Towards sustainable wellbeing: Integrated policies and transformative indicators.

Deliverable D2.1

The Index of Sustainable Economic Welfare for the EU27 and beyond: methodology, data and results

WP2 – Empirical analysis of different processes of economic growth

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Document History

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Brief Description	This report supplements the dataset on ISEWs for EU and non-EU countries by giving details about the data collection and compilation as well as giving results of a first analysis of the data.
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List of abbreviations

ΔK	Net capital investments
Δk or k	Net capital investments/capita
AIC	Actual individual consumption
bce	Benefits and costs experienced/capita (ISEW)
BCE	Benefits and costs experienced (ISEW)
bcpa	Benefits and costs of present activities/capita (ISEW)
BCPA	Benefits and costs of present activities (ISEW)
BEC	Broad ecological costs
bec	Broad ecological costs/capita
C_i	Individual consumption expenditures
c_i or ci	Individual consumption expenditures/capita
CO_2	Carbon dioxide
DALY	Disability-Adjusted Life Years
$DIRE_p$	Defensive, intermediate and rehabilitative (private) expenditures
$dire_p$ or direp	Defensive, intermediate and rehabilitative (private) expenditures/capita
DMUI	Diminishing marginal utility of income = inequality adjustment index
EEA	European Environment Agency
EU or EU27	European Union
FF55	Fit for 55
g_c or gc	Non-defensive collective government consumption/capita
G_c	Non-defensive collected government consumption
GDP	Gross domestic product
gdp	Gross domestic product/capita
GHG	Greenhouse gases
GPI	Genuine Progress Indicator
GWh	Gigawatt hours
HETUS	Harmonised European Time Use Surveys
ILO	International Labour Organisation
INQ	Welfare losses from income inequality
inq	Welfare losses from income inequality/capita
ISEW	Index of sustainable economic welfare
kWh	Kilowatt hours
LULUCF	Land use, land-use change and forestry
MAIS	Maximum Abbreviated Injury Scale
N_r	Reactive nitrogen
NEC	Narrow ecological costs
nec	Narrow ecological costs/capita
NH_3	Ammonia
NMVOC	Non-Methane Volatile Organic Compounds
NO_x	Nitrogen oxides
OECD	Organisation for Economic Cooperation and Development
$PM_{2.5}$	Particulate matter < 2.5µm
PPP	Purchasing Power Parity
S	Shadow economy
s	Shadow economy/capita
SCC	Social cost of carbon
SCP-HAT	Hotspot Analysis Tool for Sustainable Consumption and Production
SES	Structure of Earnings Survey
SNA	System of National Accounts
SO_2	Sulphur dioxide

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SO_x	Sulphur oxides
UK	United Kingdom
UN	United Nations
UNFCCC	United Nations Framework Convention on Climate Change
US	United States
UW	Unpaid work
uw	Unpaid work/capita
VOC	Volatile Organic Compounds
VOLY	Value Of a Life Year
VSL	Value of a Statistical Life

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Executive summary

This deliverable provides a dataset featuring two variants of the Index of Sustainable Economic Welfare (ISEW) for individual EU countries, the EU as a whole, and two non-EU countries. It is accompanied by a detailed report that outlines the data, methodologies used, and key findings from the welfare trend analysis. Covering the period from 1995 to 2020, the dataset allows for direct cross-country comparisons, as a consistent methodology was applied across all nations. This deliverable thus addresses a crucial research gap in the study of Beyond GDP indicators.

The two variants of the Index of Sustainable Economic Welfare (ISEW) estimated in this deliverable are derived from Van der Slycken and Bleys (2023). They are designed to focus on two distinct concepts: (1) the Benefits and Costs Experienced (BCE) in the present within a specific country, and (2) the Benefits and Costs of Present Activities (BCPA), which consider both current impacts and those projected into the future, both domestically and internationally. The primary distinction between these ISEW variants lies in how they account for ecological costs and changes in capital stocks.

The $ISEW_{BCE}$ variant emphasizes the Benefits and Costs Experienced in the present within a particular country. This index considers the benefits and costs resulting from past and/or current activities. It is calculated as follows:

$$ISEW_{BCE} = UW + C_i + S + G_c - DIRE_p - INQ - NEC \tag{1}$$

On the other hand, the $ISEW_{BCPA}$ variant focuses on the Benefits and Costs of Present Activities. It takes into account the impacts of activities occurring today, considering their effects in the present and/or future, and within a specific country and/or beyond its borders. It is calculated as follows:

$$ISEW_{BCPA} = UW + C_i + S + G_c - DIRE - INQ - BEC + \Delta K \tag{2}$$

UW is a component representing the value of unpaid work (positive effect), C_i represents the value of individual consumption (positive effect), S is the value of the shadow economy (positive effect), G_c is the value of non-defensive collective government consumption (positive effect), $DIRE_p$ represents the defensive, intermediate and rehabilitative private expenditures (negative effect), INQ measures the welfare losses from income inequality (negative effect), NEC is the value of the narrow ecological costs experienced in the present and within domestic borders (negative effect and only in $ISEW_{BCE}$), BEC represents the broad ecological costs including both current costs within domestic borders and the costs shifted in time and space (negative effect and only for $ISEW_{BCPA}$) and ΔK is the value of the yearly net capital investments (the actual effect can be positive or negative depending on the change happening in that year, and only for $ISEW_{BCPA}$).

An analysis of the per capita values of the Index of Sustainable Economic Welfare (ISEW) across the EU27 reveals that while both welfare measures (BCE and BCPA) increased over time, their growth was slower compared to GDP per capita. Between 1995 and 2020, GDP per capita rose by 34.99%, whereas BCE and BCPA increased by only 15.21% and 16.95%, respectively. To gain a deeper understanding, the study period was divided into subperiods, particularly focusing on the financial crisis (2008-2011) and the COVID-19 crisis (2019-2020). A key finding is that during these crises, GDP experienced a sharper decline than the welfare measures. This outcome is primarily due to reductions in both narrow and broad ecological costs between 2008 and 2011, as well as a combination of reduced ecological costs and welfare losses from income inequality during the COVID-19 crisis.

The evolution of the Index of Sustainable Economic Welfare (ISEW) across individual EU countries was also analyzed and compared. Countries were grouped based on the trends in their welfare measures over the study period, with a decomposition of ISEW components providing insight into these trends. When examining the evolution of $ISEW_{bcpa}$ in two subperiods (1995-2008 and 2008-2020), the following patterns emerged: in 8 EU countries, the welfare measure increased during both subperiods; in another 8, it increased until 2008 and then stagnated; in 7 countries, the measure stagnated throughout both periods; in 3 countries, it increased until 2008 and then declined; and in 1 country, it stagnated until 2008 before decreasing. The analysis concludes that the four most critical components influencing ISEW values are individual consumption expenditures, the value of unpaid work, broad ecological costs (only for the $ISEW_{BCPA}$), and welfare losses from income inequality.

The differing trajectories of GDP and the welfare measures underscore that the additional societal and environmental factors included in the ISEWs significantly impact welfare assessment, highlighting that GDP

alone does not accurately measure overall welfare. We also demonstrate that it is feasible to compile welfare estimates for countries both within and outside the EU using a consistent methodology, ensuring direct comparability across nations. The deliverable also highlights the need for further refinement of the methodology and suggests several avenues for future developments.

Keywords: Index of Sustainable Economic Welfare (ISEW), Beyond GDP, Alternative macroeconomic accounting, Macroeconomic Cost-Benefit Analysis, Genuine Progress Indicator (GPI), European Union.

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About ToBe

ToBe is a 3-year project funded by the European Union through the Horizon Europe framework programme. Tampere University (Finland) acts as a coordinator for the project.

The ToBe project aims at studying the way in which mindsets, indicators, innovations, and policies could better work together towards a sustainability paradigm. The need for moving toward a sustainability paradigm has been widely called for, yet the path to achieving that is not clear. ToBe aims to contribute to filling this gap and create an understanding of a sustainable wellbeing economy through integrated policies and transformative indicators.

The ToBe consortium brings together acknowledged scholars with previous high-quality research on the topic and with diverse backgrounds from social sciences, ecological and political economy, environmental and innovation studies, science and technology, data science, AI and machine learning. All partners represent well-known and established universities, other research institutions and non-governmental organisations (NGOs). Table 1 lists the members of the consortium, which consists of 13 beneficiaries and one associated partner.

Table 1: *ToBe Consortium Members*

No	Role	Short Name	Legal Name	Country
1	COO	TAU	TAMPEREEN KORKEAKOULUSAATIO SR	FI
2	BEN	SU	STOCKHOLMS UNIVERSITET	SE
3	BEN	VTT	TEKNOLOGIAN TUTKIMUSKESKUS VTT OY	FI
4	BEN	EURADA	ASSOCIATION EUROPEENNE DES AGENCESDE DEVELOPPEMENT	BE
5	BEN	Sciences Po	FONDATION NATIONALE DES SCIENCES POLITIQUES	FR
6	BEN	ICHEC	HAUTE ECOLE ICHEC - ECAM - ISFSC	BE
7	BEN	IPE	INSTITUT ZA POLITICKU EKOLOGIJU	HR
8	BEN	UB	UNIVERSITAT DE BARCELONA	ES
9	BEN	Ugent	UNIVERSITEIT GENT	BE
10	BEN	EPC	EUROPEAN POLICY CENTRE	BE
11	BEN	UAB	UNIVERSIDAD AUTONOMA DE BARCELONA	ES
12	BEN	EPN Ecuador	ESCUELA POLITECNICA NACIONAL	EC
13	BEN	CHAL	CHALMERS TEKNISKA HOGSKOLA AB	SE
14	Associated partner	UnivLeeds	UNIVERSITY OF LEEDS	UK

The main objective of ToBe is to contribute to a clearer understanding of how to move to a sustainability paradigm. More specifically, ToBe aims at achieving the following objectives:

- Construct a theoretical framework for a sustainable wellbeing economy by providing a systemic and dynamic understanding of how changing policy goals, mindsets, indicators, innovations and policies work together towards a sustainability paradigm.
- Identify different processes of economic growth by analysing their social and environmental implications.
- Evaluate and compare alternative growth initiatives as systemic innovations with a focus on drivers and barriers to implementation and impacts.
- Develop an ecological macroeconomic model combining conventional macroeconomic variables with

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indicators of wellbeing and sustainability to assess policies from a multidimensional perspective, and to reveal the synergies and trade-offs inherent in the transition to sustainability.

- Co-create policy solutions together with stakeholders to help institutionalise the new policies and indicators in Europe and beyond (potentially including South American and African countries).

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1 Introduction

Deliverable 2.1. of the ToBe project consists of this report together with the dataset of Indexes of Sustainable Economic Welfare (ISEWs). The deliverable presents data about trends in GDP and in two alternative measures of welfare as per Task 2.1 of the project.

We compile two variants of the ISEW for the EU27 and its Member States for the period 1995-2020, drawing on the methodology set out by Van der Slycken and Bleys (2023). We also make several updates to items by building on novel insights and/or more recent data sources. Following the same methodology and comparable data, we additionally compile the two ISEWs for two countries outside of the EU, namely the United Kingdom and the United States. We also made an effort to collected as much data as possible for South Africa, but the lack of some important data did not allow us to make the full index compilation. Using such alternative measures of welfare allows to investigate the extent to which economic growth in the EU27 has become "uneconomic" (Daly, 2014) in the sense that the costs of additional economic activities outweigh their benefits. From an ecological economics perspective it is important to include the ecological costs associated with a growing economy in order to determine the optimal scale of the economic system.

This task is part of the Work Package "Empirical analysis of different processes of economic growth" of the ToBe project, which, as explained above, also contains tasks and deliverables about the economic growth and social policy, about the redistribution and attitudes towards carbon taxes, and about an analysis of the sustainable economic development and living conditions at the neighbourhood level in Africa. This work package is one of the six work packages constituting the project aiming at an understanding of a sustainable well-being economy by developing integrated policies and transformative indicators. Along this work package dedicated to empirical analyses, other work packages focus on the theory behind sustainable well-being and the different existing indicators used to measure well-being. Their findings will inform our discussion about the indexes of sustainable economic welfare. A third work package focuses on identifying innovative policy options and on understanding the processes of change. Another work package focuses on modelling well-being and sustainability outcomes. The work in this work package will take into account the findings of the other work packages, including our findings about the evolution of the ISEWs in the EU. Finally, the results created in this project are carefully communicated and disseminated in different ways in order to increase the impact of these findings. By putting the results of all these work packages, we hope to concrete a novel understanding of economic growth and influence policy-making in order to create a sustainable and inclusive economy.

The development of alternative welfare measures has a long tradition going back to the early 1970s, as GDP's deficiencies when used as a welfare measure were rapidly recognized after the introduction of the System of National Accounts that provided a standardized methodology to measure a country's output. Today, moving "Beyond GDP" is still regarded as one of the most important areas of research in ecological economics and post-growth literature. One of the remaining issues in this literature is the lack of methodological standardization of alternative welfare measures, hence the non-comparability of estimates from different studies (Bleys and Whitby, 2015). These issues were also raised during the Beyond Growth conference that took place in the European Parliament in Brussels in 2023. By compiling data for these two ISEWs for the 27 EU countries using a similar methodology, allowing the comparability of the results, we participate in the development of these new welfare measures by bringing new results.

In this report we present the methodology that was used to compile two variants of the ISEW: one that focuses on benefits and costs of present (and past) economic activities that are currently experienced in society, and one that focuses on the present and future benefits and costs of economic activities today. Afterwards the results of these compilations are presented and discussed, both at the EU27 level and for different groups of Member States. In this way, we give first insights into welfare trends in Europe and reflect on the (un)economic nature of GDP growth over the past decades. Task 2.2 of the ToBe project will dive deeper into the underlying mechanisms that drive (un)economic growth in the EU: here we will identify different determinants of welfare increases (or decreases), and compare these to the determinants of economic growth using panel regression analysis. Additionally, the methodology presented in this report will be thoroughly discussed during a workshop organised in the framework of the MERGE project (also under Horizon Europe). This latter project aims at harmonising the research in the beyond GDP framework to increase its influence on policy-making.

This report is structured as follows. First, we provide a theoretical framework on measuring welfare in section 2. Next, section 3 introduces the methodology, including valuation methods, and data used to compile the two ISEW variants. Section 4 then presents the results of the ISEW compilations at the EU27 level and the level of individual Member States. For both cases, the evolution of the overall indexes is studied and accompanied by a short analysis of the evolution of the different components included in these indexes. Afterwards, section 5 presents the data used to compile the two ISEWs for specific countries outside of the EU and discusses the results for these countries. Finally, section 6 presents a discussion on the ISEWs and the different compilations, while section 7 concludes.

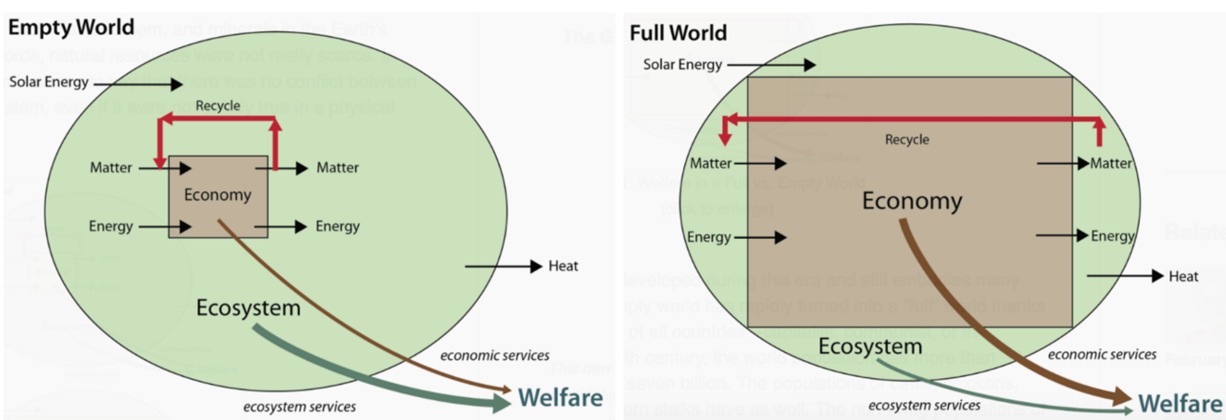
2 What is the Index of Sustainable Economic Welfare?

In the ecological economics' vision of the embedded economy - the economy being an open subsystem of the natural environment that is closed - it is important to not only keep track of the economic services provided by the economy to society, but to also look at the ecosystem services that are given up in the process, as for example clean air, water supply, food and drinks,... (NatureScot, 2023). Indeed, economies grow through using material and energy from the natural environment, which impacts the ecosystem in which our economy is embedded.

As illustrated in figure 1, over the years, the scale of the economy has been increasing within an ecosystem that has a fixed size, going from what Daly (2015) refers to an "empty world" where the economy only occupies a small part of the economy to a "full world" where the economy takes up almost the whole space available within the ecosystem. As the economy takes up more and more (material and energy) space in the ecosystem, more economic services are created (brown arrows), yet only at the expense of the ecosystem services (green arrows) which are decreasing simultaneously. In short, the increasing scale of the economy comes at the expense of ecosystem services that are lost.

Figure 1: Welfare in an empty (panel A) and in a full (panel B) world.

Panel A Panel B



Note: Daly (2015).

Borrowing from welfare economics, ecological economists argue that in order to determine the optimal scale of the economy, one should compare the marginal utility coming from the economic services and the marginal disutility coming from the losses of the ecosystem services. As figure 2 shows, the marginal utility coming from economic services can be thought of as decreasing with increases in production and consumption, while the marginal disutility coming from losses of ecosystem services can be seen as increasing as production and consumption increase. The decreasing utility of consumption and increasing disutility regarding the ecosystem services show that having more is not always better. These concepts can be illustrated by an example about devices used to access the internet. Having one device to go on the internet brings a lot of utility to someone and has a certain impact on the ecosystem services. Having a the second device to go on the internet still brings some utility to that person, but less than the first one, and adds to the impact on the ecosystem services. The utility of another device keeps decreasing as the number of devices increases,

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while the negative impact on the ecosystem services keeps increasing as the number of devices increases. This framework, developed by Daly (2014), allows to identify different limits to economic growth.

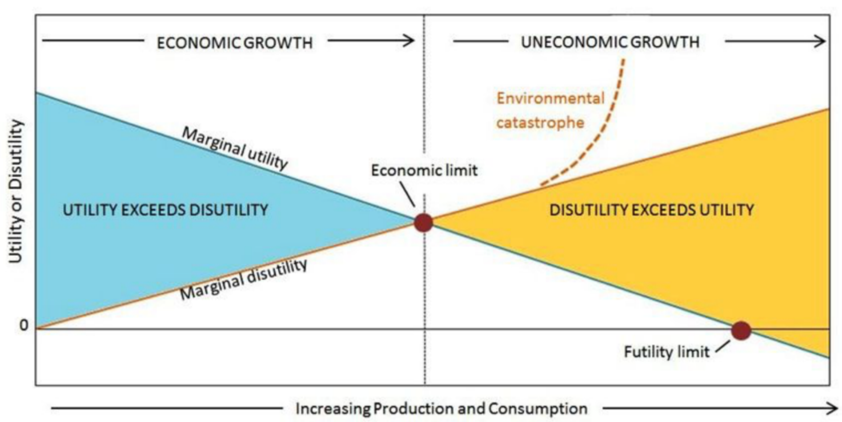
The first limit is the economic limit, which is reached when the marginal utility and marginal disutility from an increased production and consumption are equal to each other (Daly, 2014). Before this point, the utility from economic services is higher than the disutility caused by damaging the ecosystem, meaning that economic growth has net benefits (Daly, 2014). After that point, the disutility generated by damaging the ecosystem becomes higher than the utility created by the economic services. From this point onwards, economic growth becomes "uneconomic" (Daly, 2014). The economic limit hence represents the point where the marginal benefits of economic activities are equal to their marginal costs, and the threshold between economic and uneconomic growth - i.e. the "optimal scale" of the economy (Daly, 2014).

The second limit is the futility limit and is only linked to the marginal utility of economic services. Indeed, from a certain amount of production and consumption onwards, consuming or producing more does not bring any more utility, because "there is a limit to how much we can consume and still enjoy" (Daly, 2014). This limit hence shows that always producing or consuming more and more is not necessarily always bringing us utility (Daly, 2014). This limit is reached at a much higher level of production and consumption than the economic limit, indicating that a lot of the growth is uneconomic already before reaching that limit.

The third limit is the environmental limit and refers to the environmental catastrophe that could happen with infinitely increasing production and consumption. This last limit is not really a limit, but rather a change in the growth rate of the costs/disutility caused by increased production and consumption because of their negative impact on the ecosystem. Indeed, from a certain point onwards, the environmental costs linked to production and consumption start increasing much faster than before, leading to an environmental catastrophe (Daly, 2014). This increased growth rate of the environmental costs could, for example, happen after crossing some tipping points in damaging the environment. Again, this limit is probably reached after the optimal scale of the economy.

These different limits and risks associated with increasing production and consumption highlight the fact that other components, such as the environment, need to be taken into account when making the decision on whether to continue producing and consuming more or not. Indeed, from a certain point onwards, the growth becomes "uneconomic" and leads to more costs/disutility than benefits/utility, showing that additional increases in production and consumption should not be pursued. Alternative measures of welfare, by looking beyond consumption and production, could be used to assess whether economic growth today is indeed truly "economic", or has become "uneconomic".

Figure 2: Uneconomic growth.



Note:Daly (2014).

As the two previous illustrations show, a proper measure of welfare should look at both benefits related to the economic services and the costs of giving up ecosystem services. Such a macroeconomic cost-benefit analysis is needed in order to quantify the optimal scale of the economy. The Index of Sustainable Economic Welfare (ISEW) provides such a macroeconomic cost-benefit analysis tool by including both "uncancelled" benefits from economic activities as well as "uncancelled" costs. The "uncancelled" benefits are the "true"

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benefits to individuals, hence "what remains after all intermediate transactions involved in generating service-yielding goods have cancelled out (Daly, 1979)" (Lawn, 2008b, p.62) and hence represent a correction of the consumption expenditures by deducting, for example, the expenses made on defensive goods and services and the estimated welfare losses from (income) inequality. The "uncancelled" costs included in the ISEW, defined as the "loss of natural capital services as a consequence of fuelling the economic process" (Lawn, 2008b, p.59), are the environmental costs linked to economic activities. The ISEW is thus a monetary index that is directly comparable to GDP.

The ISEW was initially proposed by Cobb and Daly (1989) in an appendix to their book "For the Common Good: Redirecting the Economy toward Community, the Environment, and a Sustainable Future". The authors wanted to debunk neoclassical economic theory and promote an alternative worldview based on individuals as persons-in-community that live well within their natural environments. In the appendix, the ISEW is presented as an alternative to GDP to better measure economic progress by taking into account both the costs and benefits of economic activities. In doing so, Daly and Cobb draw on previous efforts to improve measures of welfare such as the Measure of Economic Welfare put forward by Nordhaus and Tobin (1972) and the Economic Aspects of Welfare by Zolotas (1981). Both measures can be thought of as "adjusted GDPs" in that they factor other elements contributing to welfare (e.g., household labour, leisure time, costs of urbanization). By expanding on this work, Cobb and Daly (1989) try and overcome the most important criticisms on GDP when the indicator is used as a welfare measure (England, 1997).

Following the introduction of the Index of Sustainable Economic Welfare in the late 1980s, early studies mostly focused on estimating the index for individual countries. Based on the results from five different countries for which the ISEW was compiled in the early 1990s, Max-Neef (1995, p.117) put forward a "threshold hypothesis": "for every society there seems to be a period in which economic growth (as conventionally measured) brings about an improvement in the quality of life, but only up to a point–the threshold point–beyond which, if there is more economic growth, quality of life may begin to deteriorate". Some of the more recent ISEW studies indicate that GDP growth has indeed become "uneconomic" in some countries, while for other countries it was found not to be the case as welfare levels did not decline over time. These differences in findings can at least partially be explained by differences in methodological choices made by different scholars, as Neumayer (1999) and Neumayer (2000) argued. Furthermore, the ISEW - and related measures, such as the Genuine Progress Index (GPI), a variant to the ISEW that gained traction in the US - was criticized for not having a clear theoretical framework for the different components it takes into account.

Ten years after its conception, Lawn and Sanders (1999) and Lawn (2003) developed such a theoretical framework building on (i) the ideas of "uncancelled" benefits and "uncancelled" costs as outlined above and (ii) the income concept put forward by Irving Fisher in 1906. On the contrary to more traditional definitions of income that focus on production and/or consumption, Fisher (1906) defines income as a psychic stream of "services" delivered by the consumption of goods and services. According to Fisher, these "services" are psychic, subjective satisfactions that emerge in one's consciousness as a result of consuming. This conceptualization of income also allows for including negative experiences or sentiments in an income measure to account, for instance, for negative emotions related to labour, pain or other inconveniences. Most economists refer to psychic income as a measure of the utility levels that individuals achieve (Lawn, 2003). Lawn and Sanders (1999) use the Fisherian income concept to investigate to what extent a nation's economy contributes to the overall level of well-being experienced by the inhabitants of that country - in line with framework developed by Daly (2014) above. The "net psychic income" measures the difference between uncancelled benefits (psychic services derived from consumption, taking into account different negative psychic experiences) and the uncancelled costs (i.e. loss of ecosystem services).

Since the development of this theoretical framework, many additional ISEW (and GPI) compilations were undertaken, and this both at the national as well as at the subnational level - see Bleys and Van der Slycken (2020) for an overview. These compilations mostly focus on single countries, and scholars tend to make adjustments to the methodology based on either issues of data availability or to include country- or region-specific issues in the welfare measures. This leads to ISEW (and GPI) time series not being comparable across countries, slowing down the uptake of these alternative welfare measures (Bleys and Whitby, 2015). In addition, little attention is paid to pursuing consistency with the theoretical framework developed by Lawn and Sanders (1999) and Lawn (2003). ISEW (and GPI) scholars tend to mix together components that focus on present experiences and components that look at costs or benefits of present economic activities in their efforts.

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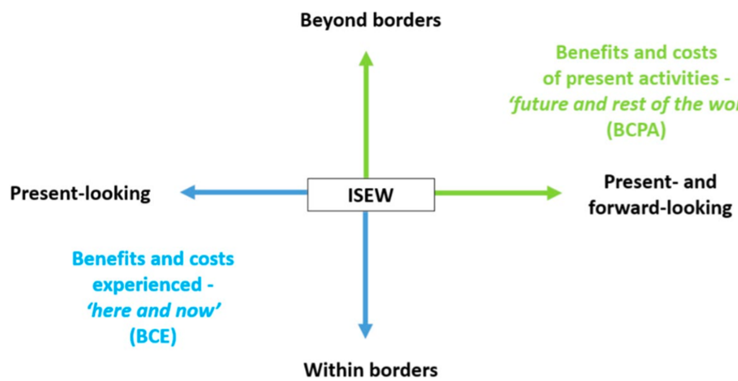
Van der Slycken and Bleys (2023) address these inconsistencies by proposing two variants of the ISEW, one targeting on the benefits and costs experienced today (from both past and present activities), and the other accounting for the (present and future) benefits and costs of present economic activities.. The two variants of the ISEW and their characteristics are presented in figure 3. The first variant, looking at the benefits and costs experienced in the present is named the $ISEW_{BCE}$, to reflect the fact that it looks at the Benefits and Costs Experienced (Van der Slycken and Bleys, 2023). The second variant is named the $ISEW_{BCPA}$ to reflect the fact that it looks at the Benefits and Costs of Present economic Activities (Van der Slycken and Bleys, 2023).

Figure 3: $ISEW_{BCE}$ versus $ISEW_{BCPA}$



Note:Van der Slycken and Bleys (2023).

The distinction made by Van der Slycken and Bleys (2023) between the two variants of ISEWs is mainly based on the distinction between the definitions of income suggested by Fisher (1906) and Hicks (1939). Indeed, the $ISEW_{BCE}$ suggested by Van der Slycken and Bleys (2023) is maximally following the definition of income given by Fisher (1906), which, as explained before, defines an "experiential income concept" in the way that "only the current experiential consumption services that are flowing from capital stocks count as income" (Van der Slycken and Bleys, 2023, p. 4), because it includes only the current ecological costs experienced in the present and within a country and does not include a measure of the capital stock. Alternatively, the $ISEW_{BCPA}$ suggested by Van der Slycken and Bleys (2023) is following the definition of income suggested by Hicks (1939), who argues that income "can be approximated as the sum of consumption and capital accumulation" (Van der Slycken and Bleys, 2023, p. 4), because it includes a measure of capital changes. Additionally, the inclusion of ecological costs shifted in time and space in the $ISEW_{BCPA}$ also comes from following the Hicksian definition of income, but the extended version that deducts the depletion of natural capital (Van der Slycken and Bleys, 2023).

Van der Slycken and Bleys (2023) argue that the $ISEW_{BCPA}$ is more aligned on the position of ecological economists in that the index accounts for ecological costs shifted in time and space. Additionally as the $ISEW_{BCPA}$ accounts for the consumption of physical capital, it is the preferred ISEW alternative when it comes to pursuing "full" accountability of current economic activities. If, however, one wants to focus on measuring current experiences - something related to hedonic approaches to well-being, for instance - the $ISEW_{BCE}$ could be used instead.

3 Methodology

In this section we present the methodology used for compiling the two ISEWs presented above. We provide details about the reasons for including the different components, the valuation methods and the data used, the choices and assumptions made when collecting the data, and a short illustration of the data for selected countries.[1] After presenting the equations for the two ISEW measures, we dedicate a subsection to each of their components.

[1]The reasons for choosing specific countries for the illustration are given in the text. In many cases, the countries for which the component increases or decreases the most is chosen. Sometimes, the country with, for example, the third strongest increase is selected instead of the country with the strongest increase, this is to have some diversity in the countries used for

3.1 Two variants of the ISEW

As mentioned above, we collect data for two different ISEWs in this study. The main difference between these two ISEWs is the way ecological costs and net capital investments are included.

3.1.1 ISEW - Benefits and Costs Experienced (BCE)

The $ISEW_{BCE}$ (Benefits and Costs Experienced) takes into account the benefits and costs experienced in the present and within the borders of a particular country. It does not take into account the costs and benefits experienced in the future nor those experienced abroad. Because of the fact that the $ISEW_{BCE}$ does not look into the future nor abroad, it includes only the ecological costs of economic activities that are experienced today and within the country's borders (e.g., current costs of air pollution and costs of extreme weather events) - we refer to these as the 'narrow' ecological costs. This first variant of the ISEW is based on Irving Fisher's definition of income and hence does not include net capital investments (also because it does not look at the benefits and costs in the future) (Fisher, 1906).

The $ISEW_{BCE}$ is composed as follows:

$$ISEW_{BCE} = UW + C_i + S + G_c - DIRE_p - INQ - NEC \quad (3)$$

where, following Van der Slycken and Bleys (2023), UW is a component representing the value of unpaid work (positive effect), C_i represents the value of individual consumption (positive effect), S is the value of the shadow economy (positive effect), G_c is the value of non-defensive collective government consumption (positive effect), $DIRE_p$ represents the defensive, intermediate and rehabilitative private expenditures (negative effect), INQ measures the welfare losses from income inequality (negative effect) and NEC is the value of the narrow ecological costs experienced in the present and within domestic borders (negative effect).

3.1.2 ISEW - Benefits and Costs of Present economic Activities (BCPA)

The $ISEW_{BCPA}$ (Benefits and Costs of Present Activities) takes into account the present and future benefits and costs of current economic activities and this both within a country's borders as well as abroad. Here, we include the 'broad' ecological costs that also keep track of the costs of a country's activities abroad as well as in the future (e.g., all damage costs related to present greenhouse gas (GHG) emissions). This measure is hence broader than the narrow ecological costs included in the $ISEW_{BCE}$. This second variant of the ISEW is based on the Hicksian view of income and hence also takes into account changes in capital stocks Hicks (1939).

The $ISEW_{BCPA}$ is composed as follows:

$$ISEW_{BCPA} = UW + C_i + S + G_c - DIRE - INQ - BEC + \Delta K \quad (4)$$

The first six components are the same as for the $ISEW_{BCE}$ (unpaid work; individual consumption; shadow economy; non-defensive collective government consumption; defensive, intermediate and rehabilitative private expenditures; welfare losses from income inequality). The first difference is the inclusion of the ecological costs with BEC representing the broad ecological costs including both current costs within domestic borders and the costs shifted in time and space (negative effect). The second difference comes from the inclusion of capital changes with ΔK representing the yearly net capital investments (the actual effect can be positive or negative depending on the change happening in that year).

3.2 GDP, population, exchange rates and deflators

The general variables are the variables that are used in different components (e.g., GDP and population) and/or to adjust the currency or the base year of the collected data (e.g., the exchange rate and the GDP deflator).

The exchange rate data is collected from AMECO (2023c) for all EU countries for the years 1990-2024. The data collected is the annual average exchange rate showing the number of units of national currency being equal to 1 euro. The GDP deflator data is also collected from AMECO (2023b) for all EU countries

the illustrations.

for the years 1960-2024. For all countries, the GDP deflator is collected in euro and in national currency. The GDP deflator in national currency is used to deflate the monetary data of countries that do not use the euro, before transforming the data in euro using the exchange rate. The total population data is collected for all EU countries for the years 1995-2022 from Eurostat (2024h) and is measured in number of people.

Data for GDP at market prices is collected from Eurostat (2024e) for the years 1995-2022 for all EU countries. The data for euro countries is collected in million euro in current prices and the data for non-euro countries is collected in million units of national currency in current prices. For some components, GDP estimates before 1995 are needed. To complete the series, data collected from AMECO (2023a) for the years 1960-1995 is used. This data is collected in euro and national currency for all countries. The GDP data before 1995 is not available for all countries, when the necessary data is not available, tailored solutions are used to fill the gaps. These solutions are explained in detail in the 'data' section of each of the components.

The yearly GDP in million euros in 2015 prices is calculated based on the GDP in current prices in million euros or national currencies, the GDP deflators in euro or national currency and the exchange rate of national currency per euro in 2015, following the steps described in the section below. GDP in million euros in 2015 prices for the years 1994-2020 is available for all countries except for the year 1994 for Croatia, because of missing data for the 1994 GDP deflator.

Notes on handling different currencies and base years

One important general remark about the data collection is that, when dealing with monetary data, the data is collected directly in euros for countries that are part of the Eurozone (Austria, Belgium, Croatia, Cyprus, Estonia, Finland, France, Germany, Greece, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Portugal, Slovakia, Slovenia and Spain) and for Denmark because it has a fixed exchange rate with the Eurozone since before the start of the period studied (1995). For simplicity, these countries will be referred to as the "euro countries" for the remaining of the document. For the remaining countries (Bulgaria, Czechia, Hungary, Poland, Romania and Sweden), data is collected in national currencies because these countries do not have a fixed exchange rate with the euro for the entire period studied. As discussed by Eurostat (2023b), the data for these countries cannot be collected directly in euros in our case because of the exchange rate effect that would make the comparison over time of the data collected inappropriate. Bulgaria is included in the countries collected in national currency even though it has a fixed exchange rate with the euro nowadays because this fixed exchange rate was put in place in 1998, after the start of the data collection. These countries will from now on be referred to as "non-euro countries".

In both cases, the data is transformed to euros in 2015 prices. For the data directly collected in euros, the euro GDP deflator of the country at hand (collected from AMECO (2023b)) is used (dividing the monetary data by the corresponding year's deflator and multiplying by the 2015 deflator, often 100). For countries where data is collected in national currency the conversion into euros in 2015 prices takes place in two steps. First, the yearly deflator in national currency (also collected from AMECO (2023b)) is applied to get the data in constant (2015) national currency (same way as for the euro deflator). Secondly, the actual conversion to euro in 2015 prices takes places by dividing the constant national currency values by the exchange rate between the national currency and the euro in 2015 (collected from AMECO (2023c)).

3.3 Components

Table 2 presents the different components included in each ISEW, their definition and the sources of the data used. More details for each component is given in the corresponding sections.

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Table 2: Summary of the components

$ISEW_{BCE}$	$ISEW_{BCPA}$	**Component**	**Description**	**Sources**
✓	✓	Unpaid work (UW)	The value of unpaid work is the average time spent on unpaid work multiplied by a replacement wage, for the population aged between 15 and 74 years old (equation 5). The time spent on unpaid work includes all activities related to household management, family care, and voluntary work.	**Time spent on unpaid work:** Eurostat (2023h), OECD (2023e), United Nations (2023), Gershuny et al. (2020), or national studies. **Replacement wage:** Eurostat (2023g). **Population:** Eurostat (2023f) and Eurostat (2023e).
✓	✓	Individual consumption expenditures (C_i)	The value of the individual consumption expenditures is equal to the sum of the Actual Individual Consumption (AIC) and the net services from consumer durables (services - costs) (equation 6).	**AIC:** Eurostat (2024f). **Consumer durables:** Eurostat (2024c).
✓	✓	Shadow economy (S)	The value of unpaid work is calculated by multiplying an estimate of the size of the shadow economy as % of GDP by the GDP in that year (equation 7). It represents the legal activities that are not taken into account in GDP because they are not traded on the market.	**Size of the shadow economy:** Elgin et al. (2021). **GDP:** Eurostat (2024e).
✓	✓	Non-defensive government expenditures (G_c)	The non-defensive government expenditures are the expenditures made by the government on goods and services addressed to households but that cannot be attributed to individuals. These expenditures are the sum of general public services expenditures, housing and community amenities expenditures, and recreation, culture and religion expenditures (equation 8).	Eurostat (2024g).
✓	✓	Defensive, Intermediate, and Rehabilitative Expenditures ($DIRE_p$)	The defensive, intermediate and rehabilitative expenditures are the expenditures that do not increase welfare but that are needed to maintain a certain level of welfare. This component is the sum of expenditures on some defensive, intermediate and rehabilitative goods and services (food, alcohol, tobacco and narcotics, insurance, financial services) and the costs linked to road accidents (number of road accidents * costs) (equation 9).	**Expenditures:** Eurostat (2024d). **Number of road accidents:** OECD (2023b). **Costs of road accidents:** Bickel et al. (2006).

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Table 2 continued from previous page

$ISEW_{BCE}$	$ISEW_{BCPA}$	Component	Description	Sources
✓	✓	Welfare losses from income inequality (INQ)	The welfare losses from income inequality aim to capture the diminishing returns of utility as income grows. These losses are calculated by multiplying the net consumption by an index of diminishing marginal utility based on an income threshold (equation 12). The net consumption is equal to individual consumption expenditures + value of shadow economy - defensive, intermediate and rehabilitative expenditures.	**Net consumption:** see sources of respective components. **DMUI:** Eurostat (2024b) and Hickel (2020).
✓		Narrow Ecological Costs (NEC)	The narrow ecological costs are the ecological costs experienced in the present and within a certain country, it is the sum of the current costs of air pollution, the ecosystem costs of nitrogen pollution, and the costs of extreme weather events (equations 15, 16, 17, and 18).	**Costs of air pollution:** Eurostat (2023a) and European Environment Agency (2014). **Ecosystem costs of nitrogen pollution:** Eurostat (2023a), Eurostat (2024a) and Van Grinsven et al. (2013). **Costs of extreme weather events:** Climate ADAPT (2023).

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Table 2 continued from previous page

$ISEW_{BCE}$	$ISEW_{BCPA}$	**Component**	**Description**	**Sources**
	✓	Broad Ecological Costs (BEC)	The broad ecological costs are the ecological costs of the activities taking place today, having an impact in the present in a given country as well as in the future and/or abroad. This component is equal to the sum of the costs of air pollution including trade, the ecosystem costs of nitrogen pollution, the costs of climate breakdown, the costs depleting non-renewable energy resources, and the costs of nuclear power use (equations 19, 20, 17, 23, 25, and 24).	**Costs of air pollution:** Eurostat (2023a), European Environment Agency (2014), UNEP (2024) and Desaigues et al. (2011). **Ecosystem costs of nitrogen pollution:** Eurostat (2023a), Eurostat (2024a) and Van Grinsven et al. (2013). **Costs of climate breakdown:** European Environment Agency (2024), UNEP (2024), Friedlingstein et al. (2023), Ricke et al. (2018) and Tol (2023). **Costs of depleting non-renewable energy resources:** Eurostat (2024i) and European Commission (2021). **Costs of use of nuclear power:** IEA (2023) and Held et al. (2018).
	✓	Yearly net capital investment (ΔK)	The net capital investments represent the change in capital investment from one year to the next, it is calculated by taking the difference between the capital stock in a given year and in the previous year (equation 26).	AMECO (2023d).

Note: The sources given here are the main sources used. In some cases, alternative sources were used for a limited number of data points, this is discussed in details in the respective sections.

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3.3.1 Unpaid work (UW)

The value of unpaid work is included in both ISEWs because it does not deal with future or abroad effects. This value is included in our indexes because unpaid work is an important part of the economy that is usually not accounted for when measuring a country's economic output because it is not traded on the market (hence does not have a quantifiable economic impact) even though it is actually an essential part of the economy. Indeed, the activities performed when doing unpaid work are often necessary for people to live well in a society (e.g., cooking food, taking care of children,...) but are not included in the economic output when done by household members or on a voluntary basis. Still, the value of these activities can be quantified because usually, someone could be paid to do the same activity, and the amount paid to that person would be taken into account in the economic output of a country.

Methodology

The value of unpaid work is measured by multiplying the daily time people spend on unpaid work by a replacement wage:

$$UW = \text{time spent on unpaid work per person} * population_{15-74} * \text{replacement wage} \tag{5}$$

The time spent on unpaid work is measured in minutes per day per person for specific age groups. Following the HETUS definition of unpaid work, the time spent on unpaid work includes all activities related to household management and family care as well as voluntary work and meetings (Eurostat, 2019). The population considered in this component is restricted to the 'working' population in the broad sense of the term because it includes all people aged between 15 and 74 years old. In order to monetize the value of unpaid work, we chose to use replacement wage method, hence "valuing the work at the wage rates of professionals in the market" (United Nations, 2017). Furthermore we use a generalist wage instead of a specialist wage that would have required to assign a specific wage to each individual activity (United Nations, 2017). The generalist replacement wage used here is based on the mean earnings of the service and sales workers in the business economy.

Data

Time use

The time use data is collected from different sources. We applied a 'hierarchy' in the data sources used in order to have the highest possible comparability across data points. The number of data points for time use, and especially the time used for unpaid work is quite small and varies greatly between countries. When available, we gave a priority to data coming from Eurostat (2023h) which is based on the Harmonized European Time Use Survey (HETUS). As mentioned before in the HETUS survey, unpaid work includes all activities related to household and family care (food management, household upkeep, making and core for textiles, gardening and pet care, construction and repairs, shopping and services, household management, childcare, help to an adult family member, and unspecified household and family care) as well as activities related to voluntary work and meetings (organisational work and informal help to other households: construction and repairs as help, help in employment and farming, care of own children living in another household, other childcare as help to another household, help to an adult of another household, and other or unspecified informal help to another household) (Eurostat, 2019). When collecting data from other sources, we tried to follow this definition of unpaid work as closely as possible and only include the above components.

Some additional data points were collected from OECD (2023e), the second data source used, which follows a definition of unpaid work closely linked to the HETUS one, but these were only used when they gave additional data compared to Eurostat data. As a third data source, we looked into the UN SDG 5.4.1. database (United Nations, 2023). To ensure a better comparability with Eurostat or OECD data and when possible, we 'adjusted' the UN data by calculating a ratio between the Eurostat (or OECD) data for a year that is covered in both studies and applying this ratio to data points only covered by the UN data. This adjustment was necessary to ensure that the data collected from different sources is comparable even if the sources are not exactly following the same definition of unpaid work. The same technique was used to 'adjust' data from national studies (Statistics Estonia, 2023; Hungarian Central Statistical Office, 2023;

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National Statistics Office - Malta, 2004; Statistiska centralbyrån, 2003) and Gershuny et al. (2020), which represent the fourth and fifth data sources used to collect the time use data. Since so few data points are available for some countries, the data was extrapolated using memory items before the first available data point and after the last one. For years between two available data points, data was interpolated.

For some countries (Croatia, Cyprus, Czechia and Slovakia), no time use data is available in any of the cited sources above. For these countries, we hence constructed the data based on neighbouring countries. For each country, we investigated the geographically neighbouring countries and compared the labour force participation and employment rates (men, women, total) between the country of interest and the neighbouring countries. Based on this comparison, we selected the neighbouring countries with similar labour force participation and employment rates as the country of interest and used those time use data to construct the time use data for the countries with missing data. When data for only one neighbouring country is available, we simply copied that data. When more than one neighbouring country was selected, we took the average of the values in those countries. More specifically, for Croatia, the average of the data from Slovenia and Hungary was used because they are the only neighbouring countries with available data and similar employment characteristics as in Croatia, while Italy and Greece are disregarded because their employment characteristics are too different from Croatia's. For Cyprus, the time use data from Greece is used because it is the only neighbouring and similar country. For Czechia, the average of the time use data from Germany, Austria and Hungary is used because they are the only neighbouring countries with similar employment characteristics and available time use data. For Slovakia, the average of the time use data from Poland, Hungary, Austria and Slovenia is used because they are the neighbouring countries with available time use data.

Population 15-74 years old

The population data, measured in number of people, for the selected age class was calculated using data from Eurostat (2023f) and Eurostat (2023e) and adding up the data for three different age classes (15-64 years, 65-69 years and 70-74 years). The specific 15-74 years old age group was selected based on the two main sources used for the collection of time use data. Indeed, Eurostat (2023h), presenting the data from HETUS surveys, gives data for the population aged 20-74 years old while the OECD data covers the population aged between 15 and 64 years old. Putting the two age ranges together led us to using the broader 15-74 years old age group. This data was available for all countries except Croatia. For Croatia, the data needed to calculate the amount of people in the age class 15-74 years old is unavailable for the years 1995 to 2000. The missing data was hence extrapolated using data for the years 2001 to 2006. For the years 2001 to 2006, the proportion of people in the age category 15-74 compared to the total population was calculated. This proportion was linearly extrapolated back to 1995 and multiplied by the total population in the years 1995 to 2000 to calculate the number of people in the age category 15-74 in those years.

Replacement wage

The data used to estimate the replacement wage is collected from Eurostat (2023g), which presents the data collected in the Structure of Earnings Survey (SES) in euros. This survey is organized only every four years starting in 2002 (Eurostat, 2023g). The data is hence only available for the years 2002, 2006, 2010, 2014 and 2018 (the 2022 update was not available yet at the time of data collection). The data for the mean earnings is collected in current euro values and used as such for euro-countries. For non-euro countries, the data collected in euro is converted back to the current national currency using the yearly exchange rate before being converted to euro in 2015 prices following the steps explained above. The data in between those years is interpolated using the average of the two available values. The rest of the data (before the first data point for average earnings and after the last one) is extrapolated using data for the countries' average annual wage in current national currency, when available. For countries where data on the average annual wage is not available for the necessary years (Bulgaria, Croatia, Cyprus, Malta and Romania), data on GDP/capita at market prices was used to extrapolate the mean earnings instead of the average annual wage as both series were found to be highly correlated in the countries for which both are available. Latvia is a particular case because the average annual wage data is missing only for the year 1995. We hence extrapolated the 1995 average annual wage using the growth rate observed between 1996 and 1997. For Croatia, this extrapolation

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was used for the years 1995-2010 because the mean earnings data for the two first rounds of the survey (2002 and 2006) is not available.

Illustration

The two most important variables in the valuation of unpaid work are the time spent on unpaid work and the replacement wage. Tables 3 and 4 below present the data for time use and replacement wage for different years in Belgium and Finland, respectively. These two countries were selected to illustrate the data for time spent on unpaid work and replacement wage because they are among the countries for which the most data points could be collected. The selected years are the years for which data points were collected from different sources.

Table 3: Population 15-74, time spent on unpaid work, replacement wage and total value of unpaid work in Belgium, selected years.

Year	Population 15-74	Unpaid work time (minutes/day)	Replacement wage (€/hour)	Value of unpaid work (million €, 2015)
1999	7,694,187	198	12.82	118,779.29
2005	7,817,236	199	13.72	129,852.76
2006	7,856,733	199	13.83	131,510.63
2012	8,225,855	193	14.41	139,212.99
2013	8,265,865	193	14.33	139,027.82

Notes: The replacement wage is expressed in constant 2015 prices and the total value of unpaid work is calculated by multiplying population by (time/60)*365 by the replacement wage.

Table 4: Population 15-74, time spent on unpaid work, replacement wage and total value of unpaid work in Finland, selected years.

Year	Population 15-74	Unpaid work time (minutes/day)	Replacement wage (€/hour)	Value of unpaid work (million €, 2015)
1999	3,885,083	196.00	12.60	58,357.49
2000	3,896,916	196.00	12.99	60,362.63
2009	4,015,931	191.00	14.77	68,914.26
2010	4,036,025	191.00	15.29	71,699.96
2020	4,129,673	187.00	15.03	70,608.76

Notes: The replacement wage is expressed in constant 2015 prices and the total value of unpaid work is calculated by multiplying population by (time/60)*365 by the replacement wage.

3.3.2 Individual consumption expenditures (C_i)

As for GDP, individual consumption expenditures are important when measuring a population's welfare. The fact that consumption is central in the definition of income given by Hicks (1939) and that the value of the uncancelled benefits of the ISEWs mainly comes from consumption prove that it is important to include these expenditures in our ISEWs. Individual consumption expenditures are hence included in both ISEWs.

Methodology

This component is built on two subcomponents: the actual individual consumption (AIC) and a correction for consumption expenses on consumer durables. The first subcomponent has a positive impact on the size of individual consumption expenditures while the second one only has a positive impact if the services of consumer durables in a given year are higher than the expenses on consumer durables in that year.

$$C_i = AIC + (\text{services from consumer durables} - \text{expenses on consumer durables}) \tag{6}$$

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The starting point for compiling the individual consumption expenditures in the ISEWs is the AIC which "refers to all goods and services actually consumed by households" and "encompasses consumer goods and services purchased directly by households, as well as services provided by non-profit institutions and the government for individual consumption (e.g., health and education services)" (Eurostat, 2017). This measure is a better representation of the real consumption of households - and hence of the welfare linked to this consumption - then the private consumption expenditures reported in the System of National Accounts (Eurostat, 2017; Van der Slycken and Bleys, 2023).

