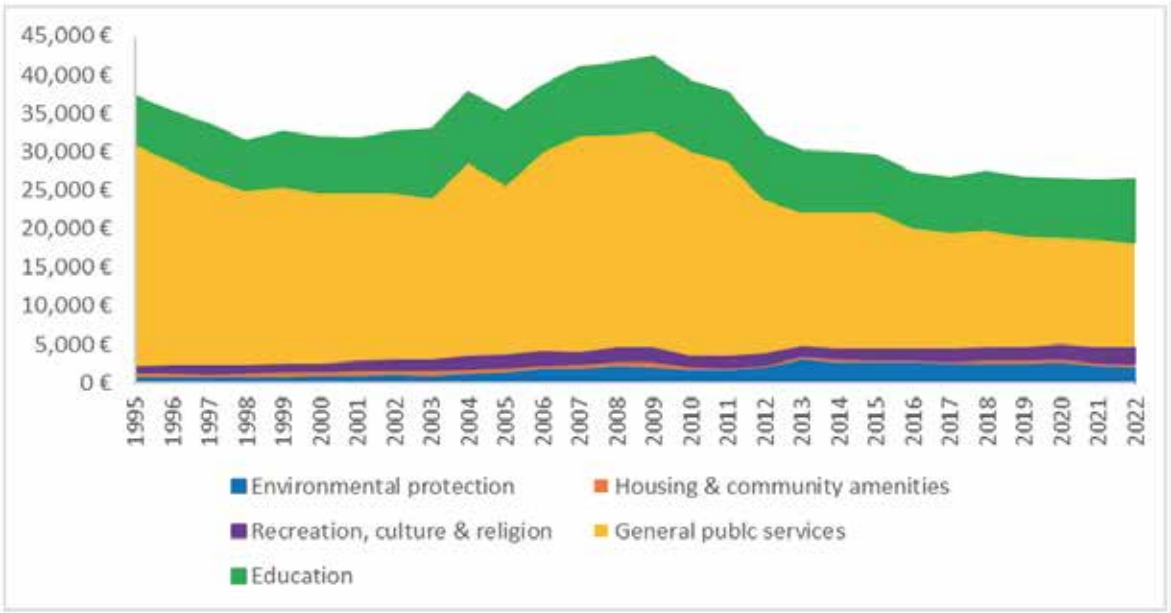

Figure 18: Composition of non-defensive government expenditures in Greece, during 1995–2022, based on selected COFOG categories (expressed in 2015 real euros)

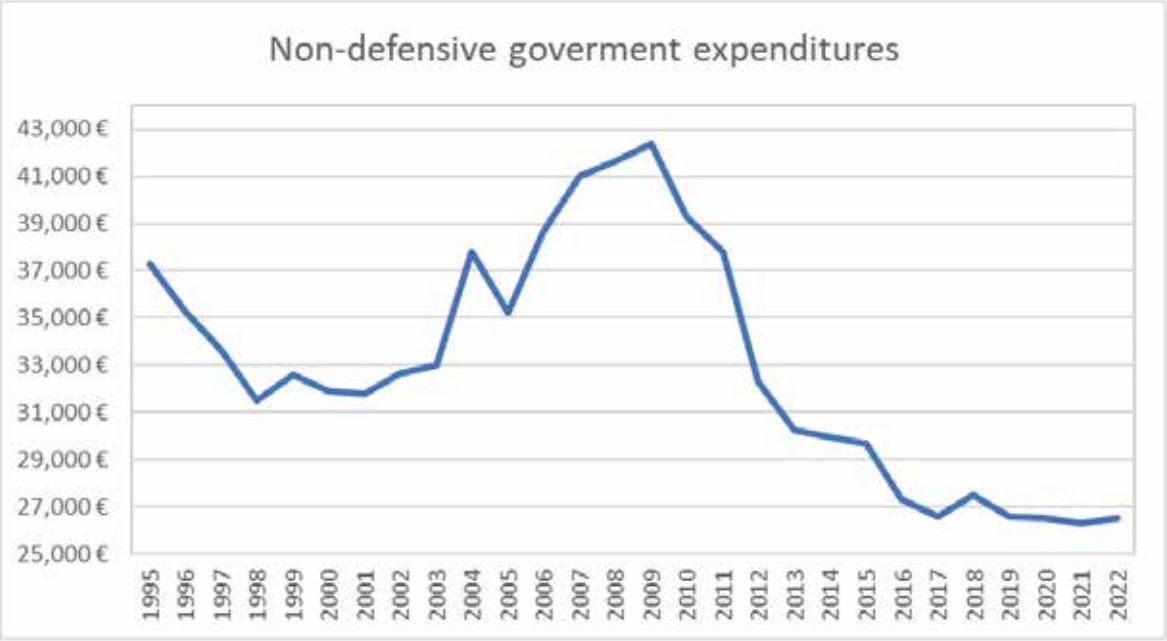

Figure 19: Non-defensive government expenditures in Greece, during 1995-2022 (expressed in 2015 real euros)

3.3.8. Value of leisure time

The variable of the value of leisure time (LT) represents the monetary value of changes in employees' leisure time resulting from annual increases or decreases in actual working hours. It is an indicator that aims to quantify the benefit gained from reduced working hours, or the cost incurred from longer working hours, on individuals' well-being. The calculation follows the approach proposed by Kim and Moon (2024). Specifically, the value of leisure time is given by:

$$\begin{aligned} \mathbf{LT} &= \mathbf{Total\ Employment} \\ &\times \mathbf{\Delta(Average\ Annual\ Working\ Hour)} \\ &\times \mathbf{Average\ Annual\ Wage\ per\ Hour} \end{aligned} \qquad \mathbf{(7)}$$

where:

- Total Employment: refers to the total number of employed persons aged 15–74, as reported by Eurostat.[23]
- Δ(Average Annual Working Hours): is the change in average actual annual working hours per employee compared to the previous year. Data are sourced from the OECD[24] and include both full-time and part-time workers. This indicator is calculated by dividing the total number of hours worked in a year by the average number of employees in the economy.
- Average Hourly Wage: is calculated by dividing average annual wages (in full-time equivalents) by the corresponding average annual hours worked, based on OECD data.[25]

[23] Source Eurostat: https://doi.org/10.2908/lfsa_egan (Retrieved 10.03.2025).
[24] Source OECD:https://www.oecd.org/en/data/indicators/hours-worked.html (Retrieved 12.03.2025).
[25] Source OECD: https://www.oecd.org/en/data/indicators/average-annual-wages.html (Retrieved 12.03.2025).

A positive value of the variable indicates that workers worked fewer hours than in the previous year, gaining more leisure time, which is associated with improved well-being. Conversely, a negative value reflects an increase in working hours, resulting in reduced leisure time and, consequently, a decline in well-being.

As shown in Figure 20, the variable fluctuates moderately between positive and negative values over the period 1995–2019. However, a sharp negative value is recorded in 2020, likely reflecting the disruption in the labour market caused by the COVID-19 pandemic. This is followed by a strong positive value in 2021, probably due to reduced working hours and changes in working conditions. In 2022, a positive but more moderate change is observed.

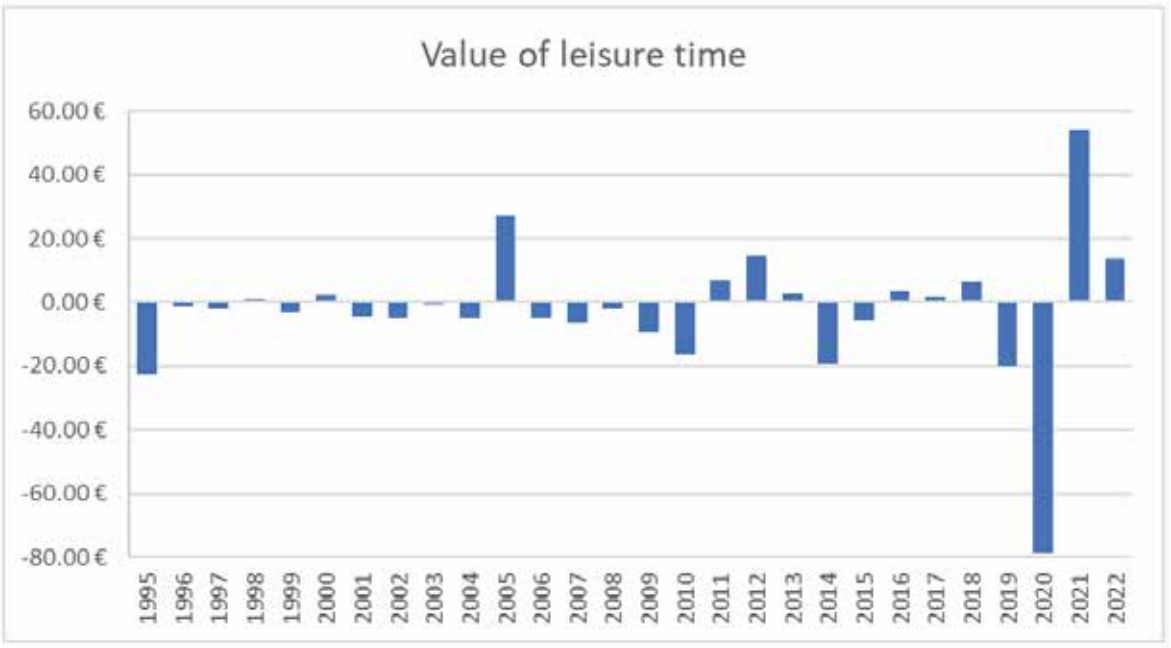

Figure 20: Value of leisure time in Greece, during 1995-2022 (expressed in 2015 real euros)

3.3.9. Non-welfare enhancing household expenditures

The Non-Welfare Enhancing Household Expenditures (NWEHE) variable captures household spending that, while essential for maintaining a basic standard of living, does not directly contribute to improved well-being. These expenditures are primarily related to maintenance, daily functioning, or necessity, rather than to enhancing quality of life.

To estimate the variable, data from Eurostat[26] were used. Specifically, the Household Final Consumption Expenditure by Purpose dataset (COICOP 1999) was employed, which classifies household spending into 12 main categories and their subcategories. From total household consumption, the following categories were selected and aggregated:

[26] Source Eurostat: https://doi.org/10.2908/nama_10_co3_p3 (Retrieved 05.03.2025).

Food and Non-Alcoholic Beverages: Covers the purchase of essential food and drink items necessary for daily nutrition. While fundamental for survival, these expenditures do not contribute to well-being beyond the basic level.

- **Alcoholic Beverages, Tobacco, and Narcotics:** Refers to spending on alcohol, tobacco, and similar substances. Although classified as consumer goods, they are generally not considered beneficial to health or overall well-being.
- **Insurance:** Includes various forms of insurance coverage that provide protection against risks. While important, these expenditures serve a preventive function rather than directly enhancing welfare.
- **Financial Services:** Relates to banking and financial services associated with house hold transactions and account management.
- **Household Maintenance:** Encompasses goods and services required for regular upkeep of the household, such as cleaning supplies, tools, and minor repairs.
- **Personal Care:** Covers spending on hygiene products, grooming, and other personal care items, which support daily functioning but do not necessarily lead to increased well-being.

Figure 21 presents the detailed breakdown of the variable by category. It is evident that Food and Non-Alcoholic Beverages consistently account for the largest share of total expenditure, followed by Financial Services and Insurance. The remaining categories contribute smaller but relatively stable amounts. These trends reflect both pricing developments and shifts in household preferences and needs over time.

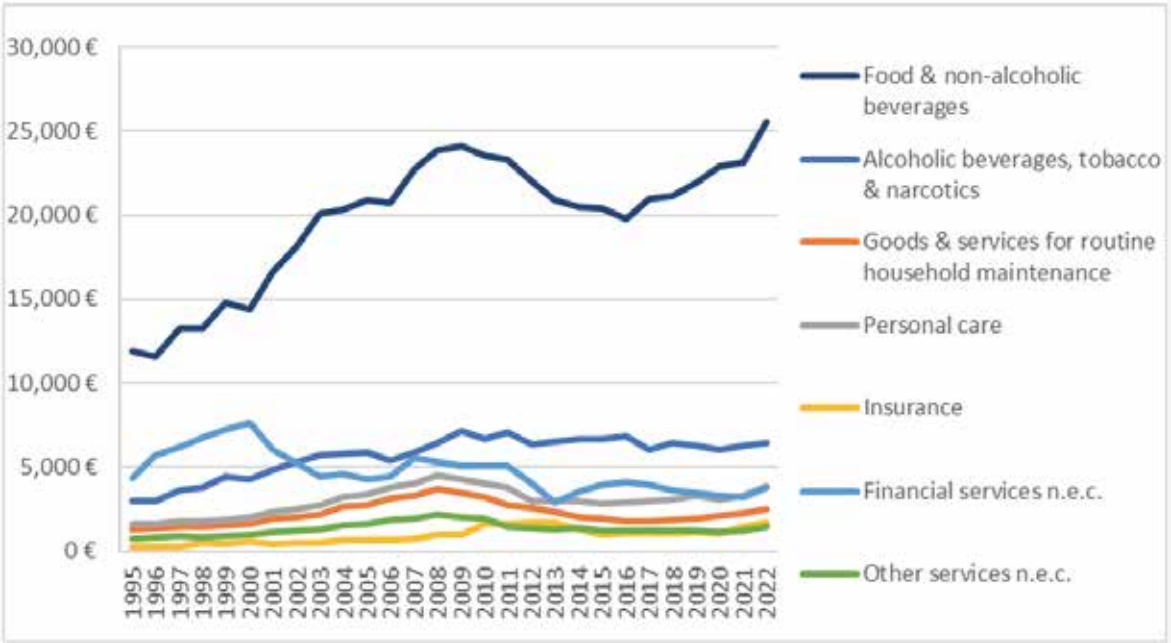

Figure 21: Composition of non-welfare enhancing household expenditures by COICOP category, Greece 1995–2022 (expressed in 2015 real euros)

Figure 22 illustrates the evolution of the total cost of these expenditures over the period 1995–2022. As shown, costs increased steadily until 2009, reflecting rising consumption levels and higher prices. This is followed by a decline lasting until 2014, likely due to the economic recession and reduced disposable income. From 2015 onward, a gradual upward trend is observed.