Next, a correction for consumption expenses on consumer durables is added to the AIC. This correction is equal to the difference between the services from consumer durables in a given year and the expenses on consumer durables in that year. Consumer goods should be treated as a stock variable, and hence the expenses on consumer durables are not the appropriate (flow) variable to include in a welfare measure. These expenses do not necessarily reflect the value of the services derived from the stock, yet represent an investment in the stock of consumer durables, and should be treated as such (i.e. deducted from the traditional consumption expenditures). Following Van der Slycken and Bleys (2023), we assume that durable goods last, on average, for eight years. The estimated value of the services of consumer durables is added to the value of individual consumption expenditures because it represents the benefits of using different consumer durables in a given year. This component is based on the data collected for the costs of consumer durables. Since a consumer durable is assumed to last for eight years, we impose a depreciation rate of 12.5% on the stock of durable goods. Additionally, we follow previous ISEW studies that impose a 7.5% interest rate on the capital stock. By adding up these two rates, we obtain a 20% rate that is used to calculate the services from consumer durables based on the yearly estimated stock. In this sense, the stock of consumer durables in a given year is the sum of the depreciated value of the expenses on consumer durables in the previous seven years and the expense on consumer durables in that given year. The value of services from consumer durables is equal to 20% of this stock of consumer durables.

Data

Actual individual consumption

The data for AIC is collected in current million euros or units of national currency from Eurostat (2024f) for all countries and transformed into euros in 2015 prices following the steps presented above.

Expenses and services of consumer durables

The data for the expenses on consumer durables are collected from Eurostat (2024c) where data for final consumption aggregated by durability can be collected in current million euros and units of national currency. Only the data for the final consumption expenses of households on durable goods is selected here.

As mentioned above, the data for services of consumer durables is based on the data collected for measuring the costs of consumer durables. However, since consumer durables are expected to last for 8 years, we need data about the expenses on consumer durables until 1988 to calculate the stock of durable goods in 1995. For some countries (Denmark, Finland and France), this data is readily available. For other countries, this data needs to be extrapolated for several years. For countries that have GDP and GDP deflator data from 1987 onwards, the trend in GDP was used to extrapolate the data of expenses on consumer durables because there is a strong positive correlation between these series. The expenses on consumer durables were extrapolated between 1988 and the first available data point using GDP for Austria, Belgium, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain and Sweden. For the remaining countries, the data for GDP and/or GDP deflator is not available early enough to use the trend in GDP to extrapolate the spending on consumer durables. For some of these countries (Bulgaria, Cyprus, Czechia, Hungary, Malta, Poland, Romania and Slovenia), the data for the expenses on consumer durables is only missing for the three years or less and was hence extrapolated using memory items. For the remaining countries (Croatia, Estonia, Latvia, Lithuania and Slovakia), where data is missing for more than 3 years, the data for the expenses on consumer durables for the missing years was extrapolated using a linear trend.

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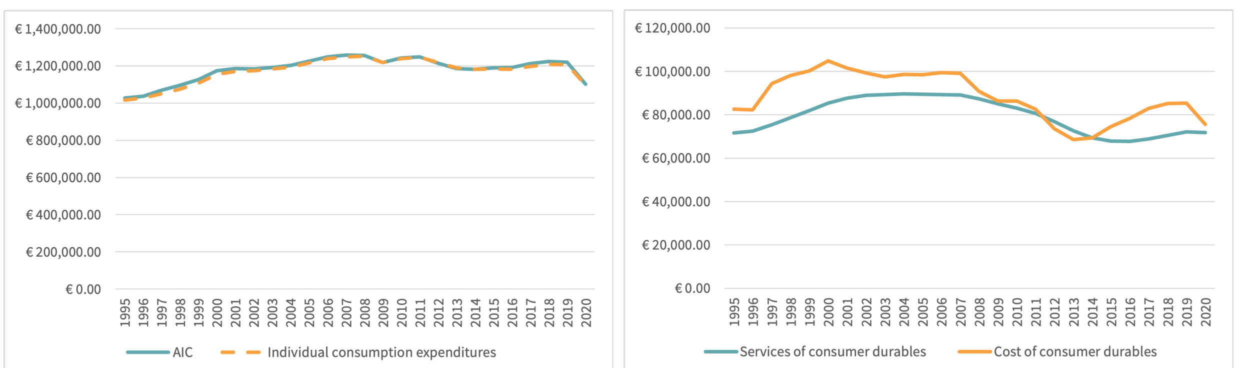
Illustration

Figures 4 and 5 present the evolution of the value of individual consumption expenditures and AIC in figures 4a and 5a and services and costs of consumer durables in figures 4b and 5b for Italy and Slovakia, respectively. These two countries were selected because over the study period they present the lowest and highest increase of individual consumption expenditures, respectively. It is interesting to see that for both countries, the value of individual consumption is almost equal to the value of AIC throughout the entire period. This common evolution of the two measures shows that the correction for consumer durables has little impact on the component.

For Italy, we can see that when the services from consumer durables are higher than their costs, between 2012 and 2014, the value of individual consumption expenditures is slightly higher than AIC. Additionally, we see that the low increase in the total individual consumption expenditures comes from the increase in AIC but is so small because of the decrease in the correction for consumer durables. Indeed, the expenditures on consumer durables decreased over time, which also has a negative impact on the services from consumer durables even though these services still increased slightly over the years. For Slovakia, the big increase in individual consumption expenditures is caused by big increases in AIC and the correction for consumer durables.

Figure 4: Evolution of the AIC and the individual consumption expenditures (Panel A), and evolution of the services and costs from consumer durables (Panel B) in Italy.

Panel A Panel B



Note: The values presented are the total value (not in per capita terms) and measured in million euros in 2015 prices.

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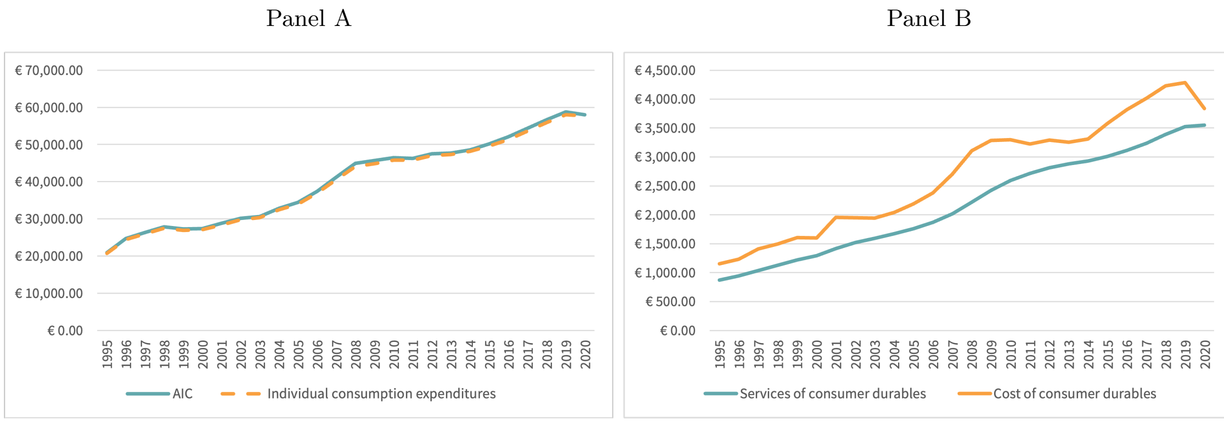
Figure 5: Evolution of the AIC and the individual consumption expenditures (Panel A), and evolution of the costs and services from consumer durables (Panel B) in Slovakia.



Note: The values presented are the total value (not in per capita terms) and measured in million euros in 2015 prices.

3.3.3 Shadow economy (S)

The shadow economy is defined by Elgin et al. (2021) as including “activities that, if recorded, would contribute to GDP, and does not cover illegal activities or household production (Medina and Schneider, 2018; Schneider et al., 2011)” (p. 7). The value of the shadow economy in the different countries is included in both ISEWs because, like unpaid work, the shadow economy is not accounted for in the System of National Accounts (SNA) because its activities are not traded on the market and hence difficult to quantify. Still, the shadow economy is part of the economy and the legal activities taking place in the shadow economy should be accounted for as benefits because of their welfare contributions.

Methodology

The value of the shadow economy in any given year is calculated by multiplying the size of the shadow economy as a percentage of GDP by that year’s GDP in million euros (2015 prices):

$$S = 0.5 * \text{size of shadow economy} * GDP \tag{7}$$

The size of the shadow economy used in this component does not account for illegal activities. However, some of the things included in the measure of the shadow economy presented by Elgin et al. (2021) could also be accounted for in other components of our ISEWs such as AIC or unpaid work. For example, the value of childcare could lead to double counting because it could be included in both the unpaid work component and in the shadow economy component. This situation would arise if someone who is paid to take care of someone else’s children and does not declare it, such as a teenager doing babysitting. Similarly, double-counting with AIC could arise in case people buy and consume products that are homemade and sold by someone who does not have an official business registration. To avoid double counting with the other components, we follow Van der Slycken and Bleys (2023) and only include half of the value of the shadow economy as a component of our ISEWs. Our estimate of the size of the shadow economy is hence relatively conservative (Van der Slycken and Bleys, 2023).

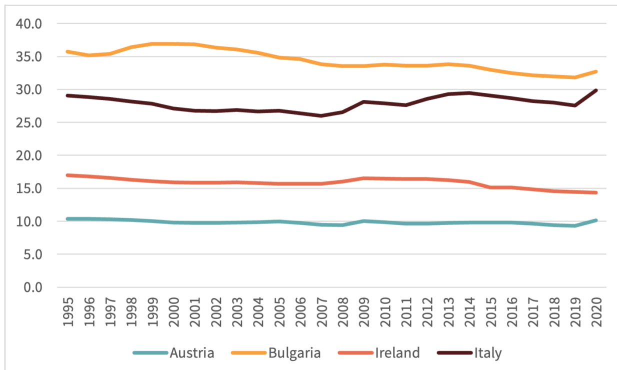
Data

The size of the shadow economy as a percentage of the country’s GDP is collected from a World Bank database constructed by Elgin et al. (2021). The GDP in million euros in 2015 prices is used to calculate the size of the shadow economy to get estimates of the size of the shadow economy in million euros 2015 directly.

Illustration

To illustrate this data, the size of the shadow economy in the different countries was compared. The graph in figure 6 represents the evolution of the size of the shadow economy as a percentage of GDP in Austria, Bulgaria, Ireland and Italy. Within the dataset, Austria has the lowest size of shadow economy as a percentage of its GDP in 2015 (9.8%) and Bulgaria the highest (33%), this is why these two countries were selected to illustrate the data. Additionally, Ireland and Italy were also selected because they experienced the highest decrease (-15.39%) and increase (2.56%), respectively, of the size of their shadow economy over the whole period.

Figure 6: Evolution of the size of the shadow economy (as % of GDP) in different countries.



Note: The size of shadow economy for each country is measured in percentage of that country's GDP.

3.3.4 Non-defensive collective government consumption (G_c)

The non-defensive government expenditures included in both ISEWs represent the "goods and services produced by the general government but consumed by households collectively" (Van der Slycken and Bleys, 2023, Appendix p.7). The general government is defined as including "institutional units which are non-market producers whose output is intended for individual and collective consumption, and are financed by compulsory payments made by units belonging to other sectors, and institutional units principally engaged in the redistribution of national income and wealth" and has "four subsectors: the central government, the state government, the local government, and the social security funds" (Eurostat, 2023d). More precisely, the expenditures considered here are the expenditures on general public services, housing and community amenities, and recreation, culture and religion as they are considered to be beneficial to the population's welfare. All other government expenditures that cannot be attributed to individuals are hence considered to be defensive (Van der Slycken and Bleys, 2023). The expenditures made by the government on defence, public order and safety, and environmental protection are hence, for example, considered to be defensive.

Methodology

The total value of the non-defensive collective government expenditures is the sum of the values of the three above-mentioned types of expenditures:

$$\begin{aligned} G_c = &\text{ general public services expenditures} \\ &+ \text{housing and community amenities expenditures} \\ &+ \text{recreation, culture and religion expenditures} \end{aligned} \quad (8)$$

Data

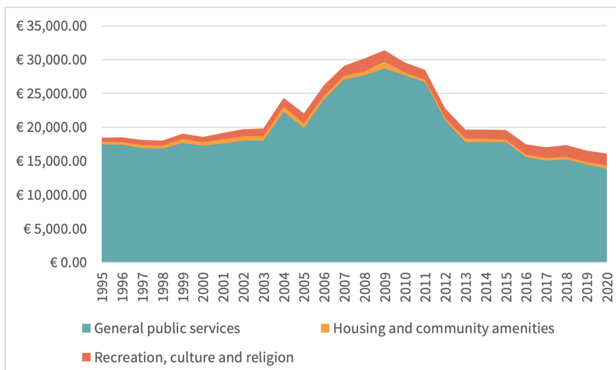
The data of the value of these three types of expenditures is collected from Eurostat (2024g) in current million euros or units of national currencies for all countries and converted into million euros in 2015 prices following the steps presented previously.

Illustration

Two countries, Greece and Lithuania are selected to show the evolution of the size of the government expenditures and of the importance of each type of expenditure over the whole period. These two countries are selected because of the big changes over time in the total value of government expenditures. Greece is the country with the third highest rate of decrease of the whole period, after the Netherlands and Italy. Lithuania is the country with the strongest increase over the whole period. These illustrations are presented in figures 7 and 8, respectively.

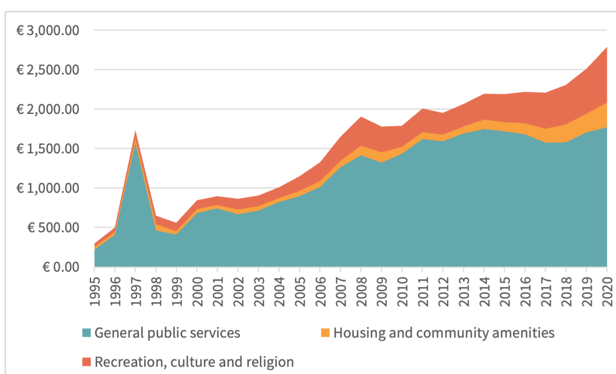
In both cases, the expenditures on general public services are the most important and hence driving the trend over time of the component. Indeed, in Greece, the spending on housing and communities amenities and on recreation, culture and religion increased over the whole period, but due to the high decrease in spending on general public services, the overall component decreased. These expenditures started falling after the financial crisis. For Lithuania, all types of spending increased over the whole period but the spending that increased the most is the one on recreation, culture and religion.

Figure 7: Evolution of the non-defensive government expenditures in Greece.



Note: The expenditures are valued in million euros in current prices.

Figure 8: Evolution of the non-defensive government expenditures in Lithuania.



Note: The expenditures are valued in million euros in current prices.

3.3.5 Defensive, Intermediate and Rehabilitative (Private) Expenditures ($DIRE_p$)

As the value of actual individual consumption is included in the component measuring the private consumption expenditures (see section 3.3.2) and that this variable includes some private defensive expenditures, we include a component adjusting the value of the private expenditures taken into account in our ISEWs.[2] The

[2]The public expenditures do not need to be adjusted because only the non-defensive expenditures are included, as explained in section 3.3.4.

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expenditures that are classified as defensive, intermediate and rehabilitative in both ISEWs are expenditures that do not increase welfare but that are needed simply to maintain a certain level of welfare. Considering the fact that these expenditures do not increase the individuals' welfare, we deduct their estimated value from the ISEWs in order to correct the private consumption expenditures included in section 3.3.2.

Methodology

The DIRE component for a country is calculated by adding the estimated expenditures on different defensive, intermediate and rehabilitative goods and services to the estimated costs of road accidents in this country:

$$DIRE_p = \text{expenditures on DIRE goods and services} + \text{Costs of road accidents} \tag{9}$$

Where

$$\begin{aligned} &\text{expenditures on DIRE goods and services} = 0.25 * \text{Food expenditures} \\ &+ 0.25 * \text{Alcohol expenditures} + \text{tobacco and narcotics expenditures} \\ &+ \text{insurance expenditures} + \text{financial services expenditures} \end{aligned} \tag{10}$$

and

$$\begin{aligned} &\text{Costs of road accidents} = 1.02 * \text{Number of road fatalities} * \text{Cost of road fatalities} \\ &+ 2.25 * \text{Number of road injuries} * \text{Cost of road injuries} \end{aligned} \tag{11}$$

As a first step in accounting for the expenditures on defensive, intermediate and rehabilitative goods and services, we subtract (parts of) the expenditures made by individuals on food, alcohol, tobacco and narcotics, insurance and financial services. Following previous studies, only 25% of the expenditures on food and alcohol are excluded from the ISEWs due to food and beverages being wasted and/or overconsumed (Van der Slycken and Bleys, 2023; Talberth and Weisdorf, 2017), while the other expenditures mentioned above are fully excluded. The expenditures on food and alcohol are treated differently than the expenditures on tobacco, narcotics, insurance and financial services because only parts of the expenditures on food and alcohol are considered defensive. Indeed, only the part of expenditures on food and alcohol representing the waste of these goods and/or the overconsumption of these goods is included because wasting these goods and overconsuming them does not increase welfare.

In a second step, (parts of) the costs of road accidents are excluded from the ISEWs as they constitute defensive expenditures. These costs are calculated by multiplying the number of road accidents leading to injuries and fatalities by their respective average costs per accident.

Data

Expenditures on defensive, intermediate and rehabilitative goods and services

The data for the first part, expenditures on defensive, intermediate and rehabilitative goods and services, is collected from Eurostat (2024d) for all countries, in current million euros or units of national currency, from a database containing details on final consumption expenditures. The data for food, alcohol, insurance and financial services expenditures is collected directly from Eurostat (2024d) while the data for tobacco and narcotics has been calculated manually by deducting the expenditures on alcohol from the expenditures on alcohol, tobacco and narcotics, in order to get only the expenditures on tobacco and narcotics.

Costs of road accidents

For the second part, the data for the number of injuries and fatalities because of road accident are collected from OECD (2023b). The database presented by the OECD only includes the number of fatalities and injuries following car accidents without differentiating between the different states of severity of the injuries. Next, the approximation of the direct and indirect costs of road injuries and fatalities is taken from a study by Bickel et al. (2006).

Regarding the costs of injuries, several choices are made to value the costs of car accidents. Firstly, Bickel et al. (2006) make a distinction between the costs of serious and slight injuries but this distinction is not done when looking at the number of injuries following car accidents. We chose to focus on the costs of slight injuries to keep a conservative estimate. Using this cost estimate for the total number of injuries following a

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car accident reduces the total costs. Secondly, the costs estimated by Bickel et al. (2006) are given only for the year 2002. The costs for the years before and after 2002 are extrapolated using the trend in national GDP measured in current million euros or units of national currency, as suggested by the authors (Bickel et al., 2006, p. 89-90). Thirdly, to account for the unreported road accidents and following the recommendations of Bickel et al. (2006), we correct the number of road accidents by multiplying the number of fatalities by 1,02 and the number of slight injuries by 2,25.

For some countries, the data for the number of road fatalities and injuries or for the costs of road accidents is not available so tailored solutions have been applied. For Cyprus, the number of road fatalities and injuries is not available from OECD (2023b). The data was hence collected from CyStat (2021) which gives tables showing the number of road fatalities and injuries in Cyprus. For Denmark, the number of road injuries from the OECD database is only available until 2019. The number of road injuries for 2020 was then collected from the website of Statistics Denmark (2023). The data for number of road injuries in Luxembourg also stops before the end of the period covered in this study, in 2018. The number of road injuries in Luxembourg in 2019 and 2020 was collected from LU'STAT (2023). For Malta, the OECD database only presents the number of road fatalities and injuries for the years between 1999 and 2017. On the website of the National Statistics Office (1996, 2019, 2021), press releases present the total number of casualties and deaths from road accidents, allowing to collect the necessary data for the number of road fatalities and injuries (by subtracting the number of deaths from the total number of casualties) for the years 1995 and 2018 to 2020. The news releases do not cover the years 1996 to 1998 so the data for these years has been interpolated using the available information for 1995 and 1999. Some data for the number of road injuries is also missing for the Netherlands, for the years 2010 until 2020. The SWOV (2023) presents some data about road accidents that could be used to fill in the gap. However, the data presented by the SWOV (2023) is considerably different when compared to the data collected from the OECD database for the years 2000 to 2009. For this reason, the data from the SWOV (2023) for the years 2010 until 2020 should be adjusted to ensure that they are comparable to the data for earlier years and other countries. The data for the years 2010 until 2020 from the SWOV (2023) was adjusted by calculating the average of the ratio between the OECD (2023b) data and the SWOV (2023) data for the years 2000 to 2009 and multiplying the SWOV data by this average ratio to scale it down to a level that is similar to the OECD data. Finally, for Romania, the number of deaths and injuries caused by road accidents for 2020 was collected from the Romania - Institutul National de Statistica (2022) because it is not available in the OECD database used for the other years.

For Bulgaria, Croatia and Romania, the costs of road accidents are not calculated by Bickel et al. (2006). For these countries, the costs of road accidents have been estimated using the average of the costs for road fatalities and injuries that are available for other EU countries. The costs of road fatalities and injuries are the same for these three countries in 2002 but diverge for the years before and after that because they are extrapolated using the trend in national GDP of the respective countries.

Illustration

Figures 9 and 10 show the evolution of the total amount spent on defensive, intermediate and rehabilitative expenditures in Estonia and Italy, respectively. These two countries are selected because of the growth rate of the component over the whole period. Estonia is the country with the second highest growth rate after Slovakia while Italy is the only country that experienced a decrease over the whole period.

In both cases, we see that the costs of road accidents presented in panel B play a minor role in the evolution and size of total defensive, intermediate and rehabilitative expenditures. This minor impact on the total defensive, intermediate and rehabilitative expenditures is due to the low value of the costs of road accidents compared to the value of the expenditures on defensive, intermediate and rehabilitative goods and services. Indeed, the costs of road accidents represent, on average, 1.12% of the total defensive, intermediate and rehabilitative expenditures in Estonia, and 1.49% in Italy.

The evolution of the cost estimates of road accidents is following the evolution of the countries' GDP. In both countries, the costs of road accidents decreased over the years even though the costs, following the evolution of GDP, increased over the years. In both cases, the overall decrease in the costs of road accidents is hence due to the decrease in the number of road injuries and fatalities over the years.

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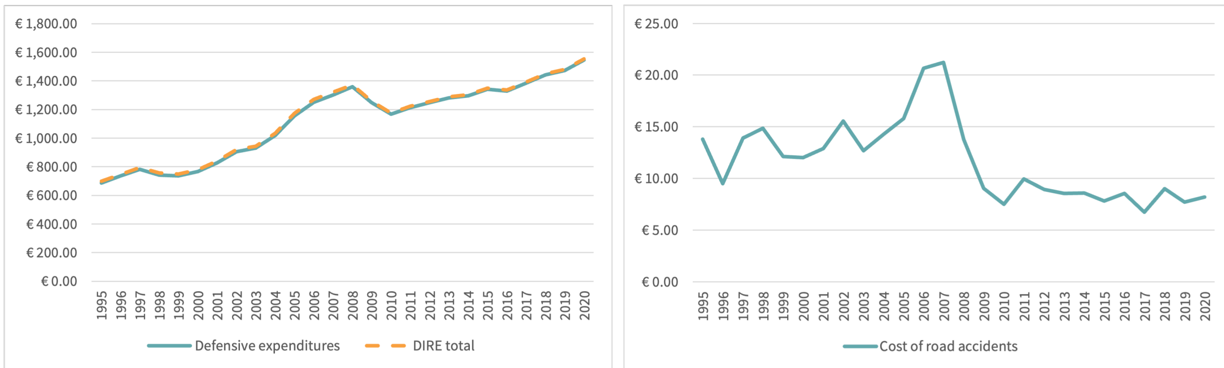
Figure 9: Evolution of defensive, intermediate and rehabilitative expenditures (Panel A) and costs of road accidents (Panel B) in Estonia

Panel A | Panel B



Note: the expenditures and costs are valued in million euros in 2015 prices.

Figure 10: Evolution of defensive, intermediate and rehabilitative expenditures (Panel A) and costs of road accidents (Panel B) in Italy.

Panel A | Panel B

Note: the expenditures and costs are valued in million euros in 2015 prices.

3.3.6 Welfare losses from income inequality (INQ)

The welfare losses from income inequality are included in both indexes to adjust the above consumption components to the diminishing returns of utility that people experience as they get richer.[3] The more unequally incomes are distributed in a given society, the lower the welfare gained from the same amount of consumption and the higher the estimated losses would be. For these reasons, the welfare losses from income inequality are deducted from the ISEWs.

Methodology

The value of the component is estimated by multiplying the total net consumption by an inequality adjustment index:

$$INQ = \text{net consumption} * DMUI \tag{12}$$

The value of net consumption in the above equation is equal to the individual consumption component calculated previously (including the AIC and the costs and services of consumer durables) to which the value

[3]This idea of diminishing returns of utility is for example supported by the futility limit introduced by Daly (2014).

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of the shadow economy is added. Next, the value of defensive, intermediate and rehabilitative expenditures is deducted to get the total value of net consumption.

Different studies have used different ways to account for the welfare losses of income inequality in welfare measures. In this study, we follow Van der Slycken and Bleys (2023) and other studies such as Talberth and Weisdorf (2017) and construct the inequality adjustment index based on diminishing marginal utility of income using a sufficiency threshold. Since we are looking at the diminishing marginal utility return of income, we calculate the actual average equivalised disposable income[4] per decile for each country. The actual average equivalised disposable income per decile[5] is calculated by multiplying the share of national equivalised income in each decile[6] by the GDP in million euros (2015 prices) and dividing by the population per decile which is the yearly total population divided by 10.

Based on a sufficiency threshold, a number of income deciles are adjusted to reflect the diminishing marginal utility of income above a certain threshold. Indeed, comparing the value of a country-specific sufficiency threshold to the average income in each decile allows us to determine in which decile the sufficiency threshold is crossed. Since the sufficiency threshold is found to be between two deciles, the last unadjusted decile that is included in the sum of adjusted and unadjusted deciles is the lowest of the two. Following Talberth and Weisdorf (2017) and Van der Slycken and Bleys (2023), the average income in the deciles above the sufficiency threshold is adjusted by multiplying the sufficiency threshold by the natural logarithm of the division of the average income in the decile by the sufficiency threshold and adding the value of the sufficiency threshold, as shown in equation 13. Following this adjustment, the average income in the first deciles is usually included in full (except when the threshold is below the average income in the first decile, as in Luxembourg), but in the deciles that are above the sufficiency threshold, the average income is "corrected" for decreasing marginal utility (see panel A in figures 11 and 12), making the average income in the adjusted decile lower than in the unadjusted decile.

$$\begin{aligned}\text{Adjusted income} &= \text{sufficiency threshold} * \ln\left(\frac{\text{average income in given decile}}{\text{sufficiency threshold}}\right) \\ &+ \text{sufficiency threshold}\end{aligned} \tag{13}$$

The inequality adjustment index (DMUI) is based on a ratio calculated by dividing the sum of the average income in the unadjusted and adjusted deciles (orange bars in panel A of figures 11 and 12)[7] by the sum of the average income in all unadjusted deciles (blue bars in panel A of figures 11 and 12). The inequality adjustment index is calculated following equation 14.

$$\text{DMUI} = 1 - \frac{\text{sum of average income in unadjusted and adjusted deciles}}{\text{sum of the average income in the 10 unadjusted deciles}} \tag{14}$$

The inequality adjustment index is higher when the sufficiency threshold is in lower deciles because in that case, the sum of deciles including some adjusted ones is more different than the sum of only unadjusted deciles, leading to a lower ratio. The higher the inequality adjustment index, the higher the losses from income inequality. In short, this component shows how consumption translates into welfare. The ISEW takes into account the decreasing marginal utility of income above a certain threshold, so that increases in income do not necessarily translate one on one into increases in welfare. In other words, the first part of net consumption is always accounted fully in the ISEWs but for countries with higher levels of income and more inequality, welfare losses are deducted from the ISEWs to correct consumption for decreasing marginal utility.

[4] The disposable income is "the total income of a household, after tax and other deductions, that is available for spending or saving" (Eurostat, 2021). By dividing this disposable income by the number of household members, the disposable income is equivalised, meaning that it takes into account the differences in the size and composition of households (Eurostat, 2021; Van der Slycken and Bleys, 2023).

[5] Referred to as "average income" for simplicity.

[6] The share of national equivalised income in the relevant decile is the share of national disposable income in the relevant decile as a percentage of total national disposable income (Eurostat, 2023c). More specifically, the share of national equivalised income in each equivalised disposable income decile group is equal to the equivalised disposable income after social transfers of the decile group divided by the total equivalised disposable income after social transfers (Eurostat, 2023c).

[7] The total number of deciles included is always 10. The number of adjusted deciles depends on the sufficiency threshold, only the deciles containing an income higher than the threshold are adjusted.

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Data

The data sources for calculating the net consumption are presented in the previous sections 3.3.2, 3.3.3 and 3.3.5.

The share of national income per decile needed to calculate the average income per decile is collected from Eurostat (2024b). The data collected show the shares of national equivalised disposable income measured in PPS in each decile. This data for 2002 is missing for all countries and is then calculated by taking the average of the 2001 and 2003 values when these are available. For some other countries, more data had to be extrapolated or interpolated, we used similar techniques in similar cases between the countries. When data is completely missing for the beginning of the period studied, we used memory items for all the missing years and using the first available data point. This technique has been used for Bulgaria (1995-2005), Croatia (1995-2009), Cyprus (1995-2004), Czechia (1995-2004), Denmark (1995-2002), Estonia (1995-2003), Finland (1995), Hungary (1995-2004), Latvia (1995-2004), Lithuania (1995-2004), Malta (1995-2004), Poland (1995-2004), Romania (1995-2006), Slovakia (1995-2004), Slovenia (1995-2004), Sweden (1995-2003). For Finland, France, Italy, Portugal and Spain, the value for 2003 is missing in addition to the missing value of 2002. These two values were interpolated using a linear trend and the values for 2001 and 2004. For Germany and the Netherlands, the values for the years 2002 to 2004 are missing from the collected data. These values were interpolated using the values for 2001 and 2005. The value for 2003 is calculated by taking the average of these two values while the values for 2002 and 2004 are calculated by taking the average of the values for 2003 and 2001 or 2005, respectively.

The remaining data needed for calculating the average income per decile, the total population and the GDP in million euros in 2015 prices are collected from the same source as those presented in section 3.2.

The sufficiency threshold considered in this component is taken from Hickel (2020) and is fixed at 20,000 US$ in 2011 prices. To calculate the sufficiency threshold for each country, we first deflated the threshold to get it in 2015 prices and then the specific purchasing power parity (PPP) exchange rate in 2015 for each country, collected from OECD (2023a), was used to get a country-specific sufficiency threshold in euros in 2015 prices. For some countries, the PPP exchange rate with the US dollar is given in national currency per US dollar. In this case, that PPP exchange rate is divided by the exchange rate with the euro in 2015 to get the PPP exchange rate in euro per US dollar in 2015.

Illustration

Figures 11 and 12 below show the effect of adjusting the deciles where average income is higher than the sufficiency threshold for France and Hungary. In both figures, panel A illustrates the difference in average income between unadjusted and adjusted deciles in the year 2015. The two countries were specifically chosen because France is a country where a lot of deciles are adjusted in 2015 since the only unadjusted decile is the first one, while in Hungary fewer deciles are adjusted in 2015 since only the six top deciles are adjusted. In both figures, panel B shows the evolution of the net consumption and the actual welfare losses deducted from the ISEWs. In both countries, the welfare losses more or less follow the evolution of the net consumption as these losses increase throughout the period. When looking at Hungary, it can clearly be seen that at the beginning of the period, the welfare losses are really low compared to those at the end of the period. This difference is caused by the fact that the threshold is falling in higher deciles at the beginning of the period than at the end of the period, which is the result of economic growth pushing the threshold towards lower deciles because of an increase in incomes.

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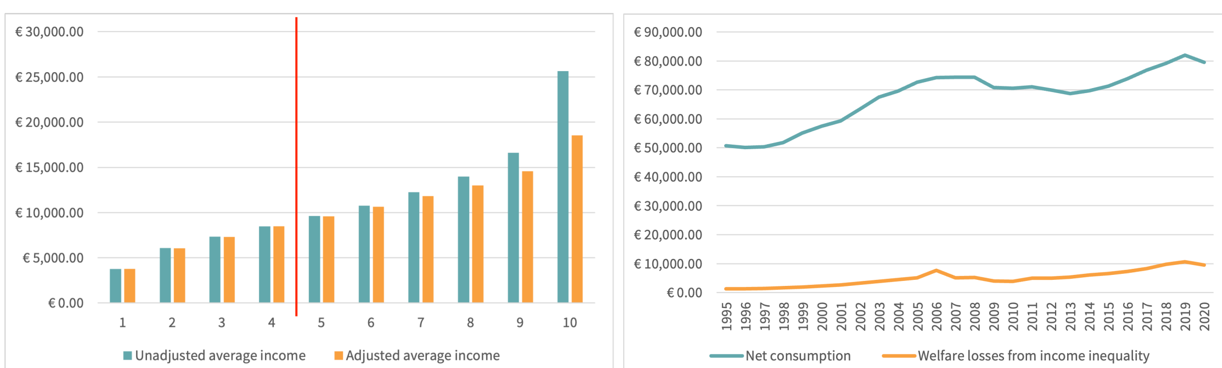
Figure 11: Comparison between unadjusted and adjusted average income per decile in 2015 (Panel A) and evolution of net consumption and welfare losses from income inequality between 1995 and 2020 (Panel B) for France

Panel A Panel B

Note: The average income per decile is measured in euros in 2015 prices. The red line on panel A indicates which deciles are left unadjusted (to the left) or are adjusted (to the right). The net consumption and welfare losses are measured in million euros in 2015 prices.

Figure 12: Comparison between unadjusted and adjusted average income per decile in 2015(Panel A) and evolution of net consumption and welfare losses from income inequality between 1995 and 2020 (Panel B) for Hungary

Panel A Panel B



Note: The average income per decile is measured in euros in 2015 prices. The red line on panel A indicates which deciles are left unadjusted (to the left) or are adjusted (to the right). The net consumption and welfare losses are measured in million euros in 2015 prices.

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3.3.7 Narrow Ecological Costs (NEC)

Ecological costs are included in our welfare indexes because they have a negative impact on individuals' welfare experiences. This component is the first one where we make a difference between the Benefits and Costs Experienced and the Benefits and Costs of Present Activities. Indeed, when looking at the benefits and costs experienced in the present and within a given country ($ISEW_{BCE}$), we include only the "narrow" ecological costs (NEC) that are currently experienced as a result of present or past activities. In this component, the environmental costs resulting from current activities that are shifted into the future or occur outside of domestic boundaries (i.e., ecological costs related to trade) are not included here.

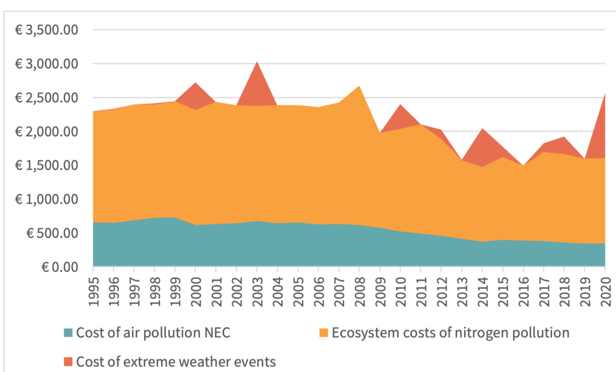
$$NEC = \text{current costs of air pollution} + \text{ecosystem costs of nitrogen pollution} + \text{costs of extreme weather events} \tag{15}$$

The narrow ecological costs consist of three different subcomponents: the current costs of air pollution, the ecosystem costs of nitrogen pollution and the costs of extreme weather events. The value of the three components in million euros (2015 prices) are added up to obtain the total value of narrow ecological costs in million euros (2015 prices) to be deducted when calculating the $ISEW_{BCE}$.

Figures 13 and 14 show the evolution of the costs of the three NEC subcomponents in two countries, Croatia and Slovenia, over the whole study period. These two countries were selected to illustrate the data because of the evolution of the value of the component over the whole period. Croatia is the country with the strongest increase. Interestingly, the total value of the narrow ecological costs only increased in two other countries: Latvia and Lithuania. Among the many other countries where the total value of narrow ecological costs decreased, Slovenia is the country with the second strongest decrease after Belgium.

In both countries, we see that the subcomponent that affect NEC the most is the ecosystem costs of nitrogen pollution, followed by the current costs of air pollution. These two subcomponents decrease over time for both countries. The costs from extreme weather events are very volatile in both countries and over the whole period. The increase in the total value of NEC for Croatia is actually caused by a peak in the costs of extreme weather events in 2020.

Figure 13: Evolution of the costs of NEC subcomponents in Croatia.



Note: The costs are measured in million euros in 2015 prices.

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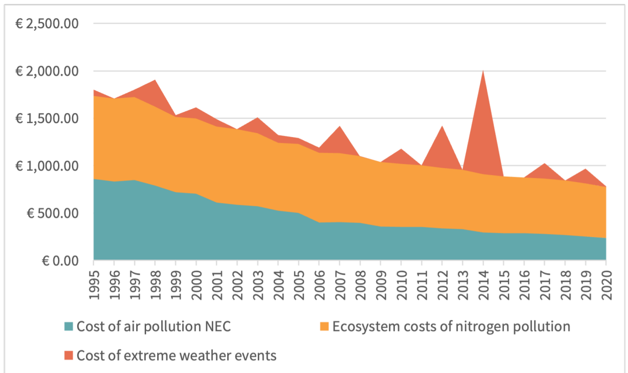
Figure 14: Evolution of the costs of NEC subcomponents in Slovenia.



Note: The costs are measured in million euros in 2015 prices.

Current costs of air pollution

The current costs of air pollution is the first subcomponent of the narrow ecological costs included in the $ISEW_{BCE}$.

Methodology

This subcomponent is estimated by taking into account the emissions of different types of air pollutants over the years and multiplying these emissions by country-specific cost estimates for each type of pollutant:

$$\begin{aligned} &\text{Current costs of air pollution} = 0.2 * ((\text{emissions } PM_{2.5} * \text{cost estimate } PM_{2.5}) \\ &+ (\text{emissions } NH_3 * \text{cost estimate } NH_3) + (\text{emissions } NO_x * \text{cost estimate } NO_x) \\ &+ (\text{emissions NMVOC} * \text{cost estimate NMVOC}) + (\text{emissions } SO_x * \text{cost estimate } SO_2)) \end{aligned} \tag{16}$$

Since NEC only takes into account the impact of (past and present) emissions on current experiences, we need to include only the present costs associated with these air pollutants. To do that, an adjustment of the total costs of air pollution is needed. Indeed, the cost estimates presented by the European Environment Agency (2014) take into account the acute (short-term) and chronic (long-term) effects of air pollution, without specifying what part of the cost estimate represents each of these effects. Since we need to take into account only the present costs of air pollution and not the future costs, we follow Van der Slycken and Bleys (2023) (who followed Lawn (2008a) who made a similar adjustment) and assume that only 20% of the costs of air pollution are experienced in the present. The current costs of air pollution included in NEC are hence equal to 20% of the total costs of air pollution in each year, as shown in equation 16.

In this component we only include emissions within a country's borders, meaning that we include only the production-based emissions. Following Van der Slycken and Bleys (2023), the pollutants that are accounted for are the particulate matter < 2.5 µm ($PM_{2.5}$), ammonia (NH_3), nitrogen oxides (NO_x), non-methane volatile organic compounds ($NMVOC$) and sulphur oxides (SO_x).

Data

The data about the emissions for each pollutant in the different countries and years is available from Eurostat (2023a) and was collected in tonnes of pollutant.

The cost estimates for each of these pollutants are taken from a study by the European Environment Agency (2014). This study calculates the country-specific damage costs per tonne of different pollutants. They calculate two "contrasting but complementary approaches for valuing health damage caused by main air pollutants": the Value of a Statistical Life (VSL) and the Value of a Life Year (VOLY) (European Environment Agency, 2014, p.23). While the VSL gives "an estimate of damage costs based on how much people are willing to pay for a reduction in their risk of dying from adverse health conditions", the VOLY is "an estimate of damage costs based upon the loss of life expectancy and takes into account the age at which

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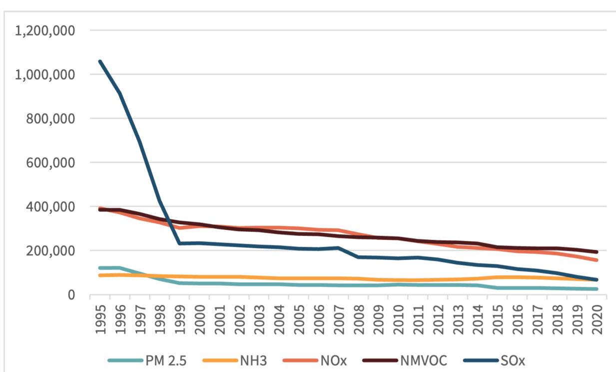
deaths occur" (European Environment Agency, 2014, p.23). The former cost estimate is usually higher than the later one. In this study, the VOLY, taking into account the loss of life expectancy, is chosen to measure the value of the cost of air pollution because, by accounting for the years of life lost, it provides information that is more useful for this study than the VSL that only gives the value of a statistical life (Van der Slycken and Bleys, 2023; European Environment Agency, 2014). The European Environment Agency (2014) report provides VOLY cost estimates in euros/tonne of pollutant for $PM_{2.5}$, NH_3, NO_x and NMVOC. The cost estimate for sulphur oxides (SO_x) is not given by the European Environment Agency (2014) but the cost estimate that they provide for sulphur dioxide (SO_2) can be used instead because SO_2 is the one with the highest concentration in the group of sulphur oxides and can be used as "the indicator for the larger group of gaseous sulphur oxides" (US Environmental Protection Agency, 2024). The cost estimates are collected from the European Environment Agency (2014) report in 2005 prices (€/tonne) and are transformed into 2015 prices using the country-specific GDP deflators in euros. The cost estimates are specific for each country and pollutant but do not vary over the years in our study because the European Environment Agency (2014) report only provides a single cost estimate for the year of the study. These estimates are different for the different countries because they depend on country-specific characteristics, such as the overall pollution load of the atmosphere and the spatial location of emission sources.

Illustration

Figures 15 and 16 present the evolution of the production-based emissions in two countries over the study period. These two countries were selected because Czechia has the second strongest decrease in the total value of the current costs of air pollution, after Bulgaria, and Romania has the third weakest decrease in the total value of current costs of air pollution, after Austria and Croatia. Since the cost estimates presented in table 5 are constant over time, the decrease in the total value of the current costs of air pollution comes from the decrease in the amount of emissions over the period, as seen in the two figures.

In both countries, the SO_x emissions are clearly higher than the others at the beginning of the period, and decreasing the most over time, ending up being among the least important emissions in 2020. Additionally, the amount of emissions from $NMVOC$ and NO_x are similar to each other and decreasing over time in both cases, becoming the most important emissions after the decrease of the SO_x emissions. The lowest amount of emissions are for the $PM_{2.5}$ and NH_3.

Figure 15: Evolution of some production-based emissions in Czechia



Note: The emissions are measured in tonnes.

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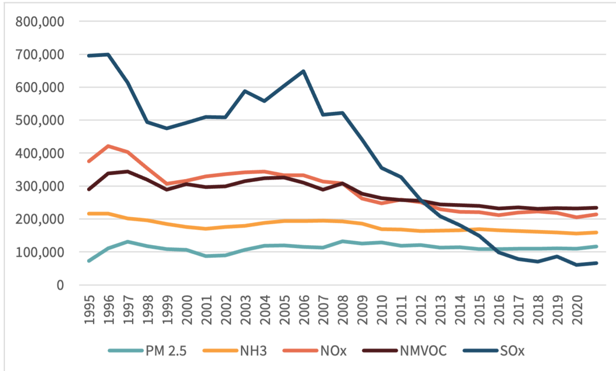
Figure 16: Evolution of some production-based emissions in Romania



Note: The emissions are measured in tonnes.

Table 5: Pollutant-specific cost estimates

Pollutant	Average across EU27	Czechia	Romania
$PM_2.5$	€ 33,928.54	€ 49,858.71	€ 54,703.72
NH_3	€ 11,837.34	€ 24,150.51	€ 17,512.68
NO_x	€ 5,766.16	€ 8,026.00	€ 11,514.07
NMVOC	€ 1,763.21	€ 2,594.07	€ 1,777.65
SO_x	€ 13,803.82	€ 15,605.69	€ 16,362.34

Note: The estimates are measured in VOLY €/tonne in 2015 prices.
The red estimate is the highest estimate among EU countries.

Ecosystem costs of nitrogen pollution

Following Van der Slycken and Bleys (2023), we include a measure of the costs of nitrogen pollution in the ecological costs measures. This component is included in the NEC because we look at the current ecosystem costs within domestic borders.

Methodology

Still following Van der Slycken and Bleys (2023), we only include the ecosystem costs of nitrogen pollution and disregard the health and climate impacts to avoid double-counting with the other components such as the costs of air pollution. These ecosystem costs of nitrogen pollution are calculated by multiplying the amount of pollution from certain pollutants by specific cost estimates and adding up the costs across different pollutants:

$$\begin{aligned}&\text{Ecosystem costs of nitrogen pollution} = (\text{emissions } NH_3 * \text{ecosystem cost estimate } NH_3)\\&+ (\text{emissions } NO_x * \text{ecosystem cost estimate } NO_x)\\&+ (N_r \text{ consumption} * \text{ecosystem cost estimate } N_r)\end{aligned} \tag{17}$$

The pollutants that are included in this component are the emissions of ammonia (NH_3) and nitrogen oxides (NO_x). Additionally, the consumption of inorganic fertilizers is included as a proxy for the costs of reactive nitrogen (N_r) losses to rivers and seas from agricultural sources.

Data

The data on the amount of annual emissions for the two pollutants included in this subcomponent are available from Eurostat (2023a) and collected in tonnes. The data regarding the consumption of inorganic fertilizers is also available from Eurostat (2024a). For this pollutant the data are only available for all EU countries from 2000 onwards. For the first five years of the study, memory items were used to deal with missing data.

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The cost estimates for the ecosystem costs of nitrogen pollution are taken from a study by Van Grinsven et al. (2013). In a table, they present the costs associated with the emission of NO_x and NH_3 in the air, as well as the costs associated with the N_r losses to rivers and seas. For all pollutants, we collected only the data for the ecosystem costs and disregarded the others. For NO_x and NH_3, we focus on the ecosystem costs from all sources while for N_r, we only take into account the ecosystem costs from agricultural sources. Van Grinsven et al. (2013) present ranges for the cost estimates of the different pollutants in billion euros per year in 2008 prices. Taking the average of these ranges for each pollutant in 2008, multiplying this by 1000 (to get million euros) and dividing this average by the total emissions for the given pollutant in the EU27 in 2008 gives a cost estimate in million euros per tonne of pollutant in 2008 prices. After multiplying this cost estimate by 1,000,000 and using the EU's GDP deflator, we obtain the cost estimate in € per tonne in 2015 prices for each pollutant. This cost estimate is then used to value the pollution from NO_x, NH_3 and the run-off of inorganic fertilizers to the rivers and seas. Only one cost estimate is given for the whole EU by Van Grinsven et al. (2013) so for all countries and years, the same cost estimate is used for each of the different pollutants included.

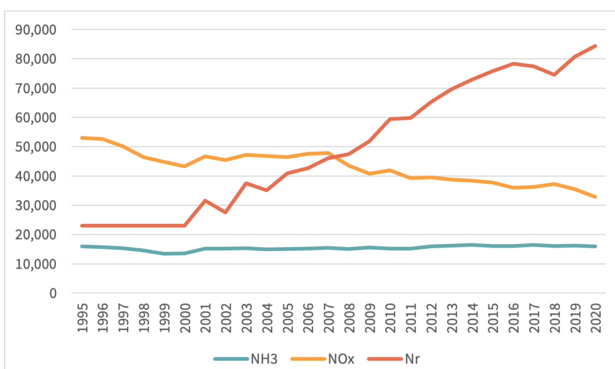
Furthermore, the inclusion of the consumption of inorganic fertilizers to proxy for the run-off of reactive nitrogen to rivers and seas from the agricultural activities allows to account for the cost of water pollution which hence does not have to be included as a separate subcomponent in the narrow ecological costs.

Illustration

Figures 17 and 18 show the evolution of the three pollutants considered here over the study period for Latvia and the Netherlands, respectively. These two countries were selected because of the evolution of their total value of the ecosystem costs of nitrogen pollution. Latvia exhibits the strongest increase in the total value of the ecosystem costs of nitrogen pollution while the Netherlands has the strongest decrease of these costs. In both cases, the changes in the total ecosystem costs of nitrogen pollution are due to the changes in the amount of emissions from the different sources because, as shown in table 6, the cost estimates of the emissions from the different sources are constant over time and for all countries.

From the graphs, we can see that in both cases the emissions from NH_3 are relatively stable over time while emissions from NO_x are decreasing over time. However, the pollution from N_r linked to agricultural activities evolved in opposite directions in the two countries. In Latvia, the pollution from inorganic fertilizers increased a lot over the period while it slightly decreased for the Netherlands. This difference explains the difference in the evolution of the total ecosystem costs from nitrogen pollution.

Figure 17: Evolution of different types of nitrogen pollutants in Latvia.



Note: The emissions are measured in tonnes.

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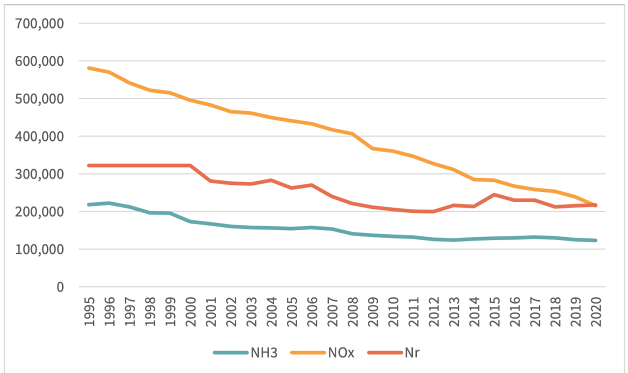
Figure 18: Evolution of different types of nitrogen pollutants in the Netherlands.



Note: The emissions are measured in tonnes.

Table 6: Pollutant-specific ecosystem cost estimates

Pollutant	Ecosystem cost estimate
NH_3	€ 12,367.19
NO_x	€ 5,063.86
N_r	€ 6,521.70

Note: The cost estimates are measured in €/tonne in 2015 prices.

Costs of extreme weather events

The costs of extreme weather events is the last subcomponent included in the narrow ecological costs. These costs are regarded as the costs of climate change that are currently being experienced in any given country.

Methodology

In order to avoid double-counting with the DIRE expenditures (that already exclude expenditures on insurance from the ISEWs), we only take into account the uninsured costs of extreme weather events in this subcomponent. These uninsured costs are calculated by subtracting the insured losses from extreme weather events from the total losses from those events:

$$\begin{aligned}\text{Costs of extreme weather events} &= \text{Total economic losses from extreme weather events} \\ &- \text{Insured economic losses from extreme weather events}\end{aligned} \tag{18}$$

Data

The data for this subcomponent are collected from the Climate ADAPT (2023) platform which presents parts of the CATDAT dataset by Risklayer (2024). From this platform, it is possible to collect data for both the total losses from extreme weather events as well as the total insured losses from these events. Taking the difference between both estimates allows us to calculate the amount of losses from extreme weather events that are uninsured and hence directly affect the population. This dataset contains data about weather- and climate-related extremes as well as geotechnical hazards. The data collected encompasses the losses from these different types of events, hence covering the losses from hydrological events, meteorological events, climatological events (heatwaves and others) and geophysical events. These costs are expressed in million euros in 2022 prices and converted into million euros in 2015 prices by using the countries' GDP deflators in euros.