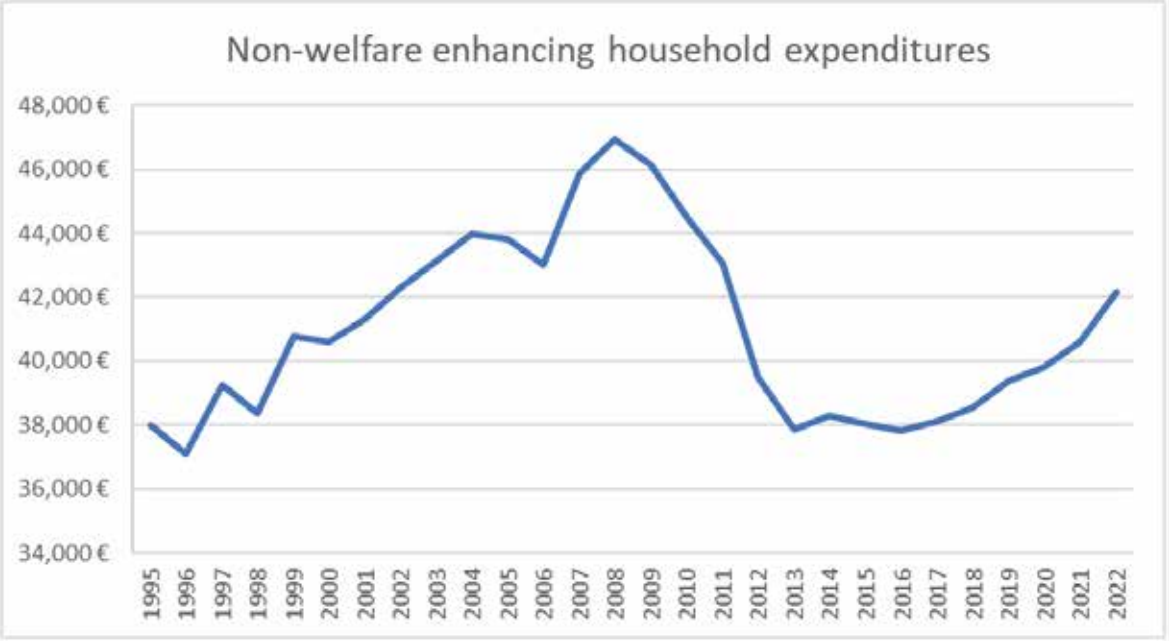

Figure 22: Value of non-welfare enhancing household expenditures in Greece, during 1995-2022 (expressed in 2015 real euros)

3.3.10. Cost of road accidents

The variable of the cost of road accidents (CRA) was based on the following:

- Data on road accidents (1995-2022) were taken by ELSTAT[27]
- The estimation of cost was based on International Transport Forum (2020) and Kour tis et al. (2018). The cost per lethal accident as well as the cost per accident with serious and slight injuries was estimated.

Because ELSTAT provided data only on lethal accidents/ accidents with injuries, it was assumed that the ratio between accidents with slight/ serious injuries is 7:3. This was based on the data on accidents of Kourtis et al. (2018). Then the cost of each accident (lethal/ with injuries) was multiplied with the number of accidents respectively.

As in Figure 23, a clear decreasing trend is observed. However, since 2014, the decrease rate has been slowing down.

[27] Source ELSTAT: https://www.statistics.gr/el/statistics/-/publication/SDT04/2022 (Retrieved 20.03.2025).

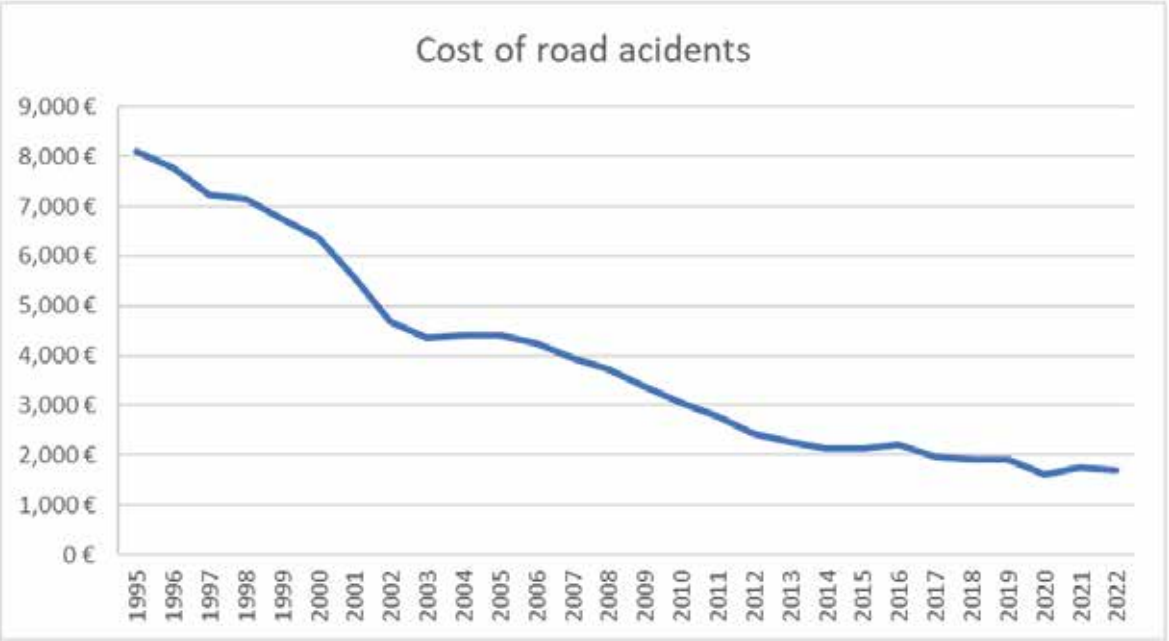

Figure 23: Cost of road accidents in Greece, during 1995-2022 (expressed in million 2015 real euros)

3.3.11. Cost of crime

The estimation of the variable of the cost of crime (CC) was based on Eurostat and more specifically on COFOG dataset (see section 3.3.7) from 2001 onwards.28 Based partially on the methodology proposed by Cook and Davíðsdóttir (2021), it was assumed that the cost of crime equals the annual government expenditures on GF03 Public order & safety and, mainly, the sum of the subcategories Police services, Law courts and Prisons. For the years 1995-2001, a yearly increase of 3% is assumed.

As shown in Figure 24, the cost of crime increased until 2009, followed by a downward trend until 2015, then remained fairly stable between 3,000 and 3,500 million €.

[28] Source Eurostat: https://doi.org/10.2908/GOV_10A_EXP (Retrieved 28.02.2025).

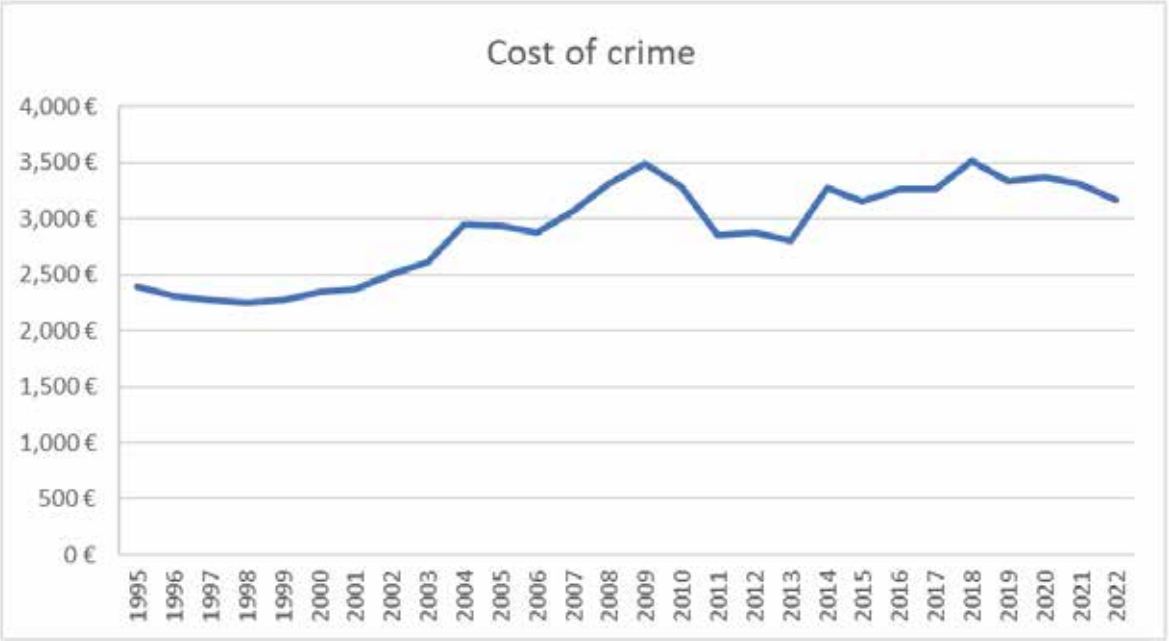

Figure 24: Cost of crime in Greece, during 1995-2022 (expressed in million 2015 real euros)

3.3.12. Cost of divorces

The total cost of divorces (CD) was based on the distinct estimation of two main divorce categories, namely, consensual and adversarial divorces, for the period with data availability (2008-2022), while, during the period 1995-2007 there is no distinction, hence divorces are available as one unified statistic. Data on total divorces (1995-2007) were taken by ELSTAT29 and data on the distinction of divorces into consensual and adversarial (2008-2022) were taken by ELSTAT.30 The mean price of Consensual divorces cost (800 €) was taken from Menegaki and Tsagkarakis (2015), and Kathimerini (2014), as well as additional research to the webpages of various law firms in Athens,31 made by the authors. The mean price of adversarial divorces is very difficult to obtain, as it remains a case-oriented result, affected by negotiations between the couple, the existence of children or not, and so on. We assumed that the mean cost of adversarial divorce is the maximum cost available for a consensual divorce, thus equals to 1,500 €. Finally, for the period 1995-2007 where the distinction between divorces into consensual and adversarial is not available, we use the average cost of these two categories (thus, 1,150 €) and multiply it with the respective number of divorces. It goes without saying that this is a very conservative assumption, as the actual cost of adversarial divorces is expected to be much higher than that, hence the actual cost of divorces in Greece is substantially underestimated in our case (see Figure 25).

[29] Source of total divorces (1995-2007): https://www.statistics.gr/el/infographic-marriages-2015?inheritRedirect=true (Retrieved 20.03.2025).
[30] Source of consensual and adversarial divorces for 2008-2017 period (ELSTAT): https://www.statistics.gr/documents/20181/16314203/Στατιστικές+Διαζυγίων+%28+2017+%29.pdf/c6722cda-7c31-4f55-9eaa-6177db8cdcd7?t= 1555059288837 & Source of consensual and adversarial divorces for 2018-2022 period (ELSTAT): https://www.statistics.gr/ documents/20181/3a2748aa-9f4c-a4fa-76b1-2c14348eaa19
[31] Most law firms in Greece estimate that a consensual divorce costs approximately around 500 – 1,500 euros.

Figure 25: Cost of divorces in Greece, during 1995-2022 (expressed in 2015 real euros)

3.3.13. Cost of noise pollution

The cost of noise pollution (CNP) is based on the percentage (%) of population reporting that noise is a problem in the living environment, according to the World Health Organization (WHO). The period with available data provided by WHO is 2004-2012.32 For the years 2013-2017 we assume a constant percentage (%), equal to the latest year with available data. For the years 2017-2022 we adopt the European Environment Agency (EEA) estimating that there was a 2% decrease in the number of people exposed to harmful noise.33 We did not attempt to estimate the cost of noise pollution for the period 1995-2003, due to lack of data availability. The Greek population data were retrieved by ELSTAT.34 Population data was multiplied with the respective percentage per year, to estimate the population affected by noise pollution. The per capita cost of noise pollution was estimated by calculating the average yearly cost based on three (3) different estimates on noise pollution cost (see Fig. 26):

[32] Percentage (%) of population affected by noise, dataset provided by World Health Organization (WHO): https://gateway.euro.who.int/en/indicators/enhis_54-percentage-of-population-reporting-that-noise-is-a-problem-in-the-living-environment/#id=21431 (Retrieved 20.02.2025).
[33] Source EEA: https://www.eea.europa.eu/en/european-zero-pollution-dashboards/indicators/exposure-of-europes-population-to-environmental-noise-indicator-1?activeTab=36d0b18e-971a-43c0-b578-be85eed448c7 (Retrieved 25.02.2025).
[34] Source ELSTAT: https://www.statistics.gr/en/statistics/-/publication/SPO18/- (Retrieved 01.03.2025).