Illustration

The figures 19 and 20 show the evolution of the total, insured, and uninsured economic losses from extreme weather events for Germany and Spain over the study period. These two countries were selected because

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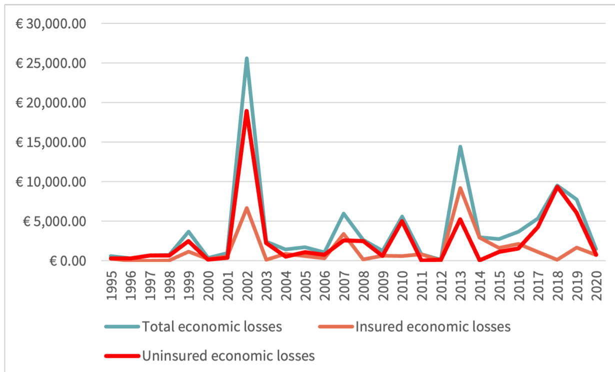
those are among the countries with the most available data points.

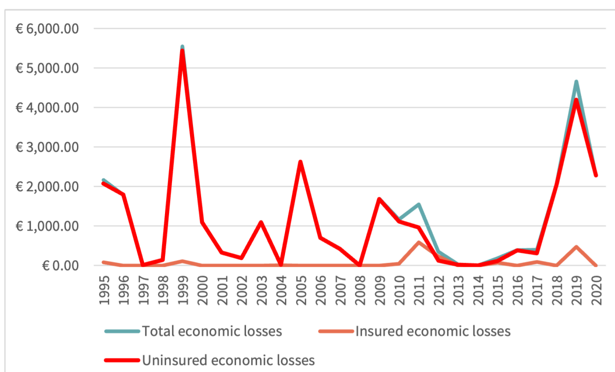
The difference in the proportion of insured losses between these two countries is interesting to see. In Germany, a considerable amount of losses are not included in the welfare measure because they were insured while in Spain, almost all economic losses are included in the $ISEW_{BCE}$ because only a limited amount of them were insured.

Figure 19: Evolution of the total, insured and uninsured economic losses from extreme weather events in Germany.



Note: The costs are in million euros in 2022 prices.

Figure 20: Evolution of the total, insured and uninsured economic losses from extreme weather events in Spain.



Note: The costs are in million euros in 2022 prices.

3.3.8 Broad Ecological Costs (BEC)

As indicated above, the index presenting the benefits and cost of present economic activities includes broader ecological costs because it looks at the impact of the economic activities taking place in the current year on the welfare of societies here and now as well as abroad and in the future.

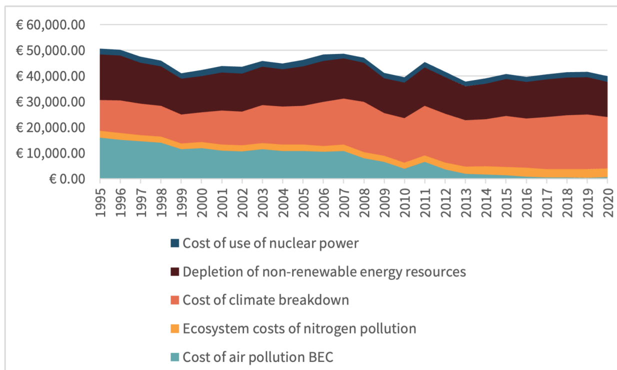
$$\begin{aligned} BEC &= \text{costs of air pollution} + \text{ecosystem costs of nitrogen pollution} \\ &+ \text{costs of climate breakdown} + \text{costs of depleting non-renewable energy resources} \\ &+ \text{costs of nuclear power use} \end{aligned} \tag{19}$$

This component includes more subcomponents than the narrow ecological costs because it includes costs shifted abroad and/or into the future. The subcomponents of the broad ecological costs are the costs of air pollution (including the costs embodied in trade), the ecosystem costs of nitrogen pollution, the costs of climate breakdown, the costs of depletion of non-renewable energy resources, and the costs of the use of nuclear power.

Figures 21 and 22 present the evolution of the costs for each subcomponent of the BEC for Bulgaria and Malta, respectively. Bulgaria is the country where the total value of the broad ecological costs decreased the most over the whole period while Malta is the country where it increased the most.

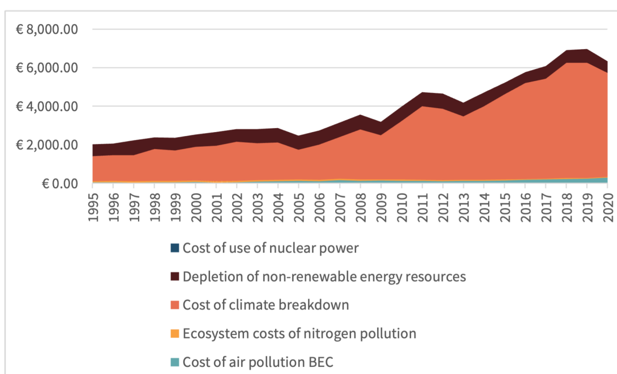
In both cases, the most important subcomponents are the costs of climate breakdown and the costs of depleting non-renewable energy resources. For Malta, these two subcomponents make up almost the total value of the broad ecological costs because the costs from air pollution and the ecosystem costs of nitrogen pollution are much lower. Additionally, the costs of nuclear power use are not visible because they are equal to zero for Malta as there are no nuclear plants in the country. For Bulgaria, at the beginning of the period, the costs of air pollution are quite high and important in the total value of broad ecological costs. Over time, these costs decrease and become less important, explaining partially the decrease in total broad ecological costs. As for Malta, the ecosystem costs of nitrogen pollution are not very important, and the costs of nuclear power use are present but again very low.

Figure 21: Evolution of the costs for the subcomponent of BEC in Bulgaria.



Note: The costs are in million euros in 2015 prices.

Figure 22: Evolution of the costs for the subcomponent of BEC in Malta.



Note: The costs are in million euros in 2015 prices.

Costs of air pollution including trade

The subcomponent tracking the costs of air pollution in BEC starts from the same baseline numbers as the subcomponent included in NEC (see section 3.3.7).

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Methodology

The difference between the costs of air pollution included in NEC and those included here, in BEC, is that we now include the full costs of air pollution (compared to only 20% in NEC) because we also take into account the costs of current air pollution in the future. Additionally, we also include the costs of air pollution embodied in trade because we look at the broad costs also experienced abroad and not only within a country's borders. The total costs of air pollution including the costs embodied in trade are calculated by adding up the costs of current air pollution from the production-based emissions and the the costs embodied in trade:

$$\text{Costs of air pollution} = \text{costs of current air pollution} + \text{costs of air pollution embodied in trade} \tag{20}$$

where

$$\begin{aligned}&\text{Costs of current air pollution} = (\text{emissions } PM_{2.5} * \text{cost estimate } PM_{2.5})\\&+ (\text{emissions } NH_3 * \text{cost estimate } NH_3) + (\text{emissions } NO_x * \text{cost estimate } NO_x)\\&+ (\text{emissions NMVOC} * \text{cost estimate NMVOC}) + (\text{emissions } SO_x * \text{cost estimate } SO_2)\end{aligned} \tag{21}$$

and

$$\begin{aligned}&\text{Costs of air pollution embodied in trade} = (\text{costs from consumption} - \text{costs from production})\\&* \text{cost estimate}\end{aligned} \tag{22}$$

The production-based costs of air pollution emissions are exactly the same as those partially included in the NEC component. These costs are calculated by multiplying the amount of emissions from certain pollutants by country- and pollutant-specific cost estimates. For more details, see section 3.3.7. The costs of air pollution included in trade are calculated by multiplying the amount of air pollution embodied in trade by a cost estimate.

Data

Details about the data used to calculate the production-based costs of air pollution can be found in section 3.3.7.

Regarding the pollution embodied in trade, it is determined based on data collected from UNEP (2024), presenting the SCP-HAT data, and a cost estimate from Desaigues et al. (2011). The UNEP (2024) dataset presents the damages on human health caused by emissions from consumption and from production, measured in kilo-DALY (Disability-Adjusted Life Years). The pollutants that are taken into account in this measure are the emissions of $PM_{2.5}$, NH_3, SO_2 and NO_x (UNEP, 2024). The impact of pollution embodied in trade is calculated by subtracting the impact of pollution from production emissions from the impact of pollution from consumption emissions. The cost estimate used to monetarily value the impact of pollution embodied in trade comes from a study by Desaigues et al. (2011). In their study, they present different VOLY estimates in euros per life year. The one that is used in this study is the EU-wide estimate of 40,000 euro per life year (in 2010 prices). This estimate is deflated using the EU GDP deflator to get the VOLY estimate in euros per life year in 2015 prices. This VOLY estimate in 2015 prices is then used to transform the impact of pollution measured in kilo-DALY into costs of air pollution expressed in million euros (in 2015 prices). The same cost estimate is used for all countries and years in the sample to value the costs of air pollution embodied in trade since Desaigues et al. (2011) provide an EU-wide estimate.

Illustration

Figures 23 and 24 present the evolution of the costs of air pollution from production and those embodied in trade for Estonia and Malta, respectively. These two countries were chosen to illustrate this data because of the overall evolution of their total value of the costs of air pollution, Estonia experiencing the second strongest decrease (after Bulgaria) and Malta experiencing the strongest increase. The cost estimates used to value the production-based costs of air pollution are the same as in table 5 while the cost estimate to value the costs of air pollution embodied in trade is equal to 42,386.13 euro (in 2015 prices) for every country and over the full study period.

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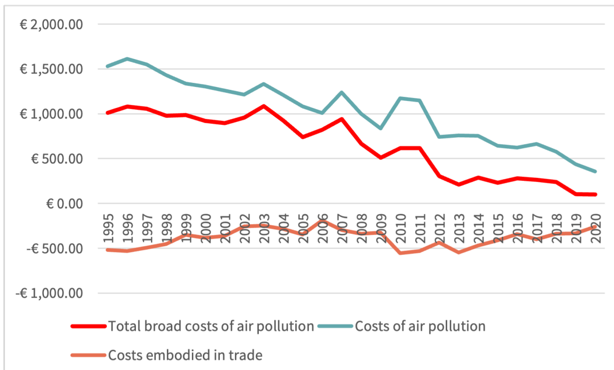
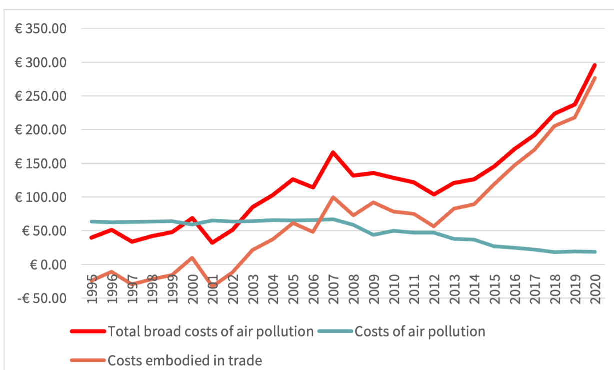
In both cases, the production-based costs of air pollution decreased over the study period. In contrary, the costs of air pollution embodied in trade evolved differently in the two countries. In Estonia, these costs are negative throughout the entire period[8], decreasing the total value of the costs of air pollution. Still, the overall decrease of the overall value is mainly caused by the decrease in production-based costs. In Malta, the substantial increase in the total costs of air pollution is mainly caused by the massive increase of the costs embodied in trade over the period. Starting from negative values, they increased a lot and, by the end of the period studied, make up almost the total value of the total costs of air pollution because of the decrease in the production-based costs. The big increase of the costs embodied in trade indicate that Malta imported more and more goods, widening the gap between the emissions from production and consumption.

Figure 23: Evolution of the costs of air pollution from production and trade in Estonia



Note: The costs are in million euros in 2015 prices.

Figure 24: Evolution of the costs of air pollution from production and trade in Malta



Note: The costs are in million euros in 2015 prices.

Ecosystem costs of nitrogen pollution

This subcomponent is exactly the same as the one included in the narrow ecological costs because we assume that the ecosystem costs of nitrogen pollution are experienced in the present and where the pollution happens. Since the broad ecological costs include both the costs in the present and on the territory in addition to the costs in the future and abroad, the ecosystem costs of nitrogen pollution are also added here. More details regarding this subcomponent can be found in section 3.3.7.

[8]The negative costs of air pollution embodied in trade indicate that the costs from production are higher than the costs from consumption and hence that some of the costs are incurred to produce exported goods.

Costs of climate breakdown

The costs of climate breakdown subcomponent is the broad counterpart of the cost of extreme weather events included in NEC. The subcomponent presenting the costs of extreme weather event is hence disregarded from the BEC to avoid double-counting with this subcomponent measuring the costs of climate breakdown.

Methodology

The costs of climate breakdown are estimated by multiplying different types of greenhouse gas (GHG) emissions by a time-varying global estimate for the Social Cost of Carbon (SCC):

$$\begin{aligned}&\text{Costs of climate breakdown} = (\text{total UNFCCC emissions} + \text{emissions from international aviation}\\&+ \text{emissions from international navigation} + CO_2 \text{ emissions from biomass}\\&+ \text{national LULUCF emissions} + (\text{consumption emissions} - \text{territorial emissions})\\&+ \text{land use change footprint}) * \text{SCC}\end{aligned} \tag{23}$$

Data

GHG emissions

We collected the emissions reported by the different countries to the UNFCCC from the European Environment Agency (2024) data viewer. More precisely, we collected data for the total territorial GHG emissions - excluding Land Use, Land-Use Change and Forestry (LULUCF) but including indirect CO_2, the GHG emissions from international aviation and navigation, the GHG emissions from national LULUCF and CO_2 emissions from biomass. All emissions except the biomass emissions are expressed in tonnes of CO_2 equivalents and hence include all GHG emissions.

Following Van der Slycken and Bleys (2023), the emissions from international navigation have been adjusted to better fit the purpose of this exercise, because the emissions collected from the European Environment Agency (2024) data viewer are based on the sales of fuels by the countries, which are not equivalent to the international navigation activity-based emissions of a country. The countries that have important ports typically report higher emissions from international navigation when using these sales-based emissions. To adjust the amount of emissions from navigation and have an estimate that also reflects the activity-based emissions from international navigation, we use a report by Transport and Environment (2019) that presents some estimations of the emissions from international navigation based on the country's activities for the year 2018. The sales-based estimate from the European Environment Agency (2024) data viewer is compared to the activity-based estimate from Transport and Environment (2019) by taking the ratio between the two estimates for the year 2018. This ratio between the sales-based 2018 estimate and the activity-based 2018 estimate is used to calculate a series of new estimates that better reflect the activities-based estimates for all years by dividing the sales-based estimates by the said ratio. The adjusted emissions from navigation are then calculated by taking a combination of the sales-based estimate and the calculated activities-based estimates. Each estimate is given a 50% weight, allowing to have a final estimate that reflects the emissions based on fuel sales and the actual activities of the given country. For land-locked countries (Austria, Czechia, Hungary, Luxembourg and Slovakia), no estimate of activity-based emissions is provided by the Transport and Environment (2019) report. For these countries, the emissions from international navigation were not adjusted, the emissions taken into account are simply the sales-based emissions collected from the European Environment Agency (2024). For two of these land-locked countries, Czechia and Hungary, the data for international navigation is not available from the European Environment Agency (2024) data viewer. An estimate of the emissions from international navigation was then created by using the data collected for the three other land-locked countries. The emissions from international navigation are hence exactly the same for Czechia and Hungary and equal to the average of the emissions for Austria, Luxembourg and Slovakia. For some countries, there are some gaps in the data for the emissions from international navigation collected from the European Environment Agency (2024) data viewer. For Romania, data is missing for the years 1995 to 1997 and the years 1999-2006. To fill in the first gap, memory items using the data for 1998 is used. For the second gap, the data is interpolated based on the data for 1998 and 2007. For Slovakia, no data is available for 2000. The data points for 1999 and 2001 were then used to interpolate the data point in 2000.

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For Slovenia, the data between 1995 and 2004 was extrapolated using the trend in GDP at market prices. The trend in GDP at market prices was also used for Malta, to extrapolate the missing data for the years 1995 until 2009 for the amount of CO_2 emissions from biomass.

Footprint emissions

In addition to these estimations of the territorial GHG emissions, two types of footprint emissions are included to reflect the emissions - and hence also the costs - beyond borders. The first footprint emission item to be included is the amount of emissions embodied in trade. This footprint is calculated in million tonnes of CO_2 by subtracting the million tonnes of CO_2 emissions from a country's production activities from the million tonnes of CO_2 emissions created by a population's consumption. These emissions are collected from Friedlingstein et al. (2023), who collected data for the Global Carbon Budget 2023. The second footprint measure is the land-use change footprint, also measured in million tonnes of CO_2 emissions. This footprint measure aims at representing the amount of CO_2 emissions produced by a given country following changes in its land use. Data about the land use consumption footprint measured in million hectares for each individual country can be collected from UNEP (2024). To convert this estimate into a measure of CO_2 emissions, global estimates are used. Global estimates of the land use consumption footprint are collected from UNEP (2024), like for individual countries. Taking the ratio of the individual country footprint to the global footprint allows to determine the responsibility of each country in the global footprint. Global estimates of the land use change emissions measured in billion tonnes of carbon can be collected from Friedlingstein et al. (2023) and converted to million tonnes of CO_2 by multiplying the estimates by a conversion factor of 3,664. Using the country's responsibility in the global land use change consumption footprint, land-use change emissions for individual countries can be calculated. The ratio of country to global footprint is multiplied by the global estimate of emissions due to land-use changes, giving an estimate of the CO_2 emissions due to land-use changes for each country based on its part of responsibility in global LULUCF emissions.

Social cost of carbon

The Social Cost of Carbon (SCC) captures all present and future costs related to the emissions of a tonne of CO_2 today. The SCC estimate used here is taken from Ricke et al. (2018) and has a value of 417 US$ in 2017 prices[9] following their "reference scenario" (p. 897). This scenario is a global estimate of the social cost of carbon that is calculated by taking "'middle-of-the-road' parameters (socio-economic scenario SSP2, climate scenario RCP6.0 and a central specification of Burke-Hsiang-Miguel damage function (short run, no income differentiation), a pure time preference rate of 2% and an elasticity of marginal utility of consumption of 1.5)" (p. 897). The SCC that is used in the $ISEW_{BCPA}$ to value the costs of climate breakdown, is time-varying and increasing over time because additional emissions come with higher costs at higher levels of carbon dioxide levels. The growth rate applied here is taken from Tol (2023) who calculated an average growth rate for SCC of 2.2% per year based on different studies. Since the SCC estimate from Ricke et al. (2018) is a global estimate, the same cost estimate, equal to 365.17 euro in 2015, is applied to all EU27 countries. The 2.2% growth rate implies that the SCC is lower at the beginning of the study and higher at the end of the study, with estimates of 234.03 euro in 1995 and of 407.15 euro in 2020[10].

After having collected the necessary data for all territorial and beyond border emissions in million tonnes of CO_2, the emissions are added to have an estimate of the total CO_2 emissions from the country's activities affecting its territory and the rest of the world. Multiplying this total estimate by the yearly social cost of carbon gives a measure of the costs of climate breakdown in million euros (2015 prices).

Illustration

Figures 25 and 26 present the evolution of the emissions included in this subcomponent compared to the evolution of the total amount of emissions included in this component for Greece and Latvia, respectively. These two countries were again selected to illustrate the data used in this subcomponent because of the evolution of their total value of the costs of climate breakdown. Greece is the country where the costs of climate breakdown increased the least while Latvia is the country where they increased the most.

[9]The base year of the estimate is assumed because it is not specified in the paper.
[10]These two estimates are again expressed in euro in 2015 prices

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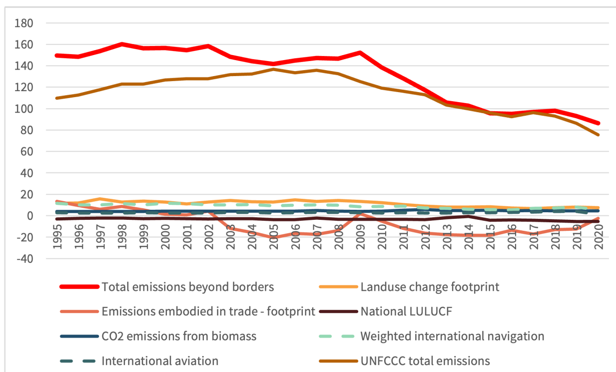
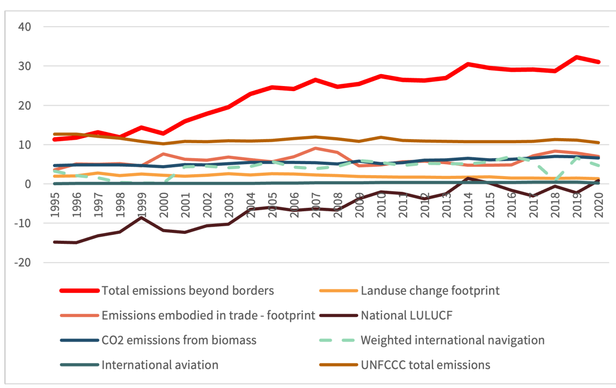
The evolution of the total value of the costs of climate breakdown depends on the evolution of the emissions included in this subcomponent, as presented in figures 25 and 26, and the evolution of the global estimate of the social cost of carbon (SCC) used to value these emissions, which, as explained before, is increasing over the years and is the same for all countries. The decrease in total emissions for Greece, mostly lead by the total UNFCCC emissions, combined with the increase of the SCC explains the low growth rate of the total value of the costs of climate breakdown. Similarly, the high increase in the emissions combined with the increasing SCC explains the high increase of the total value of the costs of climate breakdown for Latvia. The increase of emissions in Latvia is mainly due to an increase in the emissions from national LULUCF emissions. These emissions are a measure of the impact of human activities on terrestrial sinks (United Nations, 2024b). An increase in these emissions indicates that the human impact has increased over the years, which, among other things, could be caused by an increased deforestation in Latvia over the years (Global Forest Watch, 2023).

Figure 25: Evolution of the emissions taken into account in the costs of climate breakdown in Greece.



Note: The emissions are valued in million tonnes of CO_2 equivalent (tonnes of CO_2 for biomass emissions).

Figure 26: Evolution of the emissions taken into account in the costs of climate breakdown in Latvia.



Note: The emissions are valued in million tonnes of CO_2 equivalent (tonnes of CO_2 for biomass emissions).

Costs of depleting non-renewable energy resources

The costs of depleting non-renewable energy resources are also an important ecological cost that is included only in the broad ecological costs because it is a cost that is imposed mainly on future generations. The depletion of non-renewable resources constitutes an ecological cost to be included in the $ISEW_{BCPA}$ because the ecosystem services are given up to accommodate present consumption. This depletion is problematic for future generations who might hence miss some important natural capital.

Methodology

The value of the depletion of non-renewable energy resources is calculated by multiplying the total primary energy consumption in each country and year by a constant marginal cost estimate:

$$\text{Costs of depleting non-renewable energy resources} = \text{primary energy consumption} * \text{cost estimate} \qquad (24)$$

Data

The data for the amount of primary energy consumption comes from Eurostat (2024i) and is collected in thousand tonnes of oil equivalent.

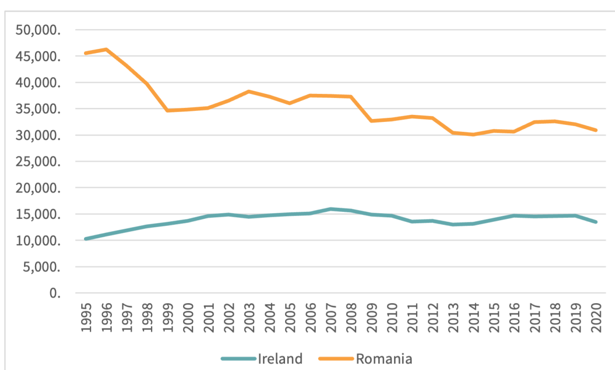
The marginal cost estimate is based on the investment expenditures needed in the EU to reach the goals of the Fit-for-55 package (FF55) and the annual primary energy consumption in the EU. The investment expenditures are presented in an impact assessment written by the European Commission in 2021 (European Commission, 2021). Three different scenarios, with different associated costs, are presented to reach the goals of the FF55. We decided to use the MIX scenario which is a mix of the two other scenarios discussed in the sense that we would be "relying on both carbon price signal extension to road transport and buildings and intensification of energy and transport policies" to reach the FF55 goals (European Commission, 2021). This estimate of 1051 billion € per year in 2015 prices is then divided by the annual primary energy consumption for the EU27 in 2021 in tonnes of oil equivalent collected from Eurostat (2024i) to get a marginal cost of 801.56 euros per tonne of oil equivalent (in 2015 prices).

Illustration

Figure 27 presents the evolution of the primary energy consumption in Ireland and Romania throughout the period. These two countries show, respectively, the strongest increase and decrease of the costs of depletion of non-renewable resources.

The evolution of the costs of depletion of non-renewable depends solely on the evolution of the amount of primary energy consumption because these amounts are valued using the marginal cost of 801.56 euros per tonne of oil equivalent (in 2015 prices) for all countries and years to calculate the cost of depletion of non-renewable energy resources. From the figures, we see that the amount of primary energy consumption increased slightly for Ireland, while it decreased for Romania.

Figure 27: Evolution of the primary energy consumption in Ireland and Romania.



Note: The amounts consumed are in thousand tonnes of oil equivalent.

Costs of use of nuclear power

Some of the costs of using nuclear power are not accounted for in any other subcomponent but it is important to take them into account in our welfare measures because they can be quite high in some countries and involve some uncertainty in the real costs of dismantlement and storage. This subcomponent is only included in the broad ecological costs because a great part of the costs associated with the use of nuclear power such as the disposal of nuclear waste will be experienced in the future.

Methodology

The costs of use of nuclear power are valued by multiplying the amount of electricity produced using nuclear power in any given countries and year by a cost estimate of using nuclear power:

$$\text{Costs of use of nuclear power} = \text{nuclear electricity generation} * \text{cost estimate} \tag{25}$$

Data

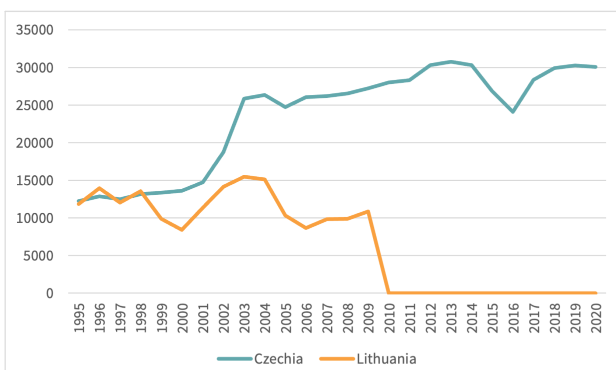
The data about the production of electricity using nuclear power for all countries is collected from the website of the IEA (2023) in GWh. Some countries do not use nuclear power to produce electricity. For these countries, the estimate of this subcomponent is hence set to zero. The countries for which this is the case include Austria, Croatia, Cyprus, Denmark, Estonia, Greece, Ireland, Italy, Latvia, Lithuania after 2009, Luxembourg, Malta, Poland, Portugal and Romania in 1995.

The cost estimate used to value the cost of using nuclear power is equal to 0.13 euro per kWh (in 2015 prices) and assumed to be the same for all countries and over time. This estimate is the same as the one used by Van der Slycken and Bleys (2023) and comes from a study by Held et al. (2018) who estimated the cost of using nuclear power for Germany based on two German studies (Meyer, 2012; Meyer and Fuhrmann, 2012). The estimate calculated by Held et al. (2018) include "the costs of dismantlement, search of a disposal site and final storage of radioactive waste as well as costs of insurance against a worst case scenario accident" (p. 394). This estimate is used for all EU countries because no country-specific estimates were found.

Illustration

The figure 28 presents the evolution of the generation of electricity using nuclear power in Czechia and Lithuania. Once again, these countries are selected to illustrate this data because they present the most opposite evolution. Czechia is the country that increased the most its nuclear power use to produce electricity while Lithuania decreased its nuclear power use, which even becomes zero from 2010 onwards. It is clear that the amount of electricity produced using nuclear power is very different between countries. The evolution of the total costs of nuclear production only depends on the evolution of the amount of electricity produced using nuclear power because the production of electricity using nuclear power is valued using the same cost estimate of 0.13 euro per kWh (in 2015 prices) throughout the period and for all countries.

Figure 28: Evolution of the nuclear electricity generation in Czechia and Lithuania.



Note: The amount produced is measured in GWh.

3.3.9 Net capital investments (ΔK)

The last component, the value of net investments in physical capital is only included in the index taking into account the costs and benefits of present activities because this index is taking into account the future benefits and costs of capital adjustments. Indeed, investing too little (and hence eroding physical capital stocks) will not impact current welfare experiences in the $ISEW_{BCE}$, yet as the $ISEW_{BCPA}$ takes stock

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of the future costs of current activities, it is important to account for changes in physical capital stocks. Depleting these stocks in the current period should be regarded as a cost borne by future generations and in a cost-benefit analysis of present economic activities, net physical capital investments should be taken into account.

Methodology

Net capital investments[11] are added to the $ISEW_{BCPA}$ to account for changes in the fixed capital stock. Net investments can be either positive when investments are larger than depreciation or negative in the opposite case. The value of net investments (ΔK) included in the $ISEW_{BCPA}$ is calculated by taking the difference between net capital stock in a given year and the net capital stock in the previous year:

$$\Delta K = \text{net capital stock in year t} - \text{net capital stock in year t-1} \tag{26}$$

Data

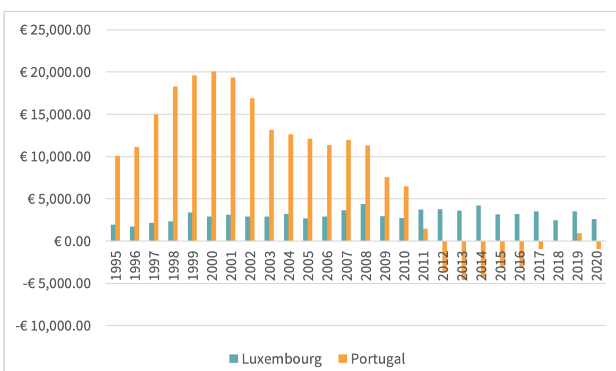
The data for the countries' net capital stock is collected from AMECO (2023d) in billions of euro in 2015 prices. The data for net capital stock presented in this database follows the definition of fixed capital formation and consumption of the European system of accounts (Eurostat, 2013).

For some countries, the data for 1994 (needed to calculate the net investment in 1995) had to be extrapolated. The trend in the GDP in euro or national currency in 2015 prices was used to extrapolate the 1994 capital stock data for Bulgaria, Croatia, Cyprus, Czechia, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Romania, Slovakia and Slovenia.

Illustration

As can be seen in figure 29 presenting the evolution of the net investments in Luxembourg and Portugal, net investments are very volatile over the years. Looking at the overall evolution of the component over time for selecting the illustrating countries does not make much sense here. Portugal was hence selected because it is one of the countries with negative values in different years. Luxembourg was selected because net investments in the country are positive throughout the entire study period.

Figure 29: Yearly net investments in Luxembourg and Portugal.



Note: The adjustments are measured in million euros in 2015 prices.

4 Results

In this section, the evolution of the two welfare measures in per capita terms for the EU27 as a whole as well as for individual countries is presented and discussed. The evolution of both measures is first compared to the evolution of GDP per capita. Additionally, the two welfare measures are studied in greater details to

[11] Referred to as "net investments" from this point on, for simplicity.

highlight the components that are driving the evolution of the overall measures. For some of the components, the evolution of the subcomponents is also studied to determine as precisely as possible what is driving the changes in the welfare measures. Except when stated otherwise, the values of the variables discussed are the values in 'per capita' terms.[12] These 'per capita' values are written in lower case. $ISEW_{BCE}$/capita is hence now written bce, $ISEW_{BCPA}$/capita is written bcpa, and GDP/capita is written gdp. Similarly for the components, uw is the value of unpaid work in 'per capita' terms and so on.

The results for the EU27 as a whole are discussed first, in section 4.1, followed by a discussion of the results for individual countries. When comparing the evolution of the welfare measures (bce and bcpa) to that of the gdp, we divide the whole period studied (1995-2020) in different subperiods to see the effect of different events on the level of the three measures studied. The first period that is analysed is the period between 1995 and 2001.The two important elements of this first period are the run up to the euro and the implementation of the rules of the Maastricht treaty. The second period of interest is the period between 20001 and 2008, which represents the build up to the financial crisis. Then, the period between 2008 and 2011 represents the evolution of the measures during the financial crisis and its aftermath. Looking at the period between 2011 and 2014, we can see what happened after the financial crisis and during the debt and euro crisis. From 2014 until 2019, no significant economic events took place, this is the period in between the financial and debt crisis, and the COVID-19 crisis. The last period only lasts for one year, between 2019 and 2020, and is showing the impact of the COVID-19 crisis on the different measures.

4.1 Evolution of welfare in the EU27

In this section, the evolution of the welfare measures for the EU27 is studied. The analysis goes from the overall results to the more detailed results. The first part looks at the trend over time of the overall welfare measures, comparing the two welfare measures to gdp and to each other. In the second part, the importance and growth rates of the components are discussed. Analysing the evolution of the components and of their importance allows to have a better understanding of the evolution of the overall welfare measures. Finally, the trends of the components and subcompents are discussed to understand where the changes in the components come from.

4.1.1 Evolution of the overall welfare measures

From figure 30 and the last column of table 7, it can be seen that the gdp in the EU increased a lot more than the two welfare measures studied here.[13] Indeed, gdp increased by around 35% in total over the whole period while the bce and the bcpa only increased by around 15 and 17% in total, respectively.[14] Table 7 shows the annual growth rate[15] for the periods presented before for the three measures and we can see that the gdp growth rate is not always higher than the growth rates of the welfare measures.

From the above, it is clear that the two welfare measures and gdp have evolved differently, and that the measures have been affected in different ways by the events highlighted in this report. During the period of the run up to the euro (1995-2001), all three measures increased relatively well, with gdp increasing faster than the two welfare measures. During the build up period to the financial crisis (2001-2008), gdp increased much more than the welfare measures The higher increase in gdp than in welfare measures during these two

[12] The values in per capita terms are obtained by dividing the total value of a (sub)component by the total population in a given country and year.

[13] On the one hand, the value of each ISEW for the EU27 is calculated by following equations 3 and 4 where the value of the different components for the EU27 is equal to the sum of the value of each component in the different EU countries. On the other hand, the value of GDP for the EU27 is collected directly from Eurostat (2024e). In both cases, to get the values in per capita terms, the total values are divided by the total population in the EU, calculated by adding up the total population in each of the 27 EU countries.

[14] In all cases, the total growth rates are calculated following this equation:

$$\begin{aligned}\text{total growth rate} &= ((\text{value at the end of the period} \\ &- \text{value at the beginning of the period})/\text{value at the beginning of the period}) * 100\end{aligned} \tag{27}$$

[15] In all cases, the exponential annual growth rates are calculated following this equation:

$$\text{annual growth rate} = ((\text{value at the end of the period}/\text{value at the beginning of the period})^{(1/25)} - 1) * 100 \tag{28}$$

The annual growth rates are always the exponential growth rates in those years, except when stated otherwise.

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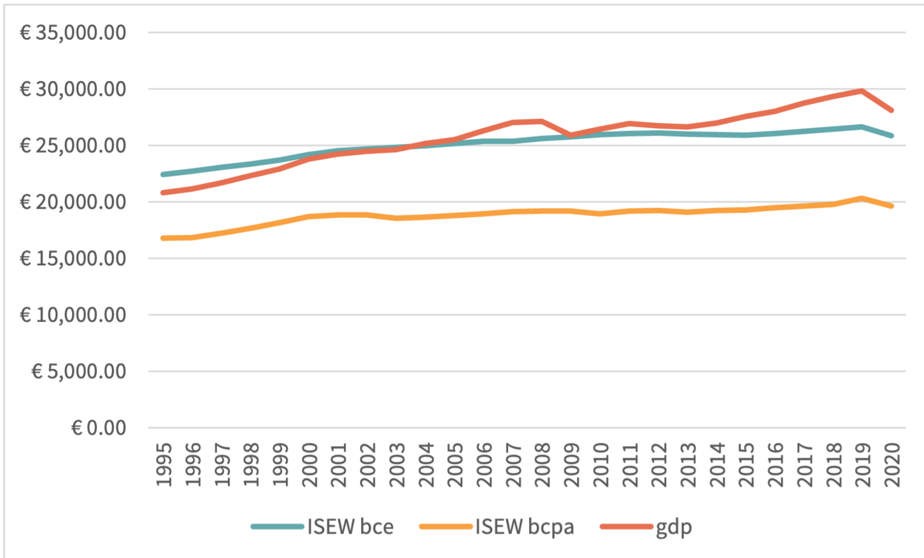
Figure 30: Evolution of the $ISEW_{bce}$, the $ISEW_{bcpa}$ and the gdp in the EU27 for the period 1995-2020 (measured in € in 2015 prices).



periods caused gdp to become higher in absolute terms than the bce from 2004 onwards. Before 2004, the level of the bce is higher than the level of the gdp but increasing at a slower pace.

Looking at the effect of the financial crisis and its direct aftermath (2008-2011), we see that gdp has been more strongly impacted than the welfare measures. Indeed, both gdp and bcpa decreased during that period, but gdp decreased faster than bcpa. On the contrary, bce kept increasing even though at somewhat lower rates than before. This shows that the direct economic impact of the financial crisis was higher than its welfare impact, indicating that the economic crisis did not necessarily translate into lower welfare. During the debt and euro crisis (2011-2014), gdp started to increase again, at a low rate. The bcpa also started to increase again at a low rate, but faster than gdp. On the contrary, during that period, the bce decreased, showing that the financial crisis had a delayed effect on that welfare measure or that the debt and euro crisis had a more important impact on that welfare measure than on gdp. Between the crises (2014-2019), all measures increased, with gdp again increasing more strongly than the welfare measures. The COVID-19 crisis had an important impact on all the measures because they all decreased quite a lot between 2019 and 2020, and the impact on gdp was the highest.

Table 7: Average annual exponential growth rates of ISEWs and GDP per capita for the EU27 (in %).

Time period	$ISEW_{bce}$	$ISEW_{bcpa}$	**gdp**
1995-2001	1.49	1.98	2.58
2001-2008	0.62	0.25	1.61
2008-2011	0.59	-0.02	-0.22
2011-2014	-0.11	0.09	0.03
2014-2019	0.52	1.12	2.03
2019-2020	-3.05	-3.54	-5.77
1995-2020 (total)	0.57 (15.21)	0.63 (16.95)	1.21 (34.99)

4.1.2 Evolution of the importance of the components for the ISEW and their growth rates

The evolution of the overall welfare measures is driven by the evolution of the different components that are included in these measures. In this section, the evolution of the importance of the different components over time is presented and discussed, followed by the presentation and discussion of the growth rates of these components. By analysing the evolution of the importance and growth rates of the components, it is possible to have a better understanding of the evolution of the overall indexes.

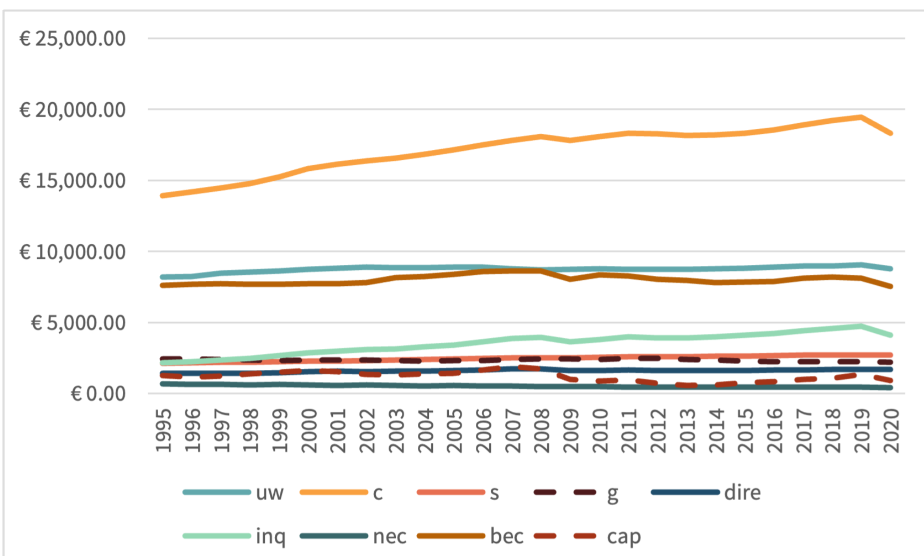
Importance of the components based on absolute values

The importance of the components goes hand-in-hand with the growth rates of these components, discussed in the next subsection. The evolution of the importance of the components within the indexes is discussed first because knowing how important each component is in calculating welfare, we also know how importantly the changes in this component impact the welfare measure. The importance of the different components can be shown in different ways, either by looking at the absolute values of the components or by looking at the weight of each component in the welfare measures. Both illustrations are discussed here.

First, figure 31 presents the evolution of the absolute values of the nine different components over the years. From this figure, it can clearly be seen that three of these components are higher than others, hence having more weight in the final welfare measures (especially since there is no weighting of the components in the calculation of our welfare measures). The three most important components are individual consumption expenditures, the value of unpaid work, and the broad ecological costs. Additionally, it can be seen that the importance of the welfare losses from income inequality is growing over time as its absolute value increases. Two of the most important components are contributing to welfare while the other two are reducing welfare.

The fact that the most important benefit to welfare is the individual consumption expenditures is not surprising since, as mentioned in section 3.3.2, individual consumption is so central in the definitions of income. The value of unpaid work being the second most important benefit for welfare confirms that it is important to include this component and that it has an important value. The importance of the broad ecological costs for the $ISEW_{BCPA}$ does not come as a surprise either because we know that our actions today will have an important impact on tomorrow's environment. Similarly, the increase of welfare losses from income inequality comes as no surprise because of the rise of incomes linked to economic growth, leading to a stronger overshoot of the sufficiency threshold. The evolution of these components, and some others, is studied in more details in the next subsection.

Figure 31: Evolution of the components for the EU27.



Note: the components are measured in euros in 2015 prices.

Importance of the components in bce and bcpa based on relative weights

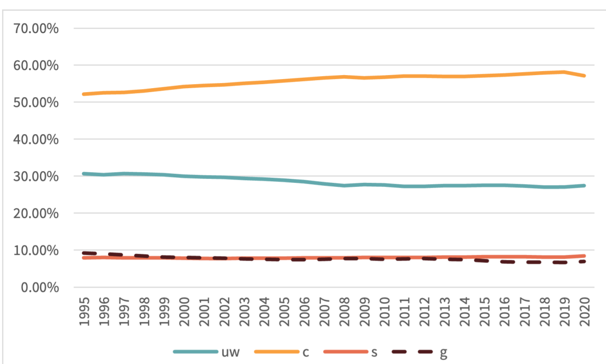
After identifying the most important components based on their absolute values, is it important to look into the relative weights of those components. Figures 32 and 33 present the evolution of the importance of the different components of the bce and bcpa, respectively. In both cases, the positive[16] and negative[17] components are studied separately to be able to identify the most important components in each of these categories. This distinction between the bce and the bcpa is important because they include different components, and the broad ecological costs - included in bcpa but not bce, is among the most important ones. This distinction when looking at the importance of the components can hence help to explain the difference in the evolution of the overall welfare measures.

Looking at the figure 32a, we see that within the positive components, two of them clearly have a higher weight than the others: the individual consumption expenditures and the value of unpaid work. This is in line with what we saw when looking at the absolute values. We see here that the importance of the individual consumption expenditures increases slightly over time while the importance of the value of unpaid work slightly decreases, this is caused by the higher increase in individual consumption expenditures over time. The two other positive components, the value of the shadow economy and the non-defensive government expenditures, have a very similar weight that is quite stable over time.

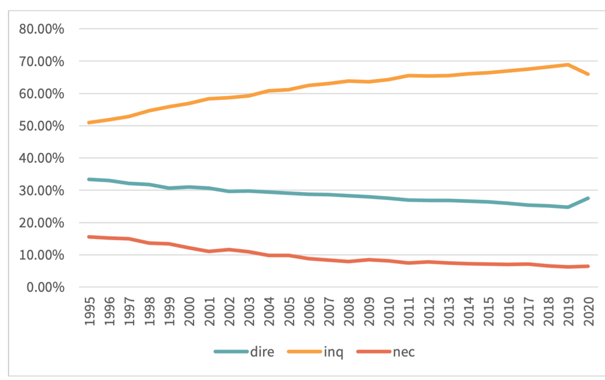
Now looking at the negative components of bce, figure 32b shows that the three negative components have very distinct weights. In the case of the bce, the most important component is the welfare losses from income inequality, which have an increasing importance over time. This finding is in line with what was found when looking at the evolution of the absolute values. The two other components have lower and decreasing weights over time. Interestingly, the weight of the defensive, intermediate and rehabilitative expenditures have a higher weight than the narrow ecological costs throughout the period studied. The ecological costs have only a very small influence on the experienced welfare and it even decreases over time.

Figure 32: Evolution of the importance of the positive (Panel A) and negative (Panel B) components in bce for the EU27.

Panel A



Panel B



Note: The importance of each component, in percentages, is calculated by dividing the value of a component in a year by the sum of all positive/negative components.

Figure 33a presents the relative weights of the positive components in the bcpa. This is a very similar picture to what we saw for the bce. Indeed, the individual consumption expenditures and the value of unpaid work are the two most important and are respectively increasing and decreasing over time. The non-defensive government expenditures and the value of the shadow economy have similar and stable weights. The only difference is the inclusion of the net investments among the positive components. However, this component

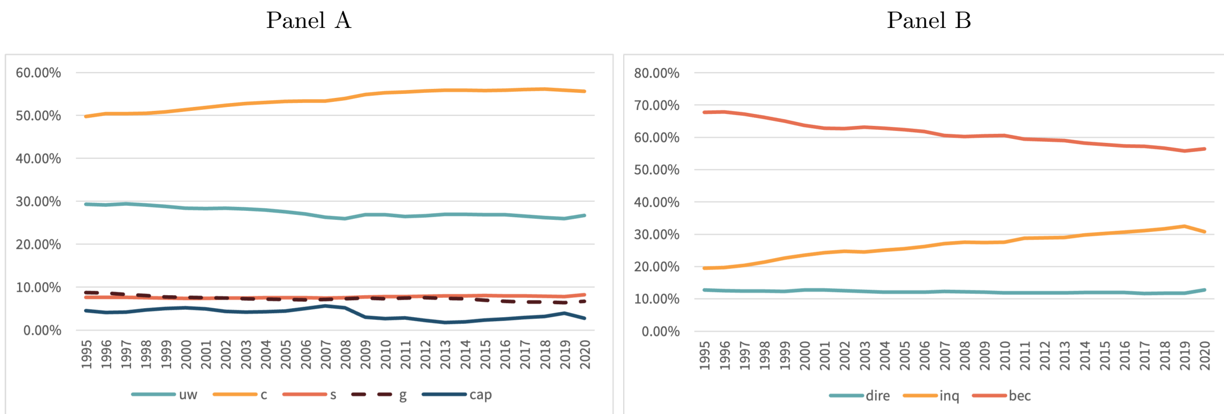
[16]The positive components are all components that are added to the value of the welfare measures: the value of unpaid work, individual consumption, the shadow economy, non-defensive government expenditures, and net investments. When these components increase, the welfare measures also increases.

[17]The negative components are all components that are deducted from the value of the welfare measures: the value of the private defensive intermediate and rehabilitative expenditures, the losses from income inequality, the narrow ecological costs, and the broad ecological costs. When these components increase, the welfare measures decrease.

has the lowest weight of all positive components, indicating that it does not play a major role in determining the value of the bcpa, nor in explaining the difference between the value of the bce and bcpa.

Figure 33b however presents a graph that is relatively different from the one we saw for the bce, but it still has some commonalities. Indeed, the weight of the welfare losses from income inequality is still increasing over time and higher than the decreasing weight of the defensive, intermediate and rehabilitative expenditures. However, looking at the weight of the ecological costs, we see a big difference between bce and bcpa. The broad ecological costs are the most important when determining the negative components of the bcpa. This is a very big difference compared to the bce where the narrow ecological costs are the least important. As discussed before, this really shows that our activities today and within a country have a very high impact on the environment tomorrow and abroad, this impact is much higher than what we are experiencing within our country and in the present. Quantitatively, the big difference in the importance of the different ecological costs included in the two indexes is the main explanation when looking at the differences in the level and evolution of these indexes.

Figure 33: Evolution of the importance of the positive (Panel A) and negative (Panel B) components in bcpa for the EU27.



Note: The importance of each component, in percentages, is calculated by dividing the value of a component in a year by the sum of all positive/negative components.

Growth rates of the components

In this section, after highlighting which components are the most and least important in determining the value of welfare, the growth rates of these components are studied in greater details by looking at some subperiods. The main focus is on the four components that were identified as the most important: individual consumption expenditures, the value of unpaid work, broad ecological costs, and welfare losses from income inequality. However, some of the other components and their growth rates are discussed when deemed necessary. In table 8, the annual growth rates of the components of the two welfare measures are presented for the entire period and the same subperiods as before.

Overall period (1995-2020)

First looking at the overall period (1995-2020), we see that among the components included in the welfare measures, individual consumption expenditures and the value of shadow economy are the positive components with the highest growth rates by increasing by around 31.5 and 27.5% in total over the period.[18] These two increases had a positive impact on the size of both welfare measures. The value of unpaid work also had a positive impact on the size of the two welfare measures, but with a total increase of around 7%, this impact is less important.

[18]Reminder: the values discussed are the values in per capita terms, except when stated otherwise.

Among the components that have a positive impact on the welfare measures, some also decreased, having a negative impact on the size of the welfare measures. More specifically, the amount of non-defensive government expenditures decreased over the whole period by around 9.5%. This negative impact affects both welfare measures. On the other hand, the relatively high decrease in net investments over the whole period, of around 29.5% only impacted the bcpa.

Regarding the components that are deducted from the welfare measures, we again see some differences in the growth rates of the different components. The negative component that increased the most over the whole period is the amount of losses from income inequality. This component increased by around 88% over the whole period, negatively impacting the trend over time of both welfare measures. The amount of defensive, intermediate and rehabilitative private expenditures also increased over the years, by around 19.5%, also reducing both welfare measures over time. On the contrary, both ecological costs components (narrow and broad) decreased over time, meaning that they reduced the welfare measures less over time. More precisely, the narrow ecological costs (here and now) decreased by around 40% over the whole period, participating to the increase of the bce while the broad ecological costs (abroad and in the future) remained relatively stable over the whole period.

It is important to combine these findings about the growth rates of the components with the findings about the importance of the different components to understand what these changes actually mean for the values of the welfare measures. Knowing that the individual consumption expenditures and the value of unpaid work are the two components that have the highest weight in the value of the welfare measures, the most important growth rates to consider for the positive components are the increase in the individual consumption expenditures and the lower increase in the value of unpaid work. These two increase had a positive impact on the size of the two welfare measures, but their effect were a bit higher for bce than bcpa because their importance is higher in the first than in the second case. Regarding bcpa, given the low weight of net investment, its big decrease does not impact the overall bcpa value much. Regarding the negative components, the importance of the ecological costs included in the two welfare measures is very different. Indeed, the narrow ecological costs only have a small importance for the overall bce value, indicating that its overall decrease did not impact the value of bce much. However, the broad ecological costs are very important components of the bcpa, indicating that their stability throughout the period had an important impact on the overall bcpa value, making the value of bcpa more stable than if the broad ecological costs had increased or decreased a lot. A second important negative component are the welfare losses from income inequalities. This component is more important for the bce than for the bcpa, meaning that the big increase in losses from income inequality has a more important negative impact for the first than the second welfare measure. In section 4.1.1, it was shown that over the whole period, the bce increased a bit less than the bcpa. The combination of the findings about the importance and growth rates of the components shows that this difference in overall growth rates can mainly be explained by the big increase of losses from income inequality having a higher impact on bce than on bcpa and the low impact of the decrease in narrow ecological costs for bce compared to the big impact of the stability of the broad ecological costs for bcpa.

Period 1: run up to the euro (1995-2001)

From this section onwards, we will focus mainly on the components that were found to be the most important when calculating the welfare measures, except when these components cannot explain the difference in growth rates between the two welfare measures.

Indeed, looking that the growth rates of the different components, and especially the most important ones, the higher increase of bcpa (1.98%) compared to bce (1.49%) during the period of the run up to the euro can be explained.

For the positive components, the growth rate of individual consumption expenditures is equal to 2.52% per year, which is quite high and impacting both welfare measures similarly. The second most important positive component, the value of unpaid work, also increased during that period but at a slightly lower rate of 1.23% per year. Again, this increase impacts both welfare measures similarly. Looking at the first most important negative component, the broad ecological costs, we see that it increased a bit during that period, having a negative impact on the bcpa but no impact on the bce. The second important negative component, the welfare losses from income inequality, increased a lot during that period. Given that this component has a much higher relative impact on bce than on on bcpa, this increase can explain the lower bce growth rate

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during that period. Since the narrow ecological costs have such a low importance for the bce, their decrease is not enough to counter the increase of the losses from income inequality.

Period 2: build up to the financial crisis (2001-2008)

During the build up to the financial crisis, the bce increased more than the bcpa, with respective annual growth rates of 0.62 and 0.25% per year.

The individual consumption expenditures increased during that period, even though at a lower rate than during the previous period. This increase had a similar impact on both welfare measures. Similarly, the value of unpaid work affected both welfare measures in a similar way but it had a negative impact because of its decreasing growth rate during that period. The welfare losses from income inequality increased again quite a lot during that period, having a higher negative impact on the size of the bce than on the size of the bcpa because of the higher importance of this component for the bce. Finally, the broad ecological costs increased by 1.56% during that period, which is not very high but still not negligible, especially given the importance of this component for the size of the bcpa. The high increase in the broad ecological costs can be the reason why the bcpa increased less than the bce during that period.

Period 3: Financial crisis and its aftermath (2008-2011)

During the financial crisis and its aftermath (2008-2011), the bce increased by 0.59% per year while the bcpa decreased by 0.02% per year. This period is the first one during which the evolution of the two welfare measures go in opposite directions. The two most important positive components increased during that period, but at lower rates than before, having a positive impact on both welfare measures. The most important negative component, the broad ecological costs, decreased by almost 1.5% per year during that period, which, given the importance of that component for the size of the bcpa, should have led to an increase of the overall bcpa. The second most important negative component, the welfare losses from income inequality, increased slightly during that period, but much less than during the previous two periods. During that period, the evolution of these four components, identified as the main drivers of the size of the bce and bcpa, does not explain the difference between the evolution of the bce and bcpa.

The importance of the different positive components is very similar for both measures, but slightly higher for the bce. Their increase hence had a similar impact on both welfare measures. Still, the inclusion of the net investments in the bcpa could be part of the explanation regarding the decrease of bcpa. Indeed, even though this component only has a low importance when calculating the size of the bcpa, its big decrease of around 18.60% per year during that period certainly still had a somehow important negative impact on the size of the bcpa. In addition to that, the negative components, those that have not been discussed yet, all decreased during that period. On the one hand, the value of the narrow ecological costs continued to decrease at a relatively high rate during that period. However, this component only has a minor importance for the bce, meaning that this decrease probably did not cause much of the difference in the evolution of the overall measures. On the other hand, the value of the defensive, intermediate and rehabilitative expenditures also decreased by almost 2% per year during that period. Given that this component is more important for the bce than for the bcpa (around 30% of the total value of negative components for the bce and around 10% for the bcpa), this decrease certainly had a higher positive impact on the size of the bce than on the size of the bcpa. The combination of the negative impact of the decrease in net investments and the low positive impact from the increase of the positive components and decrease of some negative components can explain that the bce increased during that period while the bcpa slightly decreased during that period.

Period 4: Debt and euro crisis (2011-2014)

During the debt and euro crisis (2011-2014), there is again some divergence in the rates of growth of the two welfare measures, with bce decreasing by 0.11% and bcpa increasing by 0.09%. As for the other periods, the evolution of the most important components is studied first to know if it can explain the different evolution of the two welfare measures. The individual consumption expenditures decreased by around 0.22% per year during that period. This decrease had a similar negative impact on both welfare measures. The value of unpaid work continued to increase during that period, but at a lower rate than in the previous subperiods. This low increase also had a similar impact on both measures, but a positive one.

Regarding the negative components, the broad ecological costs, which is very important for the bcpa, decreased by almost 2% every year during that period. This important decrease had substantial positive impact on the size of bcpa during that period, but no impact at all on the size of bce. The welfare losses from income inequality also decreased during that period, leading to positive impacts for both measures, but higher for bce than for bcpa. The difference between the evolution of the two measures can clearly be explained by the large decrease in broad ecological costs during that period.

The negative growth of bce during that period can mainly be explained by the decrease in the individual consumption expenditures, which is an important component, as well as the decrease in the non-defensive government expenditures, even though this component is not very important. Additionally, the narrow ecological costs decreased less during that period than during the previous period, meaning that this decrease countered the losses from positive components less than in previous subperiods.

Period 5: Between the crises (2014-2019)

During the period between the financial crisis and the COVID-19 crisis, both welfare values increased again. However, the growth rates of the two measures were still quite different, with an increase of 0.52% per year for the bce and 1.12% per year for the bcpa.

Among the most important positive components, the individual consumption expenditures had a noticeable positive impact on both welfare measures by increasing by 1.34% each year. The value of unpaid work also positively influenced the size of the two welfare measures, because of its increase, even thought lower than that of individual consumption expenditures. These two increases positively impacted the two welfare measures in a similar manner.

The broad ecological costs, being very important for the value of bcpa, increased during that period, meaning that it had a negative impact on the value of bcpa. The welfare losses from income inequality increased again during that period, having a negative impact on both welfare measures, but especially on bce because of the higher importance of that component for that measure. This negative impact is part of the explanation of the lower growth rate for bce than for bcpa.

The higher bcpa positive growth rate can be explained by the very high increase in net investment during that period. Indeed, even though this component is the least important for bcpa, its massive increase of almost 17% per year led to a higher increase in bcpa.

Period 6: COVID-19 crisis (2019-2020)

During the COVID-19 crisis, both welfare measures experienced an important drop in their values, more important for the bcpa than for the bce (respectively - 3.54% and -3.05%).

The big decrease in all positive components and especially in individual consumption expenditures and the value of unpaid work led to these important decreases in both welfare measures. The decrease of the ecological costs and welfare losses from income inequality were not high enough to counter the negative effects of dropping positive components. The higher importance of the decrease in losses from income inequality for bce than for bcpa partly explains the lower rate of decrease for bce than for bcpa. The higher decrease in broad ecological costs had a positive impact on the size of the bcpa. However, the decrease of the bcpa is still higher than that of the bce because of the very big drop in net investments during that period. Again, even though that component is the least important for bcpa, such a high decrease is enough to impact the growth rate of bcpa.

In sum, the evolution of the bce and bcpa throughout the entire period studied and the different subperiods can be explained by looking at the evolution of the different components. More specifically, the welfare losses from income inequality can often be used to explain the difference between the evolution of the bce and that of the bcpa because of the much higher importance of that component for the first welfare measure. The evolution of the broad ecological costs also often leads to differences between the evolution of the two measures because it has a high importance for the value of bcpa but no importance for the value of bce. In general, these two most important negative components could be used to understand the difference in the evolution of the two measures. The two most important positive components, individual consumption expenditures and the value of unpaid work, are not very useful in explaining this difference because they have a very similar importance for both welfare measures, hence impacting them similarly. Only for a few subperiods was it necessary to look at the minor component to explain the difference in the evolution of the welfare measures, and in those cases, the big changes in the net investment could often explain the higher or lower growth rates of the bcpa.

Table 8: Annual growth rates of components in per capita terms in the EU27 (in %).

	uw	ci	s	gc	direp	inq	nec	bec	k
1995-2001	1.23	2.52	1.27	-0.60	1.65	5.45	-2.70	0.32	3.10
2001-2008	-0.18	1.61	1.36	0.53	1.48	3.98	-2.08	1.56	1.81
2008-2011	0.17	0.48	0.73	0.13	-1.96	0.43	-2.53	-1.47	-18.60
2011-2014	0.13	-0.22	0.43	-1.26	-0.79	-0.05	-1.15	-1.92	-12.76
2014-2019	0.61	1.34	0.81	-1.12	1.11	3.44	-0.20	0.80	16.91
2019-2020	-3.00	-5.96	-0.38	-0.87	0.50	-13.26	-7.37	-7.20	-33.67
1995-2020 (total)	0.28 (7.22)	1.10 (31.56)	0.97 (27.36)	-0.39 (-9.37)	0.71 (19.50)	2.55 (87.77)	-2.02 (-39.93)	-0.04 (-0.98)	-1.38 (-29.34)

Note: ‘uw’ = unpaid work, ‘ci’ = individual consumption expenditures, ‘s’ = shadow economy, ‘gc’ = non-defensive government expenditures, ‘direp’ = defensive, intermediate and rehabilitative private expenditures, ‘inq’ = welfare losses from income inequality, ‘nec’ = narrow ecological costs, ‘bec’ = broad ecological costs, and ‘k’ = net capital investments. All components are measured in ‘per capita’ terms.

4.1.3 Trends in the components and subcomponents

In this section, we analyse the trend of the total values of the individual components and their subcomponents (when there are some) to understand what is driving the changes in the components that are presented in table 8.[19] The (+) or (−) indicated next to the name of the component indicates whether the component is positively or negatively impacting the welfare measures.

For each component, a table presenting the values of the subcomponents and of the component for selected years is included. The selected years are the years used for defining the subperiods included in table 8.

The evolution of the value of unpaid work (+)

The discussion about the value of unpaid work should start with a word a caution. Indeed, the value of the subcomponents, especially the values of the time spent on unpaid work and the values of the replacement wage at the EU-level cannot be exactly calculated because these values depend on the weight of each country’s value in the total EU value, but these weights cannot be calculated due to the ‘double multiplication’ needed to calculate the value of unpaid work.[20] In order to still be able to look into the evolution of the subcomponents, we estimated the values of the time spent on unpaid work and the value of the replacement wage by weighting each country’s value by its proportion of workers taken into account in this component.[21]

The values of the total population taken into account in this component and the estimated values of time spent on unpaid work and of the replacement wage at the EU-level are presented in table 9. The values of the time spent on unpaid work and of the replacement wage are obtained by adding up the ‘workers-weighted’ values for each country. These estimated values of the subcomponents are then used, in combination with the total values of the selected population, to calculate the estimated values of the total value of unpaid

[19]The trends analysed here are the trends in the total values of the components and subcomponents, and not their ’per capita’ values, because the goal of the analysis is to see which subcomponent is driving the changes in the component and the conclusions are the same when looking at the components and subcomponents in total or in ’per capita’ values.

[20]As a reminder, the value of unpaid work is calculated as follows:

$$UW = \text{time spent on unpaid work per person} * population_{15-74} * \text{replacement wage} \quad (29)$$

[21]For example,

$$\text{‘workers-weighted’ time spent on unpaid work in country X in 1995} =$$
$$\text{time spent on unpaid work in country X in 1995} * \left(\frac{\text{number of workers in country X in 1995}}{\text{total number of workers in the EU in 1995}}\right). \quad (30)$$

work. As can be seen in table 9, the estimated total values of unpaid work are not exactly equal to the actual values of unpaid work, which are based on the values of the unpaid work in each country directly, but are close enough to perform the exercise and find out which component is mainly driving the changes in the total value of unpaid work.

As can be seen in tables 8 and 9, the value of unpaid work increased between 1995 and 2020. This component depends on three subcomponents (i) the amount of population in the age range 17 to 74 years old, (ii) the amount of time spent on unpaid work, (iii) and a replacement wage used to value the time spent on unpaid work by the selected part of the population. The increase in the total value of unpaid work can hence be caused by changes in one or several of these subcomponents.

Looking at the values of the subcomponents presented in table 9, we see that they evolved differently over the years. Indeed, the amount of population taken into account increased by 3.70% in total between 1995 and 2020, the amount of time spent on unpaid work decreased by 4.09% in total over the period studied, and the replacement wage had a total increase of 13.76% between 1995 and 2020. From these numbers, it is then clear that the increase in the value of unpaid work between 1995 and 2020 is mainly due to the increase in the replacement wage.

The changes in the values of the replacement wage are also the main explanation for the changes in the value of unpaid work in the selected subperiods, such as between 2019 and 2020, where the value of unpaid work decreased. During that subperiod, the decrease in the value of unpaid work can only be explained by the decrease in the replacement wage since there was an increase in the population and no change in the time spent on unpaid work. Still, for some subperiods, another component can be explaining the change in the total value of unpaid work, as for the subperiod between 2001 and 2008 where the value of unpaid work decreased even though the value of the replacement wage was higher in 2008 than in 2001 and hence increased during that subperiod. The explanation for the decrease in the value of unpaid work in this subperiod hence comes from the strong decrease in time spent on unpaid work, which offset the positive impact of the increase in the replacement wage.

Table 9: Population 15-74, estimated time spent on unpaid work, estimated replacement wage, estimated total value of unpaid work, and real value of unpaid work for the EU27 for selected years.

Year	**Population 15-74 (Persons)**	**ESTIMATED Unpaid work time (minutes/day)**	**ESTIMATED Replacement wage (€/hour (2015 prices))**	**ESTIMATED Value of unpaid work (Million € (2015 prices))**	**REAL Value of unpaid work (Million € (2015 prices))**
1995	323,940,603	213	8.43	€ 3,530,747.84	€ 3,488,039.73
2001	328,473,040	212	9.07	€ 3,840,927.15	€ 3,786,442.46
2008	335,648,543	206	9.24	€ 3,884,921.96	€ 3,822,091.23
2011	334,635,636	204	9.45	€ 3,920,809.00	€ 3,852,389.47
2014	335,136,680	204	9.52	€ 3,959,162.52	€ 3,892,945.96
2019	335,484,302	204	9.87	€ 4,109,604.38	€ 4,045,400.34
2020	335,912,673	204	9.58	€ 3,994,664.58	€ 3,931,514.37
Growth rate 1995-2020	3.70%	-4.09%	13.76%	13.14%	12.71%

Note: The estimated values are the values of the subcomponents that were estimated based on the values of the subcomponents of the individual countries. Using these values to calculate the value of unpaid work gives the estimated value of unpaid work, which is slightly different from the actual value of unpaid work calculated based on the values of the components for the individual countries.

The evolution of the value of individual consumption (+)

As can be seen from tables 8 and 10, the value of individual consumption increased over the whole period. This component depends on two subcomponents (i) the actual individual consumption (AIC), (ii) the net services of consumer durables.[22] Table 10 shows that all of the subcomponents increased during the period

[22] The net services of consumer durables are equal to the services of consumer durables - the costs of the consumer durables.

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studied, with the highest increase being for AIC, with a total growth rate of 37,86% over between 1995 and 2020. The services and costs of consumer durables increased by 24,23 and 20,40%, respectively, in total over the period studied, leading to an increase in the net services of consumer durables.[23]

Based on the values and the growth rates of the subcomponents presented in table 10, it can be concluded that the changes in the value of the individual consumption expenditures are mainly driven by the changes in AIC because it is the subcomponent that changed the most over time. Indeed, looking at the changes in the values of the subcomponents between 2011 and 2014 and between 2019 and 2020, two subperiods during which the individual consumption expenditures decreased, we see that the decrease is coming entirely from the decrease in AIC because the net services of consumer durables actually increased during those subperiods.

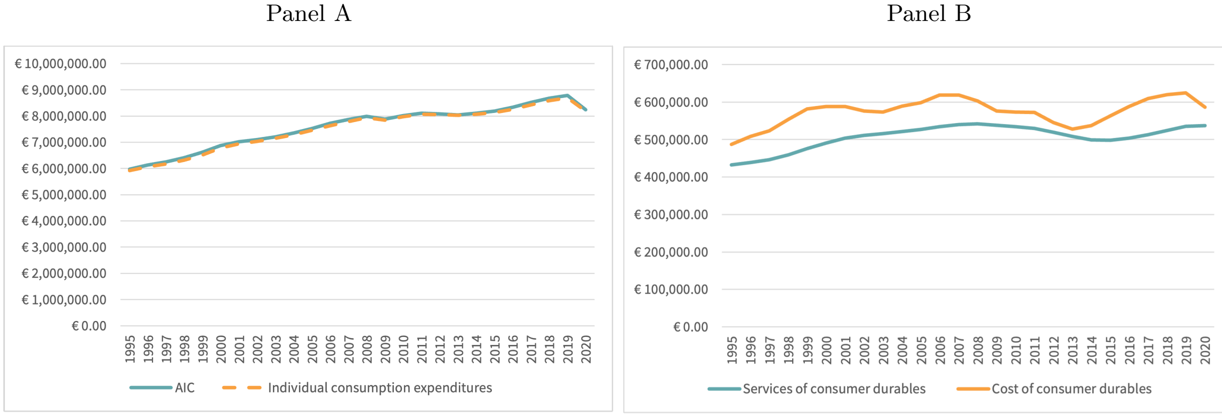
The conclusion that the changes in the value of individual consumption expenditures come from changes in AIC is also clearly visible from figure 34. Indeed, in panel A, which shows the evolution of AIC and of individual consumption expenditures between 1995 and 2020, we see that the subcomponent and the component have values that are almost equal for the whole period and that they are really following each other. Additionally, panel B shows the evolution of the services and costs from consumer durables and hence also the value of the net services of consumer durables, which is the distance between the two curves. That panel hence shows that the net services from consumer durables hence increased in total over the period studied, even if it fluctuated a lot over time. Still, even though the net services from consumer durables increased between 1995 and 2020, the curves in panel A show that this increase only had a very small impact on the values of individual consumption expenditures, which really follow the values of AIC throughout the period studied.

Table 10: AIC, services and costs of consumer durables, net services of consumer durables, and total individual consumption expenditures for the EU for selected years.

Year	AIC	Services of consumer durables	Cost of consumer durables	Net services of consumer durables	Individual consumption expenditures
1995	€ 5,975,753.68	€ 432,094.34	€ 487,096.75	-€ 55,002.41	€ 5,920,751.27
2001	€ 7,018,559.15	€ 503,795.65	€ 587,851.42	-€ 84,055.77	€ 6,934,503.38
2008	€ 7,989,982.88	€ 541,897.40	€ 603,390.45	-€ 61,493.05	€ 7,928,489.83
2011	€ 8,107,448.51	€ 529,653.30	€ 572,328.01	-€ 42,674.71	€ 8,064,773.80
2014	€ 8,102,520.51	€ 499,437.56	€ 537,194.82	-€ 37,757.26	€ 8,064,763.24
2019	€ 8,779,156.09	€ 534,884.95	€ 624,127.08	-€ 89,242.14	€ 8,689,913.95
2020	€ 8,238,075.21	€ 536,796.84	€ 586,460.96	-€ 49,664.12	€ 8,188,411.08
Growth rate 1995-2020	37.86%	24.23%	20.40%	* (+)	38.30%

[23] The size of the increase in the net services of the consumer durables cannot be calculated because of the negative values.

Figure 34: Evolution of the AIC and the individual consumption expenditures (Panel A), and evolution of the costs and services from consumer durables (Panel B) in the EU27.



Note: The values presented are the total value (not in per capita terms) and measured in million euros in 2015 prices.

The evolution of the value of the shadow economy (+)

The value of the shadow economy depends on the size of the shadow economy expressed in percentage of GDP and on the yearly GDP measured in million euros in 2015 prices. As can be seen in table 11 and figure 35, the total value of the shadow economy increased between 1995 and 2020, while the size of the shadow economy decreased by 5.65% in total over the period studied and GDP increased by 41.90% in total for that period.

Following from the growth rates and absolute values shown in table 11 and figure 35, it can be concluded that the changes in the total value of the shadow economy over the years are primarily due to changes in GDP, which changed more than the size of the shadow economy over the years. Indeed, in figure 35, it can be seen that the total value of the shadow economy mainly follows the evolution of GDP. Indeed, between 1995 and 2020, the high increase in GDP more than compensated the decrease in the size of the shadow economy, leading to a total increase in the value of the shadow economy.

The conclusion that the changes in GDP are driving the changes in the total values of the shadow economy is clearly illustrated by the change in the value of the shadow economy between 2019 and 2020, during which table 8 shows that the value of the shadow economy decreased slightly. In table 11, we see that the value of the size of the shadow economy was higher in 2020 than in 2019, indicating that there was an increase in the size of shadow economy between 2019 and 2020, which is clearly visible in panel A of figure 35. Still, in table 11, we see that GDP was lower in 2020 than in 2019, indicating that there was a decrease in GDP between 2019 and 2020, again clearly visible from panel B in figure 35. As we saw from table 8 that the total value of the shadow economy decreased between 2019 and 2020, indeed, the value of the shadow economy in 2020 in table 11 is slightly lower than the value of the shadow economy in 2019 (the decrease in the value of the shadow economy is so small that it is not really visible from panel C in figure 35), and that only GDP decreased between those years, it is proven that GDP is the subcomoponent driving the changes in the total value of the shadow economy.

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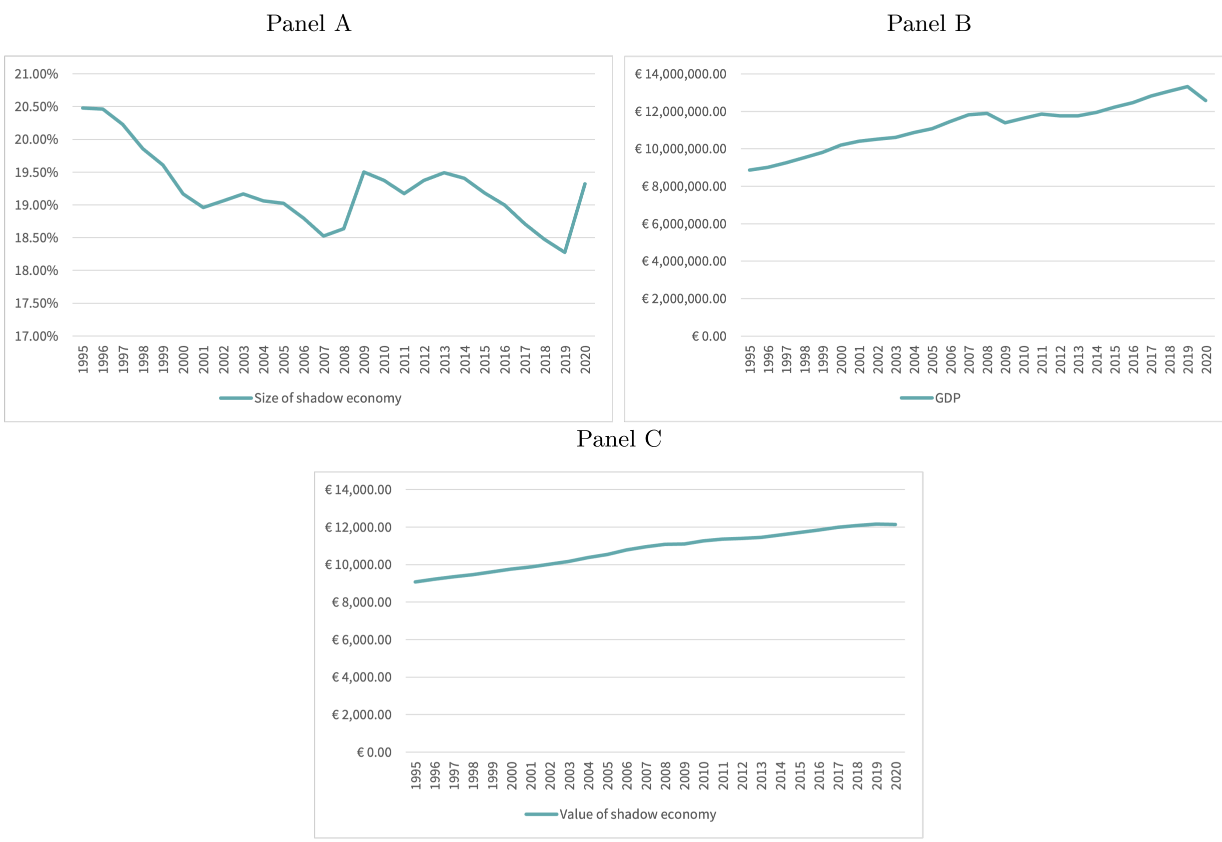
Table 11: Size of the shadow economy (% of GDP), GDP, and total value of shadow economy for the EU27, for selected years.

Year	Size of shadow economy	GDP	Total value of shadow economy
1995	20.48%	€ 8,856,454.95	€ 9,068.70
2001	18.96%	€ 10,407,260.94	€ 9,866.26
2008	18.64%	€ 11,897,710.94	€ 11,086.77
2011	19.17%	€ 11,852,759.76	€ 11,362.79
2014	19.40%	€ 11,942,929.92	€ 11,587.63
2019	18.28%	€ 13,311,639.82	€ 12,164.03
2020	19.32%	€ 12,567,528.62	€ 12,141.14
Growth rate 1995-2020	-5.65%	41.90%	33.88%

Note: The size of the shadow economy is measured as a % of GDP, GDP and total value of the shadow economy are expressed in million euros in 2015 prices.

Figure 35: Evolution of the size of the shadow economy (Panel A), evolution of GDP (Panel B), and evolution of the value of the shadow economy (Panel C) in the EU27.



Note: The size of the shadow economy is measured in % of GDP, GDP and the value of the shadow economy are measured in million euros in 2015 prices.

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The evolution of the value of the non-defensive government expenditures (+)

As can be seen in table 12 and figure 36, the value of the non-defensive government expenditures decreased between 1995 and 2020. This component is constituted by three subcomponents (i) the expenditures on general public services, (ii) the expenditures on housing and community amenities, and (iii) the expenditures on recreation, culture and religion. Figure 36 shows that the expenditures on general public services represent the highest share of the total government expenditures and table 12 shows that these expenditures decreased over the period studied. The subcomponent changing the most in the total government expenditures is the value of the expenditures on recreation, culture and religion, which increased over time, as can be seen on table 12 and figure 36. Finally, the third subcomponent also decreased over time, as can be seen from table 12 and figure 36.

From the changes in the subcomponents shown in table 12 and figure 36, we can see that the decrease in the total government expenditures over the entire study period was mainly caused by the decreases in the expenditures on general public services and on housing and community amenities, which more than offset the increase in the expenditures on recreation, culture and religion, leading to an overall decrease in the total government expenditures between 1995 and 2020. Among the two subcomponents driving the changes in the total government expenditures, the second subcomponent (expenditures on housing and community amenities) played a more important role by decreasing more than the expenditures on general public services between 1995 and 2020.

However, when looking at the subperiods, the conclusion on which subcomponent is mainly driving the changes in the total non-defensive government expenditures changes slightly. Indeed, when looking at the evolution of the total non-defensive government expenditures and the evolution of the different subcomponents, we see that the expenditures on general public services are the only ones that are always changing in the same direction as the total non-defensive government expenditures, indicating that this subcomponent is the one principally driving the changes in the total non-defensive government expenditures. For example, between 2014 and 2019, there was a decrease in the total non-defensive government expenditures, as can be seen from tables 8 and 12, and during that subperiod, the expenditures on the general public services are the only ones that also decreased. Similarly, between 2008 and 2011, tables 8 and 12 show that there was an increase in the total non-defensive government expenditures and table 12 shows that during that subperiod, the expenditures on general public services are the only ones that also increased.

Table 12: General public services expenditures, housing and community amenities expenditures, recreation, culture and religion expenditures, and total non-defensive government expenditures for the EU27, for selected years.

Year	General public services	Housing and community amenities	Recreation, culture and religion	Total non-defensive government expenditures
1995	€ 852,805.76	€ 99,911.67	€ 90,708.54	€ 1,043,425.97
2001	€ 808,316.86	€ 90,150.72	€ 116,588.14	€ 1,015,055.72
2008	€ 835,993.73	€ 96,229.98	€ 144,248.31	€ 1,076,472.02
2011	€ 854,115.59	€ 85,619.43	€ 143,937.61	€ 1,083,672.62
2014	€ 835,986.74	€ 75,390.96	€ 138,949.51	€ 1,050,327.21
2019	€ 769,303.47	€ 76,478.03	€ 155,069.40	€ 1,000,850.91
2020	€ 763,406.11	€ 78,193.25	€ 152,488.25	€ 994,087.60
Growth rate 1995-2020	-10.48%	-21.74%	68.11%	-4.73%

Note: All the expenditures are measured in million euros in 2015 prices.

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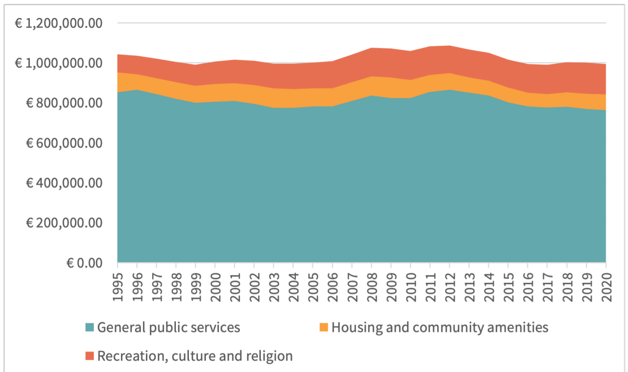
Figure 36: Evolution of the non-defensive government expenditures in the EU27.



Note: The expenditures are measures in million euros in 2015 prices.

The evolution of the value of the private defensive, intermediate and rehabilitative expenditures (−)

The total value of the private defensive, intermediate and rehabilitative expenditures for the EU27 increased between 1995 and 2020. The evolution of this component depends on the evolution of its two subcomponents, (i) the expenditures on defensive, intermediate and rehabilitative goods and services and (ii) the costs of road accidents. Table 13 and the figure 37 show that the expenses on defensive, intermediate and rehabilitative goods and services increased by 26,76% in total over the whole period studied, while the total costs of road accidents decreased by 24,93% in total over the period studied.

Following from the changes in the subcomponents between 1995 and 2020, it can be concluded that the subcomponent primarily driving the changes in the total defensive, intermediate and rehabilitative expenditures is the value of the expenses on defensive, intermediate and rehabilitative goods and services. Indeed, figure 37 also confirms that conclusion by showing, in panel A, that the total value of defensive, intermediate and rehabilitative expenditures is almost equal to the value of the expenditures on defensive, intermediate and rehabilitative goods and services, indicating that the costs of road accidents only play a minor role in determining the value of the total defensive, intermediate and rehabilitative expenditures.

The conclusion that the changes in the total defensive, intermediate and rehabilitative expenditures are primarily driven by changes in the value of the expenses on defensive, intermediate and rehabilitative goods and services is confirmed by looking at the changes in selected subperiods. Indeed, in the subperiods between 2001 and 2008 and between 2019 and 2020, we see from tables 8 and 13 that the total defensive intermediate, defensive and rehabilitative expenditures increased. Still, in these two subperiods, we see that the value of the expenses on defensive, intermediate and rehabilitative goods and services increased, while the value of the costs of road accidents decreased. The fact that only the expenses on defensive, intermediate and rehabilitative goods and services increased during those subperiods prove that the increases in the total defensive, intermediate and rehabilitative expenditures is caused by the changes in the expenses on defensive, intermediate and rehabilitative goods and services.

As a side note, it is interesting to look closer at the costs of road accidents. We saw in table 13 and figure 37 that these costs decreased between 1995 and 2020. These costs are determined by the number of road accidents (separated between number of injuries and fatalities) and by the cost of road accidents (also different for injuries and fatalities). As explained in the methodology section, more precisely in section 3.3.5, the costs of road accidents for the year 2002 are taken from a study by Bickel et al. (2006). These costs are then extrapolated to the beginning and the end of the period studied using the trend in GDP. Even though these costs have not been estimated at the EU-level, it is clear that, following the extrapolation based on the trend in GDP, the costs of road accidents increased over time. Knowing that the costs of road accidents increased over time, the decrease in the total costs of road accidents can only be explained by a decrease in the number of road accidents. The number of road accidents for the EU27 has not been estimated, but since they decreased in almost all the individual EU countries, it is indeed correct to say that it decreased at the EU-level as well, indeed explaining the decrease in the total costs of road accidents.

Table 13: Defensive expenditures, costs of road accidents, and total defensive, intermediate and rehabilitative expenditures in the EU27, for selected years

Year	**Expenses on defensive, intermediate and rehabilitative goods and services**	**Costs of road accidents**	**Total defensive, intermediate and rehabilitative expenditures**
1995	€ 594,999.05	€ 13,488.51	€ 608,487.56
2001	€ 661,801.53	€ 15,381.47	€ 677,183.00
2008	€ 752,676.64	€ 14,200.18	€ 766,876.82
2011	€ 712,400.16	€ 12,337.53	€ 724,737.69
2014	€ 700,761.70	€ 11,624.31	€ 712,386.00
2019	€ 746,147.13	€ 12,892.33	€ 759,039.45
2020	€ 754,237.75	€ 10,126.49	€ 764,364.25
Growth rate 1995-2020	26.76%	-24.93%	25.62%

Note: All the expenditures and costs are presented in million euros in 2015 prices.

Figure 37: Evolution of the defensive expenditures and of the total defensive, intermediate and rehabilitative expenditures (Panel A), and evolution of the costs of road accidents (Panel B) in the EU27.

Panel A Panel B

Note: All the expenditures and costs are measured in million euros in 2015 prices.

The evolution of the welfare losses from income inequality (−)

As shown in table 14 and figure 38, the welfare losses from income inequality between 1995 and 2020. The value of the welfare losses from income inequality depends on the amount of net consumption as well as on an adjustment based on the diminishing marginal utility of income (DMUI), as explained in section 3.3.6. From table 14, we can see that both the net consumption and the adjustment based on the DMUI increased between 1995 and 2020, leading to the increase in welfare losses from income inequality. The growth rates of the two subcomponents was relatively similar. The increase in net consumption is also visible in figure 38.

Due to the fact that the increase of the two subcomponents is relatively similar over the period studied, it is difficult to know which of these two subcomponents has the strongest impact in driving the changes in the welfare losses from income inequality. Similarly, when looking at changes in the welfare losses from income inequality and the two subcomponents in selected subperiods, we see that the two subcomponents generally changed in the same direction as the welfare lossed from income inequality. The only exception is for the subperiod between 2008 and 2011, when the welfare losses from income inequality increased. During that subperiod, the net consumption also increased, but the adjustment based on the DMUI decreased slightly. The fact that, during this period, the welfare losses from income inequality increased despite the small decrease in the adjustment based on DMUI indicates that the value of net consumption has more importance in driving the changes in welfare losses from income inequality. Still, since the two subcomponents play such an important role in the changes over the whole period studied, and that in the other periods, they move in the same direction, the conclusion remains that the two subcomponents play an important role in driving the changes in welfare losses from income inequality.

While the increase in net consumption is easily interpretable, it is interesting to discuss the increase in the adjustment based on the DMUI. At the EU-level, the adjustment based on DMUI is calculated as the weighted-sum of the adjustments in each country. The weight assigned to the adjustment of each country is the proportion of its value of net consumption compared to the total value of net consumption for the EU27, which itself is the sum of the individual countries' values of net consumption. The explanation of the meaning of an increase in the adjustment based on DMUI hence comes from looking at the results for individual countries, but the interpretation remains the same at the EU level. When looking at the adjustment based on DMUI in an individual country, we see that an increase in this adjustment indicates that the ratio of the sum of adjusted income deciles over the sum of unadjusted income deciles decreased.[24] In all of the individual EU countries except Italy where the ratio increased, the decrease in the ratio of adjusted and unadjusted sums of income deciles comes from an increase of the sum of unadjusted deciles that was higher than the increase in the sum of adjusted deciles. In all of the individual EU countries, the number of adjusted deciles taken into account in the sum of adjusted deciles generally increases. What the decrease in the ratio of the adjustment based on DMUI hence indicates is that the adjustment for inequality becomes higher over the years, increasing the difference between the sum of unadjusted deciles and the sum of adjusted deciles. At the EU-level, the increase in the adjustment based on DMUI hence also indicates that the adjustment for inequality becomes higher over the years, as reflected by the higher welfare losses from income inequality.

Table 14: Net consumption, DMUI, and welfare losses from income inequality in the EU27, for selected years.

Year	Net consumption	Diminishing Marginal Utility of Income	Welfare losses from income inequality
1995	€ 6,219,133.70	0.1493	€ 928,556.58
2001	€ 7,243,946.74	0.1778	€ 1,287,771.87
2008	€ 8,270,290.15	0.2092	€ 1,730,211.60
2011	€ 8,476,315.02	0.2074	€ 1,757,606.98
2014	€ 8,511,139.95	0.2076	€ 1,766,508.54
2019	€ 9,147,277.95	0.2306	€ 2,109,033.57
2020	€ 8,638,160.52	0.2122	€ 1,832,855.28
Growth rate 1995-2020	38.90%	42.11%	97.39%

Note: The net consumption and welfare losses from income inequality are in million euros in 2015 prices.

[24] Indeed,

$$\text{DMUI} = 1 - \frac{\text{sum of average income in unadjusted and adjusted deciles}}{\text{sum of the average income in the 10 unadjusted deciles}}. \quad (31)$$

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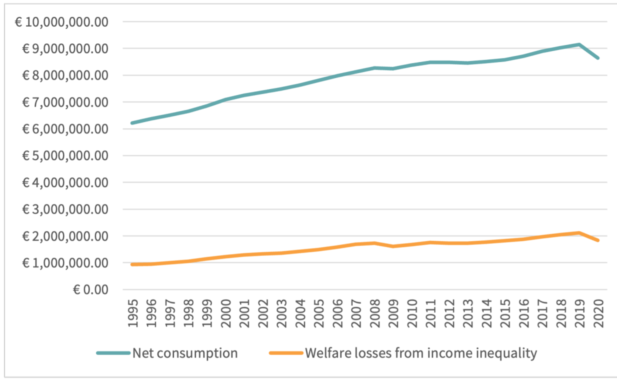
Figure 38: Evolution of the net consumption and of the welfare losses from income inequality in the EU27.



Note: The two variables are measured in million euros in 2015 prices.

The evolution of the value of the narrow ecological costs (−)

Table 15 and figure 39 show that thetotal value of narrow ecological costs (here and now) decreased between 1995 and 2020. This decrease depends on the evolution of the three subcomponents included in the narrow ecological costs, (i) the current costs of air pollution experienced here and now, (ii) the ecosystem costs of nitrogen pollution, and (iii) the costs of extreme weather events. Two of these subcomponents contributed to the decrease of the total narrow ecological costs. The costs of air pollution decreased by 64,47% while the ecosystem costs of nitrogen pollution decreased by 27,23%. On the contrary, the costs of extreme weather events increased by 94,78% during that period. In quantitative terms, this increase was not important enough to lead to an increase of the overall narrow ecological costs because of the decrease of the two other subcomponents, but it shows that even though the pollution emitted by the population decreased, the effects of climate change in the form of climate disasters increased.

The conclusion that the changes in the costs of extreme weather events have a small impact on the narrow ecological costs is also confirmed when looking at the changes in the component and its subcomponents in selected subperiods. Indeed, in the subperiods between 2001 and 2008, between 2011 and 2014, and between 2014 and 2019, we see that the narrow ecological costs decreased. During that subperiod, the current costs of air pollution and the ecosystem costs of nitrogen pollution also decreased, while the costs of extreme weather events actually increased. These findings again show that the changes in the costs of extreme weather events are not important enough to drive the changes in the narrow ecological costs, while the combination of the changes in the current costs of air pollution and in the ecosystem costs of nitrogen pollution can explain the changes in the narrow ecological costs.

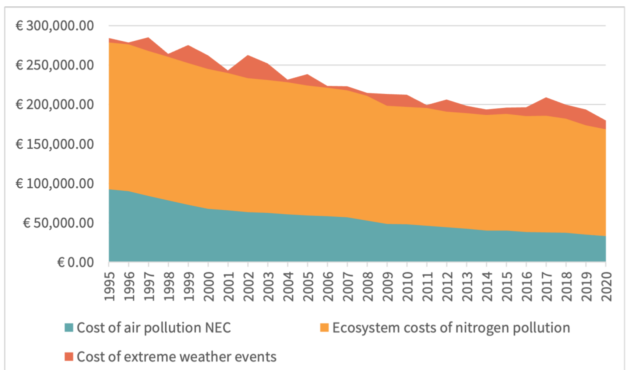
Each subcomponent is then studied individually to find out what is driving the changes in these subcomponents, and hence indirectly the changes in the narrow ecological costs. From these analyses, we see that the current costs of air pollution and the ecosystem costs of air pollution influenced the narrow ecological costs because of strong decreases in all the air pollutants included in the current costs of air pollution, especially in the emissions of SO_x, NO_x, and $NMVOC$. The decrease of NO_x emissions also impacted strongly the ecosystem costs of nitrogen pollution.

Table 15: Current costs of air pollution, ecosystem costs of nitrogen pollution, costs of extreme weather events, and total narrow ecological costs in the EU27, for selected years.

Year	Current costs of air pollution	Ecosystem costs of nitrogen pollution	Costs of extreme weather events	Narrow Ecological Costs
1995	€ 92,121.75	€ 186,259.34	€ 5,721.51	€ 284,102.61
2001	€ 65,619.15	€ 174,332.96	€ 3,204.43	€ 243,156.53
2008	€ 52,295.45	€ 158,306.46	€ 3,922.31	€ 214,524.22
2011	€ 45,787.87	€ 149,629.19	€ 3,754.68	€ 199,171.74
2014	€ 39,960.41	€ 146,782.66	€ 6,909.12	€ 193,652.19
2019	€ 34,840.50	€ 138,611.11	€ 19,854.02	€ 193,305.63
2020	€ 32,732.17	€ 135,536.96	€ 11,144.61	€ 179,413.74
Growth rate 1995-2020	-64.47%	-27.23%	94.78%	-36.85%

Note: All the costs are measured in million euros in 2015 prices.

Figure 39: Evolution of the total narrow ecological costs in the EU27.



Note: The costs are measured in million euros in 2015 prices.

The evolution of the current costs of air pollution

Table 16 shows that the current costs of air pollution decreased between 1995 and 2020. The values of this subcomponent depend on the amount of emissions of five different air pollutants and their pollutant-specific cost estimates, when multiplying these values, the values of the total costs of air pollution are obtained. Additionally, it is important to remember that the current costs of air pollution are equal to only one fifth of the total costs of air pollution. As shown in table 17, the pollutant-specific cost estimates are constant over time. The evolution of the current costs of air pollution hence only depends on the evolution of the different air pollutants.

From table 16 and figure 40, we can see that the emissions of all the air pollutants taken into account in this subcomponent decreased quite a lot between 1995 and 2020, which led to the decrease in the current costs of air pollution. Still, the emissions of some of the air pollutants decreased more than the others. Indeed, the emissions of SO_x are the ones that decreased the most over the period studied, followed by the decreases in the emissions of NO_x and of $NMVOC$. These decreases hence influenced the decrease in the current costs of air pollution even more than the decreases in the other air pollutants.

Table 16: $PM_{2.5}$ emissions, NH_3 emissions, NO_x emissions, $NMVOC$ emissions, SO_x emissions, and current costs of air pollution in the EU27, for selected years.

Year	PM2.5 emissions	NH3 emissions	NOx emissions	NMVOC emissions	SOx emissions	Current costs of air pollution
1995	2,333,548	4,114,522	13,087,008	12,806,915	14,254,030	€ 92,121.75
2001	1,912,350	4,005,938	11,348,733	10,339,511	8,465,090	€ 65,619.15
2008	1,788,972	3,688,286	9,537,568	8,463,985	4,927,979	€ 52,295.45
2011	1,647,897	3,546,267	8,345,938	7,509,722	3,727,748	€ 45,787.87
2014	1,476,943	3,535,121	7,394,855	6,872,671	2,495,074	€ 39,960.41
2019	1,375,292	3,454,800	6,222,979	6,545,724	1,606,027	€ 34,840.50
2020	1,306,291	3,418,504	5,580,717	6,499,660	1,402,550	€ 32,732.17
Growth rate 1995-2020	-44.02%	-16.92%	-57.36%	-49.25%	-90.16%	-64.47%

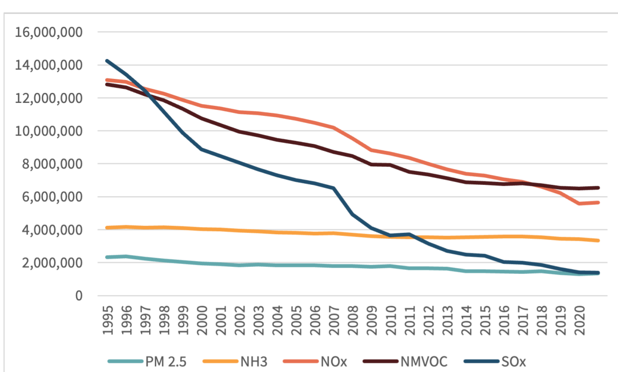
Note: The emissions are measured in tonnes and the current costs of air pollution are measured in million euros in 2015 prices. The values of the current costs of air pollution are obtained by multiplying the values of the emissions by the pollutant-specific cost estimates from table 17 and by 0.2 to only account for the current costs of air pollution.

Table 17: Average pollutant-specific cost estimates

Pollutant	Average across EU27
$PM_2.5$	€ 33,928.54
NH_3	€ 11,837.34
NO_x	€ 5,766.16
NMVOC	€ 1,763.21
SO_x	€ 13,803.82

Note: The estimates are measured in VOLY €/tonne in 2015 prices.

Figure 40: Evolution of the production-based emission in the EU27.



Note: All the emissions are measures in tonnes.

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The evolution of the ecosystem costs of nitrogen pollution

The ecosystem costs of nitrogen pollution decreased between 1995 and 2020, as can be seen in table 18. The values of this subcomponent depend on the amount of emissions and consumption of three nitrogen pollutants (NH_3, NO_x, and N_r) and the pollutant-specific cost estimate for these pollutants. The ecosystem costs of nitrogen pollution are then obtained by multiplying the amount of emissions by the right cost estimate and summing these values. As shown in table 19, the pollutant-specific cost estimates are constant over time, indicating that the evolution of the values of the ecosystem costs of nitrogen pollution only depends on the evolution of the nitrogen pollution.

From table 19 and figure 41, we see that the emissions of the nitrogen pollutants considered in this subcomponent all decreased, leading to the overall decrease of the ecosystem costs of nitrogen pollution. Even though all the emissions of the nitrogen pollutants decreased between 1995 and 2020, the emissions of NO_x are the ones that decreased the most, hence being one of the main drivers of changes in the ecosystem costs of nitrogen pollution. The consumption of inorganic fertilizers (N_r) is the pollutant for which the emissions decreased the least over the period studied, hence having a relatively small impact on the ecosystem costs of nitrogen pollution. The relatively small impact of this pollutant on the changes of ecosystem costs of nitrogen pollution can also be seen in table 18. During the subperiods between 2011 and 2014 and between 2019 and 2020, the N_r consumption increased but the ecosystem costs of nitrogen pollution decreased because of decreases in the emissions of the two other nitrogen pollution.

Table 18: NH_3 emissions, NO_x emissions, N_r consumption, and ecosystem costs of nitrogen pollution in the EU27, for selected years.

Year	NH3 emissions	NOx emissions	Nr consumption	Ecosystem costs of nitrogen pollution
1995	4,114,522	13,087,008	10,595,937	186,259.34 €
2001	4,005,938	11,348,733	10,322,829	174,332.96 €
2008	3,688,286	9,537,568	9,874,088	158,306.46 €
2011	3,546,267	8,345,938	9,738,134	149,629.19 €
2014	3,535,121	7,394,855	10,061,281	146,782.66 €
2019	3,454,800	6,222,979	9,870,534	138,611.11 €
2020	3,418,504	5,580,717	9,966,682	135,536.96 €
Growth rate 1995-2020	-16.92%	-57.36%	-5.94%	-27.23%

Note: The emissions and consumption are measured in tonnes and the ecosystem costs of nitrogen pollution are measured in million euros in 2015 prices. The values of the ecosystem costs of nitrogen pollution are obtained by multiplying the values of the emissions by the pollutant-specific cost estimates from table 19.

Table 19: Pollutant-specific ecosystem cost estimates

Pollutant	Ecosystem cost estimate
NH_3	€ 12,367.19
NO_x	€ 5,063.86
N_r	€ 6,521.70

Note: The cost estimates are measured in €/tonne in 2015 prices and are the same as those used for individual EU countries.

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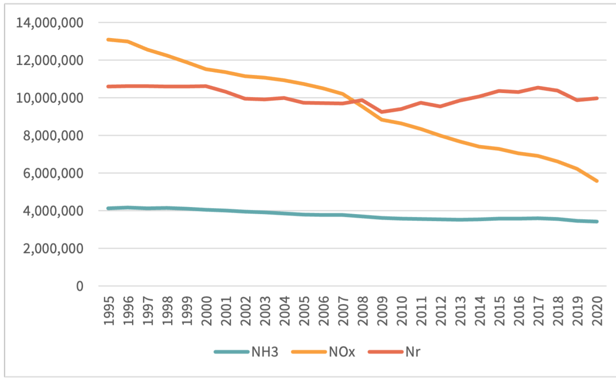
Figure 41: Evolution of nitrogen pollutants in the EU27.