- According to EEA, the cost of road & rail noise pollution in Europe per year is approximately 40 billion euros (thus cost per person/year: 88 €).[35]
- Weinhold (2013) calculated the required income transfer to compensate for the noise affections and estimated the costs of noise pollution to be approximately around €172 per household/per month.
- Gaufield and O'Mahony (2007) estimate the cost of noise pollution at 137.2 € per person/year.

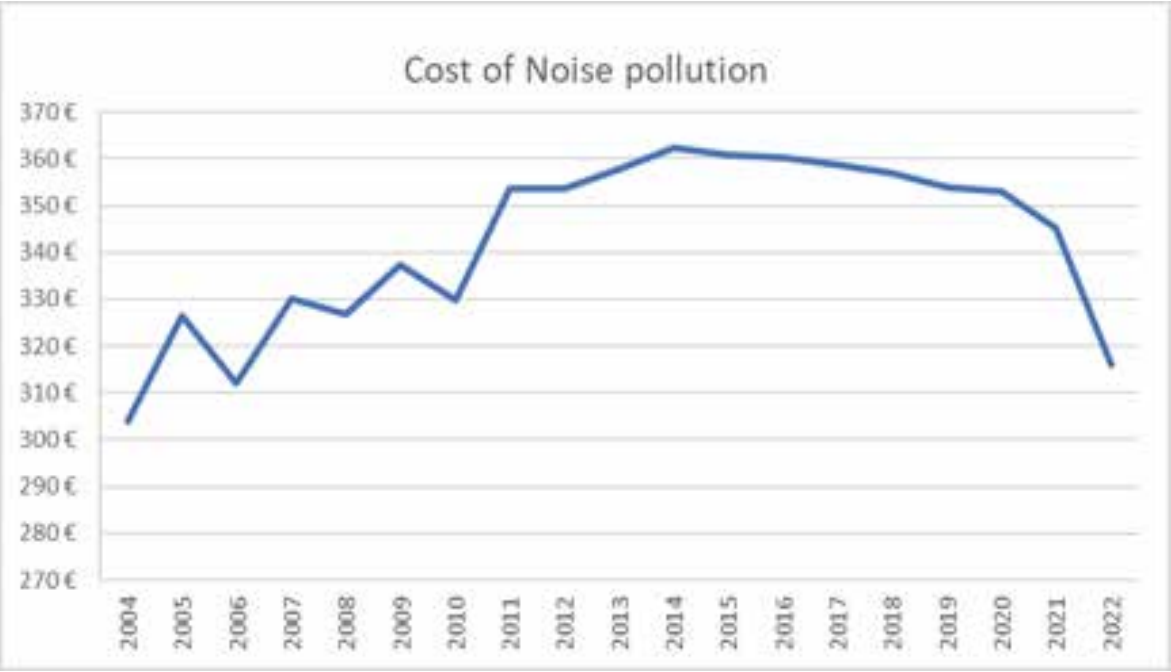

Figure 26: Cost of noise pollution in Greece, during 2004-2022 (expressed in million 2015 real euros)

3.3.14. Cost of air pollution

The cost of air pollution (CAP) represents the monetary value of cost estimates to health and the environment caused by pollutants emitted to air. Data for this variable are sourced from Soupart and Bleys (2024b).[36] As data are only available up to 2020, estimates for 2021 and 2022 were generated by applying the average annual rate of change from the preceding five years. The cost of air pollution is given by:[37]

$$\text{CAP} = \text{costs of current air pollution} + \text{costs of air pollution embodied in trade} \quad (8)$$

[35] Source EEA: https://www.eea.europa.eu/soer/2015/europe/noise#note6 (Retrieved 03.03.2025).
[36] Source dataset: 10.5281/zenodo.13365452 (Retrieved 01.03.2025).
[37] Costs of current air pollution is given by: (emissions PM2.5 * cost estimate PM2.5) + (emissions NH3 * cost estimate NH3) + (emissions NOx * cost estimate NOx) + (emissions NMVOC * cost estimate NMVOC) + (emissions SOx * cost estimate SO2). Costs of air pollution embodied in trade is calculated as follows: (costs from consumption - costs from production) * cost estimate. For details on the index construction methodology, see Soupart and Bleys (2024, pp. 11–13).

Both components of air pollution present an increasing trend until 2007. Since 2008 the cost of air pollution from production has decreased and stabilized since 2019. The cost of air pollution embodied in trade decreases more than the cost of air pollution from production until 2015 but then increases and surpasses it from 2020 onwards (see Fig. 27).

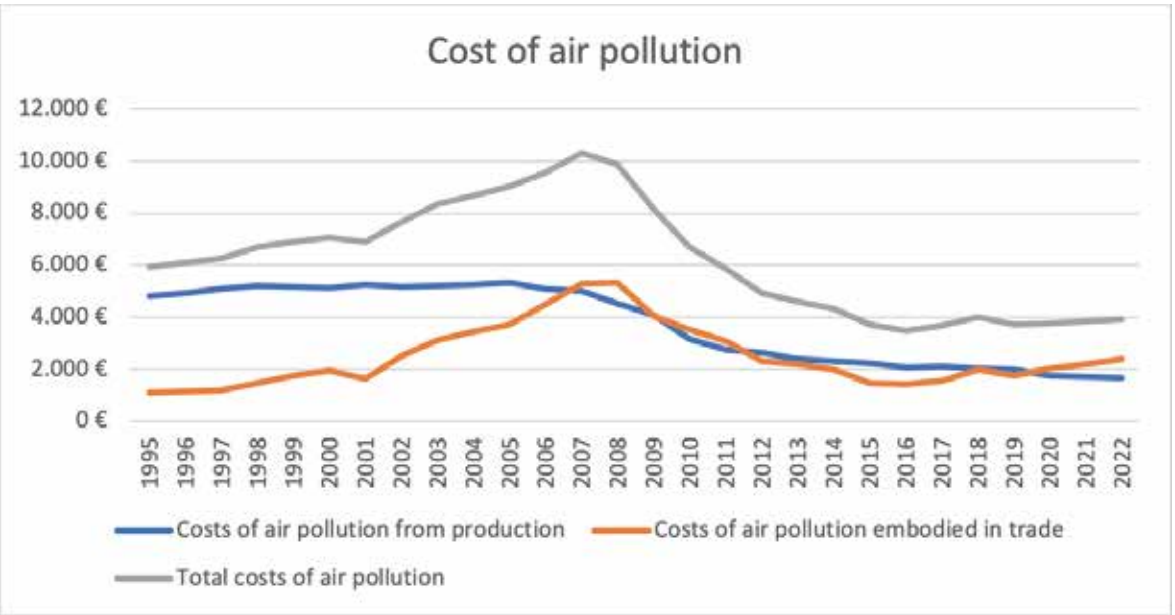

Figure 27: Cost of air pollution in Greece, during 1995-2022 (expressed in million 2015 real euros)

3.3.15. Ecosystem cost of nitrogen pollution

The ecosystem cost of nitrogen pollution (ECNP) represents the monetary value of cost estimates to environment caused by nitrogen pollutants such as ammonia (NH3), nitrogen oxides (NOx) and reactive nitrogen (Nr) i.e., consumption of inorganic fertilisers. Health impacts are not taken into account to avoid possible double counting with the cost of air pollution.

Data for this variable are sourced from Soupart and Bleys (2024a).[38] As data are only available up to 2020, estimates for 2021 and 2022 were generated by applying the average annual rate of change from the preceding five years. The cost of air pollution is given by:[39]

$$\begin{aligned} \textbf{ECNP} = &\textbf{(emissions NH3 *ecosystem cost estimate NH3)} \\ &+ \textbf{(emissions NOx*ecosystem cost estimate NOx)} \\ &+ \textbf{(Nr consumption*ecosystem cost estimate Nr)} \end{aligned} \quad \textbf{(9)}$$

The ecosystem costs of nitrogen pollution are fairly stable at 5,000 € until 2007, when the costs decreased until 2012 and then stabilised at 3,000 (see Fig. 28).

[38] Source dataset: 10.5281/zenodo.13365452 (Retrieved 01.03.2025).
[39] For details on the index construction methodology, see Soupart and Bleys (2024, pp. 11–13).

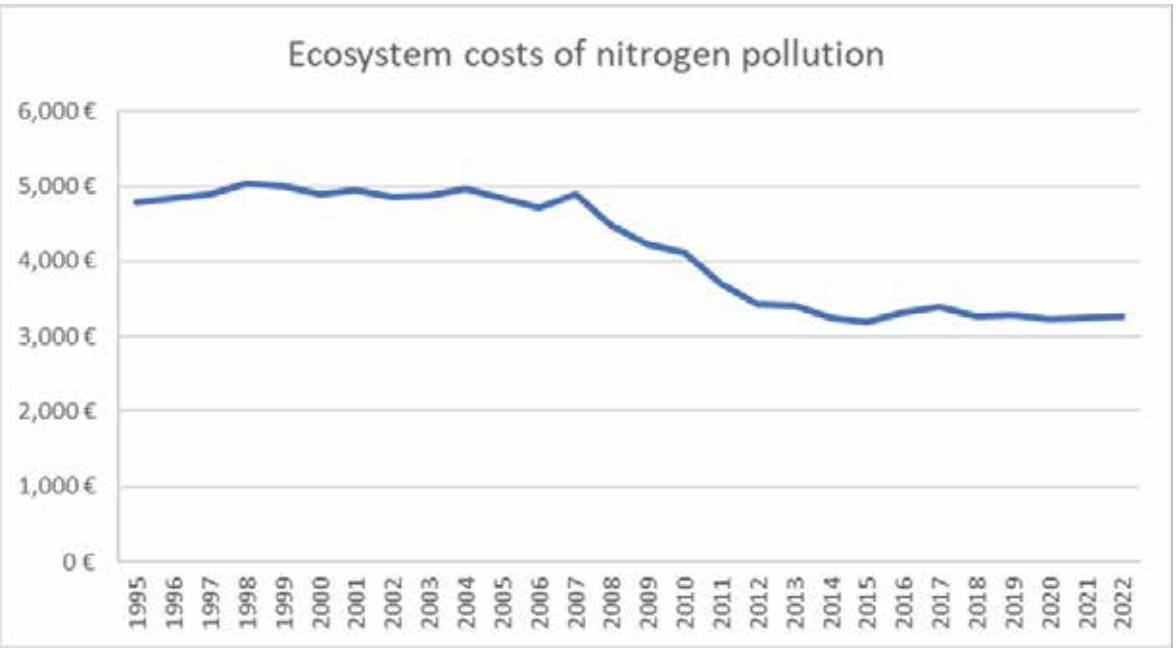

Figure 28: Cost of ecosystem costs of nitrogen pollution in Greece, during 1995-2022 (expressed in million 2015 real euros)

3.3.16. Cost of climate breakdown

The cost of climate breakdown (CCB) concerns the uninsured costs of extreme weather events now and in the future.

Data for this variable are sourced from Soupart and Bleys (2024).[40] As data are only available up to 2020, estimates for 2021 and 2022 were generated by applying the average annual rate of change from the preceding five years. The cost of climate breakdown is given by:[41]

CCB = total UNFCCC emissions + emissions from international aviation
+ emissions from international navigation
+ CO2 emissions from biomass
+ national LULUCF emissions
+ (consumption emissions - territorial emissions)
+land use change footprint)
*** Social Cost of Carbon (SCC)** **(10)**

The cost of climate breakdown presents an upwards trend until 2010. Then, the cost is decreased for the time-period 2010-2015, and since then it is fairly stabilized at 40,000 € (see Fig. 29).

[40] Source dataset: 10.5281/zenodo.13365452 (Retrieved 01.03.2025).
[41] For details on the index construction methodology, see Soupart and Bleys (2024, pp. 11–13).

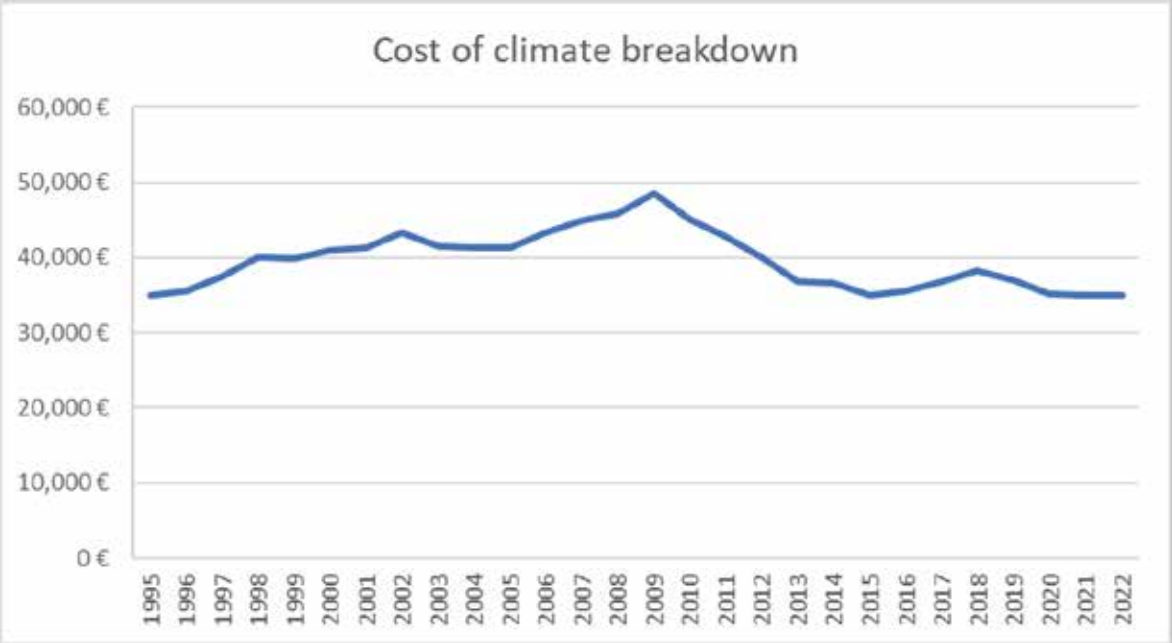

Figure 29: Cost of climate breakdown in Greece, during 1995-2022 (expressed in million 2015 real euros)

3.3.17. Cost of depletion of non-renewable energy resources

The cost of depletion of non-renewable energy resources (CDNRER) expresses the environmental cost associated with the consumption of non-renewable energy sources. It represents a form of invisible cost that is typically excluded from conventional welfare indicators, despite its direct relevance to the sustainability of natural resources. The variable was calculated based on the following formula:

$$\text{CDNRER} = \text{Primary Energy Consumption} \times \text{Marginal Cost} \quad (11)$$

Primary energy consumption was obtained from Eurostat,[42] in thousands of tonnes of oil equivalent (ktoe). This indicator includes total energy demand, transformation and distribution losses, as well as final use by consumers. It does not include use for non-energy purposes (e.g. petrochemicals).

To estimate the marginal cost, data from Eurostat's National Expenditure on Environmental Protection were used,[43] covering the period 2014 to 2019. Specifically, the average annual national environmental budget, valued at 2,260 million euros, was divided by the average annual primary energy

[42] Source Eurostat: https://doi.org/10.2908/nrg_bal_s (Retrieved 12.03.2025).
[43] Source Eurostat: https://doi.org/10.2908/env_ac_epneis (Retrieved 12.03.2025).

consumption over the same period, which amounted to 22,979 ktoe. This resulted in an estimated marginal cost of 0.098 million euros per ktoe.[44]

As illustrated in Figure 30, cost depletion increased steadily from 1995 to 2007, reflecting rising energy demand and the country's growing reliance on non-renewable resources. From 2008 onward, and especially after 2012, a clear downward trend emerges, largely due to a significant drop in consumption driven by the economic recession, as well as the gradual integration of Renewable Energy Sources into the energy mix. From 2020 onwards, a slight uptick is observed, likely linked to the recovery of economic activity following the COVID-19 pandemic.

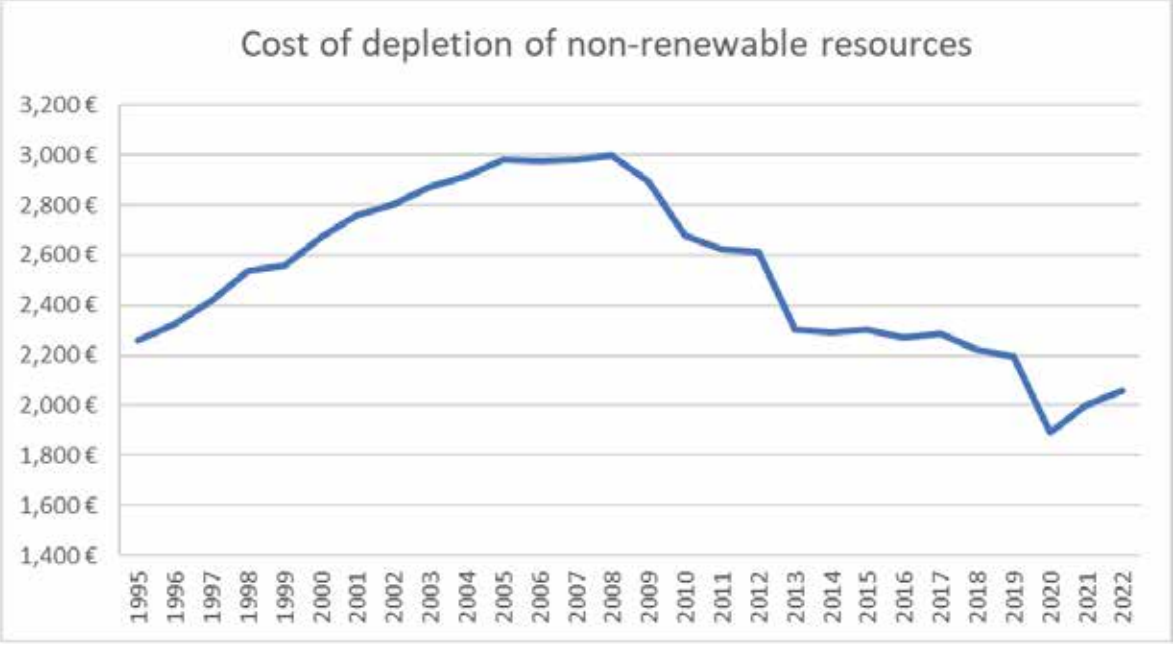

Figure 30: Cost of depletion of non-renewable resources in Greece during 1995–2022, (expressed in 2015 real euros per ktoe)

[44] The approach adopted in this study differs significantly from that of Soupart and Bleys (2024), who estimate a common marginal depletion cost for the EU as a whole. Their method is based on the investment required to achieve the targets set out in the Fit-for-55 package, as outlined in the European Commission's 2021 report. Specifically, the annual investment need, estimated at €1,051 billion, is divided by the EU's total primary energy consumption for 2021, yielding a marginal cost of €801.56 per toe. In the present analysis, a different approach is used, adapted to the national characteristics of the Greek economy and based on data on national environmental protection expenditure and average primary energy consumption in Greece. This method results in significantly lower marginal costs, estimated at approximately €98 per toe. The difference in price is largely due to the fact that the European estimate reflects large-scale investments required to meet ambitious environmental targets at the EU level, whereas the Greek approach captures local costs and policies with a smaller budget and less ambitious goals. Even though the two approaches differ, both provide useful estimates of environmental depletion costs, based on different assumptions.

3.3.18. Loss/Gain of wetland

The estimation of wetland (W) loss/gain was based on the following:

- Data were taken from Eurostat and more specifically the Land cover and land use, landscape (LUCAS).[45] Only specific years were available (2009, 2012, 2015 and 2018).
- Cost data were taken from official sources, i.e., the Ministry of Environment, Energy and Climate Change (MEECC, 2014). The cost concerned the construction of Lake Karla, the most recent and largest ecological restoration project in Greece.

A cost per km2 was estimated and then multiplied with the total gain/ loss of wetlands.
As shown in Figure 31 the economic gain due to increased surface of wetlands is gradually decreasing reaching a negative value, i.e., economic loss from 2016 onwards.

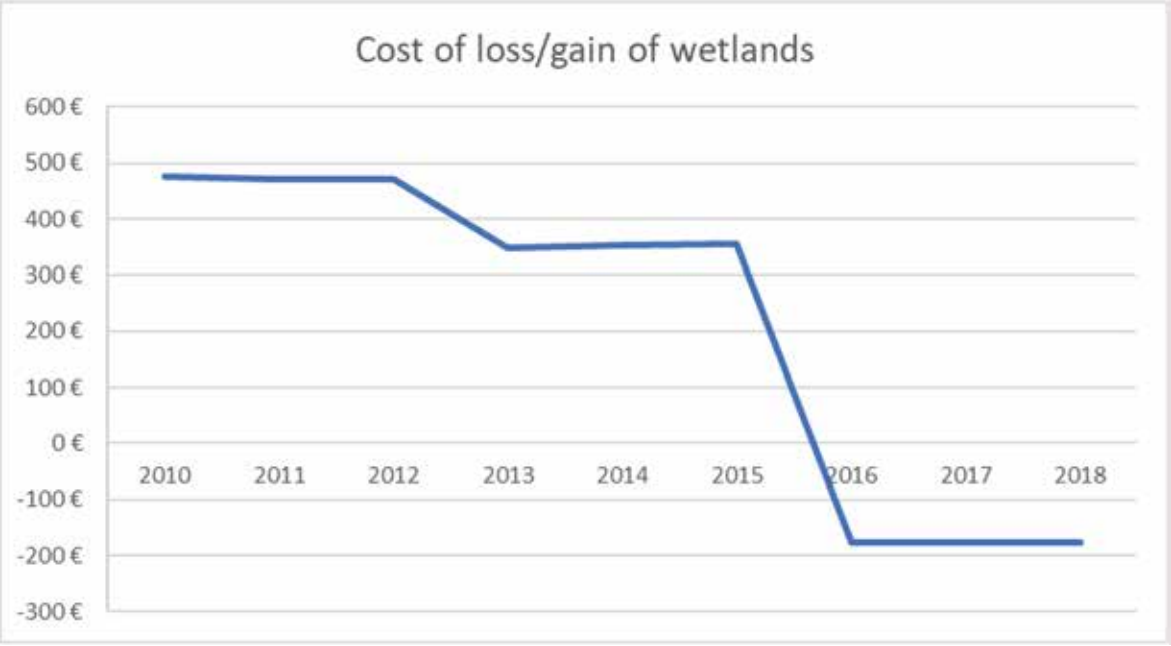

Figure 31: Cost of loss/gain of wetlands in Greece, during 2009-2018 (expressed in million 2015 real euros)

3.3.19. Loss of forests

The estimation of forest (F) land was based on data available from 2021 onwards, obtained from Global Forest Watch (2025). The analysis specifically utilized data on tree cover loss in Greece, referring to the permanent or temporary removal, degradation, or reduction of tree-covered areas due to factors such as deforestation, logging, land-use changes, fires, pests, diseases, or climate change. Additionally, the estimation followed the methodology outlined by Albanis et al. (2015), which

[45] Source Eurostat: https://doi.org/10.2908/LAN_LCV_OVW (Retrieved 12.03.2025).

presents a simple and user-friendly model for calculating the total economic value of forest land. This model incorporates established methods and techniques to evaluate the multiple functions and benefits of forest ecosystems.

The total economic value of forest land consists of:

- Wood production
- Non-timber forest products
- Grazing
- Hunting
- Recreation
- Soil protection
- Carbon storage
- Biodiversity
- Fire damage

Base prices, given by the manual, were used for the calculation of the loss of forests. To simplify the economic estimation, it was assumed that the dominant tree species was Pinus halepensis, located in an area between sea level and 200 meters above sea level.
As illustrated in Figure 32, the economic loss from forest degradation generally hovers around 2 million euros. However, significant spikes are observed in the years 2007 and 2021, which coincide with periods of extensive forest wildfires.

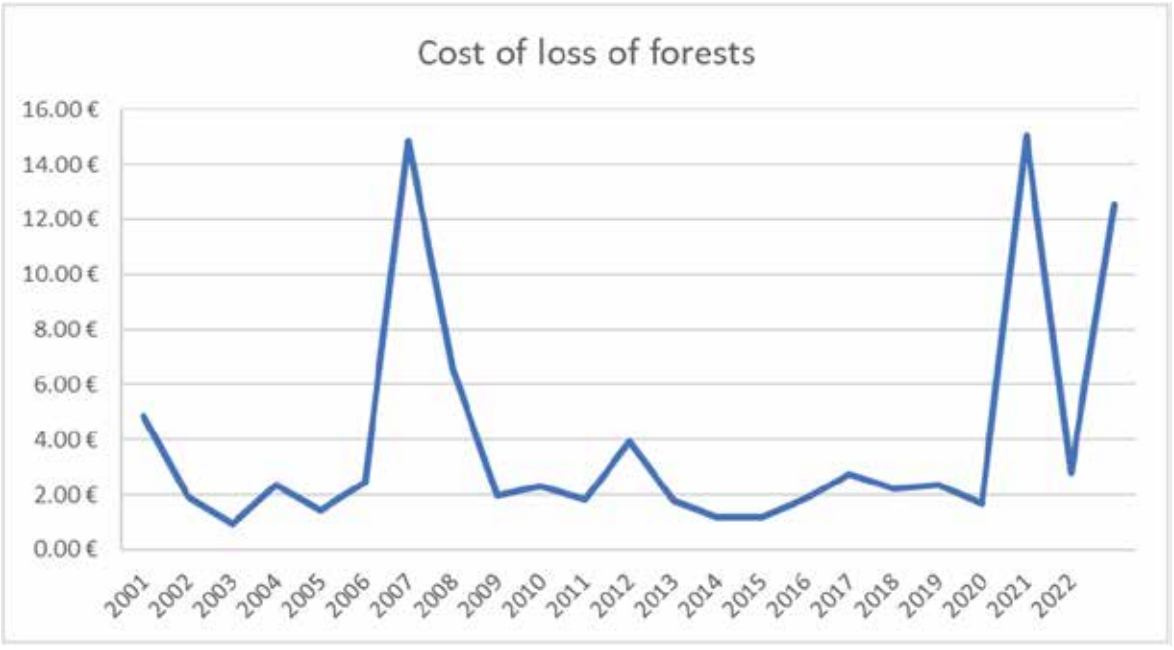

Figure 32: Cost of loss of forests in Greece, during 2001-2022 (expressed in million 2015 real euros)

3.3.20. Net investment

Net Investments (NI) represent the net investment in fixed capital within the economy, capturing the amount of new capital added to a country's productive capacity after accounting for the depreciation of existing capital assets. This indicator is essential for assessing long-term economic sustainability, as it reflects whether the economy is expanding its productive base or merely maintaining it. The variable was calculated using the following formula:

NI = Gross Fixed Capital Formation-Consumption of Fixed Capital (12)

- **Gross Fixed Capital Formation (GFCF):** Refers to investments in fixed assets such as infrastructure and equipment. This includes land improvement projects (e.g. drainage systems), purchases of machinery and factory equipment, and construction of roads, railways, schools, hospitals, and residential, commercial, or industrial buildings. In accordance with the System of National Accounts (SNA 1993), GFCF also includes net acquisitions of valuables.