Note: All the emissions are measured in tonnes.

The evolution of the costs of extreme weather events

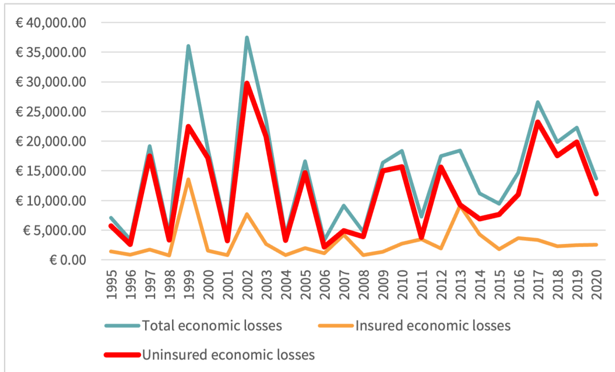
As shown in table 20 and in figure 42, the costs of extreme weather events fluctuated a lot over the years and had an overall increase between 1995 and 2020. The costs of extreme weather events depend positively on the total economic losses and negatively on the insured economic losses. Table 20 shows that these two items increased quite a lot over the years, but since the increase in the total economic losses was higher than the increase in the insured economic losses, the uninsured economic losses (proxying the costs of extreme weather events) increased as well. From figure 42, we can see that the values of the costs of extreme weather events mainly depend on the total economic losses because it follows that line more closely.

Table 20: Total economic losses from extreme weather events, insured economic losses, and uninsured economic losses in the EU27.

Year	Total economic losses	Insured economic losses	Uninsured economic losses
1995	€ 7,112.38	€ 1,390.87	€ 5,721.51
2001	€ 3,994.44	€ 790.01	€ 3,204.43
2008	€ 4,688.46	€ 766.15	€ 3,922.31
2011	€ 7,239.16	€ 3,484.48	€ 3,754.68
2014	€ 11,192.63	€ 4,283.52	€ 6,909.11
2019	€ 22,305.42	€ 2,451.40	€ 19,854.02
2020	€ 13,711.03	€ 2,566.42	€ 11,144.61
Growth rate 1995-2020	92.78%	84.52%	94.78%

Note: All the economic losses are measured in million euros in 2015 prices.

Figure 42: Evolution of the total economic losses from extreme weather events, insured losses, and uninsured losses in the EU27.



Note: All the losses are measured in million euros in 2015 prices.

The evolution of the value of the broad ecological costs (-)

Looking at table 21, we see that when looking at the ecological costs of present activities in the future and abroad and not only in the present and within a given country, the broad ecological costs increased between 1995 and 2020. The increase in the broad ecological costs is entirely due to the increase of the costs of climate breakdown that represent the effect of the emissions of different pollutants valued using the social cost of carbon. This subcomponent increased by 40,56% over the period studied. The overall broad ecological costs increased much less than the costs of climate breakdown because the four other subcomponents included in this component decreased over time. The costs of air pollution decreased by 50,73%, the ecosystem costs of nitrogen pollution decreased by 27,23%, the costs of depleting non-renewable energy resources decreased by 8,91%, and the costs of use of nuclear power decreased by 13,68%.

The fact that the broad ecological costs increased over the whole period studied even though four of its five subcomponents decreased over that period indicates that the changes in the costs of climate breakdown play an important role in explaining the changes in the broad ecological costs. The importance of the costs of climate breakdown in explaining the changes in the broad ecological costs is certainly linked to the fact that the values of the broad ecological costs make up an important part of the broad ecological costs, as shown in figure 43. As for the narrow ecological costs, the difference in the evolution of the different subcomponents shows that even though emissions decreased over time, their impact on the society still increased.

It is important to note that, as can be seen in table 8, the broad ecological costs in 'per capita' terms decreased over time. This difference between the overall growth rate in the total value and the 'per capita' value is due to the fact that the growth rate of the population is slightly higher than the growth rate of the broad ecological costs.

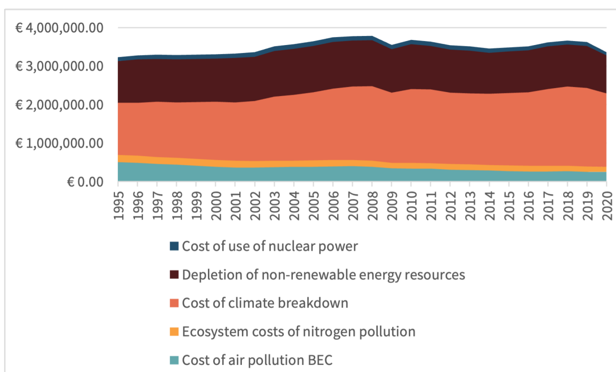
As for the narrow ecological costs, each subcomponent is also analysed to understand what is driving its changes, and hence also the changes in the broad ecological costs. For the costs of climate breakdown, we find that the increase in the CO_2 emissions from biomass and the increase in the social cost of carbon are the main drivers of the increase of the costs of climate breakdown. For the costs of air pollution, we find that, as for the narrow ecological costs, the decrease in the emissions of NO_x, SO_x, and $NMVOC$ play an important role in explaining the decrease in these costs because the costs of air pollution from production-based emissions are more important than the costs of air pollution embodied in trade. For the ecosystem costs of nitrogen pollution, the analysis for the narrow ecological costs found that the decrease in NO_x emissions was one of the main reasons why the ecosystem costs of nitrogen pollution decreased over time. For the costs of depleting non-renewable energy resources, we find that the decrease in these costs is entirely explained by the decrease in the primary energy consumption because the cost estimate used to value these costs is constant over time. Similarly, the decrease in the costs of nuclear power use are completely driven by the decrease in the amount of nuclear electricity generation as the cost estimate is constant over time. The variables found to be the main drivers of the changes in the subcomponents also have an important indirect impact on the total broad ecological costs.

Table 21: Cost of air pollution, ecosystem costs of nitrogen pollution, costs of climate breakdown, costs of depleting non-renewable energy resources, costs of nuclear power use, and total broad ecological costs in the EU27, for selected years.

Year	**Costs of air pollution**	**Ecosystem costs of nitrogen pollution**	**Costs of climate breakdown**	**Costs of depleting non-renewable energy resources**	**Costs of nuclear power use**	**Broad Ecological Costs**
1995	€ 502,206.63	€ 186,259.34	€ 1,353,813.83	€ 1,087,432.13	€ 104,047.63	€ 3,233,759.55
2001	€ 367,961.38	€ 174,332.96	€ 1,515,846.10	€ 1,149,652.64	€ 116,797.73	€ 3,324,590.81
2008	€ 382,963.43	€ 158,306.46	€ 1,937,385.13	€ 1,193,316.30	€ 116,250.73	€ 3,788,222.04
2011	€ 330,603.05	€ 149,629.19	€ 1,911,326.46	€ 1,132,459.10	€ 110,080.32	€ 3,634,098.12
2014	€ 284,632.23	€ 146,782.66	€ 1,846,529.74	€ 1,066,740.24	€ 106,766.62	€ 3,451,451.50
2019	€ 251,446.39	€ 138,611.11	€ 2,044,247.35	€ 1,085,574.68	€ 100,563.11	€ 3,620,442.64
2020	€ 247,420.92	€ 135,536.96	€ 1,902,961.64	€ 990,508.58	€ 89,811.42	€ 3,366,239.51
Growth rate 1995-2020	-50.73%	-27.23%	40.56%	-8.91%	-13.68%	4.10%

Note: All the costs are measured in million euros in 2015 prices.

Figure 43: Evolution of the total broad ecological costs in the EU27.



Note: The costs are measures in million euros in 2015 prices.

The evolution of the costs of air pollution

As table 22 and figure 44 show, the total costs of air pollution including trade decreased between 1995 and 2020. This subcomponent depends on the costs of air pollution from production-based emissions and the costs of air pollution embodied in trade. From both table 22 and figure 44, it is clear that the total costs of air pollution are more influenced by changes in the costs of air pollution from production-based emissions than by the costs of air pollution embodied in trade. Indeed, on figure 22, we can see that the evolution of the total costs of air pollution follow the evolution of the costs of air pollution from production-based emissions more closely than the evolution of the costs of air pollution embodied in trade. The growth rates over the whole period also prove this conclusion because the total costs of air pollution decreased even though the costs of air pollution embodied in trade increased a lot between 1995 and 2020. The decrease in the total costs of air pollution is hence entirely caused by the decrease in the costs of air pollution from production-based emissions.

When looking at the values of the different costs in different years and for different subperiods, we see that all the costs generally evolve in the same direction. The only exceptions are for the subperiods between 2001 and 2008 and between 2019 and 2020. Between 2001 and 2008, the total costs of air pollution increased even though the costs of air pollution from production-based emissions decreased because there was a very strong increase in the costs of air pollution embodied in trade during that subperiod. Between 2019 and 2020, the total costs of air pollution decreased even though the costs of air pollution embodied in trade increased. The changes in these two subperiods prove that the costs of air pollution from production-based emissions play a more important role for the total costs of air pollution than the costs of air pollution embodied in trade because the costs of air pollution embodied in trade offset the effect coming from the costs of air pollution from production-based emissions only when there is a very important change in the costs of air pollution embodied in trade, as between 2001 and 2008.

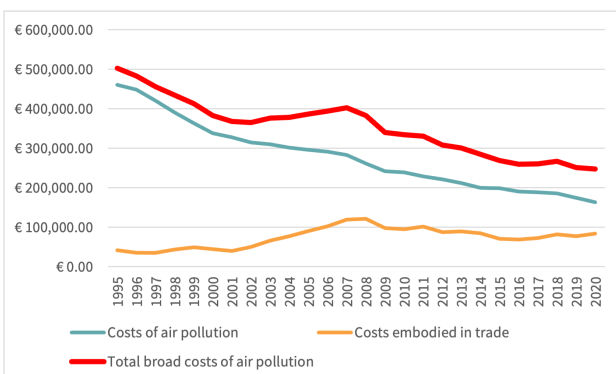
The details about the costs of air pollution from production-based emissions can be found in section 3.3.7 for the narrow ecological costs. These costs depend on the changes in emissions of different air pollutants and in particular on the emissions of SO_x, NO_x and $NMVOC$. Since the total costs of air pollution mainly dependent on the costs of air pollution from production-based emissions, these emissions play an important role in explaining the changes in the total costs of air pollution included in the broad ecological costs.

Table 22: Cost of air pollution from production-based emissions, costs of air pollution embodied in trade, and total costs of air pollution in the EU27, for selected years.

Year	Costs of air pollution from production-based emissions	Costs of air pollution embodied in trade	Total costs of air pollution
1995	€ 460,608.77	€ 41,597.85	€ 502,206.63
2001	€ 328,095.75	€ 39,865.63	€ 367,961.38
2008	€ 261,477.24	€ 121,486.19	€ 382,963.43
2011	€ 228,939.35	€ 101,663.70	€ 330,603.05
2014	€ 199,802.05	€ 84,830.18	€ 284,632.23
2019	€ 174,202.51	€ 77,243.88	€ 251,446.39
2020	€ 163,660.86	€ 83,760.06	€ 247,420.92
Growth rate 1995-2020	-64.47%	101.36%	-50.73%

Note: All the costs are expressed in million euros in 2015 prices.

Figure 44: Evolution of the costs of air pollution from production-based emissions and costs of air pollution embodied in trade in the EU27.



Note: The costs are measured in million euros in 2015 prices.

The evolution of the ecosystem costs of nitrogen pollution

This subcomponent is not detailed here as it is exactly the same as the one included and discussed in the narrow ecological costs. As a reminder, the decreases in the emissions of NO_x played an important role in the decrease of the ecosystem costs of nitrogen pollution.

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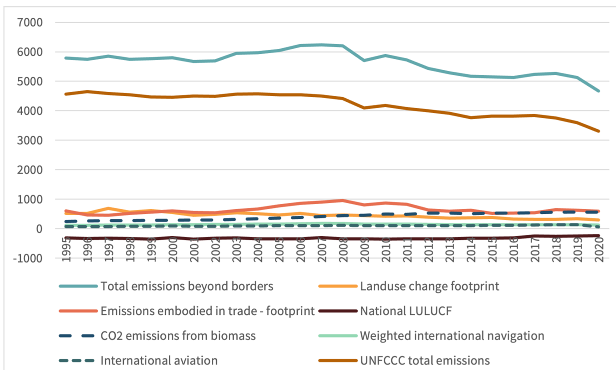
The evolution of the costs of climate breakdown

As table 23 shows, the total costs of climate breakdown increased between 1995 and 2020. These costs depends in the evolution of different emissions, presented in figure 45, and on the social cost of carbon used to value these costs. Among the seven types of emissions included in this subcomponent, we see that two of them increased between 1995 and 2020, while the five others decreased. The emissions that increased during the period studied are the CO_2 emissions from biomass, which increased very strongly, and the emissions from international navigation, which only increased slightly. The emissions that decreased the most between 1995 and 2020 are the footprint emissions from land use change, followed by the total greenhouse gas emissions (UNFCCC total) and the emissions from national LULUCF. The emissions from international aviation and the footprint emissions embodied in trade are the ones that decreased the least between 1995 and 2020. The increase in the social cost of carbon also participated in the increase of the costs of climate breakdown. In sum, the increase of the costs of climate breakdown is principally caused by a combination of the very strong increase in the CO_2 emissions from biomass, which offset the decrease in the other emissions, and of the increase in the social costs of carbon.

Figure 45: Evolution of the emissions included in the costs of climate breakdown in the EU27.



Note: The emissions are measured in million tonnes.

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Table 23: UNFCCC total emissions, emissions from international aviation, emissions from international navigation, CO_2 emissions from biomass, national LULUCF, footprint emissions embodied in trade, footprint emissions from land use change, social cost of carbon, and total costs of climate breakdown in the EU27, for selected years.

Year	UNFCCC total emissions	International aviation	International navigation	CO2 emissions from biomass	National LULUCF	Emissions embodied in trade - footprint	Land use change - footprint	Social Cost of Carbon	Total costs of climate breakdown
1995	4560.15	65.70	110.37	245.11	-316.21	600.03	519.57	€ 234.03	€ 1,353,813.83
2001	4500.26	84.27	137.27	293.31	-353.11	549.82	455.93	€ 267.45	€ 1,515,846.10
2008	4408.41	107.39	170.72	439.29	-344.26	956.39	461.36	€ 312.52	€ 1,937,385.13
2011	4069.87	102.84	150.60	482.99	-347.27	829.90	432.18	€ 334.08	€ 1,911,326.46
2014	3767.74	104.67	130.18	510.15	-327.80	618.46	366.92	€ 357.14	€ 1,846,529.74
2019	3591.29	132.98	134.97	564.20	-247.32	623.58	331.63	€ 398.39	€ 2,044,247.35
2020	3303.60	56.11	118.56	561.21	-241.04	587.36	288.06	€ 407.15	€ 1,902,961.64
Growth rate 1995-2020	-27.55%	-14.60%	7.42%	128.96%	-23.77%	-2.11%	-44.56%	73.97%	40.56%

Note: The emissions are measured in million tonnes, the social cost of carbon is measured in euros in 2015 prices, and the total costs of climate breakdown are measured in million euros in 2015 prices.

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The evolution of the costs of depleting non-renewable energy resources

Table 24 and figure 46 show that the costs of depleting non-renewable energy resources decreased between 1995 and 2020. As the growth rates presented in table 24 show, the costs of depleting non-renewable energy resources decreased exactly as much as the primary energy consumption, indicating that the costs of depleting non-renewable energy resources are only driven by changes in primary energy consumption. This conclusion is caused by the fact that the cost estimate used to value the costs of depleting non-renewable energy resources is constant over time.

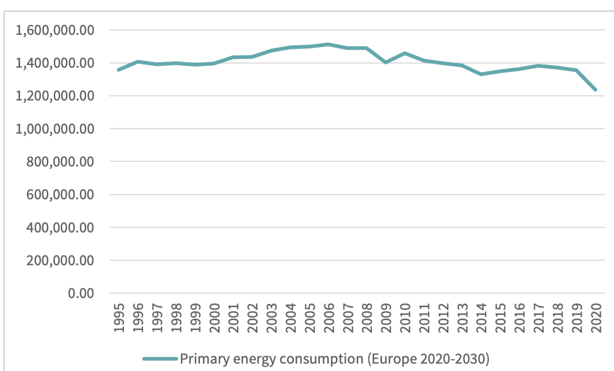
The constant cost estimate used to value the costs of depleting non-renewable energy resources is around 801.56 euros per tonne of oil equivalent in 2015 prices.[25]

Table 24: Primary energy consumption and costs of depleting non-renewable energy resources for the EU27, for selected years.

Year	Primary energy consumption	Costs of depleting non-renewable energy resources
1995	1,356,643.21	€ 1,087,432.13
2001	1,434,267.39	€ 1,149,652.64
2008	1,488,740.68	€ 1,193,316.30
2011	1,412,817.31	€ 1,132,459.10
2014	1,330,828.71	€ 1,066,740.24
2019	1,354,325.92	€ 1,085,574.68
2020	1,235,724.69	€ 990,508.58
Growth rate 1995-2020	-8.91%	-8.91%

Note: The primary energy consumption is measured in thousand tonnes of oil equivalent and the costs of depleting non-renewable energy resources are measured in million euros in 2015 prices. The costs measured in million euros in 2015 prices are obtained by dividing the amount of primary energy consumption by 1000 to obtain the consumption of primary energy in tonnes of oil equivalent and then multiplying by the constant cost estimate of around 801.56 euros per tonne of oil equivalent in 2015 prices.

Figure 46: Evolution of primary energy consumption in the EU27.



Note: The consumption is measured in thousand tonnes of oil equivalent.

The evolution of the costs of use of nuclear power

As can be seen from table 25 and figure 47, the costs of using nuclear power to produce electricity in the EU27 decreased between 1995 and 2020. The table shows that the decrease in the costs of using nuclear power is exactly the same as the decrease in the amount of nuclear electricity generation. Indeed, the cost estimate used to value the costs of using nuclear power is constant over time, indicating that the costs of

[25] The exact cost estimate is equal to 801.560886€/tonne of oil equivalent.

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using nuclear power only vary when there are changes in the amount of electricity produced using nuclear power. The nuclear electricity generation is hence completely driving the changes in the costs of using nuclear power.

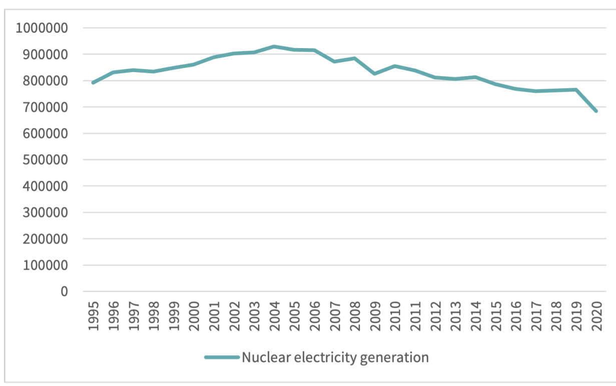
The constant cost estimate used to value the costs of using nuclear power electricity generation is around 0.13 euro per kWh in 2015 prices.[26]

Table 25: Amount of nuclear electricity generation and cost of using nuclear power for the EU27, for selected years.

Year	Nuclear electricity generation	Costs of using nuclear power
1995	791857	€ 104,047.63
2001	888892	€ 116,797.73
2008	884729	€ 116,250.73
2011	837769	€ 110,080.32
2014	812550	€ 106,766.62
2019	765338	€ 100,563.11
2020	683512	€ 89,811.42
Growth rate 1995-2020	-13.68%	-13.68%

Note: The electricity generation is measured in GWh and the costs of using nuclear power are measured in million euros in 2015 prices. The costs measured in million euros in 2015 prices are obtained by multiplying the amount of nuclear electricity generation by the constant cost estimate of around 0.13 euro per kWh in 2015 prices.

Figure 47: Evolution of nuclear electricity generation in the EU27.



Note: The production is measured in GWh.

The evolution of the value of the net investments (+)

The value of net investments fluctuated a lot over the years, as can be seen in figure 48, and had an overall decrease between 1995 and 2020, as can also be seen in figure 48 and table 26. The net investments are the difference between the given net capital stock in a given year and the net capital stock in the previous year. The decrease in net investments over the period studied indicates that the difference between the capital stock in the given year and the capital stock in the previous year is smaller in 2020 than in 1995, which indicates that there was less investments in the capital stock in 2020 than in 1995.

[26]The exact cost estimate is equal to 0.131396989€/kWh.

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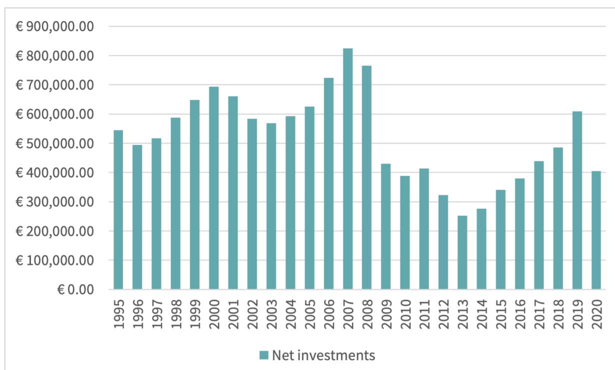
Table 26: Net investments in the EU27, for selected years.

Year	Net capital stock	Net investments
1994	€ 25,322,458.98	/
1995	€ 25,867,501.06	€ 545,042.08
2000	€ 28,808,235.05	/
2001	€ 29,468,477.76	€ 660,242.70
2007	€ 33,386,513.13	/
2008	€ 34,151,842.82	€ 765,329.69
2010	€ 34,970,737.91	/
2011	€ 35,384,726.01	€ 413,988.10
2013	€ 35,960,261.23	/
2014	€ 36,236,993.32	€ 276,732.08
2018	€ 37,881,319.01	/
2019	€ 38,490,502.78	€ 609,183.77
2020	€ 38,895,335.70	€ 404,832.92
Growth rate 1995-2020	/	-25.72%

Note: The net capital stock and the net investments are measured in million euros in 2015 prices.

Figure 48: Evolution of net investments in the EU27.



Note: The net investments are measured in million euros in 2015 prices.

4.2 Evolution of welfare in the individual EU countries

The individual countries are classified into groups depending on the evolution of their welfare levels in two subperiods, before being analysed individually. Here, the trends in the overall welfare measure for each individual countries within the groups are shortly discussed and some of the important components driving these trends are presented. However, more details on the evolution of the overall welfare measures in the different EU countries as well as the evolution of the different components in those countries can be found in appendix A. Additionally, tables allowing to easily compare the absolute values of gdp, bce, bcpa and the components of the welfare measures, all in per capita terms, in 1995 and 2020 as well as the total growth rates of these variables for the entire period studied are presented in appendix B.

Only two periods are studied in this section to be able to more easily classify the countries in different groups. The two selected subperiods are the period between 1995 and 2008, so before the financial crisis, and the period between 2008 and 2020, so during and after the financial crisis.

Only the evolution of the bcpa is taken into account to group the countries but both bce and bcpa are discussed in this section to analyse the evolution of welfare in the EU countries. The choice to focus most on the evolution of the bcpa and leaving aside the bce was made for different reasons. A first reason is practical in that grouping countries according to two measures would result in more groups. Next, from an ecological economic perspective, using the bcpa makes more sense because it aligns better with the idea of seeing the economy as embedded in the ecosystem and it accounts for physical capital, giving better information to policy-makers than bce and capturing better "the benefits of a green transition of the economy" (Van der Slycken and Bleys, 2023, 2024, p.24, p.15). And finally, by looking at the benefits and costs abroad and/or in the future in addition to those experienced today, bcpa better aligns with the overall aim of the ToBe project of creating a paradigm shift.[27]

The countries are classified into different groups based on the evolution of their welfare in each subperiod which can be increasing, decreasing or stagnating. The welfare is increasing/decreasing when the value of the bcpa increases/decreases by more than 10% in total over the selected period. When the growth rate of the bcpa is between -10 and 10% for a given period, the welfare is described as stagnating during that period.[28]

This classification leads to the creation of 3 main groups: 8 countries have increasing welfare in both subperiods, 8 countries have increasing welfare in the first subperiod but a stagnating welfare in the second subperiod and 7 countries have stagnating welfare in both subperiods. We also find two smaller groups: 3 countries have increasing and then decreasing welfare while only 1 country has stagnating and then decreasing welfare.

4.2.1 Group 1: Welfare increasing in both subperiods

The first main group of countries is the group in which bcpa increased by more than 10% in total in each subperiod. The countries for which this is the case are Bulgaria, Czechia, Estonia, Hungary, Lithuania, Poland, Romania, and Slovakia. This group hence contains only Eastern European countries, but not all of them. Table 27 presents the total and yearly growth rates for each of the subperiods and the entire period for the 8 countries included in this group. From that table, we can indeed see that the bcpa increased in total by more than 10% in the different subperiods and hence also by more than 20% for the total 1995-2020 period for these countries.

Some of the growth rates for these countries, especially in the first subperiod, should be interpreted with caution because they are highly dependent on the low bcpa values in the first years of the period. Even more caution is needed when looking at the results for two countries, Bulgaria and Poland. These two countries are included in this group because their welfare increased in both subperiods. However, due to the negative values for bcpa at the beginning of the period studied, the exact growth rates for the first subperiod (1995-2008) and for the entire period cannot be calculated.[29] Still, given the absolute increases in bcpa, it is clear that the increase was more than 10% in both cases, hence why they are still included in this group.

From figure 49, we see that in all of these countries, the bce is higher than the bcpa and increasing in a similar way. In all cases, bcpa is well below the level of bce and gdp for the whole period. From figure 49, it can also be seen that in these Eastern European countries, gdp was growing a lot over the whole period. These observations could be interpreted as showing that for these countries, traditional economic growth translates into welfare increases when the initial level of gdp is low.

Figure 49 presents the evolution of the different components of bcpa in the individual countries. In all countries, three components are always higher than the other ones: the broad ecological costs, the individual consumption expenditures, and the value of unpaid work (which is lower than the other two). In these countries, the ecological costs of the present economic activities on the future environment and other countries are very high compared to the other components of the welfare measures, explaining why the bcpa is so much lower than gdp and bce throughout the period. These high ecological costs also explain the low value of bcpa at the beginning of the period by being so much higher than the benefits from the different components included in the index. Regarding the evolution of the bcpa, in all countries, the increase in bcpa over time is due mainly to the increase of individual consumption expenditures and of the value of unpaid

[27] It should be noted that grouping the individual countries based on the bce (instead of the bcpa that we use) gives very similar results and groups: only 6 countries out of the 27 EU countries are classified differently when looking at the evolution of the bce instead of the evolution of the bcpa.

[28] This 10% threshold was selected by the authors because it is assumed that a change of less than 10% over the selected period, in one way or another, does not significantly change welfare. This threshold is even more justifiable when looking at the annual growth rate, which is around 0.77% for a total increase of 10% in the selected period. When looking at the overall period studied (1995-2020), a threshold of 20% is applied to adjust the previous threshold to the length of the total period. The threshold expressed in annual growth rate in this case would be equal to 0.73%.

[29] The impossibility to calculate these growth rates is reflected in table 27 by using an * instead of including an estimation of the growth rates.

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Table 27: Total growth and annual growth rates of bcpa in group 1

	1995-2008	2008-2020	1995-2020
Bulgaria	*	114.35 (6.56)	*
Czechia	859.86 (19.00)	33.93 (2.46)	1185.52 (10.75)
Estonia	934.32 (19.69)	11.40 (0.90)	1052.23 (10.27)
Hungary	193.74 (8.64)	34.15 (2.48)	294.05 (5.64)
Lithuania	1979.51 (26.29)	41.92 (2.96)	2851.22 (14.50)
Poland	*	77.05 (4.88)	*
Romania	346.55 (12.20)	86.71 (5.34)	733.76 (8.85)
Slovakia	443.19 (13.90)	104.22 (6.13)	1009.31 (10.10)

Note: The growth rates between brackets are the annual growth rates. The * indicate that there was a positive growth rate during that (sub)period but that the exact growth rate cannot be calculated because of the negative value at the beginning of the period studied.

work. In some countries, the small decrease in broad ecological costs also contributes to the increase of the bcpa over time.

Since the value of the broad ecological costs plays such an important role for these countries, it is interesting to look into this component to understand what are the subcomponents that make this component so high in these countries. In Bulgaria, the highest subcomponent at the beginning of the period studied is the value of the costs of depleting non-renewable energy resources, the second highest subcomponent at the beginning of the period is the value of the costs of air pollution and the third highest is the value of the costs of climate breakdown. Since the costs of depleting non-renewable resources and the costs of air pollution are decreasing over time and the costs of climate breakdown are increasing a lot, these costs end up being the highest at the end of the period studied, leading them to be the subcomponent mainly driving the high and increasing value of the broad ecological costs. In Czechia, Hungary, Lithuania, Poland and Romania, the subcomponent primarily driving the high and increasing broad ecological costs is the value of the costs of climate breakdown because it is the subcomponent with the highest value and increase throughout the period studied. In these five countries, the value of the costs of depleting non-renewable energy resources is the second highest subcomponent, but it is decreasing or not increasing as much as the costs of climate breakdown over time, making it the second most important subcomponent in explaining the high and increasing broad ecological costs in these countries. In Estonia and Slovakia, the highest subcomponent at the beginning of the period studied is the value of the costs of depleting non-renewable energy resources, while the second highest subcomponent at the beginning of the period is the value of the costs of climate breakdown. Since the costs of depleting non-renewable resources are decreasing over time while the costs of climate breakdown are increasing a lot, the subcomponent mainly driving the high and increasing value of the broad ecological costs is the costs of climate breakdown. In short, for all these countries, the value of the costs of climate breakdown is the subcomponent that, together with the value of the costs of depleting non-renewable energy resources (especially at the beginning of the period), is primarily responsible for the high (and increasing in most cases) broad ecological costs.

Still, the increase of individual consumption expenditures and unpaid work, among other things, led to an increase in bcpa for all countries over the period studied. It is hence also interesting to look at the subcomponents of these components and understand what is driving these increases. In the eight countries, the overall increases in individual consumption expenditures and in the value of unpaid work were (mainly) caused by the increase in the same subcomponents. Indeed, the value of the individual consumption expenditures increased over time principally because of an important increase in actual individual consumption, and the value of unpaid work in all countries primarily increased because of strong increases in the replacement wages used to value unpaid work.

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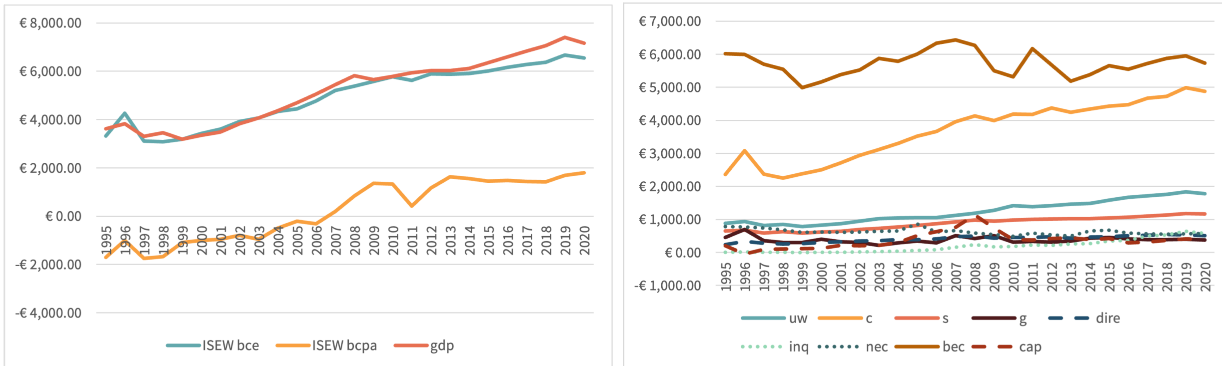
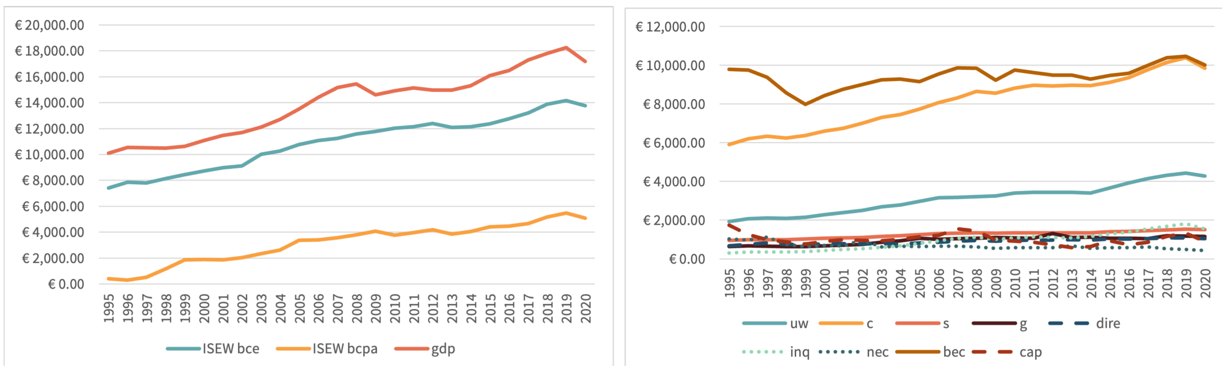
Figure 49: Evolution of the ISEWs and GDP (left) and evolution of the components (right) in group 1 countries.

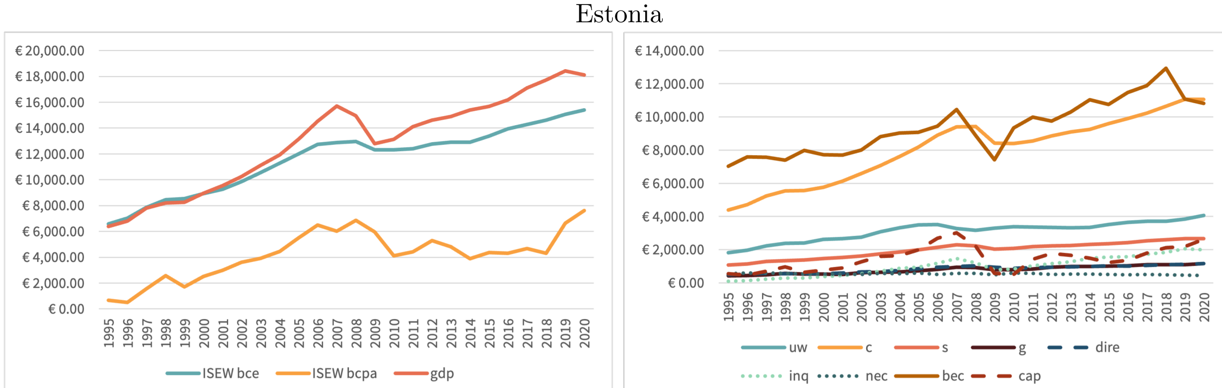
Bulgaria



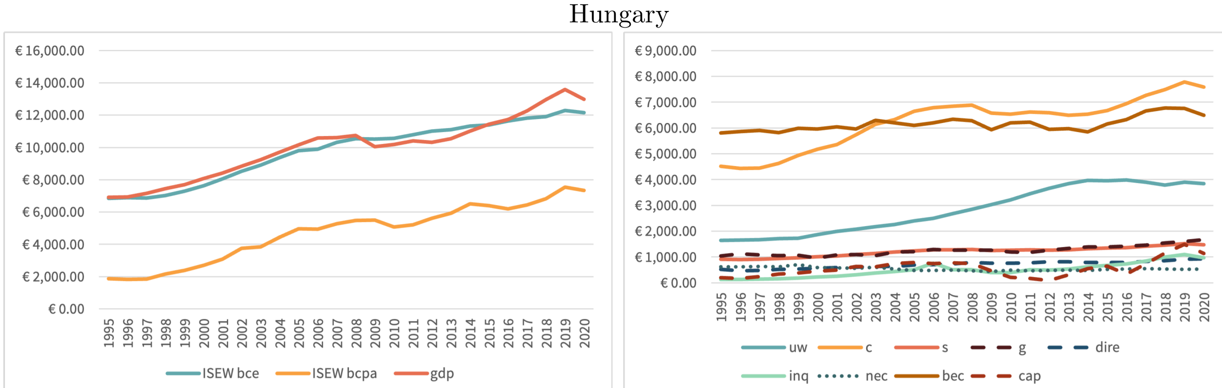
Czechia



Estonia



Hungary



Note: The prices are in million euros in 2015 prices. All three measures and components are in per capita terms.

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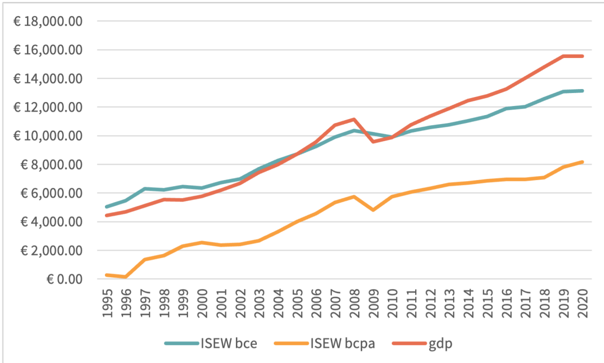
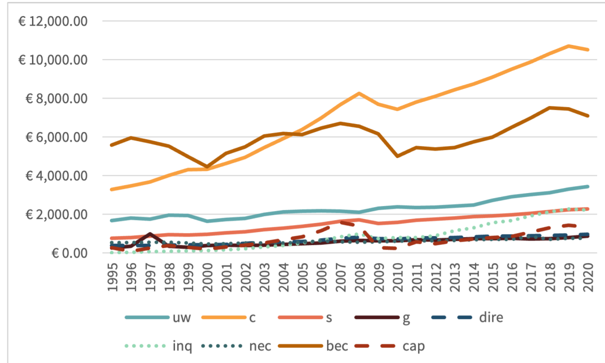
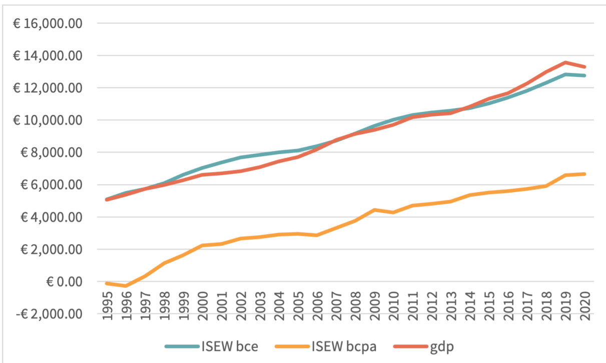
Figure 49: Evolution of the ISEWs and GDP (left) and evolution of the components (right) in group 1 countries (continued).

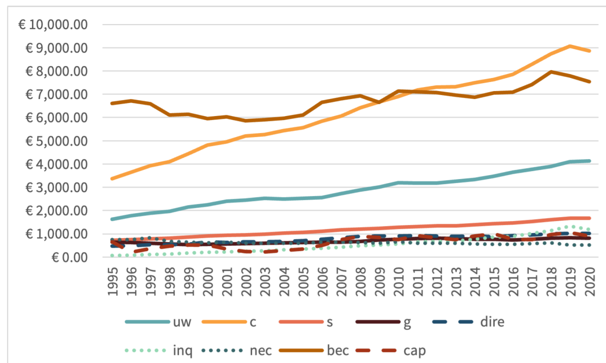
Lithuania



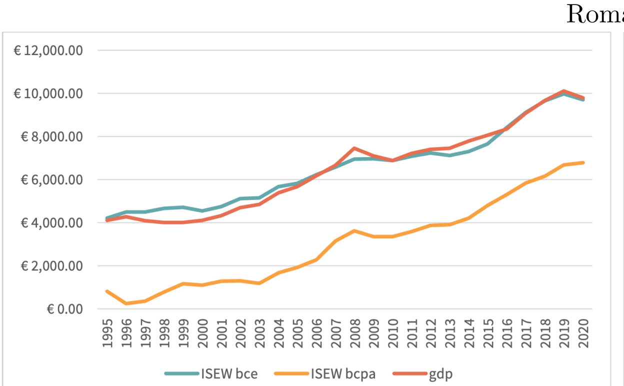


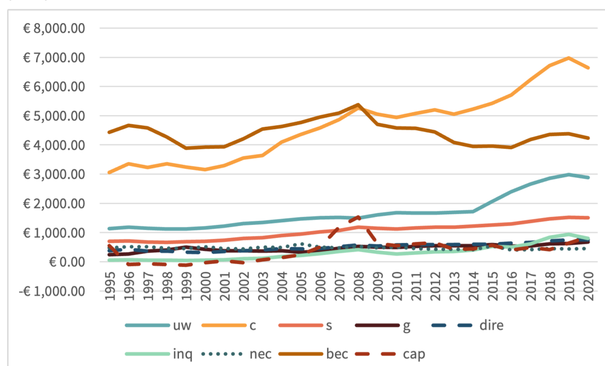
Poland



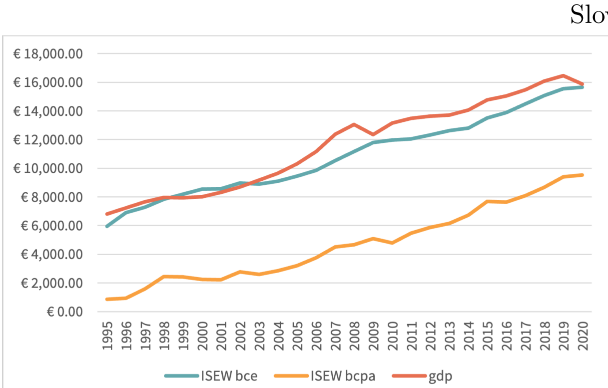


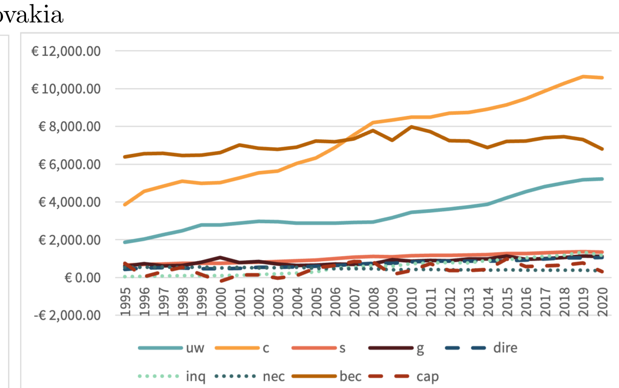
Romania





Slovakia





Note: The prices are in million euros in 2015 prices.All three measures and components are in per capita terms.

4.2.2 Group 2: Welfare increasing between 1995 and 2008 but stagnating between 2008 and 2020

The second main group is the group where the bcpa is increasing during the first subperiod and stagnating during the second subperiod, after the financial crisis. This group contains 8 of the EU countries: Croatia, Cyprus, Denmark, Finland, Ireland, Slovenia, Spain, and Sweden. This group contains a mix of Central and Eastern European countries

Table 28 presents the total and annual growth rates in each of these countries for the two subperiods and the total period. In this table, we can indeed see that the total bcpa growth rate for each country is higher than 10% in the first subperiod but between -10 and +10% in the second subperiod. Regarding the overall period, for most of the countries, the increase in the first period is high enough to result in a total increase of more than 20% over the whole period. The only exception here is Spain, where the welfare increase in the first period is not high enough to counter the low but negative growth rate in the second period leading to a growth rate over the whole period that is lower than 20%.

Table 28: Total growth and annual growth rates of bcpa in group 2

	1995-2008	2008-2020	1995-2020
Croatia	45.07 (2.90)	-6.65 (-0.57)	35.42 (1.22)
Cyprus	33.73 (2.26)	-2.12 (-0.18)	30.89 (1.08)
Denmark	19.49 (1.38)	6.88 (0.56)	27.71 (0.98)
Finland	35.15 (2.34)	7.55 (0.61)	45.36 (1.51)
Ireland	45.23 (2.91)	3.59 (0.29)	50.44 (1.65)
Slovenia	101.78 (5.55)	-3.16 (-0.27)	95.41 (2.72)
Spain	12.13 (2.72)	-6.51 (-0.56)	4.82 (0.19)
Sweden	24.93 (1.73)	9.54 (0.76)	36.85 (1.26)

Note: The growth rates between brackets are the yearly exponential growth rates.

Figure 50 presents the evolution of the three measures as well as the components in each of the countries in this group. First looking at the evolution of the measures, we see that, except in Ireland in 2019, bcpa is always lower than the two other measures. However, the difference between bcpa and bce and between bcpa and gdp are lower here than for the previous group. Looking at the evolution of the bcpa, it can indeed be seen that it increases between 1995 and 2008 in all countries. We sometimes see a more substantial increase for some countries (e.g., Slovenia) than for other countries in this groups (e.g., Spain). After 2008, bcpa is indeed relatively stable, but we do observe some fluctuations in some countries, such as in Cyprus, Ireland or Slovenia. These fluctuations are studied in more details in the appendix A but in this section, what is important to see is that over the period 2008-2020, despite some fluctuations over the years, welfare remained quite stable.

The graph showing the evolution of the components can be used to highlight the components driving the evolution of bcpa in these countries. Similarly to the previous group, the three most important components are individual consumption expenditures, broad ecological costs and the value of unpaid work. Still, unlike what we saw in the previous group, the importance of these different components[30] is different for different countries in this group. For Croatia, Cyprus and Slovenia, the value of the broad ecological costs is always higher than the value of unpaid work but lower than the value of individual consumption expenditures. In

[30] This importance is simply based on the absolute values of the components, the higher the absolute value, the more important this component is.

these countries, the increase of bcpa in the first subperiod is mainly driven by increases in the individual consumption expenditures and the value of unpaid work, which are important enough to offset increasing broad ecological costs. The stagnation of bcpa in the second subperiod is caused by the fact that these three main components also remained relatively stable over this subperiod.

For Denmark, Spain and Sweden, we see that the value of the individual consumption expenditures is also higher than the value of the two other main components for the whole period. However, in this case, the value of unpaid work is the second most important component with a value that is higher than the value of broad ecological costs over the whole period, with a minor exception for Spain between 2005 and 2008. For Denmark and Sweden, the increase at the beginning of the period is clearly caused by an increase in the individual consumption expenditures and the value of unpaid work, while in Spain the value of unpaid work slightly decreased during the first subperiod. This small decrease was countered by an increase of the individual consumption expenditures which was high enough to have a positive but not too high increase in the overall bcpa during that period. Over the second subperiod, the three main components are relatively stable in all countries, leading to the stagnation of the overall bcpa during that period.

Finally, for Finland and Ireland, even though individual consumption expenditures are still the most important component, the importance of the value of unpaid work and that of the broad ecological costs is not so distinct. For Finland, the broad ecological costs are usually higher than the value of unpaid work, but not significantly. The situation is opposite in Ireland, where the value of unpaid work is usually higher than the broad ecological costs, but only really different between 2008 and 2017. In these two countries, the increase of individual consumption expenditures seems to be the main reason for the increase of the overall bcpa in the first subperiod while the stabilization of the individual consumption expenditures in the second subperiod explains the stabilization of the bcpa.

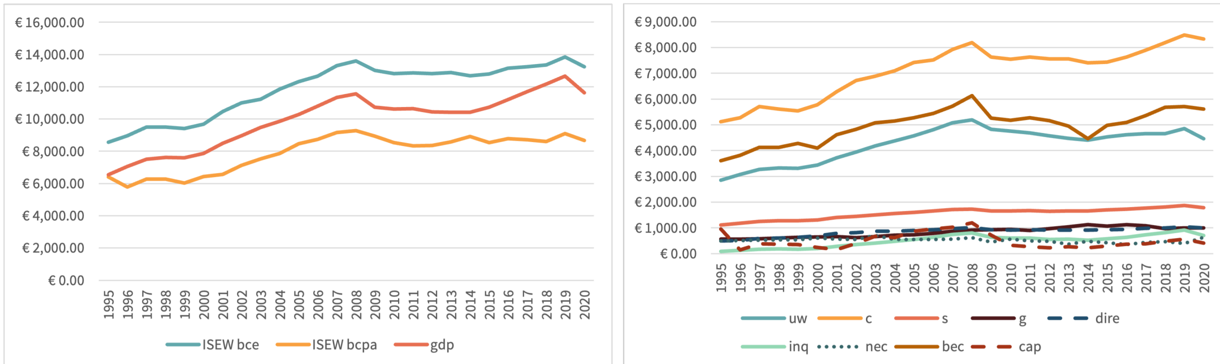
Despite the differences in level and ranking between the countries, the three main components (individual consumption expenditures, unpaid work and broad ecological costs) are evolving in a similar way for these eight countries. It is hence interesting to study these three components in more details to see whether they are determined by the same subcomponents of not. For the first subperiod (1995-2008), we see that the values of individual consumption expenditures and of the broad ecological costs evolved in the same direction and were led by the same subcomponents. Indeed, between 1995 and 2008, in all countries the individual consumption expenditures increased mainly due to an increase in actual individual consumption and the broad ecological costs also increased, primarily led by an increase in the costs of climate breakdown. The value of unpaid work also evolved in the same direction for all countries except Spain during that period. Indeed, in all countries except Spain, the value of unpaid work increased because of relatively strong increases in the replacements wages. For Spain, there was a small decrease in the value of unpaid work because of a decrease in the replacement wage.

For the second subperiod (2008-2020), there were more disparities between the countries for the values of individual consumption expenditures and for the values of unpaid work, but not for the broad ecological costs. Indeed, between 2008 and 2020, the broad ecological costs decreased in all countries, mainly because of decreases in the costs of air pollution and/or in the costs of depleting non-renewable energy resources. Regarding the value of individual consumption expenditures between 2008 and 2020, it increased in Croatia, Denmark, Finland, Slovenia and Sweden, even though much less than in the first subperiod. For all these countries, the value of individual consumption expenditures increased because of an increase in actual individual consumption, but this increase was countered by a decrease in the services of consumer durables in most countries, leading to the small increase. In the other countries of this group (Cyprus, Ireland and Spain), there was a decrease in individual consumption expenditures between 2008 and 2020 which was mainly caused by a decrease in actual individual consumption and complemented by a decrease in the services of consumer durables in Ireland and Spain. Finally, the value of unpaid work decreased in three countries (Croatia, Cyprus and Ireland), mainly because of a decrease in the replacement wages. In the other countries (Denmark, Finland, Slovenia, Spain and Sweden), there was a relatively low increase in the value of unpaid work, principally coming from small increases in the replacement wages.