- **Consumption of Fixed Capital (CFC):** Represents economic depreciation—an estimate of the value of capital goods that have been used up or worn out in the production process. This measure indicates the amount of capital that must be replaced to maintain the economy's existing productive capacity.

Data for both variables were obtained from the World Bank[46] expressed in US dollars. To convert the values into euros, the Official Exchange Rate (LCU per US$, period average), also from the World Bank,[47] was used. Since Greece's national currency was the drachma until 2001, it was assumed that for the period 1995–2001 the exchange rate remained constant and equal to that of 2002 which was the year that Greece adopted the euro.

As shown in Figure 33, net capital investments followed a steady upward trend from the mid-1990s, peaking in 2007. From 2009 onward, the variable declined to negative levels, indicating that depreciation exceeded new investment. This suggests a period of disinvestment and a weakening of the country's productive base during the economic recession. From 2020 onwards, a marginal positive shift is observed.

[46] Sources World Bank: https://data.worldbank.org/indicator/NE.GDI.FTOT.CD (Retrieved 05.03.2025) and https://data.worldbank.org/indicator/NY.ADJ.DKAP.CD (Retrieved 05.03.2025).
[47] Source World Bank: https://data.worldbank.org/indicator/PA.NUS.FCRF (Retrieved 05.03.2025).

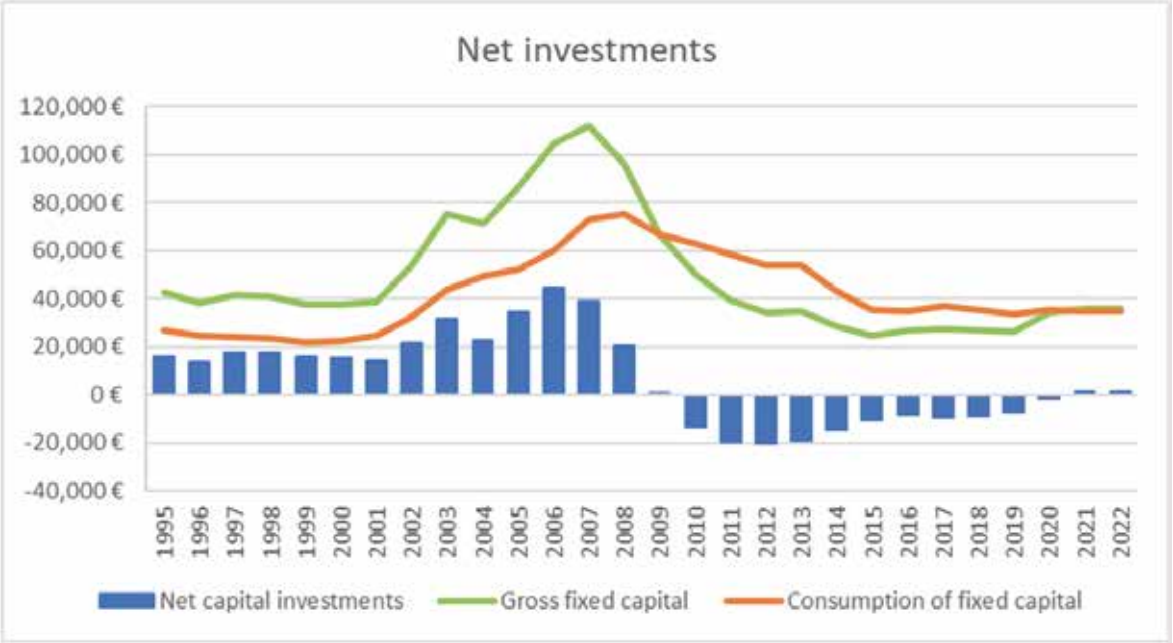

Figure 33: Net investments in Greece during 1995–2022, based on the difference between gross fixed capital formation and consumption of fixed capital (expressed in 2015 real euros)

3.3.21. Net trade balance

The variable of the net trade balance (NTB) represents the difference between a country's exports and imports of goods and services, capturing its external economic orientation and level of international competitiveness. A positive value indicates a trade surplus, meaning exports exceed imports while a negative value reflects a trade deficit, where imports are greater than exports. The variable was calculated based on the following formula:

$$\mathbf{NTB=Exports-Imports} \qquad \mathbf{(13)}$$

Data on exports and imports was sourced from the World Bank[48] and includes both goods and services. As shown in Figure 34, the NTB remains negative throughout the period 1995 to 2022, with the deficit reaching its peak in the years leading up to the financial crisis, particularly in 2008. From 2010 onward, the trade deficit gradually shrinks, especially between 2014 and 2016, reflecting a decline in domestic demand and imports. However, from 2017 onwards, the balance remains negative, with some fluctuations. In 2021 and 2022, the deficit expands again, driven by a sharp rise in imports.

[48] Sources World Bank: https://data.worldbank.org/indicator/NE.EXP.GNFS.KN (Retrieved 01.03.2025) and https://data-.worldbank.org/indicator/NE.IMP.GNFS.KN (Retrieved 01.03.2025).

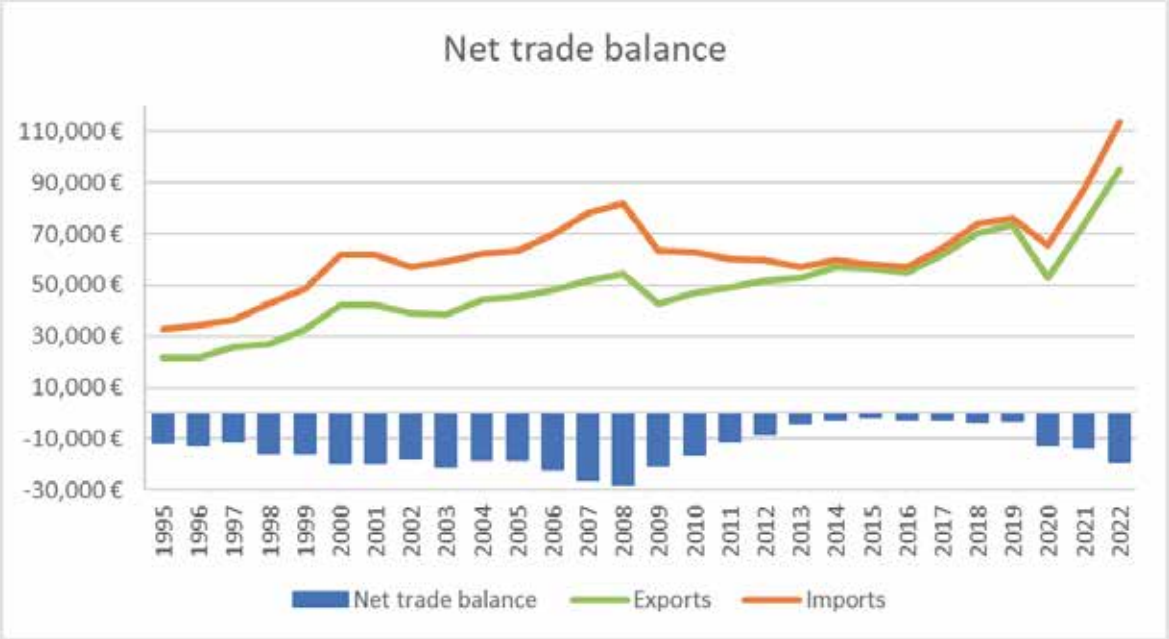

Figure 34: Net trade balance in Greece during 1995–2022, (expressed in 2015 real euros)

3.3.22. Net foreign assets

The variable of the net foreign assets (NFA) represents a country's total net external position, calculated as the difference between the foreign assets held by domestic monetary authorities and banks and their external liabilities. It reflects the country's capacity to finance external deficits or to support its domestic currency using international reserves. The variable was calculated based on the following formula:

NFA = Foreign Assets - Foreign Liabilities (14)

Data on external assets and liabilities were sourced from the World Bank,[49] covering the period from 2001 to 2022. However, for the years 1995 to 2000, no time series were available from official sources such as the World Bank, Eurostat, or the IMF. To address this gap and ensure continuity in the time series, a linear regression was applied using actual values from the period 2001 to 2008, which represents a phase of relative stability prior to the financial crisis.

The linear regression model used the annual values of NFA as the dependent variable and the corresponding years as the independent variable. This extrapolation enabled the estimation of values for the period 1995 to 2000. The resulting estimates are considered reliable, as they align with the macroeconomic trends observed in the subsequent years.

As shown in Figure 35, the country's net external position gradually deteriorated from 1995 to 2011, reaching historically low levels at the height of the financial crisis. From 2012 onward, a steady recov-

[49] Source World Bank: https://data.worldbank.org/indicator/FM.AST.NFRG.CN (Retrieved 09.03.2025)

ery is observed, with the balance turning positive and continuing to strengthen until 2020. This trend reflects economic adjustment and improvement in external balances. Finally, from 2021 onward, a slight decline is recorded.

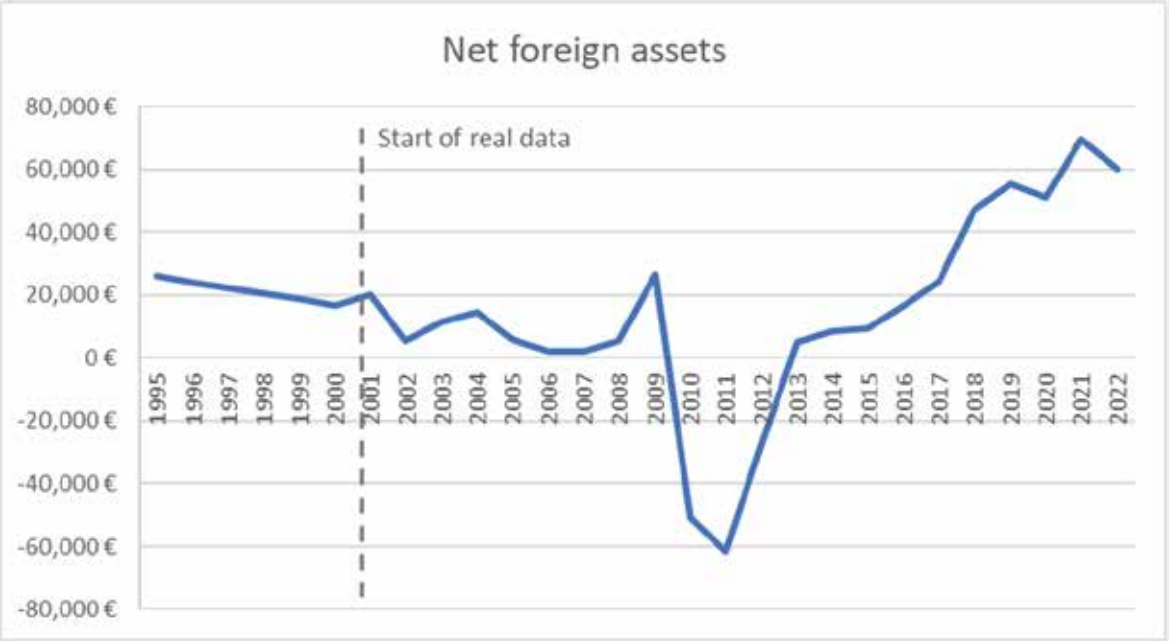

Figure 35: Net foreign assets in Greece during 1995–2022; estimated values (1995–2000) and observed data (2001–2008), (expressed in 2015 real euros).

1. Results

This section presents the empirical results derived from the estimates of the GPI for Greece for the period 1995-2022. The comparison of the GPI and GDP values reveals fundamental differences in the way in which social well-being and sustainable development are captured.

Figures 36 and 37 show the evolution of GDP and GPI in Greece over the time-period 1995-2022 in absolute and in per capita terms, respectively. As can been observed from the figures, GDP follows a steady upward trend until 2008 and then a decline due to the economic recession. In contrast, the GPI depicts a much more complex and unbalanced trend. Specifically:

- During the period 1995 – 2008, both absolute and per capita GDP levels increase. However, the GPI remains flat, with clearly lower values than the respective GDP's values. As a result, economic growth has not been accompanied by a corresponding increase in social well-being, as factors such as income inequality, social expenditure and environmental degradation have had a negative impact on social welfare.

- During the period 2009 – 2013, the GPI shows a dramatic decline and turns negative,[50] reach ing its lowest level in 2011 (-59,809, € in absolute terms, or -5,386 €, in per capita terms). This indicates the intensity of the economic, social and environmental crisis that accompanied the economic recession, which is not adequately reflected in GDP.

- Since 2014, GPI has shown signs of recovery. This trend has strengthened after 2017, with GPI reaching 75,989 € in 2021 (7,190 € in per capita terms). This improvement is associated with the recovery of the labour market, the reduction of some environmental pressures and the stabilisation of the social and non-defensive public expenditures.

[50] Negative values are not rare in the relevant literature, e.g. Soupart & Bleys (2024a,2024b) estimate negative ISEW values for Bulgaria and Poland, for specific periods.

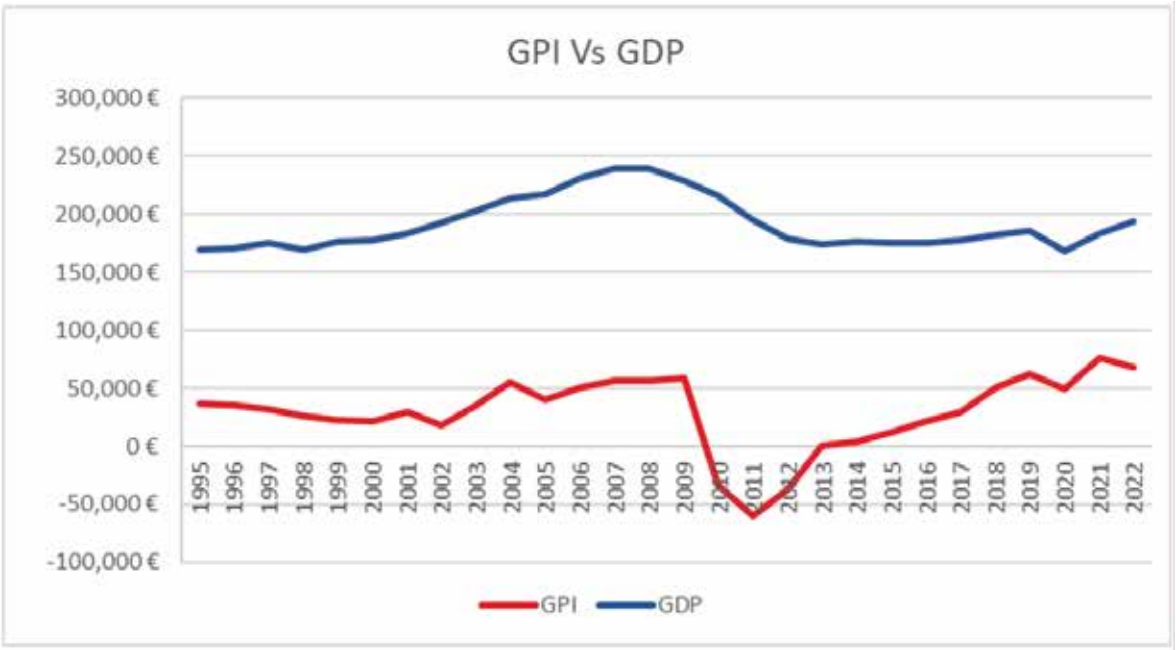

Figure 36: Comparison of GDP and GPI for Greece (million constant 2015 €).

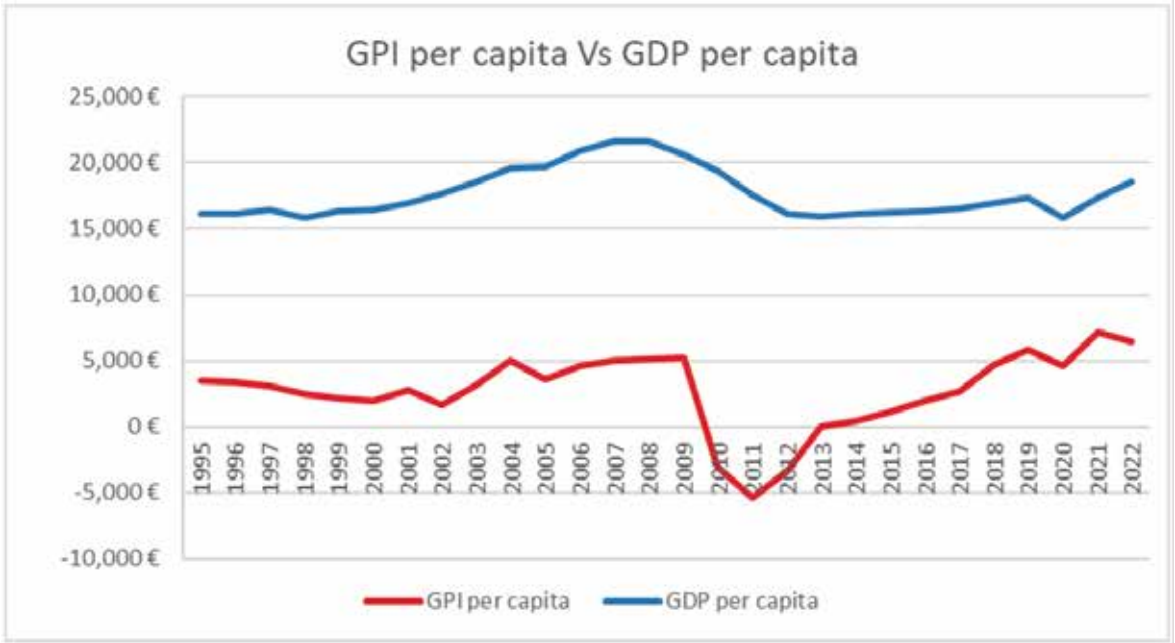

Figure 37: Comparison of GDP per capita and GPI per capita for Greece (million constant 2015 €).

The comparison of the two indicators, as shown in Figures 36 and 37, clarifies that an increase in national income does not necessarily imply a qualitative improvement in social welfare. Focusing on the most recent examined year (i.e., 2022), the percentage contribution of each individual variable to the total GPI of that year is analysed, providing a more detailed picture of the forces that determined the value of the GPI (see Fig. 38).

Specifically, the GPI value for 2022 (67.662 €) results from the net effect of various positive and negative sub-indicators. The most significant positive contributions came from the net foreign assets (NFA: €60,178 €, 88.94%), the value of unpaid work (UW: 53,78 €, 79.49%), the informal economy (IE: 50,632 €, 74.83%), and the non-defensive government expenditure (NDGE: 26,494 €, 39.16%). These components significantly increased the index, reflecting the importance of non-financial sources of prosperity and the improvement of the country's net external position.

In contrast, significant negative impacts on the index stemmed from non-welfare-enhancing household expenditures (NWEHE: -42,167 €, -62.32%), the cost of climate breakdown (CCB: -35,010 €, -51.74%), the cost of underemployment (CU: -13,751 €, -27.60%), and the net foreign trade balance (NB: -18,675 €, -20.32%).

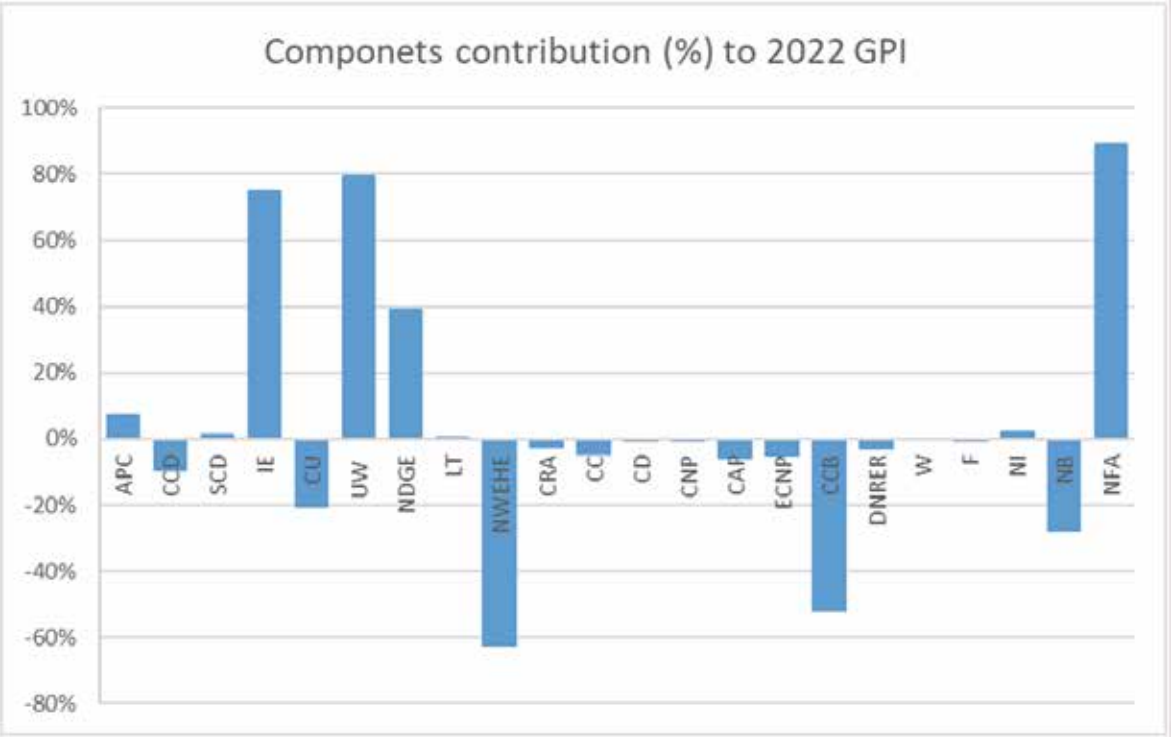

Figure 38: Percentage (%) contribution of all variables to total GPI, for 2022 in Greece.

Figures 39 and 40 present the three variables with the largest positive and negative contributions to the GPI, respectively, for the years 1995, 2000, 2005, 2010, 2015, and 2020.

Regarding the positive components (see Fig. 39), it is evident that the value of unpaid work (UW), the informal economy (IE), and non-defensive government expenditure (NDGE) are the three variables that consistently dominate across the years. Specifically:

- In 2015, UW shows the highest relative positive contribution (459.8%), followed by the informal economy (355.1%) and NDGE (234.5%).

- Similarly high contributions were observed in 2000 and 2010, confirming the steady contri bution of these elements to welfare.

- In 2020, a notable variation is observed with the country's net external position (NFA) includ ed for the first time in the three main positive variables, with a contribution of 103.38%, replacing public expenditure.

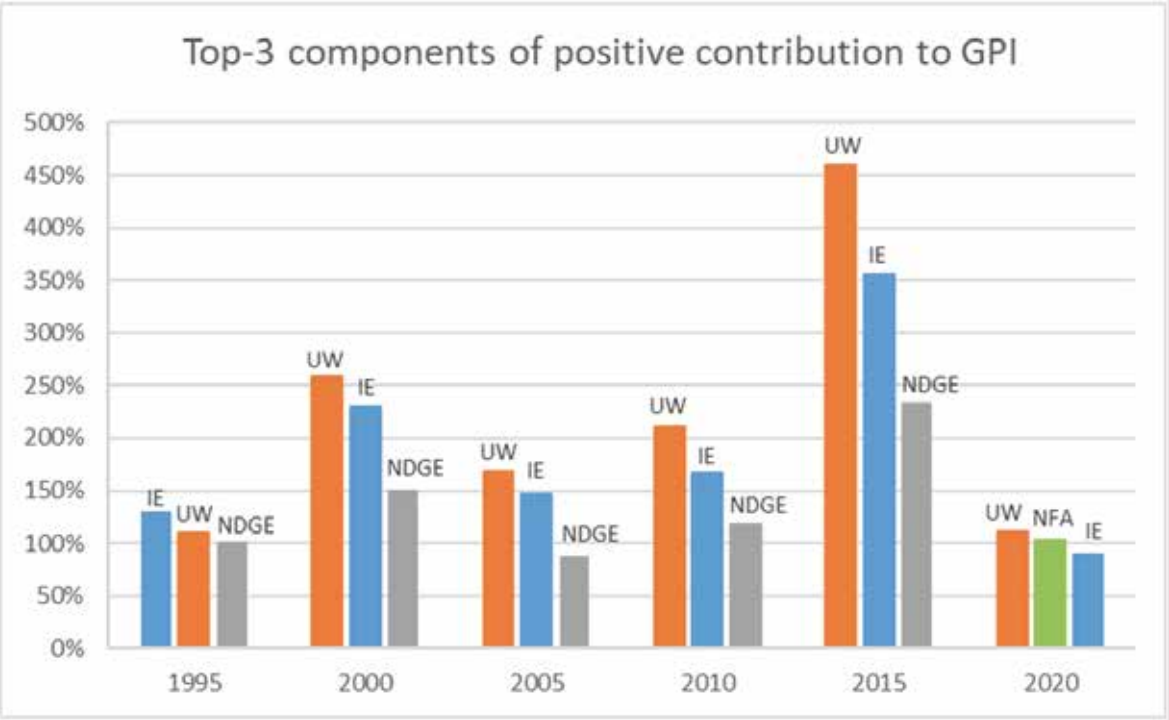

Figure 39: Estimating the top 3 components with positive percentage (%) contribution to total GPI, for various periods.

On the other hand, Figure 40 illustrates the key variables that have consistently negatively affected the GPI, revealing long-standing structural weaknesses of the Greek economy. It is notable that non-welfare-enhancing household expenditures (NWEHE) and the cost of climate breakdown (CCB) stand out as the two main negative contributors. Specifically:

- The most severe relative negative impacts were recorded in 2015. NWEHE exhibits the high est relative negative contribution (-300.9%), followed by the cost of climate breakdown (-276.4%) and the cost of underemployment (-200.4%). These values explain the overall negative GPI during that period.

- In 2010, the net foreign asset position (NFA) also appears as a negative contributor, with a value of -152.8%, indicating a sharp deterioration in the country’s balance of payments.