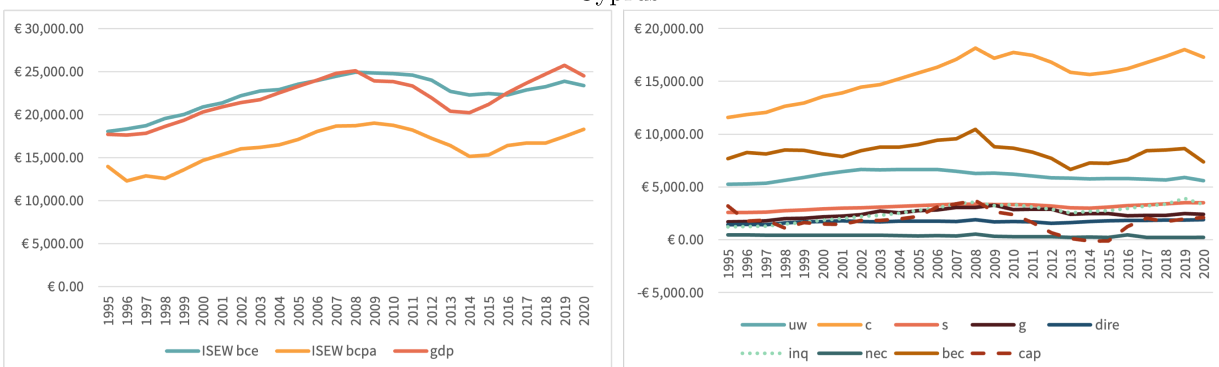
For the two periods, the value of individual consumption expenditures is mainly influenced by the changes in the actual individual consumption. Similarly, the value of unpaid work depends mainly on the values of the replacement wages in both periods. However, the main drivers of changes in broad ecological costs are different in the first period, where the costs of climate breakdown are most important, and the second period, where the costs of air pollution and of depleting non-renewable energy resources are the most important.

Figure 50: Evolution of the ISEWs and GDP (left) and evolution of the components (right) in group 2 countries.

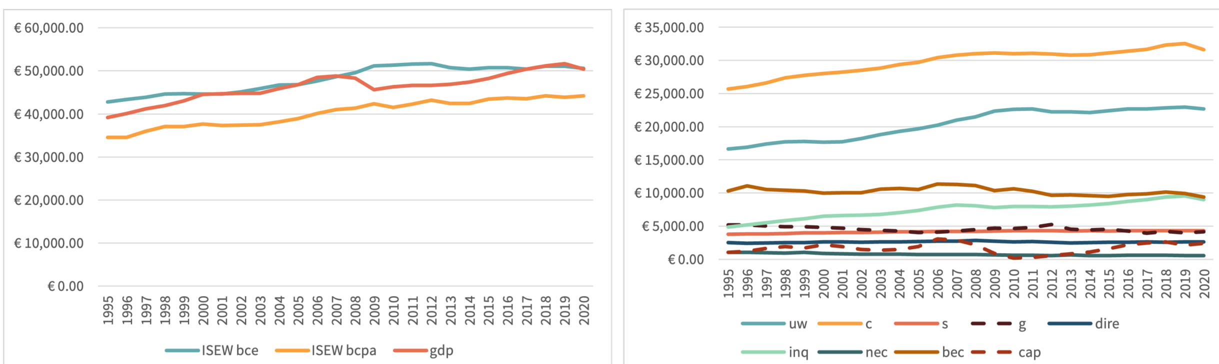
Croatia



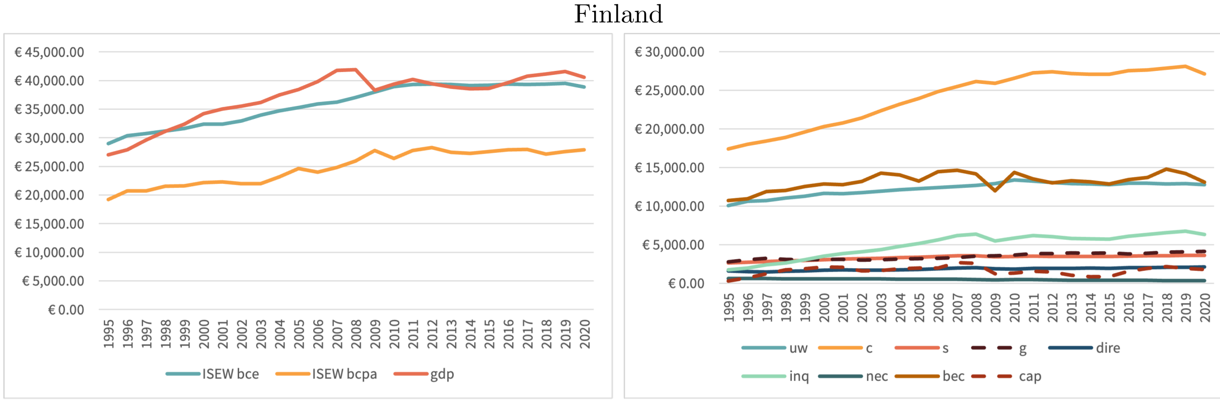
Cyprus



Denmark



Finland



Note: The prices are in million euros in 2015 prices. All three measures and components are in per capita terms.

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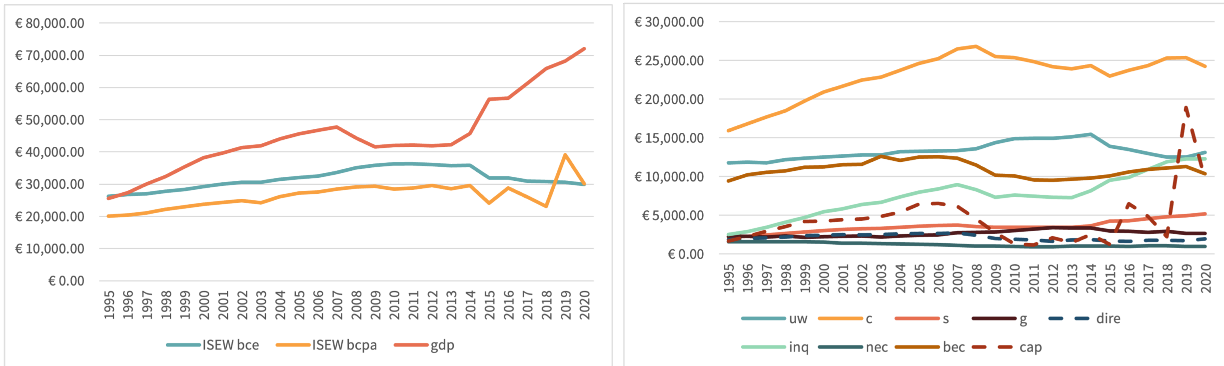
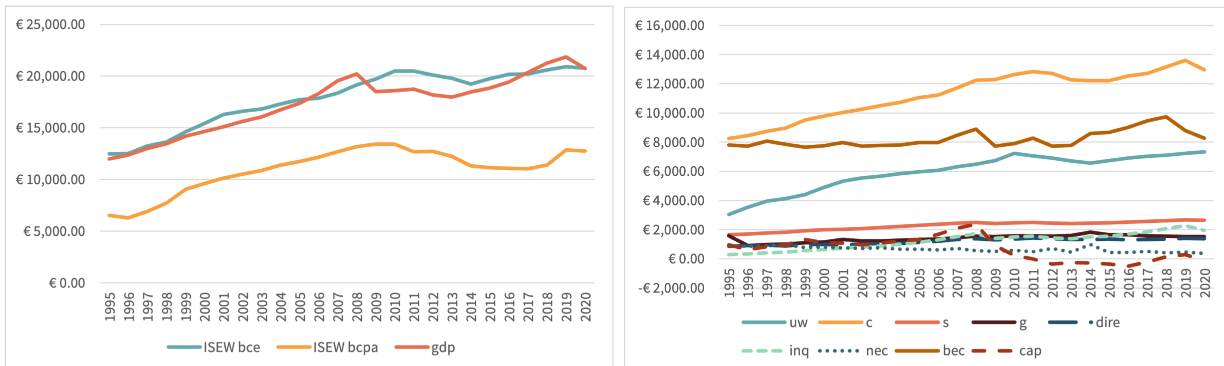
Figure 50: Evolution of the ISEWs and GDP (left) and evolution of the components (right) in group 2 countries (continued).

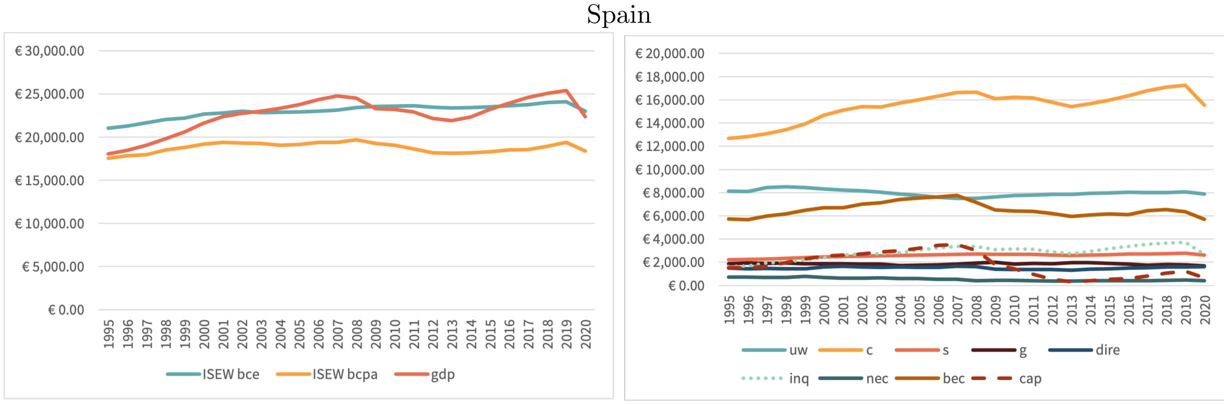
Ireland



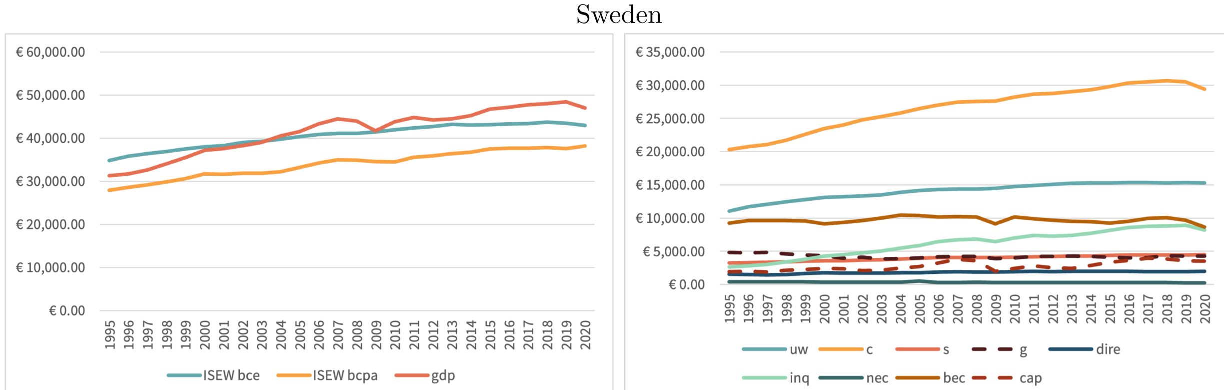
Slovenia



Spain



Sweden



Note: The prices are in million euros in 2015 prices. All three measures and components are in per capita terms.

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4.2.3 Group 3: Welfare stagnating in both subperiods

The third and last main group is the group that contains the 7 countries for which the welfare stagnated in both subperiods: Austria, Belgium, France, Germany, Luxembourg, the Netherlands, and Portugal. These are mainly Western European countries.

The total and yearly growth rates in the two subperiods and in the overall period for each country can be found in table 29. In this table, we indeed see that when looking at the subperiods, the total growth rates are between -10 and 10% for each country. Generally, the growth rate in the first subperiod, before the financial crisis, is higher than the growth rate in the second subperiod. When looking at the total growth rates for the overall period, we can see that indeed the growth rate of bcpa is stagnating for all countries because it is lower than 20%.

Table 29: Total growth and annual growth rates of bcpa in group 3

	1995-2008	**2008-2020**	**1995-2020**
Austria	3.31 (0.25)	-2.04 (-0.17)	1.20 (0.05)
Belgium	9.04 (0.67)	2.84 (0.23)	12.13 (0.46)
France	7.56 (0.56)	0.62 (0.05)	8.23 (0.32)
Germany	3.52 (0.27)	3.10 (0.25)	6.73 (0.26)
Luxembourg	8.02 (0.60)	7.76 (0.62)	16.40 (0.61)
The Netherlands	5.82 (0.44)	-0.52 (-0.04)	5.27 (0.21)
Portugal	7.41 (0.55)	3.98 (0.33)	11.69 (0.44)

Note: The growth rates between brackets are the yearly exponential growth rates.

As for the two previous groups, the evolution of the three measures as well as the evolution of the components in each country are presented in figure 51. In all countries, the bcpa is lower than the bce and gdp over the whole period with the gap between bcpa and bce being relatively stable over time while the gap between bcpa and gdp increases in most countries. In any case, the bcpa can indeed be seen to be stagnating in both subperiods, with some fluctuations over time.

In all countries, the value of the individual consumption expenditures is clearly the most important component for bcpa. The next two most important components in most countries are, as for the other groups, the value of unpaid work and the broad ecological costs. These two components have very comparable values over time. The only exception is Luxembourg, where broad ecological costs are higher than the value of unpaid work and the welfare losses from income inequality are the second most important component for most of the period, especially the second subperiod. In the other countries, the welfare losses from income inequality can be identified as being the fourth most important component, especially in the second subperiod.

In all countries, the individual consumption expenditures are increasing over the first subperiod. However, the broad ecological costs and/or the welfare losses from income inequality are also increasing during that period, while the value of unpaid work remains relatively stable. The increase in these two negative components counters the increase in the positive component, leading to the stable bcpa during that period. During the second subperiod, all components are relatively more stable, except the welfare losses from income inequality that are increasing in most countries, but not enough to lead to a decrease in the overall bcpa.

Between 1995 and 2008, the stagnation of bcpa in these countries can be explained by the fact that the trend of the components that are positively impacting bcpa and of the components that are negative impacting bcpa cancelled each other out. Indeed, the four main components (the value of unpaid work, the value of individual consumption expenditures, the value of the welfare losses from income inequality, and the value of the broad ecological costs) all increased during that subperiod. The only exception was for the value of unpaid work in France that decreased. Looking at each of these components, we can see whether these increases were caused by the same subcomponents or not. For the value of unpaid work, the increase in all the countries except the Netherlands and France was mainly due to an increase in the replacement wages. In the Netherlands, the value of unpaid work increased despite a decrease in the replacement wage because this decrease was offset by an increase in the number of hours spent on unpaid work. In France, the value of unpaid work decreased because of a decrease in the number of hours dedicated to unpaid work during that period. The increase in the value of individual consumption expenditures was mainly caused by an increase in actual individual consumption in all countries. Similarly, the increase in welfare losses from income inequality was caused by a combination of an increase in the inequality adjustment index and in net consumption in all countries. The increase in the inequality adjustment index indicates that the ratio of adjusted and unadjusted sum of income deciles decreased. Finally, the value of the broad ecological costs increased in all countries during that subperiod principally because there was an increase in the costs of climate breakdown.

Similarly, between 2008 and 2020, the growth rate of bcpa stagnated in all countries because the growth rates of the four main components or because these growth rates were not high enough to lead to a change in bcpa. It is still interesting the compare the changes in the components and subcomponents in the different countries for that subperiod, during which there were more divergences between the countries. The value of unpaid work increased in three countries (Austria, Luxembourg, and Portugal) and decreased in the four other countries (Belgium, France, Germany, and the Netherlands). The increases in the first countries were mainly due to increases in the replacement wages, while the decreases in the remaining countries had different causes. In Belgium, the value of unpaid work decreased because of a decrease in the replacement wage, in France and in Germany it decreased because of a reduction in the hours spent on unpaid work, and in the Netherlands, it was caused by both a reduction in the replacement wage and in the hours spent on unpaid work.

The individual consumption expenditures also evolved differently in the different countries. In most of the countries (Austria, France, Luxembourg, the Netherlands, and Portugal), the individual consumption expenditures decreased because of decreases in actual individual consumption. However, in Belgium and Germany, the individual consumption expenditures increased because of an increase in the actual individual consumption. There was also a different evolution between countries for the welfare losses from income inequality. In Austria, France, Luxembourg and Portugal, the welfare losses from income inequality decreased because of decreases in the inequality adjustment index and in net consumption, while in Belgium, Germany and the Netherlands, the welfare losses from income inequality increased for different reasons. In Belgium the increase in welfare losses from income inequality was mainly caused by an increase in net consumption, which more than offset a decrease in the inequality adjustment index. In Germany and the Netherlands, the increase in the welfare losses from income inequality mainly came from increases in the inequality adjustment index and in net consumption. Finally, the value of the broad ecological costs decreased in all countries, but because of decreases in different subcomponents. In Austria, Belgium, France and the Netherlands, the broad ecological costs decreased mainly due to decreases in the costs of air pollution. In Germany, the decrease in broad ecological costs was mainly led by a decrease in the costs of nuclear power use. In Luxembourg, a decrease in the ecosystem costs from nitrogen pollution was the main reason for the decrease in broad ecological costs. In Portugal, the decrease in broad ecological costs was primarily caused by a decrease in the costs of climate breakdown.

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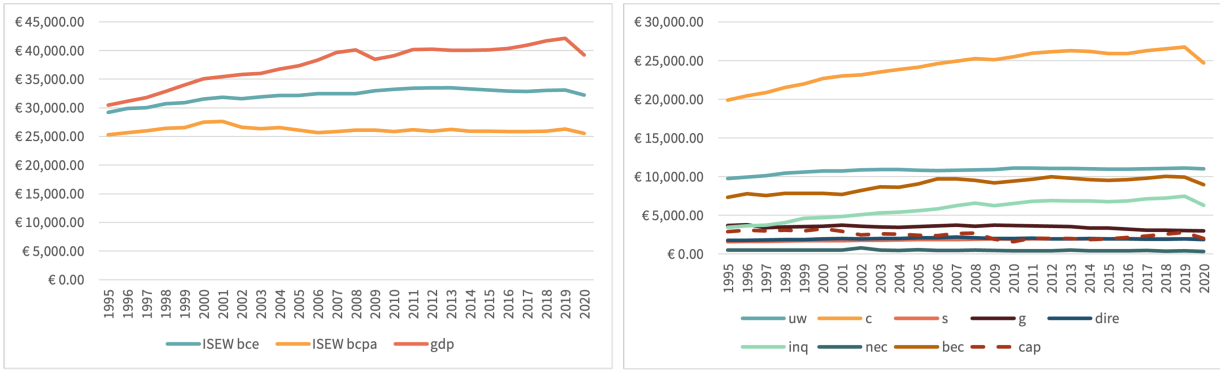
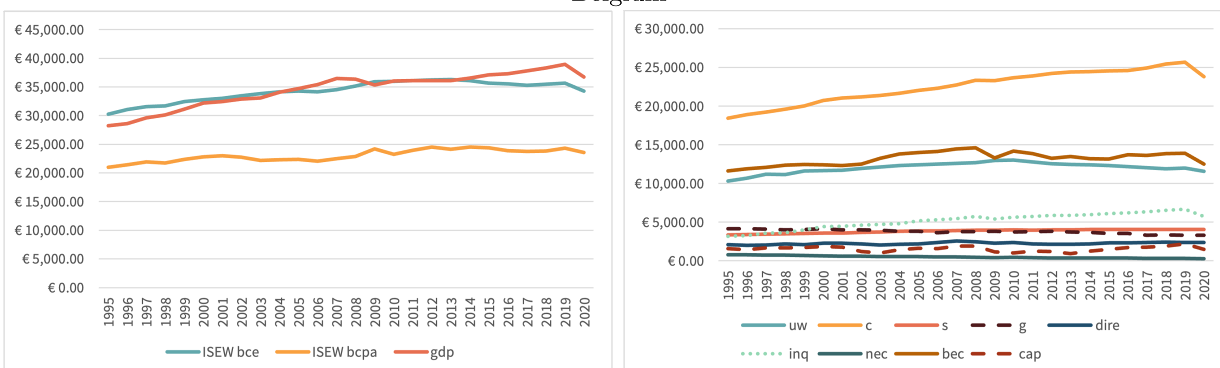
Figure 51: Evolution of the ISEWs and GDP (left) and evolution of the components (right) in group 3 countries.

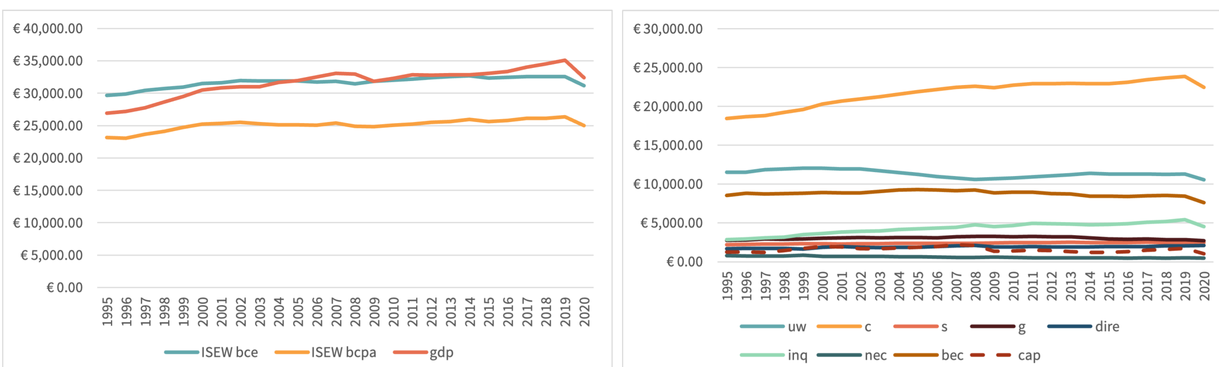
Austria



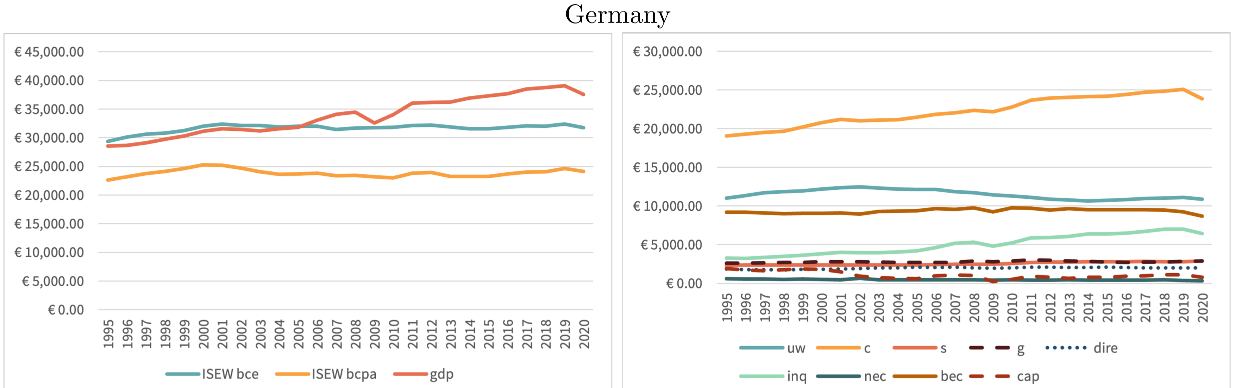
Belgium



France



Germany



Note: The prices are in million euros in 2015 prices. All three measures and components are in per capita terms.

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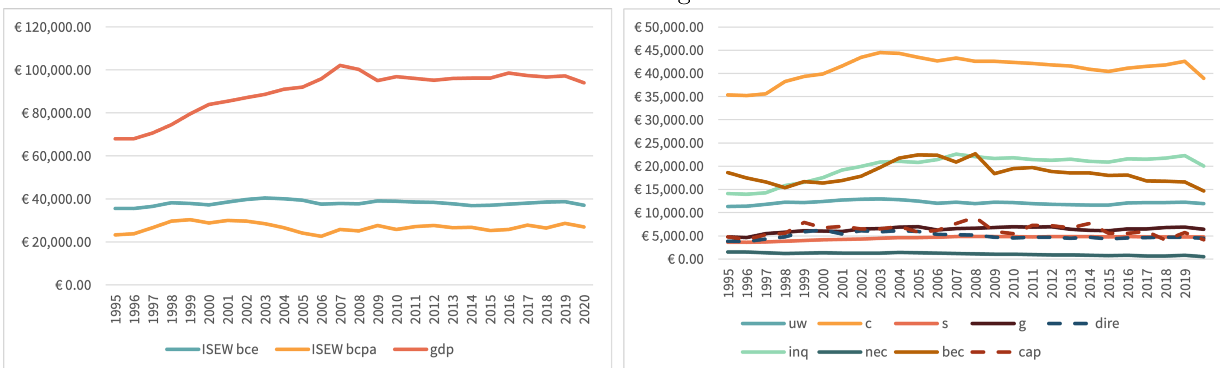
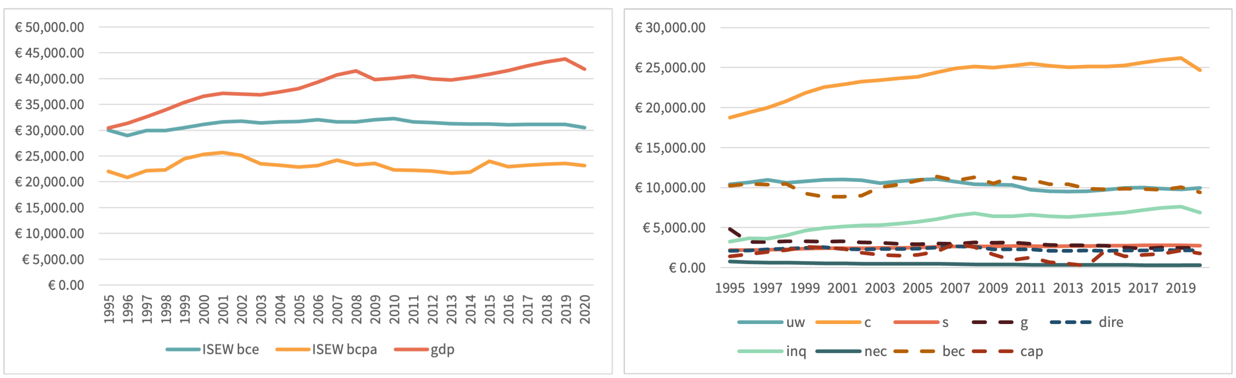
Figure 51: Evolution of the ISEWs and GDP (left) and evolution of the components (right) in group 3 countries (continued).

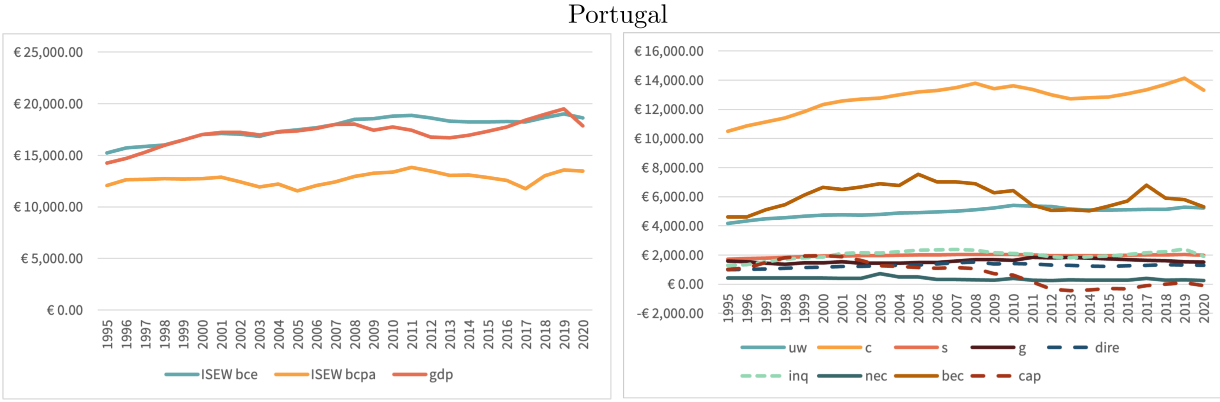
Luxembourg



Netherlands



Portugal



Note: The prices are in million euros in 2015 prices. All three measures and components are in per capita terms.

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4.2.4 Group 4: Welfare increasing between 1995 and 2008 but decreasing between 2008 and 2020

The first minor group is the group of countries for which welfare increased during the first subperiod but decreased during the second subperiod. In this group, we find 3 countries: Greece, Latvia and Malta.

Table 30 indeed shows that the growth rate during the first subperiod is higher than 10% in all countries. These positive growth rates, especially for Latvia and Greece, are even really high. In the second subperiod, bcpa indeed decreases by more than 10% for all countries, with Greece and Latvia again experiencing the biggest changes. The evolution of the bcpa over the whole period is different for the three countries. In Greece, the bcpa was stagnating over the whole period because the 9% growth rate is not high enough to be considered as an increase over this whole period. Similarly, in Malta, the bcpa was stagnating over the whole period because of the overall growth rate of around -5.6%. In Latvia, the increase in the first period is so important that over the whole period, the bcpa increased by around 146%, which is well above the 20% threshold.

Table 30: Total growth and annual growth rates of bcpa in group 4

	1995-2008	**2008-2020**	**1995-2020**
Greece	50.18 (3.18)	-27.40 (-2.63)	9.03 (0.35)
Latvia	220.26 (9.37)	-23.23 (-2.18)	145.86 (3.66)
Malta	12.03 (0.88)	-15.73 (-1.42)	-5.59 (-0.23)

Note: The growth rates between brackets are the annual growth rates.

Figure 52 presents the evolution of the ISEWs, gdp and components for the three countries in this group. Once again, bcpa is lower than bce and gdp for the whole period in all countries. The increase of bcpa in the first subperiod and its decrease in the second subperiod are visible for all countries, especially for Greece and Latvia. In the three countries, the same three components have the highest values: individual consumption expenditures, broad ecological costs, and the value of unpaid work. However, the importance and evolution of these components is different in the three countries, leading to the differences in growth rates.

In Greece, the most important component is clearly the individual consumption expenditures. Indeed, it is the component with the highest values over time and its evolution is almost identical to that of bcpa. The increase in the first period, followed by the decrease in the second period, as well as the overall increase are all clearly visible on the graph. The second and third most important components, the broad ecological costs and the value of unpaid work also influence the evolution of the bcpa but to a lower extent. It is possible to look deeper into the components impacting bcpa to understand better where its increase and decrease come from. First, looking at individual consumption expenditures, we see that it indeed increased a lot between 1995 and 2008 and then decreased, by a lower total growth rate, between 2008 and 2020. In both subperiods, the changes in individual consumption expenditures were mainly caused by an increase and a decrease in actual individual consumption. Then, looking at the value of unpaid work, we see that it also increased quite a lot between 1995 and 2008, while it decreased at a lower rate between 2008 and 2020. Again, in the two subperiods, the changes in the value of unpaid work were mainly due to the same subcomponent, namely the replacement wage used in valuing unpaid work. Thirdly, the broad ecological costs are also very important for value of bcpa and it can be seen that it evolved in the same direction as the two other components, by increasing between 1995 and 2008 and decreasing between 2008 and 2020, but this time the growth rate was higher in the second subperiod than in the first one. The fact that the broad ecological costs increased between 1995 and 2008 reduced a bit the rate of increase during that period, and inversely between 2008 and 2020. As for the two other components, the increase and decrease in the value of the broad ecological costs is due to the same subcomponent, namely an increase and a decrease in the costs of air pollution. Finally, even if it is not one of the main components of bcpa, the strong decrease in net investments between 2008 and 2020 also plays an important role in explaining the drop in bcpa during that subperiod.

In Latvia, the individual consumption expenditures are also the main component explaining the evolution

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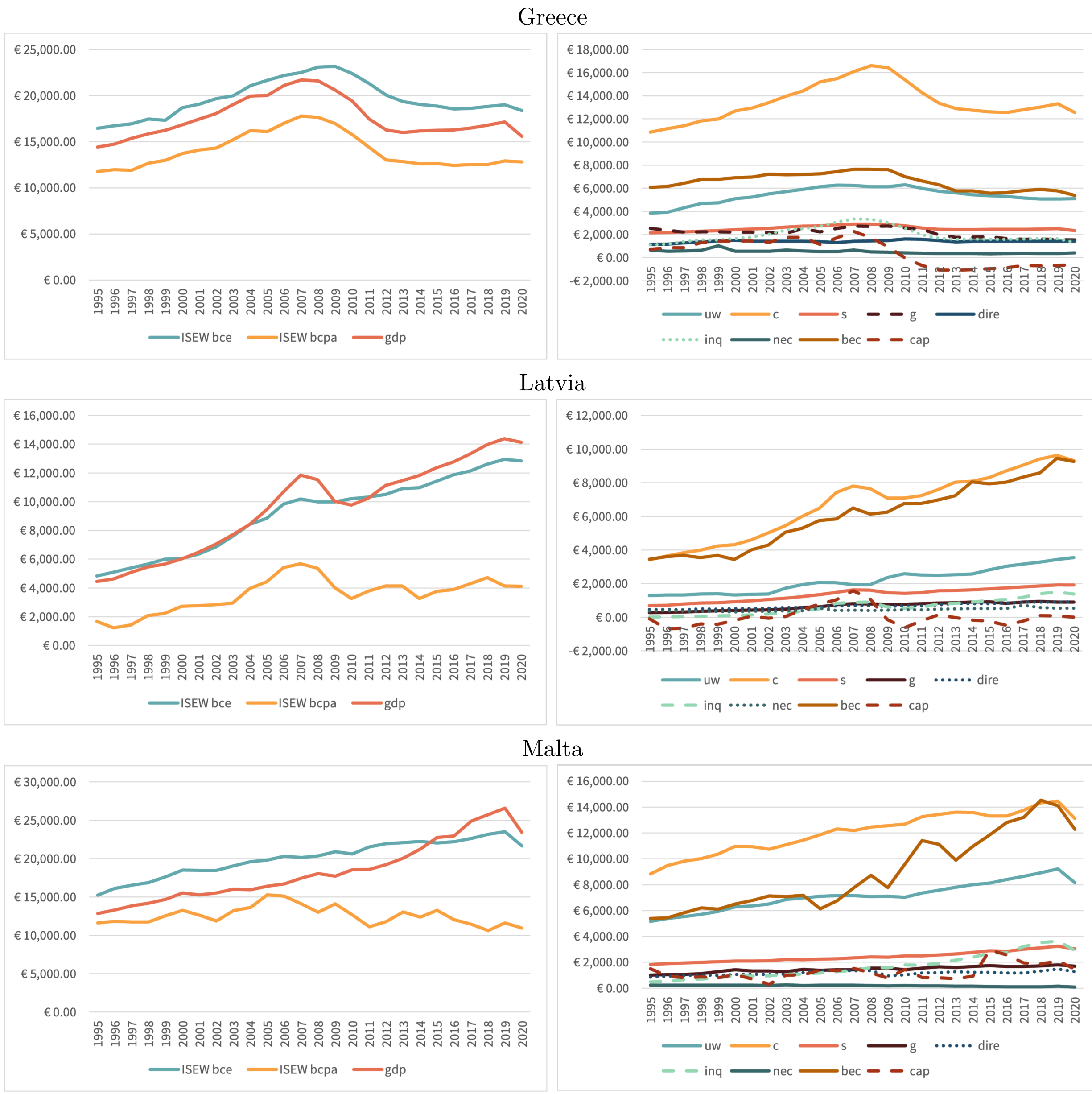
of bcpa because of the high values of the individual consumption expenditures and the similarity of the trends. However, bcpa is increasing less than the individual consumption expenditures because their increase is countered by an increase of the broad ecological costs. The value of unpaid work increased during the second subperiod, reinforcing the increase of positive components. Looking at those three components, we can see what was driving their changes in the two subperiods selected. Between 1995 and 2008, there were relatively big increases in individual consumption expenditures, the value of unpaid work, and the broad ecological costs. Additionally, we see that there was also an increase in net investments, which participated to the increase of bcpa. The increases in the three main components can be explained by looking at their subcomponents. The increase of individual consumption expenditures is mainly due to a strong increase in actual individual consumption. The increase in the value of unpaid work primarily comes from an increase in the replacement wage, and the increase in the broad ecological costs is principally caused by an important increase in the costs of climate breakdown. Between 2008 and 2020, the three main components continued to increase, the value of unpaid work even increased at a higher rate than in the previous subperiod while the two other components increased at lower rates than in the previous subperiod. These increases are linked to the same subcomponents as in the previous subperiod. However, in this subperiod, there was a really strong decrease in net investments, which mainly explains the decrease in bcpa during that subperiod.

In Malta, once again, the individual consumption expenditures play an important role in determining the size of bcpa. However, the trend in bcpa is not following the trend in individual consumption expenditures as well as for the other two countries because the broad ecological costs are also very important, especially during the second subperiod, leading to a decrease during that period. During the first period, the increase in both individual consumption and unpaid work were sufficient to counter the increase in broad ecological costs but not during the second subperiod. For the two subperiods, we see that the three main components (individual consumption expenditures, value of unpaid work, and broad ecological costs) all increased. Interestingly, the increase of these components was higher between 1995 and 2008 than between 2008 and 2020. The increase in the two components affecting bcpa positively (individual consumption expenditures and unpaid work) decreased more than the increase in broad ecological costs. As for the two other countries, the increase in the components were caused by the same subcomponents in the two subperiods. Indeed, individual consumption expenditures increased during the two subperiods because of an increase in actual individual consumption, while the value of unpaid work increased because of an increase in replacement wage and the value of the broad ecological costs increased because of strong increases in most of the subcomponents, especially in the costs of air pollution. In this case, there were no big changes in net investments, hence having only a small impact on bcpa.

Figure 52: Evolution of the ISEWs and GDP (left) and evolution of the components (right) in group 4 countries.



Note: The prices are in million euros in 2015 prices. All three measures and components are in per capita terms.

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4.2.5 Group 5: Welfare stagnating between 1995 and 2008 and decreasing between 2008 and 2020

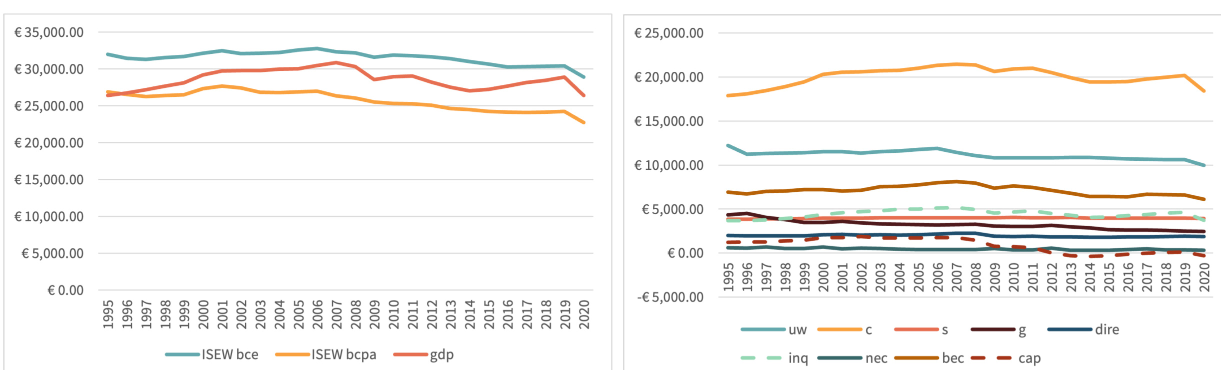
Lastly, the fifth group actually only contains one country: Italy. In Italy, as can be seen in table 31, welfare stagnated during the first subperiod and decreased during the second subperiod. However, when looking at the overall period, we see that welfare stagnated because the total growth rate is still within the 20% threshold, indicating that the decrease in the second subperiod was not strong enough to lead to an overall decrease.

Table 31: Total growth and annual growth rates of bcpa in group 5

	1995-2008	**2008-2020**	**1995-2020**
Italy	-3.05 (-0.24)	-12.75 (-1.13)	-15.41 (-0.67)

From figure 53, it can be seen that the bcpa is, as for all other countries, below the bce and gdp. From the graph showing the evolution of the measures, it can indeed be seen that bcpa is stagnating in the first subperiod and decreasing slightly during the second subperiod. Looking at the components, we see that none of them fluctuated a lot during the overall period. The three most important components are again individual consumption expenditures, the value of unpaid work and the broad ecological costs. The stagnation in the first subperiod is mainly caused by a small increase in the individual consumption expenditures and broad ecological costs, and stagnation of the value of unpaid work. The decrease in the second period is mainly caused by the small decrease in individual consumption expenditures and in the value of unpaid work. The small decrease in the broad ecological costs is not high enough to counter the decrease of the two positive components, which are more important. Again, looking at the growth rates of the components and their subcomponents allows to have a better idea of the driving forces during the two subperiods. First, the value of unpaid work decreased during the two subperiods because of decreases in the replacement wage. The rate of decrease was similar in the two subperiods. Second, the value of individual consumption expenditures increased between 1995 and 2008 but decreased between 2008 and 2020. In both cases, the changes in the value of the individual consumption expenditures were mainly caused by changes in the value of actual individual consumption. Third, the value of the broad ecological costs increased between 1995 and 2008 and decreased between 2008 and 2020. The increase in the first subperiod was primarily caused by an increase in the costs of climate breakdown, while the decrease in the second subperiod principally came from a decrease in the costs of air pollution. Between 2008 and 2020, the decrease in the components positively impacting bcpa was partially offset by the decrease in the broad ecological costs, which had a positive impact on bcpa. However, during that subperiod, there was also a strong decrease in net investments, which is an important change partly explaining the decrease in bcpa.

Figure 53: Evolution of the ISEWs and GDP (left) and evolution of the components (right) in group 5 country: Italy.



Note: The prices are in million euros in 2015 prices. All three measures and components are in per capita terms.

4.2.6 Comparison of the groups and generalisations

After analysing the different groups, we see that, even though bcpa evolved differently during the two selected subperiods in the different subgroups, the same components are often responsible for the changes in bcpa. Indeed, for all groups, and even all individual countries, we saw that the values of individual consumption expenditures and of unpaid work are the two components having a positive impact on the welfare measures with the highest values. The fact that they have the highest values also indicates that they are amongst the most important components for explaining the changes in the welfare measures.

Similarly, in all the groups and in almost all the individual countries, the component having a negative impact on bcpa that has the highest value and hence the highest impact on the values of bcpa is the value of the broad ecological costs. This generalisation is applicable to all the countries except to Ireland between 2018 and 2020 and for Luxembourg in some years and especially after 2009. Additionally, in the two groups having a decrease in bcpa between 2008 and 2020, we see that the changes in net investments also play an important role. Another component that has an important impact on the values of the welfare measures in all the countries is the value of the welfare losses from income inequality. This impact becomes especially important towards the end of the period studied because in all the individual countries, the value of the welfare losses from income inequality is increasing over time.

The components found to be the most important in driving changes in bcpa also often evolved in the same direction between 1995 and 2008 by increasing for all groups. However, the magnitude of the change differs between the countries, leading to the different groups. In any case, most of the time, the changes in the components are caused by the same subcomponents in the different groups. The value of individual consumption expenditures is mainly impacted by changes in actual individual consumption, the value of unpaid work is primarily impacted by changes in replacement wages, and the value of the broad ecological costs is principally influenced by the costs of climate breakdown and the costs of air pollution.

Between 2008 and 2020, the evolution of the components diverged more than in the first subperiod, but most of the time, the changes in the components were still led by the same subcomponents. Individual consumption expenditures continued to increase only in groups 1 and 2, while it decreased in groups 3 to 5. Still, the changes in the value of this component were caused by changes in actual individual consumption in all groups. The value of unpaid work also continued to increase for group 1 and for some countries of group 3, but decreased for the rest of the countries. Again, in most cases, the changes in the value of unpaid work were caused by changes in replacement wages. The value of the broad ecological costs decreased in all groups except group 1 where they increased for some countries also during that subperiod. As for the increase in the first period, the changes in the broad ecological costs were mainly driven by changes in the costs of air pollution and costs of climate breakdown. Leaving group 1 apart, since the different components evolved in a similar direction in the different groups, what makes the difference in the evolution of bcpa is mainly the intensity of those changes. Additionally, for the two groups showing a decrease in bcpa between 2008 and 2020, we found that big decreases in net investments played an important role.

The results presented in appendix A also allow to draw some general comments about the difference between bce and bcpa and about the impact of economic crises on gdp and the welfare measures. First, regarding the difference between bce and bcpa, we already saw that in some countries, the changes in net investments play an important role in the changes of bcpa but the components that influence the most the values of bce and bcpa are the values of the narrow and broad ecological costs, respectively. We saw in the analysis of the groups above that the value of the broad ecological costs is the component impacting bcpa negatively that has the highest value in a vast majority of the countries. Following from this conclusion, it can hence be said that in all the individual EU countries, the value of the narrow ecological costs is always lower than the value of the broad ecological costs, leading the values of bce to always be higher than the value of bcpa (except in Ireland in 2019 because of a peak in net investments, but this is an exception).[31] In some cases, the values of bce are much higher than the values of bcpa because the values of the narrow ecological costs are a lot lower than the values of the broad ecological costs. The (high) differences between the values of the narrow and the broad ecological costs lead to the impossibility of comparing the growth rates of the two components because these growth rates are influenced by the absolute values of the components, being relatively higher when the components have lower absolute values.

Secondly, some general comments can be made about the impact of the two economic crises that took

[31] These results can also be seen in the summary table presented in appendix B.

place during the period studied. The first economic crisis is the financial crisis and is represented by the subperiod between 2008 and 2011 and the second economic crisis is the COVID-19 crisis, which is represented by the subperiod between 2019 and 2020 in this research. The COVID-19 crisis (2019-2020) is discussed first because it is the one for which the generalisation is most important. During that economic crisis, in 24 of the 27 EU countries, the two welfare measures outperformed gdp by decreasing less or sometimes even increasing during that period. Most of the time, the lower decreases or increases in the welfare measures were principally due to (strong) decreases in both the narrow and the broad ecological costs and/or in the welfare losses from income inequality.[32] For 3 countries (Czechia, Ireland, Luxembourg), this generalisation does not hold. For Czechia, the generalisation only holds for bce, but not for bcpa because bcpa decreased more than gdp in that subperiod. For Ireland, the generalisation does not hold because the two welfare measures decreased during that period even though gdp increased. For Luxembourg, the generalisation does not hold either because the two welfare measures decreased more than gdp during that period. The details of the reasons why the generalisation does or does not hold for specific countries can be found in appendix A.

It is more complicated to draw general conclusions for the financial crisis because there is a lot more disparity between the countries. For 18 out of the 27 EU countries, the welfare measures outperformed gdp by decreasing less or increasing during that period. For 8 out of the 27 EU countries[33], bce outperformed gdp because it decreased less or increased during that period, but bcpa in these 8 countries did not outperform gdp because gdp either decreased less or increased more than bcpa. For Germany, gdp outperformed the two welfare measures by increasing more than them. The details regarding the reasons why the welfare meaures outperformed gdp or not during the financial crisis are presented in appendix A. In conclusion, for the two economic crises included in this study period, it can be said that most of the time, the economic crisis does not necessarily translate into lower welfare. However, it is important to keep in mind that this conclusion is more aligned with the results for the COVID-19 crisis (2019-2020) than for the financial crisis (2008-2011).

All these results and generalisations are impacted by the methodology used when compiling the indexes and the availability of data. Section 6 presents some limitations of our methodology and outlines avenues for further methodological improvements to the ISEWs. The limitations should be kept in mind when interpreting the results presented in this report.

4.3 The threshold hypothesis in the EU27

The ISEWs can also be used to test the threshold hypothesis suggested by Max-Neef (1995) presented before. As a reminder, Max-Neef (1995, p. 177) states that "for every society there seems to be a period in which economic growth (as conventionally measured) brings about an improvement in the quality of life, but only up to a point - the threshold point - beyond which, if there is more economic growth, quality of life may begin to deteriorate". This hypothesis can be tested in different ways. We do so by looking at the value of the welfare measures in 2020 and comparing that value to the 'peak value' of the measures for the different EU countries and the EU27. We assume that if the 2020 value is more than 5% lower than the 'peak value' in the period studied, the threshold hypothesis can be confirmed.[34] If the 2020 value is less than 5% lower, we conclude that there is not enough evidence to talk about a 'peak' that has been surpassed.

Table 32 shows the results when looking at $ISEW_{bce}$ and shows that the 'peak year' happened in different years in the different countries, but for around half of the EU countries, this 'peak year' happened in 2019. Similarly, there is also quite a lot of diversity in the percentage difference between the 2020 value and the 'peak year' value of the $ISEW_{bce}$. For some countries, this difference is even equal to 0 because the 'peak' in the $ISEW_{bce}$ value only happened in 2020. Based on the numbers shown in table 32 and the selected 5% threshold, we see that the threshold hypothesis can be confirmed for several countries when looking at the $ISEW_{bce}$: Greece, Ireland, Italy, Luxembourg, Malta, Cyprus, Belgium, and the Netherlands.

When looking at the results of $ISEW_{bcpa}$, table 33 shows that there is also quite a lot of diversity in the moment when the $ISEW_{bcpa}$ reached a 'peak', with more countries experiencing this 'peak' in 2020 than for the $ISEW_{bce}$. Similarly, the percentage difference between the 'peak' value and the 2020 value is quite

[32] The broad ecological costs and the welfare losses from income inequality always decreased during that period, but the narrow ecological costs sometimes did not decrease. The details can be found in appendix A.

[33] Bulgaria, Croatia, Estonia, Hungary, Latvia, Malta, the Netherlands, Sweden

[34] Threshold chosen by the authors.

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different among the countries. The hypothesis based on the chosen 5% threshold can be confirmed for a larger number of countries when looking at the $ISEW_{bcpa}$ than when looking at the $ISEW_{bce}$. Indeed, as shown in table 33, it can be confirmed for Malta, Greece, Latvia, Ireland, Italy, Luxembourg, the Netherlands, Austria, Czechia, Croatia, Spain, Slovenia, and France. This result shows that for more than half of the countries for which the 'peak year' happened before 2020, the difference between the value of the $ISEW_{bcpa}$ in 2020 and in the 'peak year' is high enough to confirm the threshold hypothesis, when looking at a 5% threshold.

In sum, we find that the data collected in this dataset can confirm Max-Neef's threshold hypothesis for several of the EU countries, especially when looking at the $ISEW_{bcpa}$ that takes into account the cost and benefits in the future and abroad. However, the ISEW results for the EU27 suggest that welfare may not have peaked yet. Indeed, for the EU27, the results of the $ISEW_{bce}$ show that the welfare measure peaked in 2019 and was only 3.05% higher than the 2020 value. Similarly, in the EU27, the $ISEW_{bcpa}$ also peaked in 2019, with a value only 3.54% higher than that of 2020. Since none of the 'peak values' of the welfare measures analysed in this study is higher than the 2020 values of the welfare measures for the EU27, the hypothesis cannot be confirmed for the EU27.