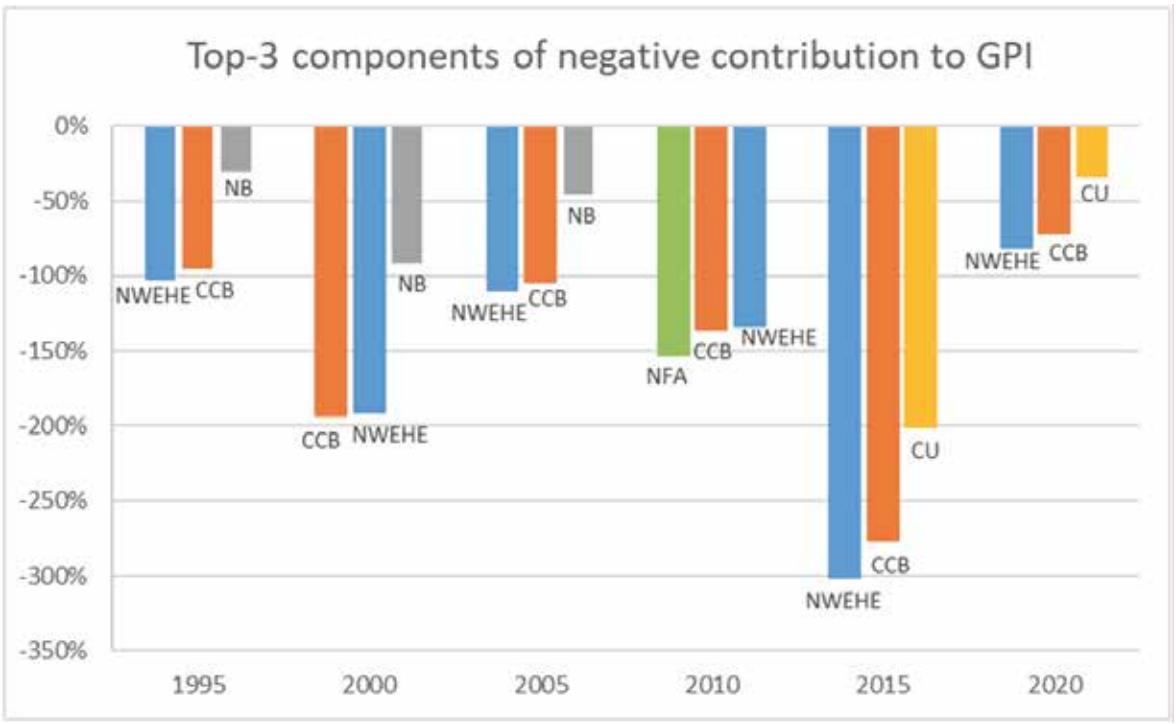

Figure 40: Estimating the top 3 components with negative percentage (%) contribution to total GPI, for various periods.

Finally, Figure 41 compares the Greek GDP and the present GPI estimate, with two other available alternative estimates (all values adjusted in million constant 2015 €, to attain comparability):

- The Greek ISEW (based on the bcpa[51] approach), estimated by Soupart and Bleys (2024a, 2024b), for 1995-2020.
- The Greek GPI, as it was estimated by Pais et al., 2019, for 1995-2015, being the first attempt, to the best of our knowledge, to estimate GPI for Greece through a cross-national analysis of the OECD countries.

Evidently, while the ISEW results in a kind of a GDP's rescaling pattern, both GPI estimates present far lower values and depict a much steeper fall during the economic recession. However, both GPI estimates once compared together, are resulting into substantial differences in terms of value during the examined period. The main reasoning behind this substantial difference is that, albeit Pais et al. (2019) use a 26 variables framework for estimating the Greek GPI, they do not include critical variables, such as the net foreign asset position (NFA) and net trade balance (NTB). Especially, NTB is constantly negative for Greece during the entire examined period. On the other hand, in our framework we have utilized 22 variables, including NFA, NTB and other critical variables, a choice which played a decisive role to the strong reduction and the negative values of the present GPI estimation. We firmly believe that the inclusion of NFA and NTB is by far a more realistic approach in terms of a proper economic analysis and in line with the mainstream GDP calculation. In any case, the observed differences highlight the crucial need for a convergence of various approaches into once solid and universally accepted method of estimating the GPI.

[51] The ISEW bcpa approach is based on the Hicksian concept of income and accounts for the welfare costs and benefits shifted in time and space.

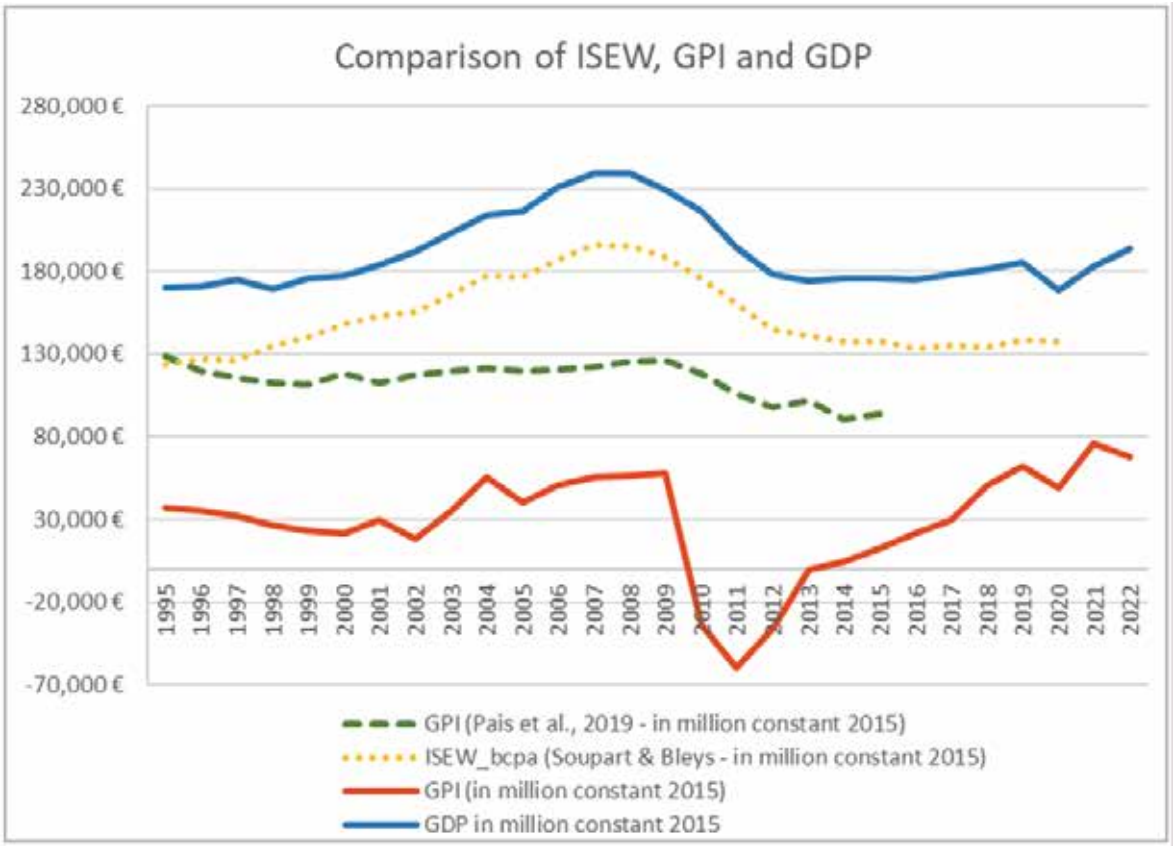

Figure 41: Comparison of GDP with our GPI estimation, the GPI estimated by Pais et al., (2019), and the ISEW (bcpa) estimated by Soupart and Bleys (2024a; 2024b), for Greece, (all values in million constant 2015 €)

5. Conclusions

The present study aims to critically examine the adequacy of Gross Domestic Product (GDP) as a measure of societal progress and to present the Genuine Progress Indicator (GPI) as a more holistic alternative by estimating it and comparing it with the GDP, during the period 1995-2022. This is one of the first research efforts of that kind for Greece and aims at providing some key research insights into the GPI methodology framework.

Through a thorough historical, conceptual, and empirical analysis, it becomes evident that while GDP remains a powerful economic tool, it fails to capture several key dimensions of well-being and sustainability. Alternatives to the GDP accounting framework have been suggested and implemented to a certain extent since the 1980's. Through the plethora of the alternative GDP frameworks, GPI fulfils equally all three dimensions of wellbeing, inclusion, and sustainability, thus justifying its selection as an alternative metric to GDP (see also Fig. 3).

GPI adjusts for factors that GDP ignores, such as environmental degradation, income inequality, the value of unpaid work, and the costs of social problems like crime. It also adds benefits from non-market activities like household labour and volunteer work, which contribute to societal welfare. Consequently, GPI integrates that wide range of economic, social, and environmental components into a single composite index, allowing for a more holistic evaluation of a nation's genuine progress.

Through a two-stage literature review, it was revealed that only a handful of reports and studies, 51 out of 761, provided GPI estimates. Based on that input, the authors ended up in using 22 variables for the estimation of the GPI for Greece. A specific methodology, tailored and adapted to the Greek context, was followed and based on available primary data for estimating their values. Only in some specific cases, variables' data were taken from specific sources, while for some few years with data gaps specific assumptions have been applied by the authors, either by using moving averages of previous periods, or by using simple projection methods.

The empirical estimation of GPI for Greece, from 1995 to 2022, reveals stark contrasts between economic growth and genuine societal, environmental or even economic progress, thus providing critical insights into the limitations of traditional economic metrics and the importance of multidimensional indicators.

The results show that, particularly during the period 1995–2008, Greece experienced a phase of significant economic expansion as measured by GDP. However, this growth was not paralleled by a similar rise in GPI, which remained stagnant and well below GDP levels. This decoupling underlines the lack of connection between market-based economic activity and actual improvements in quality of life. The stagnation in GPI during a period of economic growth reflects the negative effects of rising income inequality, environmental degradation, and social costs that were not captured by the GDP trends.

The years of the economic crisis (2009–2013) provided further evidence of GDP's insufficiency in portraying societal well-being. While GDP indeed declined during this period, GPI experienced a

steeper fall, turning negative and reaching its lowest point in 2011. This rapid decrease of GPI highlights the magnitude of social, economic, and environmental disruption that Greece endured. The increase in underemployment, loss of informal and unpaid work contributions, and rising environmental and social costs (e.g., pollution, road accidents, crime) significantly deteriorated the country's welfare, far beyond what GDP figures alone would suggest (see Fig. 36 & 37).

However, signs of recovery began to emerge post-2014, and the trend gained momentum after 2017. A short declining period observed during 2020, for both GDP and GPI, is due to the COVID-19 extraordinary pandemic circumstances. By 2021, the GPI showed a notable rebound, reaching 75,989 €, in absolute terms, and 7,189 €, in per capita terms, reflecting improvements in labour market conditions, more stable public spending, and a partial reduction in environmental pressures. This recovery clearly shows the potential for policies that support sustainable and inclusive development to produce tangible gains in societal well-being, as captured by GPI.

The detailed analysis of the components contributing to the GPI in 2022 further reveals the complex dynamics that drive well-being. The dominant positive contributions came from net foreign assets, the value of unpaid work, the informal economy, and non-defensive government expenditures (see Fig. 39). These findings underline the pivotal role of non-market activities and structural macroeconomic conditions in enhancing social welfare. On the other hand, the most significant negative components —non-welfare-enhancing household expenditures, the cost of climate breakdown, underemployment, and net foreign trade imbalance— indicate the persistent vulnerabilities and structural challenges facing the Greek economy (see Fig. 40).

From a policy perspective, these results highlight the need for a paradigm shift in how economic and social progress and well-being is measured and pursued. While GDP remains useful for tracking market activity, it cannot serve as a comprehensive barometer for public policy and monitoring of a country's welfare, especially in the context of long-term sustainability and societal well-being. The GPI offers a more comprehensive and integrative framework by accounting for environmental degradation, income distribution, unpaid work, and social costs, thus providing a fuller picture of progress. Going forward, there is a strong case for embedding GPI or similar well-being centered metrics, such as the Sustainable Development Goals (SDGs) and the Human Development Index (HDI), into national accounting systems and policymaking processes. Doing so would enable governments to better assess the real impacts of their economic, environmental, and social policies and to align national development strategies with broader goals of sustainability, equity, and quality of life.

In conclusion, this study not only demonstrates the empirical applicability of GPI in the Greek context but also reinforces the broader theoretical argument of the "Beyond GDP" movement: that true progress transcends economic transactions and must be understood in terms of the social and ecological foundations of well-being. The lessons drawn from the Greek case may possibly serve as a valuable reference to the existing research on GPI, to evaluate development through a more comprehensive and human-centred lens.

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Appendices

Appendix A (Table 5): Summary of GPI Studies

No.	Author(s)	Time-period	Country (Region)
1	Cobb et al. (1995)	1950 – 1995	USA
2	Hamilton (1999)	1950 – 1995	Australia
3	Cobb et al. (1995)	1950 – 1995	USA
4	Anielski (2001)	1961 – 1999	Canada (Alberta)
5	Costanza et al. (2004)	1950 – 2000	USA (Vermont, Chittenden County, Burlington)
6	Venetoulis & Cobb (2004)	1950 – 2002	USA (national level, San Francisco Bay Area)
7	Wen et al. (2007)	1991 – 2001	China (Suzhou & Yangzhou in Jiangsu province, Ningbo in Zhejiang province, Guangzhou in Guangdong province)
8	Bagstad & Ceroni (2007)	1950 – 2000	USA (Northern Vermont)
9	Talberth et al. (2007)	1950 – 2004	USA
10	Makino (2008)	1970 – 2003	Japan
11	Lawn & Clarke (2006)	1985 – 2003	7 countries: India, Australia, New Zealand, Japan, China, Thailand, Vietnam
12	Danilishin & Veklich (2010)	2000 – 2007	Ukraine
13	Clarke & Lawn (2010)	1986 – 2003	Australia (Victoria)
14	Lawn & Clarke (2010)	1967 – 2006	7 Asia-Pasific countries: Australia, New Zealand, Japan, China, India, Thailand, and Vietnam
15	Berik & Gaddis (2011)	1990 – 2007	USA (Utah)
16	Posner & Costanza (2011)	1950 – 2005	USA (Baltimore City, Baltimore County, and the State of Maryland)
17	McGuire et al. (2012)	1960 – 2010	USA (Maryland)
18	Bagstad & Shammin (2012)	1990 – 2005	USA (Northeast Ohio)
19	Feeny et al. (2013)	1970 – 2005	S. Korea
20	Kubiszewski et al. (2013)	1950 – 2005	17 countries: Austria, Belgium, Germany Netherlands, Poland, Italy, Sweden, UK, USA, Chile, Australia, New Zealand, China, India, Japan, Thailand, Vietnam
21	Erickson et al. (2013)	1960 - 2011	USA (Vermont)
22	Stiffler (2014)	1960 - 2011	USA (Colorado)
23	Pyzhev (2014)	2005 – 2011	Russia (Krasnoyarsk Krai)
24	Ostergaard-Klem & Oleson (2014)	1969 – 2013	USA (Hawaii)

25	Andrade & Garcia (2015)	1970 – 2010	Brazil
26	Zencey (2015)	2000 – 2010	USA (Lower Mississippi River Corridor)
27	Kubiszewski et al. (2015)	1960 – 2010	USA (Oregon)
28	Erickson et al. (2015)	1960 – 2012	USA (Massachusetts)
29	Hou (2017)	1978 – 2011	China (Liaoning Province)
30	Talberth & Weisdorf (2017)	2012 – 2014	USA (National level, Maryland, City of Baltimore)
31	Hoffrén (2017)	1945 – 2016	Finland (national level, 19 regions)
32	Lawn, P. (2017)	1986 – 2016	Australia (South Australia)
33	Balafana (2018)	2000 – 2016	Iceland
34	Fox & Erickson (2018)	2011	USA
35	Huang (2018)	1978 – 2015	China (10 megacities)
36	Brown & Lazarus (2018)	2010 – 2014	USA (California)
37	Zencey (2018)	2000 – 2015	USA (Vermont)
38	Hashim et al. (2018)	1980 – 2016	2 countries: S. Korea, Malaysia
39	Alfonso et al. (2019)	1995 – 2015	28 OECD countries: Austria, Belgium, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Israel, Italy, Japan, Latvia, Lithuania, Luxembourg, Netherlands, Norway, Poland, Portugal, S. Korea, Slovakia, Slovenia, Spain, Sweden, UK, USA
40	Kenny et al. (2019)	1962–2013	Australia
41	Patterson et al. (2019)	1970 -2016	New Zealand
42	Long, X., & Ji, X. (2019)	1997 – 2016	China (31 provinces)
43	Modi (2020)	2005 – 2018	USA (North Carolina)
44	Moore (2020)	2009 – 2018	USA (Ohio)
45	Senna & Serra (2021)	2002 – 2016	Brazil (Rio de Janeiro)
46	Cook & Davíðsdóttir (2021)	2000 – 2019	Iceland
47	Guan et al. (2021)	2016	China (national level, 29 provinces)
48	Lazarus & Brown (2022)	1995 – 2017	USA (national level, California)
49	Oleson et al. (2022)	2000 – 2020	USA (Hawaii)
50	Karatopouzis et al. (2022)	2019 – 2020	Australia
51	Kim & Moon (2024)	1970 – 2017	S. Korea

Appendix B ***(Table 6)****: Estimated variables of GPI (expressed in millions €):*

Year	APC	CCD	SCD	IE	CU	UW	NDGE	LT	NWEHE	CRA	CC	CD	CNP	CSP	ECNP	CCB	DNRER	W	F	NI	NB	NFA
1995	3,598	-8,347	834.70	48,081	-9,343	40,647	37,280	-22.62	-38,004	-8,088	-2,394	-20.80		-5,922	-4,786	-35,018	-2,262			14,048	-11,150	17,788
1996	3,673	-8,014	801.37	48,090	-10,042	41,600	35,295	-1.15	-37,101	-7,779	-2,314	-16.36		-6,082	-4,833	-35,505	-2,327			15,759	-12,541	16,685
1997	3,791	-8,160	816.04	48,863	-11,110	45,878	33,629	-1.87	-39,239	-7,235	-2,269	-15.45		-6,249	-4,896	-37,606	-2,418			13,658	-10,620	15,583
1998	3,758	-8,146	814.64	47,264	-13,648	50,066	31,485	0.88	-38,380	-7,147	-2,254	-12.17		-6,678	-5,031	-40,020	-2,535			17,571	-15,610	14,481
1999	3,995	-10,124	1,012	48,895	-14,963	50,937	32,576	-3.20	-40,755	-6,742	-2,277	-14.49		-6,885	-4,994	-39,964	-2,560			17,453	-15,733	13,379
2000	3,912	-7,753	775.34	48,883	-15,211	54,920	31,900	2.27	-40,594	-6,358	-2,343	-16.75		-7,053	-4,889	-40,934	-2,673			15,850	-19,445	12,277
2001	4,156	-9,716	971.65	50,108	-15,435	56,673	31,799	-4.30	-41,330	-5,587	-2,368	-16.01		-6,889	-4,942	-41,351	-2,761		-4.87	15,404	-19,336	20,218
2002	4,455	-10,343	1,034	52,325	-15,706	60,241	32,616	-5.04	-42,307	-4,667	-2,506	-15.40		-7,664	-4,865	-43,326	-2,801		-1.92	14,095	-17,839	5,321
2003	4,606	-10,521	1,052	55,195	-15,753	62,429	33,017	-0.58	-43,153	-4,351	-2,612	-16.15		-8,336	-4,871	-41,515	-2,873		-0.93	21,763	-20,621	11,623
2004	4,667	-11,032	1,103	57,941	-18,101	64,686	37,802	-4.84	-43,969	-4,414	-2,943	-16.04	-303.78	-8,671	-4,973	-41,279	-2,918		-2.39	31,651	-18,431	14,496
2005	4,764	-10,109	1,011	58,291	-17,399	67,292	35,233	27.10	-43,832	-4,404	-2,932	-17.26	-326.38	-9,025	-4,835	-41,410	-2,980		-1.44	22,439	-18,137	6,177
2006	4,779	-11,283	1,128	61,647	-16,033	68,929	38,635	-4.99	-43,024	-4,255	-2,881	-16.36	-312.06	-9,557	-4,717	-43,331	-2,978		-2.45	34,287	-22,037	2,131
2007	5,176	-12,009	1,201	63,264	-15,712	68,787	41,018	-6.52	-45,876	-3,960	-3,068	-15.56	-330.14	-10,290	-4,891	-44,976	-2,982		-14.86	44,750	-26,330	2,142
2008	5,417	-12,345	1,235	62,806	-15,371	67,922	41,634	-1.76	-46,925	-3,719	-3,305	-13.30	-326.76	-9,875	-4,484	-45,851	2,998		-6.57	38,753	-27,555	5,477
2009	5,281	-9,312	931.22	59,552	-18,292	68,117	42,405	-9.51	-46,125	-3,383	-3,493	-13.92	-337.40	-8,147	-4,224	-48,608	-2,895		-1.99	20,471	-20,425	26,735
2010	4,931	-7,835	783.50	55,747	-20,194	70,063	39,284	-16.32	-44,548	-3,043	-3,288	-13.37	-329.93	-6,703	-4,115	-45,189	-2,680	475.41	-2.33	395.64	-16,123	-50,932
2011	4,503	-6,432	643.19	49,522	-23,004	66,551	37,796	7.07	-43,046	-2,775	-2,854	-12.40	-353.63	-5,837	-3,703	-42,780	-2,622	470.81	-1.84	-13,193	-11,052	-61,638
2012	3,954	-5,303	530.27	45,066	-26,510	63,613	32,305	14.61	-39,517	-2,426	-2,880	-13.73	-353.64	-4,941	-3,433	-40,114	-2,611	472.39	-3.94	-19,337	-7,963	-26,909
2013	3,819	-4,509	450.92	44,168	-26,931	61,562	30,235	2.71	-37,864	-2,267	-2,805	-15.75	-358.02	-4,592	-3,418	-36,862	-2,304	347.18	-1.79	-19,842	-4,011	5,177
2014	3,949	-4,517	451.70	44,769	-26,400	59,458	29,977	-19.14	-38,300	-2,134	-3,277	-13.43	-362.49	-4,334	-3,253	-36,666	-2,291	353.99	-1.18	-19,253	-2,467	8,470
2015	3,958	-4,723	472.30	44,879	-25,326	58,113	29,639	-5.69	-38,035	-2,129	-3,152	-14.94	-360.84	-3,702	-3,196	-34,928	-2,301	354.61	-1.19	-14,537	-1,577	9,210
2016	3,955	-4,783	478.25	45,007	-23,398	56,986	27,341	3.45	-37,836	-2,199	-3,258	-10.62	-360.13	-3,489	-3,326	-35,463	-2,269	-177.10	-1.88	-10,657	-2,277	16,839
2017	4,156	-5,071	507.12	45,861	-22,028	55,682	26,585	1.74	-38,114	-1,975	-3,256	-19.13	-358.88	-3,691	-3,395	-36,888	-2,286	-176.74	-2.77	-8,194	-2,355	24,257
2018	4,405	-5,988	598.81	47,117	-19,358	54,647	27,464	6.58	-38,550	-1,902	-3,517	-12.29	-357.03	-4,020	-3,263	-38,178	-2,224	-177.15	-2.22	-9,452	-3,588	47,192
2019	4,723	-6,661	666.11	48,485	-18,529	54,543	26,586	-20.11	-39,372	-1,919	-3,329	-12.97	-353.83	-3,739	-3,283	-37,071	-2,193		-2.36	-8,714	-2,729	55,328
2020	4,405	-6,228	622.77	43,843	-16,366-	54,66854	26,542	-78.72	-39,809	-1,625	-3,369	-10.98	-353.15	-3,781	-3,236	-35,139	-1,893		-1.69	-7,393	-12,466	51,001
2021	4,464	-6,511	660.41	47,759	15,298	,223	26,305	54.15	-40,599	-1,737	-3,308	-11.50	-345.27	-3,844	-3,253	-35,074	-2,000		-15.08	-1,416	-13,726	69,661
1995	4,912	-6,481	700.32	50,632	-13,751	53,782	26,494	13.83	-42,167	-1,701	-3,164	-11.34	-316.03	-3,908	-3,271	-35,010	-2,060		-3	1,470	-18,675	60,178

*Appendix C **(Table 7)**: Values of GPI, GDP, GPI per capita, and GDP per capita*

Years	GPI (million €, 2015 prices)	GDP (million €, 2015 prices)	Population (millions)	GPI per capita	GDP per capita
1995	36,918.72	169,770.42	10.56	3,495.38	16,073.47
1996	35,348.06	170,676.88	10.61	3,331.96	16,088.24
1997	32,398.01	174,649.04	10.66	3,038.85	16,381.65
1998	25,978.41	168,975.65	10.72	2,423.24	15,761.91
1999	23,232.33	176,115.36	10.76	2,158.80	16,365.02
2000	21,250.34	177,480.42	10.81	1,966.57	16,424.54
2001	29,589.78	183,488.31	10.86	2,724.12	16,892.48
2002	18,040.76	192,081.40	10.90	1,654.81	17,618.88
2003	35,059.57	203,215.96	10.93	3,208.21	18,595.78
2004	55,289.19	214,144.65	10.96	5,046.87	19,547.41
2005	39,826.54	216,679.09	10.99	3,624.78	19,720.84
2006	51,103.89	230,640.59	11.02	4,637.22	20,928.59
2007	55,877.29	238,728.86	11.05	5,057.47	21,607.41
2008	56,461.95	238,866.03	11.08	5,096.84	21,562.51
2009	58,224.26	229,026.47	11.11	5,242.12	20,619.98
2010	-33,333.59	215,986.31	11.12	-2,997.26	19,420.89
2011	-59,809.43	194,653.82	11.10	-5,385.86	17,528.64
2012	-36,359.20	178,436.98	11.05	-3,291.91	16,155.44
2013	-19.23	174,382.65	10.97	-1.75	15,903.26
2014	4,140.43	175,764.11	10.89	380.12	16,136.38
2015	12,638.70	175,362.90	10.82	1,167.99	16,205.97
2016	21,105.90	175,307.14	10.78	1,958.61	16,268.34
2017	29,239.11	177,889.66	10.75	2,718.73	16,540.68
2018	50,840.04	181,562.50	10.73	4,736.85	16,916.47
2019	62,400.41	185,696.94	10.72	5,820.07	17,319.92
2020	49,333.75	168,619.82	10.70	4,611.23	15,760.93
2021	75,988.65	183,213.05	10.57	7,189.63	17,334.61
2022	67,662.44	193,736.16	10.44	6,483.01	18,562.65

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