Table 32: Test of the threshold hypothesis for $ISEW_{bce}$ in the EU27.

Country	$ISEW_{bce}$ **in 2020**	**Peak year**	**Peak value of ISEW**	**% difference between the ISEW value in 2020 and in the peak year**
Greece	€ 18,375.28	2009	€ 23,190.02	-20.76%
Ireland	€ 29,923.86	2011	€ 36,250.83	-17.45%
Italy	€ 28,881.73	2006	€ 32,777.53	-11.89%
Luxembourg	€ 37,058.54	2003	€ 40,427.33	-8.33%
Malta	€ 21,682.21	2019	€ 23,500.55	-7.74%
Cyprus	€ 23,352.26	2008	€ 24,908.49	-6.25%
Belgium	€ 34,264.74	2013	€ 36,284.96	-5.57%
Netherlands	€ 30,518.01	2010	€ 32,270.49	-5.43%
France	€ 31,139.51	2014	€ 32,684.56	-4.73%
Spain	€ 23,008.53	2019	€ 24,102.04	-4.54%
Croatia	€ 13,239.77	2019	€ 13,850.64	-4.41%
Austria	€ 32,197.91	2013	€ 33,515.84	-3.93%
EU-27	**€ 25,823.79**	**2019**	**€ 26,635.20**	**-3.05%**
Romania	€ 9,707.76	2019	€ 9,977.81	-2.71%
Czechia	€ 13,770.31	2019	€ 14,152.29	-2.70%
Denmark	€ 50,545.05	2012	€ 51,718.73	-2.27%
Portugal	€ 18,600.23	2019	€ 18,991.85	-2.06%
Germany	€ 31,720.91	2019	€ 32,355.57	-1.96%
Sweden	€ 42,994.44	2018	€ 43,737.18	-1.70%
Bulgaria	€ 6,555.97	2019	€ 6,666.80	-1.66%
Finland	€ 27,892.00	2019	€ 28,282.21	-1.38%
Hungary	€ 12,143.81	2019	€ 12,286.95	-1.16%
Latvia	€ 12,826.17	2019	€ 12,947.05	-0.93%
Slovenia	€ 20,752.45	2019	€ 20,889.99	-0.66%
Poland	€ 12,759.20	2019	€ 12,810.08	-0.40%
Estonia	€ 15,390.64	2020	€ 15,390.64	0.00%
Lithuania	€ 13,135.63	2020	€ 13,135.63	0.00%
Slovakia	€ 15,659.65	2020	€ 15,659.65	0.00%

Note: The thick line indicates the 5% threshold value selected in this study to determine whether the threshold hypothesis can be confirmed or not.

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Table 33: Test of the threshold hypothesis for $ISEW_{bcpa}$ in the EU27.

Country	$ISEW_{bcpa}$ **in 2020**	**Peak year**	**Peak value of ISEW**	**% difference between the ISEW value in 2020 and in the peak year**
Malta	€ 10,957.52	2005	€ 15,265.84	-28.22%
Greece	€ 12,812.54	2007	€ 17,771.06	-27.90%
Latvia	€ 4,116.27	2007	€ 5,692.49	-27.69%
Ireland	€ 30,158.01	2019	€ 39,090.23	-22.85%
Italy	€ 22,739.64	2001	€ 27,669.84	-17.82%
Luxembourg	€ 27,071.00	1999	€ 30,387.08	-10.91%
Netherlands	€ 23,147.92	2001	€ 25,669.38	-9.82%
Austria	€ 25,568.98	2001	€ 27,615.31	-7.41%
Czechia	€ 5,084.80	2019	€ 5,488.09	-7.35%
Croatia	€ 8,669.23	2008	€ 9,286.71	-6.65%
Spain	€ 18,400.04	2008	€ 19,681.96	-6.51%
Slovenia	€ 12,742.34	2009	€ 13,429.37	-5.12%
France	€ 25,028.42	2019	€ 26,375.93	-5.11%
Germany	€ 24,155.42	2000	€ 25,254.59	-4.35%
Belgium	€ 23,540.54	2014	€ 24,543.08	-4.08%
Cyprus	€ 18,289.34	2009	€ 19,006.65	-3.77%
EU-27	**€ 19,604.54**	**2019**	**€ 20,323.24**	**-3.54%**
Hungary	€ 7,332.03	2019	€ 7,548.23	-2.86%
Portugal	€ 13,461.97	2011	€ 13,835.27	-2.70%
Finland	€ 27,892.00	2012	€ 28,282.21	-1.38%
Denmark	€ 44,162.00	2018	€ 44,175.99	-0.03%
Bulgaria	€ 1,794.26	2020	€ 1,794.26	0.00%
Estonia	€ 7,624.92	2020	€ 7,624.92	0.00%
Lithuania	€ 8,155.91	2020	€ 8,155.91	0.00%
Poland	€ 6,649.37	2020	€ 6,649.37	0.00%
Romania	€ 6,781.14	2020	€ 6,781.14	0.00%
Slovakia	€ 9,536.90	2020	€ 9,536.90	0.00%
Sweden	€ 38,181.51	2020	€ 38,181.51	0.00%

Note: The thick line indicates the 5% threshold value selected in this study to determine whether the threshold hypothesis can be confirmed or not.

5 ISEWs in the UK, the US and South Africa

5.1 Data for non-EU countries

This section presents the details about the data used for compiling the two welfare measures for the United Kingdom (UK), the United States (US) and South Africa. For the UK and the US, all the data needed, except costs of extreme weather events included in the narrow ecological costs was collected for the UK and the US. For South Africa, some data could be collected, but there is a lot of important data missing, rendering the computation of the ISEWs impossible.

The methodology is not repeated here because it is the same as the one used for EU countries, presented in the methodology part for each component in section 3.3. This section presents the data sources and data 'manipulations' made during the data collection as well as the data illustration (showing the data in total values for UK and US each time). For each component, the case of South Africa is discussed, indicating whether data was found for this component or not, and if some data was found, it is added in the illustration as well.

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General variables

The general variables are the same as for the EU countries: GDP deflators, total population, GDP at market prices, GDP in million euros in 2015 prices, and the exchange rates.

The data for the GDP deflators was collected from AMECO (2023b) for the period 1960-2025 for the UK and the US. For South Africa, the data was collected from The World Bank (2023). The data for the total yearly population is collected from OECD (2023d) for all three countries. It should be noted that this data represents the mid-year estimates of population, while the data used for the EU countries referred to the estimates on January 1st. This difference should be kept in mind when comparing the results. The data for GDP at market prices between 1987 and 2022 for the UK is collected from the Office for National Statistics (2024) database. For the US, the data for GDP at market prices for the years 1987-2022 comes from the BEA (2024). For South Africa, the GDP data at market prices is collected from the OECD (2024e). The exchange rates data in terms of national currency per euro are collected from AMECO (2023c) for the UK and the US. For South Africa, the data for the exchange rate of ZAR per US$ is collected from the The World Bank (2024). This exchange rate is converted to a ZAR/€ exchange rate by multiplying the inverse of the exchange rate between the ZAR and the US$ by the inverse of the exchange rate of the US$ per euro, obtaining an exchange rate of ZAR per euro. Using the data for GDP at market prices, GDP deflators, and exchange rates, the data for the GDP of countries in euros in 2015 prices is calculated following the same steps as for the EU countries.

The data transformations presented for the EU countries to convert the values to euros in 2015 prices are also applied to the non-EU data to get the values of the variables in euros and in 2015 prices.

5.1.1 Unpaid work

Data

The data for unpaid work consists of data for the time spent by people on unpaid work, the population aged between 15 to 74 years old, and the replacement wage. All the necessary data was found for the three countries, but some might not be fully comparable to the EU data.

Time use

As for the EU countries, data for time spent on unpaid work is collected from different sources. For the UK, some data can be collected from Eurostat (2023h). This data is complemented by data collected from Gershuny et al. (2020) which has been 'rescaled' in the same way as for the EU countries to ensure a better comparability with the data from Eurostat (2023h). For the US, one data point was collected from OECD (2023e) and many others were collected from Gershuny et al. (2020). Again, the MTUS data was adjusted to ensure comparability with the OECD data. For South Africa, only one data point was found, collected from the OECD (2023e). For all countries, the missing data in between two available data points was linearly interpolated while the missing data before/after the earliest/latest collected data point was extrapolated using memory items.

Population 15-74 years old

The data for the population in the age bracket 15-74 is collected from the OECD (2023d) for all countries. In order to get the total number of people aged 15 to 74 years old, the number of people in the categories 15-64, 65-69, and 70-74 were added up.

Replacement wage

The data for the replacement wage is collected differently for each country. For the UK, the same data collection as for the EU countries is used. Data for the mean earnings of the services and sales workers in the business economy is collected from Eurostat (2023g) for the years 2002, 2006, 2010, 2014 and 2018 because it comes from a survey taking place every 4 years from 2002 onwards. The data in between these data points is interpolated linearly. For the years before 2002 and after 2018, the mean earnings are extrapolated using the trend in the annual wages collected from the OECD (2023c). For the US, the data for the replacement

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wage is collected from FRED (2024) for the years 2006 to 2020. The monthly data is collected and the average of these data points is taken to get the annual data. The early data is extrapolated using the trend in the average annual wages collected from OECD (2023c). The data collected from FRED is the average hourly earnings of all employees in the private service-providing sector. It is important to acknowledge that this data is not directly comparable to the mean earnings for services and sales workers collected for the EU countries and the UK, but that it is a close substitute. For South Africa, the ILO (2024) presents data for the average hourly earning of employees for the service and sales workers, which is similar to the data collected for the EU and UK. This data is available for the years 2001 to 2007, 2018 and 2019. The data for the years 1995-2000 and 2020 are extrapolated using memory items because the data for the average annual wages could not be found.

Illustration

Tables 34, 35 and 36 present the data used to calculate the value of unpaid work in the different countries, the selected years are based on the availability of the time use data. It is clear that the data availability varies greatly between countries. It is interesting to see the different values and their evolution in the different countries.

Table 34: Population 15-74, time spent on unpaid work, replacement wage and total value of unpaid work in the UK, selected years.

Year	Population 15-74	Unpaid work time (minutes/day)	Replacement wage (€/hour)	Value of unpaid work (million €, 2015)
1995	42,673,486	193	9.23	463856.27
2000	43,314,611	200	10.67	562515.93
2001	43,580,979	200	11.05	585743.46
2005	44,935,164	182	11.0	547450.90
2014	47,977,814	181	1.79	623068.84
2015	48,307,830	181	12.26	651877.19

Notes: The replacement wage is expressed in constant 2015 prices and the total value of unpaid work is calculated by multiplying population by (time/60)*365 by the replacement wage.

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Table 35: Population 15-74, time spent on unpaid work, replacement wage and total value of unpaid work in the US, selected years.

Year	Population 15-74	Unpaid work time (minutes/day)	Replacement wage (€/hour)	Value of unpaid work (million €, 2015)
1995	193,103,452	189	17.32	3841895.43
2003	212,116,669	208	20.43	5471093.39
2004	214,617,710	208	20.76	5627102.39
2005	217,229,452	208	20.73	5686853.67
2006	219,902,123	204	20.99	5736315.38
2007	222,422,608	201	21.05	5726660.89
2008	224,914,640	198	21.29	5763107.62
2009	227,293,872	198	21.73	5944596.48
2010	229,502,902	195	21.92	5954426.74
2011	231,542,439	193	21.93	5960504.14
2012	233,611,256	193	21.98	6025306.20
2013	235,534,335	193	22.02	6086050.75
2014	237,501,926	194	22.03	6167768.17
2015	239,541,204	198	22.29	6425181.11
2016	241,435,109	197	22.61	6541585.33
2017	242,961,945	196	22.73	6591789.73
2018	244,049,273	193	22.93	6567050.75
2019	245,151,417	219	23.33	7618349.08

Notes: The replacement wage is expressed in constant 2015 prices and the total value of unpaid work is calculated by multiplying population by (time/60)*365 by the replacement wage.

Table 36: Population 15-74, time spent on unpaid work, replacement wage and total value of unpaid work in South Africa, selected years.

Year	Population 15-74	Unpaid work time (minutes/day)	Replacement wage (€/hour)	Value of unpaid work (million €, 2015)
1995	35,106,212	182	1.35	52616.82

Notes: The replacement wage is expressed in constant 2015 prices and the total value of unpaid work is calculated by multiplying population by (time/60)*365 by the replacement wage.

5.1.2 Individual consumption expenditures

Data

The individual consumption expenditure is based on data for the actual individual consumption (AIC) and the expenditures on consumer durables, which is used also to calculate the services from consumer durables.

Actual individual consumption

For the three countries, the data for the AIC is collected from OECD (2024h). This data is available for the years 1995 to 2020 and collected in percentage of GDP. To obtain the value of AIC in million euros in 2015 prices, the AIC data in percentage of GDP was multiplied by the GDP in million euros in 2015 prices for the different years and countries.

Expenses and services of consumer durables

The data for the expenditures on consumer durables is also collected from OECD (2024i), in million units of national currency and transformed into million euros in 2015 prices using the GDP deflators and exchange rates. The data for the services of consumer durables is based on the expenditures on the consumer durables. As for the EU countries, consumer durables are expected to last for 8 years, the total stock of consumer

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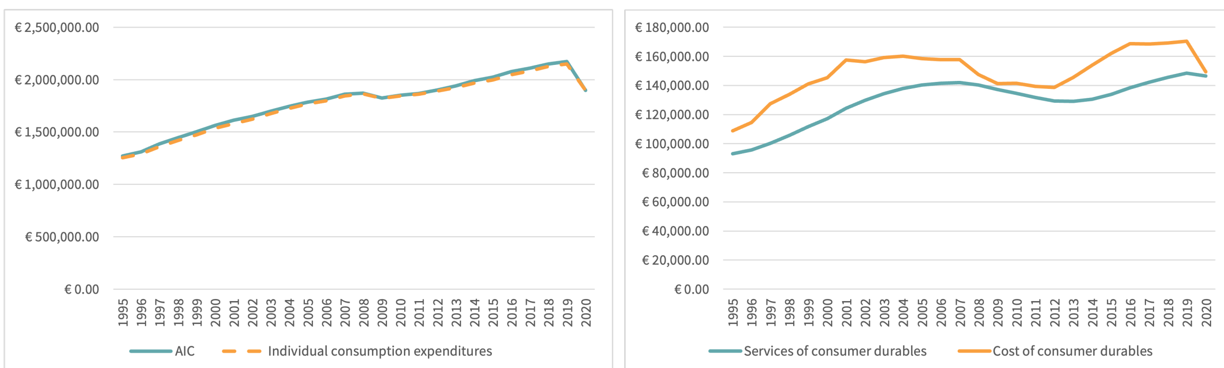
durables is hence equal to the sum of the depreciated expenditures on consumer durables of the previous seven years in addition to the expenditure of the current year. The services of consumer durables are then calculated by multiplying this total stock by 0.2. Calculating the services of consumer durables for 1995 hence requires to have data about expenditures on consumer durables from 1987 onwards. This data is readily available from OECD (2024i) for the US. For the UK, the data between 1987 and 1994 had to be extrapolated using the trend in the country's GDP. The same technique was used to extrapolate the missing data for South Africa, for the years 1987 to 1992.

Illustration

Figures 54, 55 and 56 present the evolution of the total individual expenditures, of the AIC and of the costs and services of consumer durables. As for the EU countries, the AIC and total individual expenditures are very close to each other, showing that the correction for consumer durables has a very small impact on the total individual consumption expenditures.

Figure 54: Evolution of the AIC and the individual consumption expenditures (panel A) and evolution of the costs and services from consumer durables (panel B) in the UK.

Panel A Panel B



Note: The values presented are the total value (not in per capita terms) and measured in million euros in 2015 prices.

Figure 55: Evolution of the AIC and the individual consumption expenditures (panel A) and evolution of the costs and services from consumer durables (panel B) in the US.

Panel A Panel B

Note: The values presented are the total value (not in per capita terms) and measured in million euros in 2015 prices.

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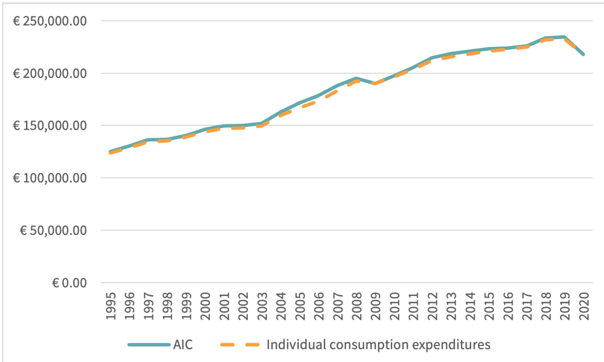
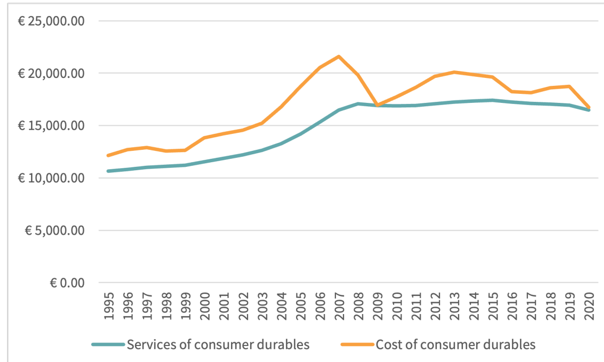
Figure 56: Evolution of the AIC and the individual consumption expenditures (panel A) and evolution of the costs and services from consumer durables (panel B) in South Africa.

Panel A



Panel B



Note: The values presented are the total value (not in per capita terms) and measured in million euros in 2015 prices.

5.1.3 Shadow economy

Data

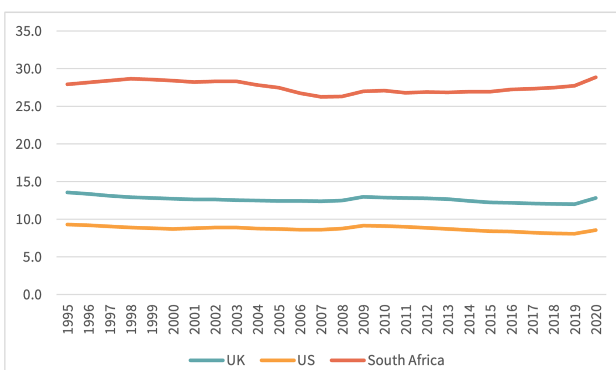
As for the EU countries, the total value of the shadow economy is calculated by multiplying the size of the shadow economy as a percentage of GDP by the GDP in that year.

The data for the size of the shadow economy in percentage economy comes from Elgin et al. (2021) for the three countries, the same source as for the EU countries. The data of the GDP in million euros in 2015 prices is used to directly calculate the total value of the shadow economy in million euros in 2015 prices.

Illustration

Figure 57 shows the evolution of the size of the shadow economy in the different countries. South Africa has the biggest size of shadow economy has a percentage of its GDP, which does not mean that it has the highest value because it certainly has a lower GDP than the two other countries. In the UK and the US, the size of the shadow economy slightly decreases over time while it slightly increases for South Africa.

Figure 57: Evolution of the size of the shadow economy (as % of GDP) in different countries.



Note: The size of shadow economy for each country is measured in percentage of that country's GDP.

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5.1.4 Non-defensive collective government consumption

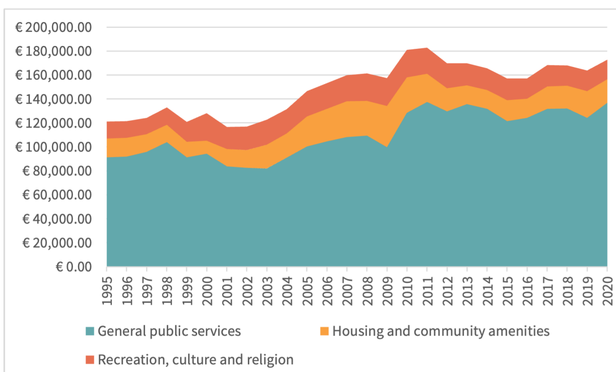
Data

To calculate the total value of the non-defensive government consumption, data about the spending on the general public services, housing and community amenities and recreation, culture and religion are needed. For the UK and the US, the data for the three types of spending is collected from OECD (2024f). For South Africa, the data for the three types of spending is collected from publications by Central Statistical Service (1997, 1998) and Statistics South Africa (1999, 2001, 2002, 2003a,b, 2004a,b, 2005, 2006, 2007, 2008, 2009, 2010, 2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018, 2019, 2020, 2021). The publications are presenting the "consolidated expenditure by the general government sector" (Statistics South Africa, 1999, 2001, 2002, 2003a,b, 2004a,b, 2005, 2006, 2007, 2008, 2009, 2010, 2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018, 2019, 2020, 2021). These publications present data about government expenditures during a given fiscal year that is spread over two calendar years, the latest year is used to determine in which year the spending was made. For example, the data from the publication 2003/2004 is used for 2004 in our data. For all countries, data is available for all years.

Illustration

Figures 58, 59 and 60 show the evolution of the overall value of the total non-defensive government consumption as well as the importance of the different types of spending. In the three countries, the spending on general public services is the most important for the whole period. In the UK, the spending on housing and community amenities and the spending on recreation, culture and religion have a similar weight while in the US and South Africa, the former has a higher weight than the later over the whole period.

Figure 58: Evolution of the non-defensive government expenditures in the UK.



Note: The expenditures are valued in million euros in 2015 prices.

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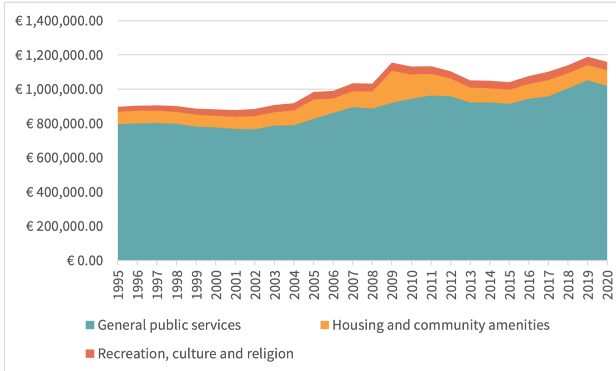
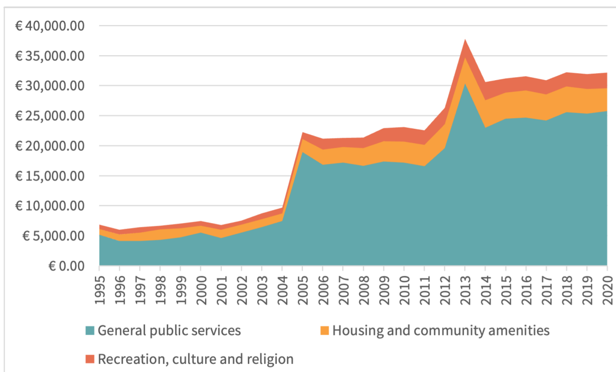
Figure 59: Evolution of the non-defensive government expenditures in the US.



Note: The expenditures are valued in million euros in 2015 prices.

Figure 60: Evolution of the non-defensive government expenditures in South Africa.



Note: The expenditures are valued in million euros in 2015 prices.

5.1.5 Defensive, intermediate and rehabilitative (private) expenditures

Data

The component representing the total value of defensive, intermediate and rehabilitative expenditures is composed of two subcomponents: the expenditures on defensive, intermediate and rehabilitative goods and services and the costs of road accidents.

Expenditures on defensive, intermediate and rehabilitative goods and services

The data for the expenditures on defensive, intermediate and rehabilitative goods and services is collected from OECD (2024g) for the UK and the US. From that database, the expenditures on food, alcohol, tobacco and narcotics, insurance and financial services in million units of national currency can be downloaded.

For South Africa, the data for these expenditures is not available from OECD (2024g). The South African Reserve Bank (2022) presents some data for these types of expenditures in different publications but this data cannot be used here because it is presented as total sums of different categories. The data for these expenditures could hence not be collected for South Africa, making the calculation of the DIRE component impossible for South Africa.

Costs of road accidents

For the second subcomponent, the costs of road accidents, data about the number of injuries and deaths caused by road accidents and about the costs of these accidents is needed.

For the UK and the US, the number of injuries and fatalities due to road accidents could be collected from OECD (2023b). For South Africa, only very few data points could be collected. The number of fatalities following road accidents for the years 2007 to 2019 are collected from Stats SA (2024). This data was not extrapolated because no correct extrapolation technique could be thought of. Additionally, the data for the number of injuries caused by road accidents could not be collected, making the calculation of the total costs of road accidents impossible anyways.

The costs linked to these accidents is collected from different sources for the three countries. For the UK, the same source as for the EU countries, Bickel et al. (2006), is used. Bickel et al. (2006) give an estimate of the costs of road injuries and road fatalities for the year 2002. Among the two types of injuries that are presented, the data for the slight injuries is collected instead of the data for the serious injuries, as for the EU countries. The extrapolation of these costs for the years before and after 2002 is done following the trend of the GDP over the years.

For the US, the costs are collected from a National Highway Traffic Safety Adminitration (2023) report. This report presents different parts of the total costs of road fatalities and of road injuries. Only the parts of the costs that are also included in the costs calculated by Bickel et al. (2006) are included. These partial costs are the medical care costs, the emergency services costs, the market productivity losses costs, the legal costs, and the property damage costs. The report presents different levels of injury, MAIS 1 to 5. The MAIS 2 level of injury is selected in order to have data that is comparable to the costs of injuries from Bickel et al. (2006) from which we use the costs of slight injuries. The report only presents an estimate of the costs for 2019 so these costs are extrapolated before and after that year in order to have data for the full period. The extrapolation technique used is the same as for the EU countries, the costs of road accidents are extrapolated following the trend in GDP. Even if choices are made to have data that would be comparable to the data collected for the UK and EU countries, we find that the costs estimates for the US are much higher than the cost estimates for the other countries. This difference is something to keep in mind when comparing the results for the US to those of other countries.

For South Africa, costs of road accidents are presented in the report by International Transport Forum and OECD (2019). This report presents the costs of road accidents for 2017. These costs are extrapolated before and after 2017 using the trend in GDP, as for other countries. Importantly, it should be noted that the methodology used to calculate these costs might not be comparable to the methodology used by Bickel et al. (2006) nor by National Highway Traffic Safety Adminitration (2023). Two choices were made when collecting the data, the costs of slight injuries were selected and the property damage costs were added to each of the injuries and fatalities costs.

Illustration

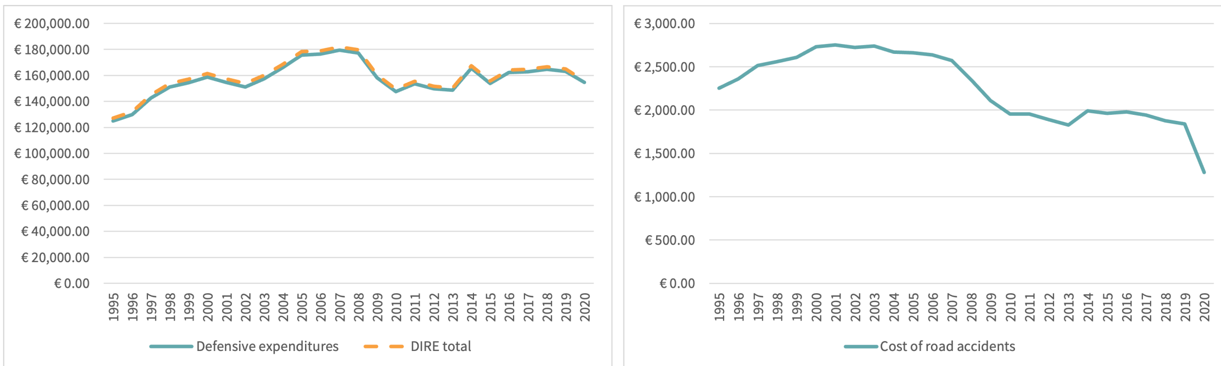
Figures 61 and 62 present the evolution of the total value of defensive, intermediate, and rehabilitative expenditures along with the evolution of the expenditures on defensive, intermediate and rehabilitative goods and services in Panel A, while Panel B presents the evolution of the costs of road accidents. These two figures present the evolution of the costs for the UK and the US.

For the UK, the costs of road accidents only have a minor impact on the total value of the defensive, intermediate and rehabilitative expenditures. For the US, the very high costs estimates for the road accidents lead to these costs having a higher impact on the total value of defensive, intermediate and rehabilitative expenditures. Still, this total value is closely following the evolution of the expenditures on defensive, intermediate and rehabilitative expenditures because they make up the biggest part of the total value of this component. For South Africa, the little number of data points for the number of road fatalities is paired with the cost estimate of road fatalities for that country and presented in figure 63, showing the a small part of the costs of road fatalities for the years 2007 to 2019.

Figure 61: Evolution of defensive, intermediate and rehabilitative expenditures (panel A) and costs of road accidents (panel B) in the UK.

Panel A

Panel B

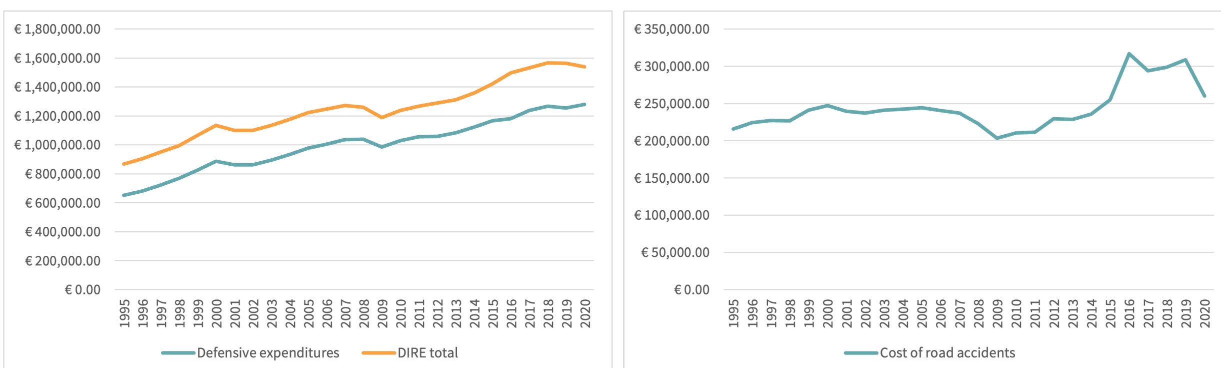


Note: The expenditures and costs are valued in million euros in 2015 prices.

Figure 62: Evolution of defensive, intermediate and rehabilitative expenditures (panel A) and costs of road accidents (panel B) in the US.

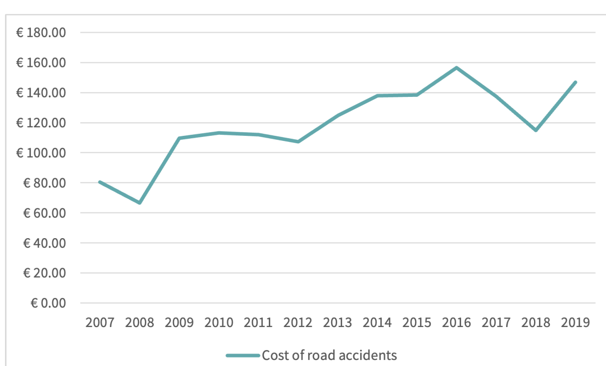
Panel A

Panel B



Note: The expenditures and costs are valued in million euros in 2015 prices.

Figure 63: Evolution of the costs of road accidents in South Africa.



Note: The costs are valued in million euros in 2015 prices.

5.1.6 Welfare losses from income inequality

Data

The welfare losses from income inequality are calculated based on the net consumption data and an index of diminishing marginal utility of income based on a threshold value for income.

The data for the net consumption is based on the data for the individual consumption expenditures, the value of the shadow economy and the total value of the defensive, intermediate and rehabilitative expenditures. Details about their data collection can be found in sections 5.1.2, 5.1.3 and 5.1.5 for the UK and the US. For South Africa however, since the total value of the defensive, intermediate and rehabilitative expenditures could not be calculated, the net consumption subcomponent cannot be calculated either.

The calculation of the index of diminishing marginal utility of income follows the same steps as described for the EU countries. To follow these steps, different data are needed. First, data about the share of income per deciles of the total population is needed. For the UK, this data can be collected from Eurostat (2024b) for the years 1995 to 2018, with a gap for the years 2002 to 2004. The data for the years 2002 to 2004 is linearly interpolated using the value from 2001 and 2005 while the missing data for 2019 and 2020 is extrapolated using memory items. For the US, data for the share of income per deciles could not be found. However, data for the income per quintiles could be collected from Census (2023). For 2013 and 2017, the data source gives two different, but similar, data points. The average of these two data points was used in the calculation of the average income per decile. The data for quintiles is used in the same way as the data for deciles in the other countries. For South Africa, this data could not be found to be collected.

The share of income per deciles or quintiles data is then used to calculate the average income per decile/quintile. This is calculated by combining the data for the share of income per decile/quintile, data for GDP in million euros in 2015 prices, and data about the total population. The exact steps of calculation are found in the section describing the methodology for the EU countries. The same methodology was used here for the UK and a very similar, with a simple adjustment, was used for the US. The adjustement is that the total population is divided by 5 instead of by 10 to represent the number of people in a given quintile.

The sufficiency threshold considered in calculating the index of diminishing marginal utility of income is the same as for the EU countries, coming from Hickel (2020), it is equal to 20,000 US dollars in 2011 prices and is converted to euros in 2015 prices using a PPP exchange rate collected from OECD (2023a). If the data about the share of income in different deciles had been found for South Africa, the same sufficiency threshold would have been used to decide which deciles to adjust. However, since this data could not be found, no calculations could be made for South Africa.

Illustration

Figures 64 and 65 present a comparison between the adjusted and unadjusted average income per decile/quintile in 2015 as well as the evolution of the net consumption compared to the evolution of the welfare losses from income inequality over the whole period. In both countries, only the very first deciles/quintile are kept unadjusted while the others are adjusted. The adjustment of the last decile/quintile has an important impact on the value of the average income. The welfare losses from income inequality are increasing over time for both countries.

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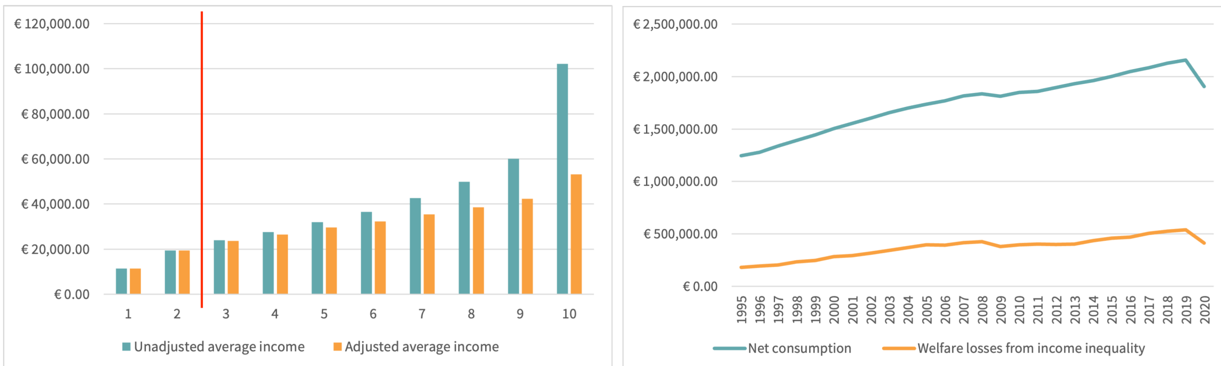
Figure 64: Comparison between unadjusted and adjusted average income per decile in 2015 (panel A) and evolution of net consumption and welfare losses from income inequality between 1995 and 2020 (panel B) in the UK.

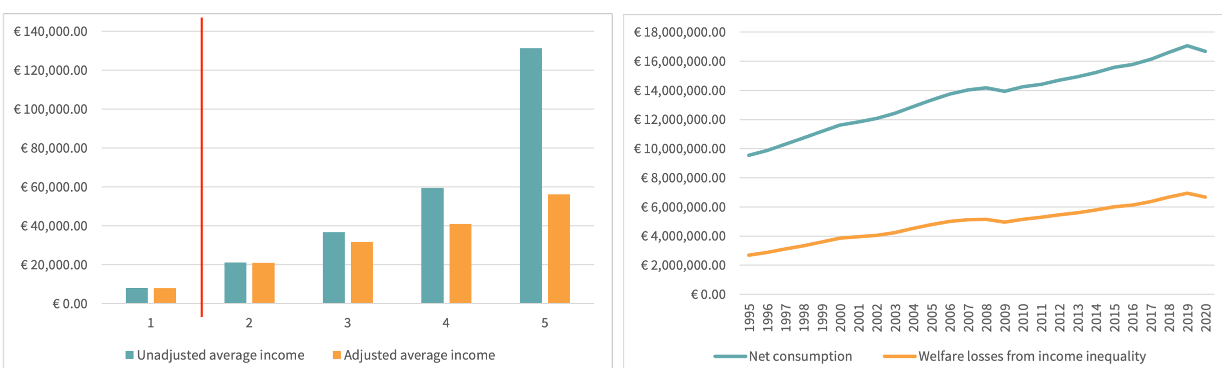
Panel A Panel B



Note: The average income is measured in euros in 2015 prices. The red line on panel A indicates which deciles are left unadjusted (to the left) or are adjusted (to the right). The net consumption and welfare losses are measured in million euros in 2015 prices.

Figure 65: Comparison between unadjusted and adjusted average income per decile in 2015 (panel A) and evolution of net consumption and welfare losses from income inequality between 1995 and 2020 (panel B) in the US.

Panel A Panel B



Note: The average income is measured in euros in 2015 prices. The red line on panel A indicates which deciles are left unadjusted (to the left) or are adjusted (to the right). The net consumption and welfare losses are measured in million euros in 2015 prices.

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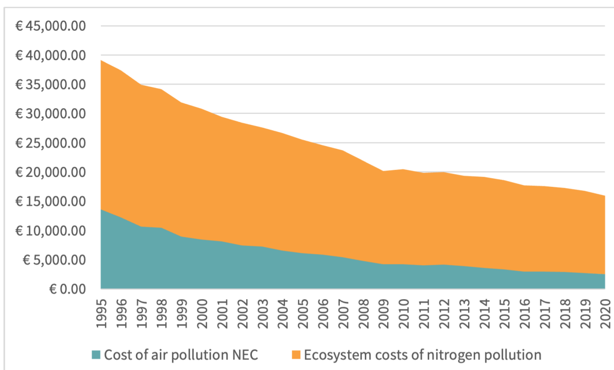
5.1.7 Narrow ecological costs

The narrow ecological costs only include the ecological costs experienced in the present and within a given country. This component is made up of three subcomponents: the current costs of air pollution, the ecosystem costs of nitrogen pollution, and the costs of extreme weather events. Still, no data could be found for the latest subcomponent for any of the three selected countries because no adequate data source could be found. This missing subcomponent is something to keep in mind when comparing the results for the non-EU countries and for the EU countries, even though this subcomponent is not the most important for the value of the narrow ecological costs for the EU countries. More details over the data collected for these subcomponents is given in the following subsections.

Figures 66 and 67 present the evolution of the total narrow ecological costs over the whole period as well as the share of these costs attributed to each of the two subcomponents. In both cases, the ecosystem costs of nitrogen pollution make up most of the value of the narrow ecological costs, which are decreasing over time.

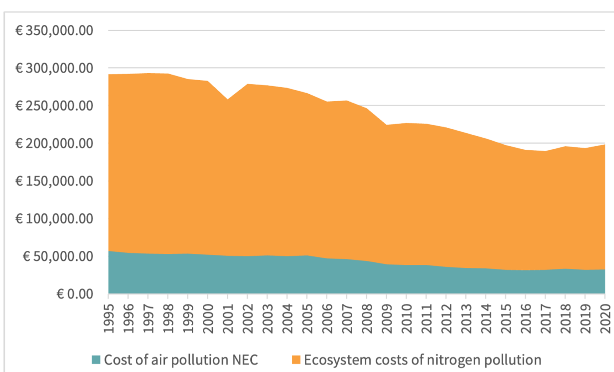
Illustration

Figure 66: Evolution of the costs of NEC subcomponents in the UK.



Note: The costs are measured in million euros in 2015 prices.

Figure 67: Evolution of the costs of NEC subcomponents in the US.



Note: The costs are measured in million euros in 2015 prices.

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Current costs of air pollution

Data

The data needed for calculating the current costs of air pollution is the amount of emissions from different sources and the costs estimates for each of these pollutants. The pollutants included here are the same as for the EU countries: $PM_{2.5}$, NH_3, NO_x, $NMVOC$, and SO_x. The data about emissions of these pollutants can be collected from OECD (2024b) for the UK and the US in thousand tonnes. For the US, all these series present a series break in 2002 (OECD, 2024b). This break is most important for the emissions of NH_3 and of $PM_{2.5}$ because they increased a lot between 2001 and 2002 for no obvious reasons. Unfortunately, no data about these emissions could be found for South Africa.

The cost estimates for the UK come from the same source as for the individual EU countries, a report of the European Environment Agency (2014). These costs, expressed in 2005 prices in the report are converted to 2015 prices. As for the EU countries, the cost estimate for SO_2 is used to value the SO_x emissions. For the US, the cost estimates are collected from Muller and Mendelsohn (2012). These cost estimates are adjusted following the adjustments explained by Lazarus and Brown (2022) to account for the update in the methodology used by Muller (2014)[35]. Furthermore, these costs estimates are assumed to be in 2005 prices and are then converted to 2015 prices before being used. Again, no cost estimate for SO_x is given, so the cost estimate of SO_2 is used. Additionally, this study does not give an estimate for NMVOC emissions but does give an estimate for VOC emissions, so all emissions no matter whether they are methane or not. In this study, the VOC cost estimate has then been used to value the NMVOC emissions because of a lack of a better cost estimate[36] and it is thought to be better to value the NMVOC emissions with this cost estimate than not include these emissions at all. It is important to note that the costs estimates from Muller and Mendelsohn (2012) for the US are not completely comparable to the costs estimates from European Environment Agency (2014) because of (possible) differences in methodologies. The comparison of results between the US and the UK and EU countries should hence be made carefully. As for the data for the emissions, no data for the cost estimates could be found for South Africa.

Illustration

Figures 68 and 69 show the evolution of the amount of emissions of the different included pollutants. For both countries, the emissions of NO_x, $NMVOC$ and SO_x are the highest but decreasing a lot over time. The total amount of emissions decreases a lot over time as well. In the graph showing the emissions in the US, the series break in 2002 is clearly visible for some of the pollutants. Table 37 presents the pollutant-specific cost estimates for each country. These costs estimates are quite different in the two countries, confirming that a comparison of the costs of air pollution between them should be done carefully. The cost estimates are constant over the whole period.

Table 37: Pollutant-specific cost estimates in the UK and the US.

Pollutant	UK	US
$PM_{2.5}$	€ 43,967.23	€ 15,172.77
NH_3	€ 10,882.73	€ 11,091.04
NO_x	€ 4,074.58	€ 1,069.69
$NMVOC$	€ 1,660.52	€ 3,068.33
SO_2	€ 16,519.35	€ 5,798.87

Note: The estimates are measured in VOLY €/tonne in 2015 prices.
For the US, the NMVOC estimate is actually the VOC estimate.

[35] The adjustment makes use of findings from Muller et al. (2011).

[36] In some studies, such as ION (2021), it is said that the NMVOC and VOC emissions are sometimes used interchangeably, giving us confidence for using the VOC cost estimate to value the NMVOC emissions.

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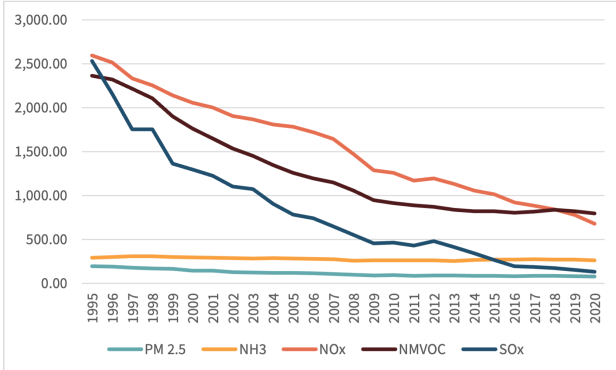
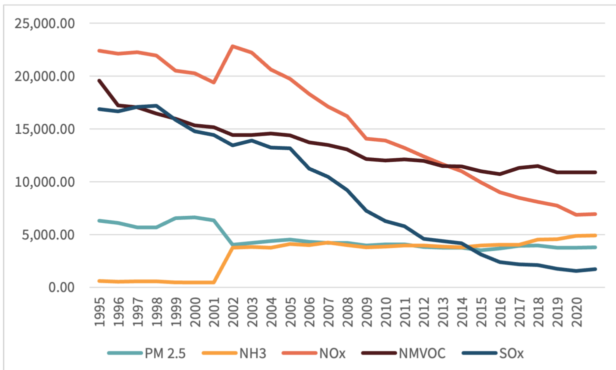
Figure 68: Evolution of some production-based emissions in the UK



Note: The emissions are measured in tonnes.

Figure 69: Evolution of some production-based emissions in the US



Note: The emissions are measured in tonnes.

Ecosystem costs of nitrogen pollution

Data

As for the current costs of air pollution, data for the amount of emissions of specific pollutants and specific cost estimates are needed to calculate the ecosystem costs of nitrogen pollution.

The data for the emissions NH_3, NO_x and Nr is collected from OECD (2024b) and OECD (2024a) for the UK and the US. The data for the years 1995 to 2020 could be collected entirely from the OECD (2024b) and OECD (2024a) for NH_3 and NO_x. For the consumption of inorganic fertilizers, proxied using the emissions of N_r, data is missing for the years 1996 to 1999 and 2018 to 2020 for the UK. The missing data at the beginning of the period was linearly interpolated using the values for 1995 and 2000 while the missing data at the end of the period was extrapolated using memory items. For the US, a memory item also had to be used for 2020. Unfortunately, again, the data for emissions from these pollutants could not be found for South Africa.

The cost estimates for the UK and the US are the same as for the EU countries, coming from Van Grinsven et al. (2013), because no country-specific estimates could be found. The same cost estimate would have been used if data for emissions of nitrogen pollution had been found for South Africa. As for the EU countries, the cost estimates collected here are the ecosystem costs estimates only, not the total ones, to avoid double-counting with the previous subcomponent.

Illustration

Figures 70 and 71 present the evolution of the nitrogen pollution considered in this subcomponent. In both countries, the emissions of NO_x are high at the beginning of the study and decrease a lot over the whole

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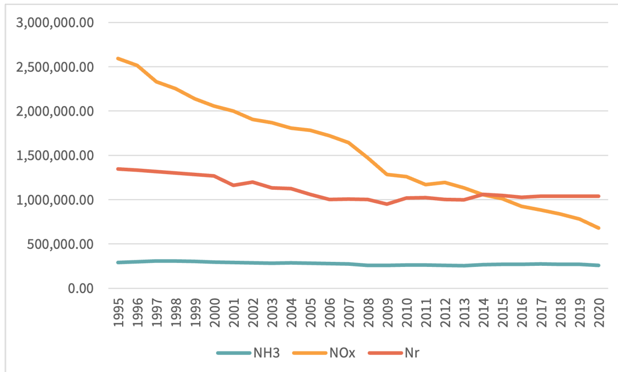
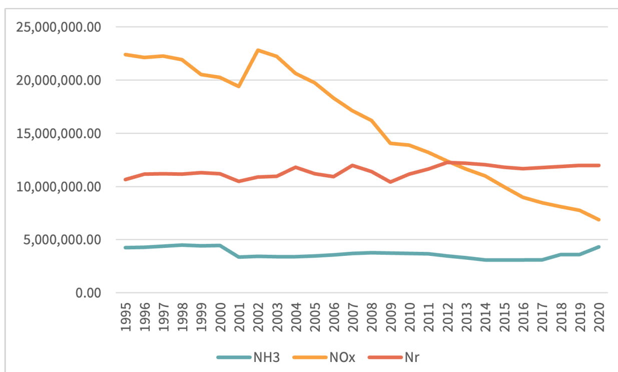
period while the emissions of NH_3 and N_r are relatively stable over time. Table 38 shows the pollutant-specific cost estimates. These cost estimates are constant over time and are the same in the UK and the US, as well as in the EU countries.

Figure 70: Evolution of nitrogen pollution in the UK.



Note: The emissions are measured in tonnes.

Figure 71: Evolution of nitrogen pollution in the US.



Note: The emissions are measured in tonnes.

Table 38: Pollutant-specific ecosystem cost estimates

Pollutant	Ecosystem cost estimate
NH_3	€ 12,367.19
NO_x	€ 5,063.86
N_r	€ 6,521.70

Note: The cost estimates are measured in €/tonne in 2015 prices.

Costs of extreme weather events

The data for this subcomponent could not be collected for any of the selected non-EU countries. The missing data for this component is the main difference of methodology compared to the EU countries. The results of this data collection, used in compiling the $ISEW_{BCE}$, are hence not directly comparable to the results for the EU countries.

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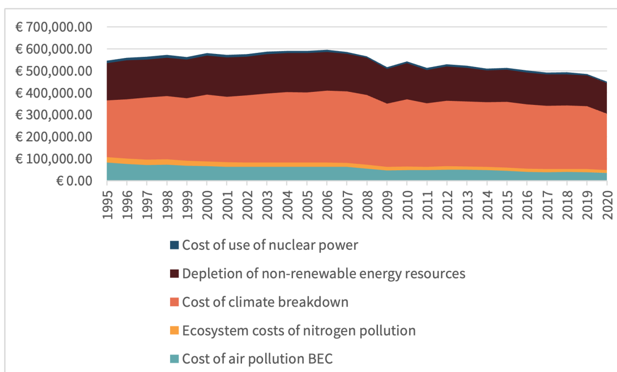
5.1.8 Broad ecological costs

The broad ecological costs refer to the costs experienced in the present in a given country as well as the costs experienced in the future and abroad. These costs hence include more subcomponents to capture the costs in the future and abroad: the costs of air pollution including the costs embodied in trade, the ecosystem costs of nitrogen pollution, the costs of climate breakdown, the costs of use of nuclear power, and the costs of depleting non-renewable energy resources. The data collected for valuing these different components is presented in the following subsections.

Illustration

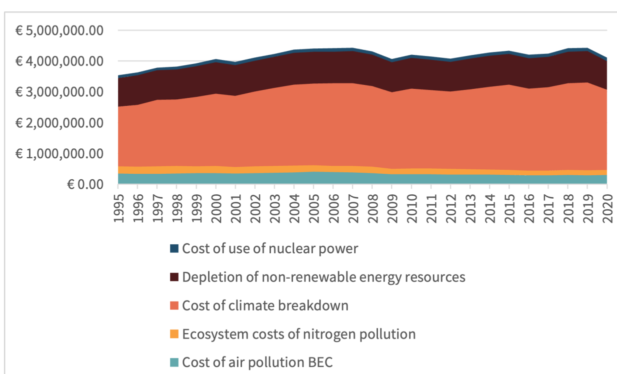
The figures 72, 73 and 74 present the evolution of the total broad ecological costs for the UK and the US as well as the evolution of the few subcomponents that could be valued for South Africa. These figures also reveal what role each of the subcomponents play in the total value of the broad ecological costs. For the UK and the US, we see that the costs of climate breakdown and the costs of depleting of non-renewable energy resources make up the biggest part of the total broad ecological costs. In the UK these total costs decreased over the whole period while they increased in the US. For South Africa, only the costs of depletion of non-renewable energy and the costs of use of nuclear power could be valued. The evolution of these two subcomponents is shown in figure 74, where we see that the costs of depleting non-renewable energy resources are higher than the cost of use of nuclear power.

Figure 72: Evolution of the costs for the subcomponent of BEC in the UK.



Note: The costs are in million euros in 2015 prices.

Figure 73: Evolution of the costs for the subcomponent of BEC in the US.



Note: The costs are in million euros in 2015 prices.

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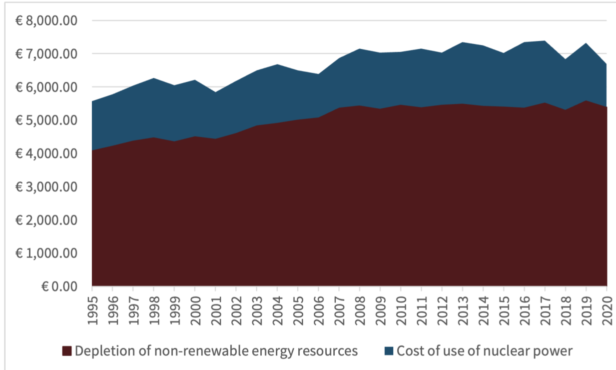
Figure 74: Evolution of the costs for the subcomponent of BEC in South Africa.



Note: The costs are in million euros in 2015 prices.

Costs of air pollution including trade

Data

The production-based emissions and cost estimates are the same as the ones used to calculate the current costs of air pollution. Details about the data sources used to collect the necessary data are given in section 5.1.7. The costs of air pollution embodied in trade are also calculated using a combination of the emissions embodied in trade and a cost estimate applied to these emissions. For the three countries, the emissions embodied in trade are collected from UNEP (2024) for all years covered in this study. The cost estimate used to value the costs associated with these emissions embodied in trade is the cost estimate that was used for the EU countries because no country-specific cost estimates could be found for the UK, the US and South Africa. The cost estimate used here hence comes from a study by Desaigues et al. (2011). This study gives a cost estimate measured in VOLY euros.

Illustration

Figures 75 and 76 show the evolution of the total costs of air pollution including trade along with the evolution of the production-based costs and those embodied in trade for the UK and the US. In both countries, the total costs decreased over time, mainly due to a decrease in the production-based costs. This decrease is countered, especially until the middle of the period, by an increase in the costs embodied in trade. Since these costs embodied in trade are valued using a constant cost estimate over time and for the two countries, the increase of the costs embodied in trade is only caused by an increase of the emissions embodied in trade, either cause by an increased of the consumption emissions or a decrease of the production emissions.

Since data could be collected for the costs of air pollution embodied in trade for South Africa, the evolution of these costs is presented in figure 77. Again, the changes in these costs are only caused by changes in the emissions embodied in trade because the cost estimate is constant over time.

Ecosystem costs of nitrogen pollution

This component is exactly the same as the one included in the narrow ecological costs. For details regarding this component, refer to section 5.1.7.

Costs of climate breakdown

Data

The costs of climate breakdown are calculated by multiplying the CO_2 emissions from different activities by an estimate of the social cost of carbon (SCC).

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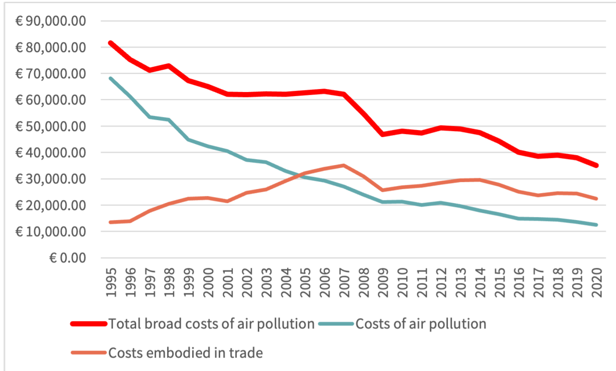
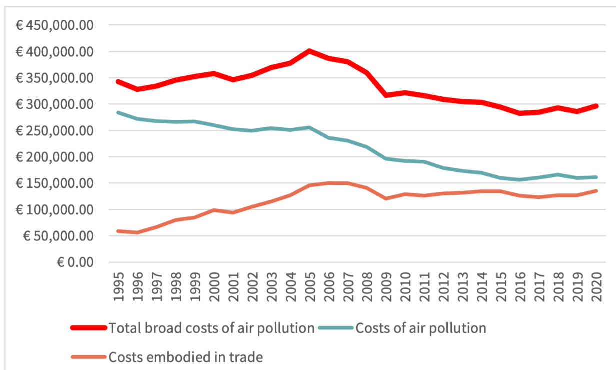
Figure 75: Evolution of the costs of air pollution from production and trade in the UK



Note: The costs are in million euros in 2015 prices.

Figure 76: Evolution of the costs of air pollution from production and trade in the US



Note: The costs are in million euros in 2015 prices.

GHG emissions

The emissions data is divided between greenhouse gas (GHG) emissions data and emission footprint data. The GHG emissions used are different emissions reported by the countries to the UNFCCC: the total UNFCCC emissions, the emissions from international navigation, the emissions from international aviation, the CO_2 emissions from biomass, and the emissions from national LULUCF. These emissions are collected from different sources. For the UK and the US, the total UNFCCC emissions data and the national LULUCF emissions data is collected from OECD (2024c) and OECD (2024d), respectively, while the emissions from aviation and navigation as well as the CO_2 emissions from biomass are collected from an data inventory by the United Nations (2024a). For South Africa, the emissions for the total UNFCCC emissions and for the national LULUCF emissions can also be collected from OECD (2024c) and OECD (2024d). Still, this data is only available for the years 2000 to 2020. Since data for 1994 is available from the same source, the data for the years 1995 to 1999 is linearly interpolated using the data for the years 1994 and 2000. The data for the emissions from navigation and aviation and for the CO_2 emissions from biomass could not be collected, making the GHG emissions data incomplete for South Africa.

It is important to note that for the EU countries, the emissions from navigation are adjusted to reflect the sales-based as well as the activity-based emissions. This adjustment led to a 17.41 % change compared to the UNFCCC values for the EU countries[37]. For the UK and the US, this adjustment could not be made. The emissions from navigation for these countries hence only represent the sales-based emissions. The comparison of the results for this component for the UK and the US with the results for the EU countries hence has to

[37]This average adjustment is calculated by adding up the average percentage change for each country and dividing this sum by 27. The average percentage change for each country is calculated by adding up the percentage change between the UNFCCC and the adjusted value in each year, and dividing this sum by 26.

Figure 77: Evolution of the costs embodied in trade in South Africa

Note: The costs are in million euros in 2015 prices.

be made with caution.

Footprint emissions

The footprint data comes from the same source for all countries. The data for the emissions in trade footprint is collected from the Friedlingstein et al. (2023) for all countries for the years 1995 to 2020. This source can be used to collect the production/territorial emissions and the consumption emissions, which are used to calculate the emissions from trade, calculated by subtracting the production emissions from the consumption emissions. The second footprint is the land use change footprint. This land use change footprint data is calculated the same way as for the EU countries, and using data from the same sources. The land use emissions of each country are calculated by comparing the land use consumption footprint from each country, collected from UNEP (2024) and measured in million hectares, to the global land use change impact. The global land use consumption footprint is also collected from UNEP (2024) in million hectares while data for the emissions for the global land use change, measured in million tonnes of CO_2 are collected from the Friedlingstein et al. (2023). By dividing each of the country-specific land use consumption footprint by the global estimate of the global land use consumption footprint, the share of that country in the land use change consumption footprint in million hectares is determined. Multiplying this share by the global land use change emissions gives an estimate of the land use change emissions for each country, in million tonnes of CO_2 emissions.

Social cost of carbon

The estimate of the social cost of carbon (SCC) comes from the same source as for the EU countries, it is the reference scenario of Ricke et al. (2018). This estimate is equal to 365.17 euros in 2015. The social cost of carbon is assumed to increase over time. The growth rate applied to the social cost of carbon is 2.2% per year. This growth rate comes from a study by Tol (2023).

Illustration

Figures 78 and 79 present the evolution of the different GHG and footprint emissions included in the costs of climate breakdown as well as the evolution of the sum of these emissions, the total emissions included in the costs of climate breakdown. In the UK and the US, we see that, of course, the total UNFCCC emissions make up the biggest part of the emissions in the costs of climate breakdown and these emissions are decreasing over time. For the UK, the emissions embodied in trade are slightly higher than the others and increasing over time, but remain quite low compared to the total UNFCCC emissions. For the US, the land use change emissions are slightly higher than the others and decreasing over time, but are very low compared to the total UNFCCC emissions. Interestingly, the national LULUCF emissions for the US are negative for the whole period, slightly decreasing the costs of climate breakdown.

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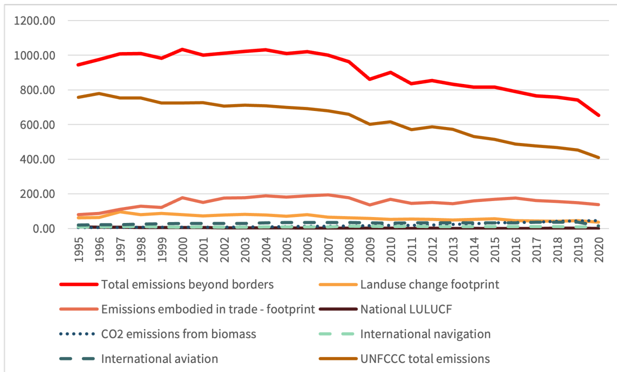
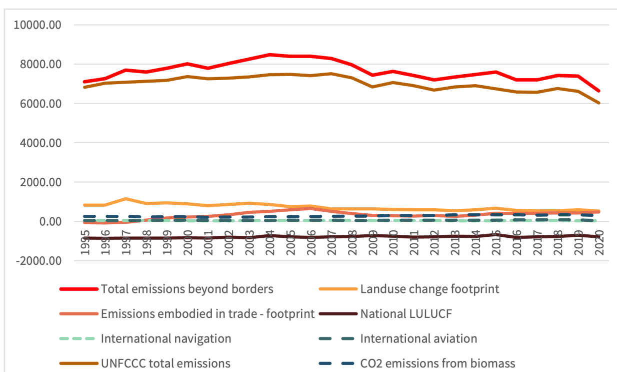
Figure 80 presents the evolution of the emissions for which data could be collected for South Africa: total UNFCCC emissions, national LULUCF emissions, emissions embodied in trade, and land use change emissions. Again, we see that the total UNFCCC emissions are much higher than the others. Interestingly, the emissions embodied in trade are negative over the whole period, decreasing the costs of climate breakdown. The emissions from national LULUCF are also negative in many years, which is slightly decreasing the costs of climate breakdown further in those years.

Figure 78: Evolution of the emissions taken into account in the costs of climate breakdown in the UK.



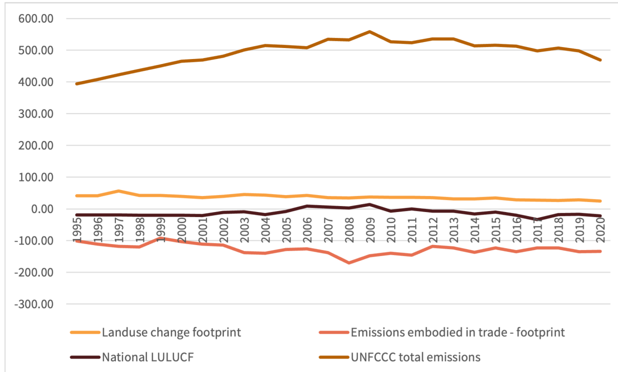
Note: The emissions are valued in million tonnes of CO_2 equivalent (tonnes of CO_2 for biomass emissions).

Figure 79: Evolution of the emissions taken into account in the costs of climate breakdown in the US.



Note: The emissions are valued in million tonnes of CO_2 equivalent (tonnes of CO_2 for biomass emissions).

Figure 80: Evolution of the emissions taken into account in the costs of climate breakdown in South Africa.



Note: The emissions are valued in million tonnes of CO_2 equivalent.

Costs of depleting non-renewable energy resources

Data

The costs of depleting non-renewable energy resources is based on the primary energy consumption and a cost estimate calculated based on the estimated investments needed to reach a certain climate goal.

The data for the primary energy consumption measured in thousand tonnes of oil equivalent is collected from Eurostat (2024i) for the UK. Since data for 2020 is unavailable, this data point is extrapolated using a memory item from 2019. For the US and South Africa, the data about the primary energy consumption is collected from U.S. Energy Information Administration (2024). This source gives data for all years covered in the study for both countries but the data is measured in quad Btu. To get the data in thousand tonnes of oil equivalent, the data is first multiplied by 10^{15} and by a conversion ratio of 0.0003 to get the data in kWh. The data in kWh is then multiplied by a conversion ratio of 8.59845E-05 and divided by 1000 to get the data in thousand tonnes of oil equivalent.

The marginal cost estimate is based on different estimated investments for each country. For the UK, the same estimate as for the EU countries is used. This estimate is collected from a report by the European Commission (European Commission, 2021). The annual estimated investment needed to reach the objectives of Fit-for-55 is divided by the annual primary energy consumption in the EU in 2021 and an estimate of 0.80 million euros in 2015 prices per thousand tonne of oil equivalent is obtained.

For the US, the cost estimate is based on the investments needed to get to net zero, a report by Net-Zero America (2023). This report presents the estimated annual investment needed for five different scenarios: high electrification (E+), less-high electrification (E-), high biomass (E- B+), renewable constrained (E+ RE-), 100% renewable (E+ RE+). The estimated costs for a reference (REF) scenario are also presented. Since none of these scenarios can be seen as a 'mix' or 'middle' scenario, the average of the estimates in each scenario is used to estimate the marginal cost of depleting non-renewable energy resources. As for the EU estimate, the average annual cost is divided by the primary consumption in the US in 2020 and a marginal cost of 0.50 million of US dollars in 2018 prices per thousand tonne of oil equivalent is obtained.

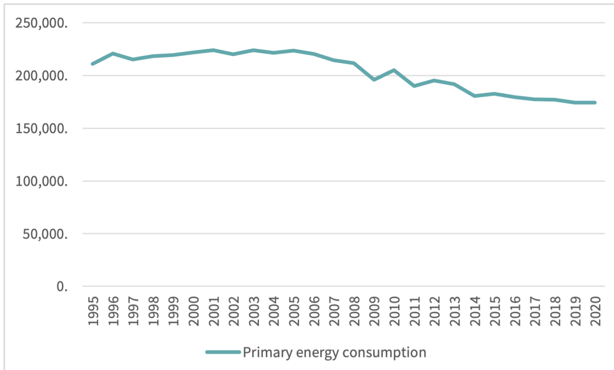
For South Africa, a similar methodology is used, based on an estimated investment costs from a report by National Business Initiative (ND) about the net-zero transition. Only one scenario is presented in that paper. The estimated annual investment needed per year to reach net zero is then divided by the total primary energy consumption in South Africa in 2021 and a marginal cost of 0.75 million of ZAR per thousand tonne of oil equivalent is obtained.

Illustration

Figures 81, 82 and 83 present the evolution of the primary energy consumption in each country. The changes in the primary energy consumption are the only influencers for changing the total costs of depleting non-renewable energy resources since the cost estimates are constant over time.

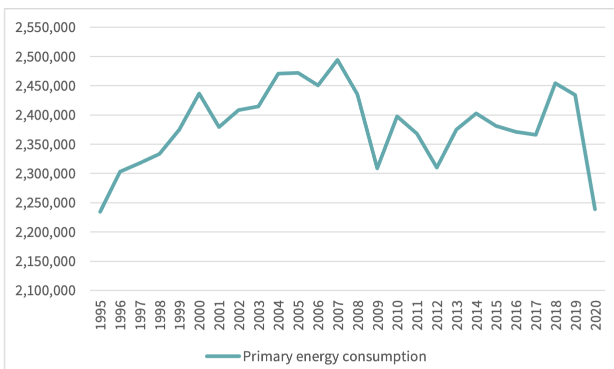
In the UK and South Africa, the primary energy consumption is not too volatile over time. In the UK, there is an overall decrease of primary energy consumption while there is an overall increase in South Africa. In the US, the consumption of primary energy consumption is very volatile for the whole period and increases a lot over the first years. Still, due to a big drop in 2020, the primary energy consumption did not change much between 1995 and 2020.

Figure 81: Evolution of the primary energy consumption in the UK.



Note: The amounts consumed are in thousand tonnes of oil equivalent.

Figure 82: Evolution of the primary energy consumption in the US.



Note: The amounts consumed are in thousand tonnes of oil equivalent.

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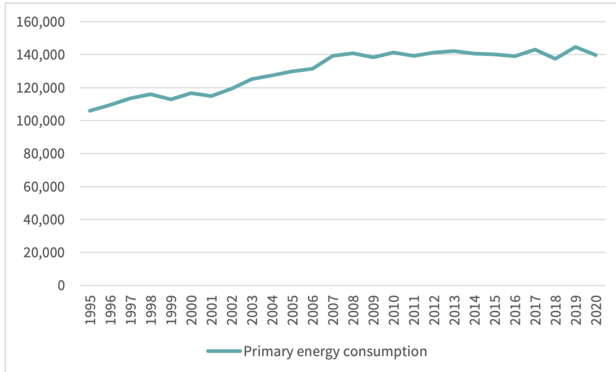
Figure 83: Evolution of the primary energy consumption in South Africa.



Note: The amounts consumed are in thousand tonnes of oil equivalent.

Costs of use of nuclear power

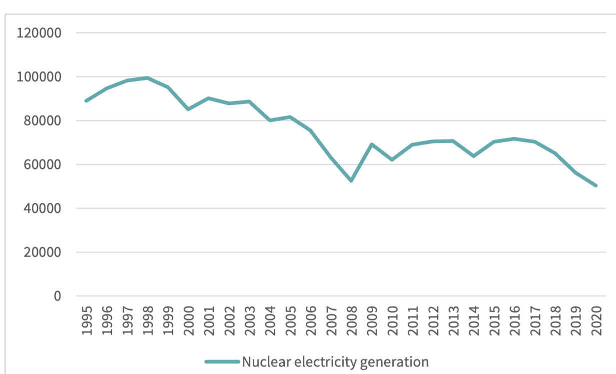
Data

Calculating the costs of use of nuclear power requires to collect data for the amount of electricity produced using nuclear power and a cost estimate of using nuclear power. The data for the amount of electricity produced using nuclear power is collected from the IEA (2023) for all countries and years, measured in GigaWhat per hour. As for other cost estimates of the ecological costs, no country-specific cost estimate for the costs of using nuclear power could be found. For this reason, the cost estimate used to value the costs of producing electricity using nuclear power is the same as the one used for the EU countries. This cost estimate comes from a study by Held et al. (2018) and is equal to 13.14 cents per kiloWhat hour, in 2015 prices (Van der Slycken and Bleys, 2023). This cost estimate is constant over time and is the same for the three countries.

Illustration

Since the cost is the same for all countries and constant over time, looking at figures 84, 85 and 86 which present the evolution of the nuclear electricity generation in each country is enough to have an idea about the evolution of the costs of use of nuclear power over the whole period. The amount of electricity generated using nuclear power is different between the three countries, and their evolution is different as well. In the UK there is an overall decrease of the generation of electricity using nuclear power while in the US, there is a small increase over the whole period. In South Africa, we also see a small decrease, but the generation of electricity using nuclear power is also more volatile than in other countries.

Figure 84: Evolution of the nuclear electricity generation in the UK.



Note: The amount produced is measured in GWh.

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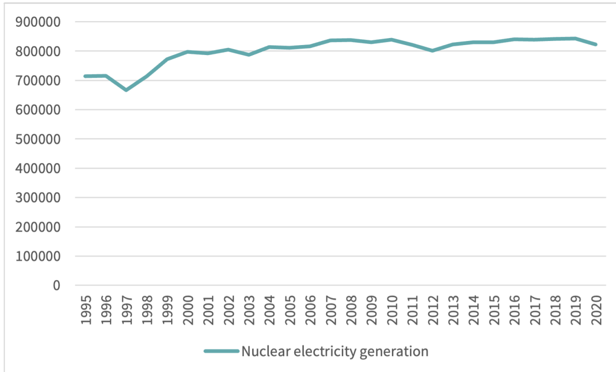
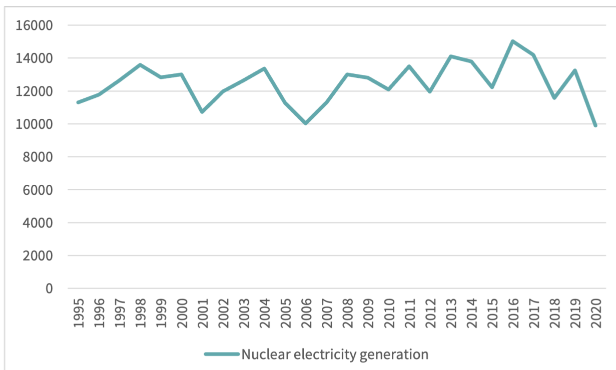
under grant agreement N°101094211.

Figure 85: Evolution of the nuclear electricity generation in the US.



Note: The amount produced is measured in GWh.

Figure 86: Evolution of the nuclear electricity generation in South Africa.



Note: The amount produced is measured in GWh.

5.1.9 Net capital investments

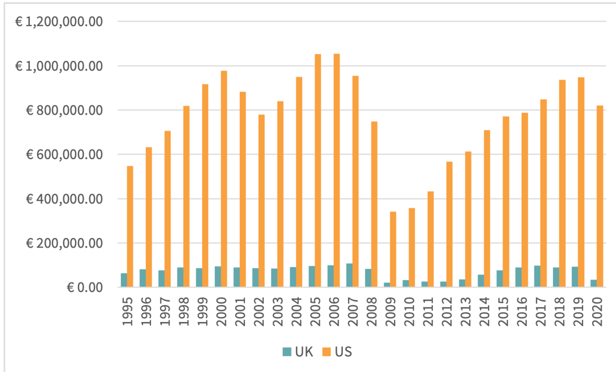
Data

The net capital investments are calculated by subtracting the value of the net capital stock in one year from the value of the net capital stock in the previous year. For the UK and the US, the data for the net capital stock needed to calculate the capital adjustments in each year is collected from AMECO (2023d) for the years 1994 to 2020. For South Africa, the data about net capital stocks is not available from AMECO (2023d) and could not be collected anywhere else. This last component hence cannot be calculated for South Africa.

Illustration

Figure 87 presents the value for the net investments for each year in the UK and the US. It can be seen that the adjustments are much higher in the US than in the UK for every year studied. Additionally, for both countries, the adjustment is always positive, meaning that the net capital stock is always higher in one year than in the previous year.

Figure 87: Yearly net investments in the UK and the US.



Note: The adjustments are measured in million euros in 2015 prices.

5.2 Results for the United Kingdom and the United States

In this subsection, the evolution of the two welfare measures and that of their components are analysed for the UK and the US separately. First, the evolution of the welfare measures themselves is discussed, highlighting the differences in trends between gdp and the welfare measures as well as between the two welfare measures. Following the discussion of the differences in trends for the two welfare measures, the evolution of some components are also discussed.

As mentioned before, even though an effort was made to collect as much data as possible to compile the two ISEWs for South Africa, we could not find the necessary data for all the components of the ISEWs, rendering their compilation impossible. Since the ISEWs could not be compiled for South Africa, this country is not discussed at all in this subsection.

5.2.1 Evolution of the welfare measures in the UK

The evolution of the welfare measures in the UK can be analysed using the results presented in figure 88 and tables 39 and 40. Figure 88 presents the evolution of gdp and of the two welfare measures between 1995 and 2020 in panel A and the evolution of the absolute values of the components of the welfare measures for the same period in panel B. Table 39 complements panel A by showing the annual growth rates of the three measures for the overall period and for selected subperiods. Similarly, table 40 complements panel B by presenting the annual growth rates of the components for the entire period and for selected subperiods. Additionally, this table presents the average importance of each components in calculating the value of the welfare measures.

First, looking at panel A of figure 88, we see that the ranking of the three measures stays the same over the whole period. Indeed, gdp always has higher absolute values than bce, which itself always has higher absolute values than bcpa. Then, from this figure and the last row of table 39, we see that between 1995 and 2020, all three measures increased at different rates. The measure with the highest growth rate is bcpa, with a total increase of 37.44% over the whole period. The total growth rate of bcpa is higher than the total growth rates of gdp and bce, which respectively increased by 27.75 and 24.89% in total over the whole period. Still, despite its higher growth rate, bcpa remains lower than the two other measures because it started from a lower level. Linked to this lower initial value, and to the lower values of bcpa over the whole period, one remark to keep in mind when comparing the growth rates of bcpa to the other growth rates is that the relatively lower values of bcpa lead to higher relative growth rates for bcpa.

The differences in growth rates for the three measures can be explained by looking at the components of the welfare measures. In panel B, we see that the value of individual consumption expenditures is the components that impacts welfare measures the most due to its high and increasing absolute values over the whole period. Another component that plays an important role is the value of unpaid work, which is also slightly increasing over the whole period. Regarding the negative components, we see that the value of the broad ecological costs is also quite high, meaning that it plays an important role in determining the size of bcpa and hence explaining why bcpa is lower than the two other measures. The relatively high decrease in the values of the broad ecological costs seen in panel B and in table 40 is the main explanation for the higher total increase of bcpa. Finally, another negative component that is increasing over time is the value of the welfare losses from income inequality. This increase can indeed also be seen in panel B and in table 40. The fact that the welfare losses from income inequality increased over time and that they play an important role for determining the value of the welfare measures can explain why the total growth rate of bce is lower than that of gdp.

Growth rates of gdp and of welfare measures in subperiods

The growth rate of each of the welfare measures can be compared to the growth rate of gdp in selected subperiods and the difference between these growth rates can be explained by looking at the evolution of the components during those subperiods. If possible, general conclusions regarding the difference between the growth rate of gdp and of the welfare measures are drawn.

Starting with the comparison of bce and gdp, we see that in all periods with positive economic growth (1995-2001, 2001-2008, 2011-2014, 2014-2019), gdp increased more than bce. The component that is primarily responsible for the lower growth rate of bce in these subperiods is the value of welfare losses from income inequality. Indeed, in these four periods, the welfare losses from income inequality increased, which had a negative impact on the values of bce. However, the positive impact coming from other components, such as decreases of the narrow ecological costs and increases in individual consumption expenditures, partially offset this negative impact to avoid a decrease in bce.

In periods, of negative economic growth, during the financial and COVID-19 crises (2008-2011 and 2019-2020), we can see that gdp decreased more than bce. Indeed, between 2008 and 2011, bce did not even decrease while between 2019 and 2020, it decreased less than gdp. In both cases, bce outperformed gdp because of a combination of decreases in welfare losses from income inequality and in narrow ecological costs. During the financial crisis (2008-2011), these decreases and the evolution of the others components were sufficient to avoid a decrease in bce. However, during the COVID-19 crisis (2019-2020), these decreases were not sufficient to offset the decreases in most of the positive components, leading to a decrease of bce.

For bcpa, we see that as for bce, during periods of crises (2008-2011 and 2019-2020), bcpa outperformed gdp. Indeed, between 2008 and 2011, gdp decreased but bcpa continued to increase thanks to decreases in the broad ecological costs and in welfare losses from income inequality, despite a decrease in net investments. Between 2019 and 2020, the decreases in broad ecological costs and in welfare losses from income inequality were not sufficient to offset the strong decrease in net investments and other positive components, leading to a decrease in bcpa, but still lower than the decrease in gdp. A general conclusion can hence be drawn for periods of negative economic growth. During these periods, the welfare measures outperform gdp because of decreases in ecological costs and in welfare losses from income inequality.

On the contrary, for periods of positive economic growth, there is no systematic relationship between bcpa and gdp. Indeed, between 1995 and 2001 and between 2014 and 2019, bcpa increased more than gdp, while between 2001 and 2008 and between 2011 and 2014, bcpa increased less than gdp. Looking at the components allows to explain why bcpa increased more or less than gdp in the different subperiods. Indeed, between 1995 and 2001, keeping in mind that the lower values of bcpa certainly play a role in obtaining a higher growth rate, the increase in net investments during that period certainly also explains this higher growth rate, among other things. Between 2001 and 2008, the decrease in net investments again probably primarily explains the lower increase in bcpa. Between 2011 and 2014, despite the strong increase in net investments and the small decrease in broad ecological costs, bcpa increase less than gdp because of, among other things, the increase in welfare losses from income inequality and decrease in non-defensive government expenditures. Between 2014 and 2019, the higher decrease in broad ecological costs combined with an increase in net investments can explain the higher increase in bcpa. For bcpa, in periods of positive economic growth, we see that in most subperiods, the changes in net investments and, to a lower extent, in broad ecological costs can explain the difference in growth rates with gdp. For bce, the difference between growth rates in positive economic growth periods was mainly due to the increases in welfare losses from income inequality, which do not seem to be the main component for bcpa, making it impossible to draw a general conclusion about the relationship between the growth rate of gdp and of the two welfare measures in periods of positive economic growth.

Comparing the growth rates of the welfare measures in subperiods

As the discussion about the overall growth of the measures and the previous section show, the growth rate of the two welfare measures also differ. It is interesting to look into the components to understand why these growth rates differ. Again, during this comparison, it is important to keep in mind that the lower values of bcpa throughout the period studied impacts its growth rates and makes them higher. First, we saw in table 39 that bcpa increased more than bce over the period studied. The higher increase in bcpa is also clearly visible from panel A in figure 88. Looking at table 40, we see that the higher growth rate of bcpa probably comes from the fact that the broad ecological costs decreased over the period studied and that they are very important for the size of bcpa. The narrow ecological costs also decreased over the period, and even more than the bcpa, but the value of the narrow ecological costs is much less important for bce than the value of the broad ecological costs for bcpa, leading bcpa to increase more than bce.

In all the subperiods selected, the two welfare measures evolved in the same direction, but at different rates. Indeed, in all subperiods except the last one, we see that there was an increase in the welfare measures, with bcpa always increasing more than bce. In the last period, between 2019 and 2020, the two measures decreased, with bcpa decreasing more than bce. By going over all the subperiods, we highlight the components and subcomponents that are primarily responsible for the bigger changes in bcpa. Between 1995 and 2001, the main reason for the higher increase in bcpa is the fact that there was an increase in net investments during that subperiod. This explanation also holds for the subperiods between 2011 and 2014 and between 2014 and 2019. Similarly, the reason for the higher decrease in bcpa between 2019 and 2020 is the big decrease in net investments during that period.

The remaining periods, between 2001 and 2008 and between 2008 and 2011, can also be analysed together. During these subperiods, net investments decreased, which should have led to a lower growth rate for bcpa than for bce. However, we still see a higher growth rate for bcpa during these subperiods. The only other components that could explain this difference are the narrow and broad ecological costs. In the two subperiods, the broad ecological costs decreased to a lower extent than the narrow ecological costs but the importance of the value of the broad ecological costs for bcpa is much higher than the value of narrow ecological costs for bce, explaining why a smaller decrease in the broad ecological costs still leads to a higher increase in bcpa. The difference in growth rate of the ecological costs is especially high for the period between 2001 and 2008. The lower decrease in the broad ecological costs compared to the decrease in narrow ecological costs is mainly due to a small increase in the costs of climate breakdown, mainly due to the increase in the social cost of carbon, but also to a smaller decrease in the costs of air pollution because of an increase in the costs of air pollution embodied in trade.

Figure 88: Evolution of the ISEWs and gdp (panel A) and evolution of the components (panel B) in the UK for the period 1995-2020 (measured in € in 2015 prices).

Panel A Panel B

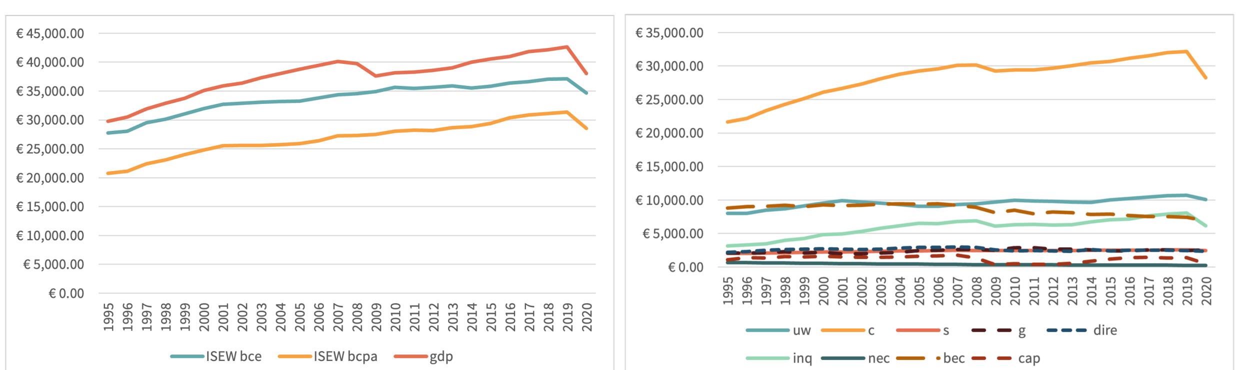


Table 39: Annual and total growth rates of the ISEWs and gdp in the UK (in %)

	bce	bcpa	gdp
1995-2001	2.79	3.53	3.15
2001-2008	0.77	0.96	1.47
2008-2011	0.90	1.08	-1.23
2011-2014	0.06	0.73	1.47
2014-2019	0.89	1.70	1.29
2019-2020	-6.67	-9.08	-10.74
1995-2020 (total)	0.89 (24.89)	1.28 (37.44)	0.98 (27.75)

Table 40: Annual growth rates and importance of the components in the UK (in %)

	uw	ci	s	gc	direp	inq	nec	bec	k
1995-2001	3.64	3.56	1.91	-0.93	3.31	7.96	-4.94	0.76	5.39
2001-2008	-0.70	1.75	1.31	4.07	1.25	4.82	-4.72	-0.45	-1.70
2008-2011	1.44	-0.83	-0.31	3.46	-5.41	-2.62	-4.08	-3.61	-32.92
2011-2014	-0.68	1.21	0.45	-3.93	1.78	2.07	-1.82	-0.42	29.44
2014-2019	2.13	1.10	0.58	-0.89	-0.97	3.63	-3.25	-1.20	9.70
2019-2020	-5.87	-12.18	-4.63	5.09	-5.91	-23.65	-5.45	-7.13	-63.96
1995-2020 (total)	0.93 (26.19)	1.08 (30.67)	0.76 (20.91)	0.84 (23.33)	0.23 (6.04)	2.75 (97.20)	-4.09 (-64.79)	-0.97 (-21.64)	-3.10 (-54.46)
Average importance in bce	22.42	66.39	5.57	5.63	29.51	65.63	4.86	/	/
Average importance in bcpa	21.80	64.56	5.41	5.47	15.14	34.45	/	50.41	2.75

5.2.2 Evolution of the welfare measures in the US

Similarly to the UK, the results of the welfare measures for the US can be analysed using the two panels in figure 89 presenting the evolution between 1995 and 2020 of gdp and the welfare measures in the first panel and the evolution of the components of the welfare measures for the same period in panel B. These two panels are complemented by tables 41 and 42 which respectively present the annual growth rates of the three measures and of the components for the entire period and for selected subperiods. Additionally, table 42 presents the average importance of the value of each component for the two welfare measures.

First looking at the absolute values of gdp, bce and bcpa presented in panel A of figure 89, we see that the three measures are relatively close to each other for the whole period and that the ranking between the values of the three measures remains the same between 1995 and 2020. Indeed, bcpa is the measure with the lowest values for the whole period, followed by gdp, and bce is the measure with the highest values. Additionally, this figure shows that the three measures increased between 1995 and 2020. The increase is confirmed by the total annual growth rates presented in the last row of table 41, showing that gdp had the highest growth rate, with a total increase of 48.03% over the whole period. The growth rate of bcpa is close to that of gdp, with a total growth rate of 43.55% over the whole period. The growth rate of bce was the lowest, with an increase of 35.21% over the whole period. Despite its higher growth rate, bcpa still remains lower than bce for the whole period studied. Since the three measures are relatively close to each other for the whole period, the value of the growth rates is only slightly affected by the difference in absolute values.

Panel B of figure 89 shows that some components have higher values than others, making them more important for calculating the value of the welfare measures and certainly driving the growth rates of the welfare measures to some extent. The component with the highest values is the value of the individual consumption expenditures, which is positively impacting the two welfare measures. Another component that is positively impacting the welfare measures and that has relatively high values is the value of unpaid work. Both of these components are increasing over time, certainly being two of the main reasons for the increase in welfare measures between 1995 and 2020. Regarding the components that are negatively impacting the welfare measures, we see that the broad ecological costs are relatively high but not changing much over time. On the contrary, the welfare losses from income inequality are also relatively high and increasing over time. The increase over time of the welfare losses from income inequality is one of the main reasons why the growth rate of bce is lower than that of bcpa.

Growth rates of gdp and of welfare measures in subperiods

Dividing the period studied in different subperiods allows to compare the growth rates of gdp and of the two welfare measures in different conditions and, if possible, to draw general conclusions about the relationship between the growth rate of gdp and of the welfare measures.

Looking at subperiods with positive economic growth, we see that in three of these subperiods (1995-2001, 2001-2008, 2011-2014), gdp growth is higher than welfare growth. In the two other subperiods (2014-2019 and 2019-2020), the comparison of the growth rates is different. Starting with the three periods where gdp growth rate is the highest, we see from table 42 that the growth rates of the welfare measures is lower than that of gdp mainly because there were increases in the welfare losses from income inequality during these periods. Additionally, the small increases in broad ecological costs are also among the main reasons for the smaller increase of bcpa. Between 2014 and 2019, all three measures increased as well, but the two welfare measures increased more than gdp. From table 42, we see that this higher increase in the welfare measures comes from a combination of increases in all of the components positively impacting the welfare and a decrease in the narrow ecological costs for bce. For bcpa, there was a small increase in broad ecological costs but the increase in the positive components and in net investments more than offset that negative impact. Between 2019 and 2020, all three measures continued to increase despite the COVID-19 crisis. In this case, the ranking of the growth rates of the three measures is again different, with bcpa increasing the most, followed by gdp and then bce. The growth rates of the two welfare measures are mainly explained by the ecological costs. Indeed, the broad ecological costs decreased a lot during that period, explaining why bcpa increased more than gdp, while the narrow ecological costs increased during that period, leading to a lower increase in bce. Still, in both cases, the relatively high decrease in welfare losses from income inequality is one of the main reasons for the increase in the two welfare measures during the crisis. It is not possible to draw a general conclusion about the subperiods of positive economic growth because the comparison between the growth rates of the welfare measures and of gdp is different in the different subperiods.

The only subperiod during which gdp decreased was during the financial crisis (2008-2011). During this subperiod, bcpa also decreased, but at a lower rate than gdp. On the contrary, bce continued to increase during that subperiod. The increase of bce during that period is mainly due to the fact that there was a decrease in the narrow ecological costs and in welfare losses from income inequality during that period. The broad ecological costs also decreased, but a relatively high decrease in the net investments led to the small decrease in bcpa. Again, it is not possible to draw a general conclusion regarding the comparison of the growth rate of gdp and of the welfare measures because there are not enough evidence to do so.

Comparing the growth rates of the welfare measures in subperiods

From table 41, we saw that bcpa increased more than bce over the period studied. Table 42 can be used to find the main reasons explaining these different growth rates. In that table, we can see that one of the main reasons for the higher increase of bcpa is the increase in net investments between 1995 and 2020, which only positively impacts bcpa. This increase was even important enough to counter a small increase in the value of the broad ecological costs during that period.

Looking at the selected subperiods allows to study the difference between the growth rates of bce and of bcpa in more details. The first interesting point to note in table 41 is that in one of these subperiods, between 2008 and 2011, bcpa decreased while bce increased. As already mentioned in the previous section, the relatively high decrease of the net investments during that period is the primary reason why bcpa decreased during that period even though bce increased.

In all the other periods, the two welfare measures evolved in the same direction by increasing and in most of them, bcpa increased more than bce. The only period in which bcpa increased less than bce is between

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2001 and 2008. It is interesting to highlight the main causes of the higher or lower increase of bcpa in the different subperiods to see whether a pattern in the difference of growth rates exists. Between 1995 and 2001, the growth rate of bcpa was higher than that of bce mainly because of an increase in net investments during that subperiod. This explanation also clearly holds for the subperiods between 2011 and 2014 and between 2014 and 2019. During these three subperiods, bcpa increased more than bce because there was an increase in net investment that more than compensated the negative impacts of other components such as the small increases in broad ecological costs.

Between 2019 and 2020, bcpa also increased more than bce, but not for the same reason. Indeed, during that subperiod, there was a relatively strong decrease in net investments. However, this negative impact was more than offset by a strong decrease in the broad ecological costs. The decrease in the broad ecological costs is hence the main reason why bcpa increased more than bce between 2019 and 2020. The decrease in broad ecological costs during that period was mainly due to decreases in the costs of climate breakdown and in the costs of depleting non-renewable energy resources. The decrease in the costs of climate breakdown was mainly caused by a decrease in the emissions from international aviation during that period. The decrease in the costs of depleting energy resources was caused by a decrease in primary energy use during that period.

Finally, between 2001 and 2008, bcpa increased less than bce and this difference was mainly due to a combination of a decrease in net investments as well as a small increase in broad ecological costs. The small increase in broad ecological costs was primarily caused by a small increase in the costs of climate breakdown, itself caused by a relatively strong increases in the footprint emission embodied in trade and in the emissions from international navigation.

Figure 89: Evolution of the ISEWs and gdp (panel A) and evolution of the components (panel B) in the US for the period 1995-2020 (measured in € in 2015 prices).

Panel A | Panel B

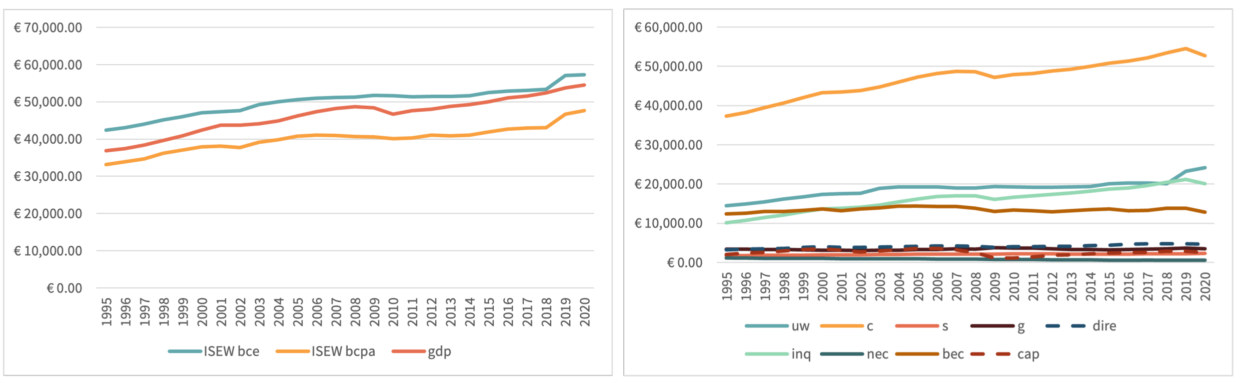

Table 41: Annual and total growth rates of the ISEWs and gdp in the US (in %)

	bce	bcpa	gdp
1995-2001	1.85	2.35	2.87
2001-2008	1.14	0.92	1.57
2008-2011	0.08	-0.30	-0.75
2011-2014	0.20	0.64	1.16
2014-2019	2.02	2.61	1.75
2019-2020	0.40	1.92	1.48
1995-2020 (total)	1.21 (35.21)	1.46 (43.55)	1.58 (48.03)

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Table 42: Annual growth rates and importance of the components in the US (in %)

	uw	ci	s	gc	direp	inq	nec	bec	k
1995-2001	3.28	2.56	1.65	-1.48	2.88	5.37	-3.11	1.09	7.06
2001-2008	1.14	1.64	1.40	1.41	1.02	2.93	-1.57	0.68	-3.24
2008-2011	0.31	-0.35	0.55	2.34	-0.65	-0.02	-3.66	-1.63	-17.33
2011-2014	0.42	1.23	-0.26	-3.29	1.59	2.39	-3.69	0.72	16.99
2014-2019	3.68	1.78	0.58	1.94	2.25	3.06	-1.87	0.56	5.32
2019-2020	4.24	-3.39	2.56	-3.59	-2.57	-4.97	1.44	-7.75	-14.30
1995-2020 (total)	2.09 (67.64)	1.39 (41.25)	1.04 (29.50)	0.15 (3.73)	1.42 (42.43)	2.78 (98.62)	-2.39 (-45.42)	0.13 (3.24)	0.74 (20.13)
Average importance in bce	26.40	65.93	2.91	4.76	19.68	76.18	4.14	/	/
Average importance in bcpa	25.47	63.61	2.81	4.59	12.18	47.41	/	40.40	3.52

5.2.3 The threshold hypothesis in the UK and the US

As for the results for the EU countries, the ISEW results for the non-EU countries can be used to test the threshold hypothesis suggested by Max-Neef (1995). In this study, the chosen threshold point is 5%, meaning that the threshold hypothesis can be confirmed if the difference between the 2020 value of a welfare measure is more than 5% lower than the 'peak value' of that welfare measure.

Tables 43 and 44 present the results of the test of the threshold hypothesis, respectively using the $ISEW_{bce}$ and $ISEW_{bcpa}$ values of the UK and the US. From these tables, we can see that the results of the test of the threshold hypothesis are quite similar for the two welfare measures. Indeed, in both cases, the 'peak year' for the UK is in 2019 and in 2020 for the US. For the UK, the threshold hypothesis based on the 5% threshold can be confirmed when looking at both welfare measures. However, for the US, since the 'peak value' is in 2020, the threshold hypothesis cannot be confirmed and indicates that welfare has not peaked yet.

Table 43: Test of the threshold hypothesis for $ISEW_{bce}$ in the UK and the US

Country	$ISEW_{bce}$ in 2020	Peak year	Peak value of the ISEW	% difference between the ISEW value in 2020 and in the peak year
UK	€ 34,649.28	2019	€ 37,124.03	-6.67%
US	€ 57,307.79	2020	€ 57,307.79	0.00%

Note: The thick line indicates the 5% threshold value selected in this study to determine whether the threshold hypothesis can be confirmed or not.

Table 44: Test of the threshold hypothesis for $ISEW_{bcpa}$ in the UK and the US

Country	$ISEW_{bcpa}$ in 2020	Peak year	Peak value of the ISEW	% difference between the ISEW value in 2020 and in the peak year
UK	€ 28,514.15	2019	€ 31,362.72	-9.08%
US	€ 47,597.28	2020	€ 47,597.28	0.00%

Note: The thick line indicates the 5% threshold value selected in this study to determine whether the threshold hypothesis can be confirmed or not.

6 Discussion

This study provides valuable insights into the welfare levels in the EU and its Member States. It reveals that trends in GDP per capita and welfare, as measured by the ISEWs per capita, diverge over the study period, with the two measures even moving in opposite directions during certain subperiods, particularly during economic recessions. However, it is important to acknowledge some general and component-specific limitations in the compilations and analysis. These limitations should be viewed as opportunities for further refinements to be taken into account in the continuously improving ISEW methodology and in the efforts of standardizing and harmonizing the ISEW.

This section outlines the limitations of the methodology used to compile the ISEWs, addressing both general challenges associated with indexes and specific issues encountered in the components of our ISEWs. It also discusses limitations related to the data used in the compilation of the indexes. Finally, a brief discussion is presented on the future of the ISEW, informed by the limitations identified earlier.

6.1 Methodology limitations

6.1.1 General comments about composite indexes and the ISEW

The ISEW is a composite index, which brings two common challenges: the aggregation of diverse variables (expressed in different units) and the issue of ”weak sustainability” (trade-offs between variables) in the index compilation.

First, to aggregate the components and compile the index, all components must be measured in the same units, requiring decisions on how to quantify and include the various variables in the index. In the case of the ISEW, a monetary aggregation was chosen to ensure comparability with GDP. However, this approach necessitates finding appropriate cost estimates to monetize variables that are not typically measured in monetary terms. These cost estimates can be difficult to obtain, and questions can arise regarding their robustness. Using monetary aggregation even leads to the exclusion of some welfare components for which no suitable cost estimates were found (e.g., biodiversity losses).

Valuing the different ISEW components can be challenging and often involves making (strong) assumptions, which necessitates caution when interpreting the results from this study. This limitation is hard to overcome, as monetary valuation studies are scarce, both in terms of frequency (typically estimated for one specific time period) and coverage (typically estimated for one specific country or region). As detailed in the methodology section (section 3) and table 45, some cost estimates used in this study rely on older sources because updated figures were not available, highlighting the difficulties in securing up-to-date and robust valuation methods.

Second, the compilation of indexes like the ISEW introduces another limitation. The index is constructed through a simple aggregation of its components, which aligns with a “weak sustainability” approach. This approach does not align with key insights from ecological economics and concerns raised within the post-growth debate. However, it is important to clarify that the ISEWs are not intended to measure sustainability. The concern here is that because the components are simply aggregated, an increase or decrease in one component can offset changes in another, potentially masking the true impact of these changes. For instance, an increase in welfare losses due to income inequality, which should negatively affect the ISEW, might be offset by a rise in individual consumption expenditures, which positively affects the index. This could

Table 45: Sources of the cost estimates used in different components for the EU data

Component	Cost estimate	Source of cost estimate
Defensive, intermediate and rehabilitative private expenditures - costs of road accidents	Costs of road accidents (injuries and fatalities)	Bickel et al. (2006)
Welfare losses from income inequality	Sufficiency threshold for calculating DMUI	Hickel (2020)
Narrow ecological costs - current costs of air pollution	Pollutant- and country-specific cost estimate	European Environment Agency (2014)
Narrow ecological costs - ecosystem costs of nitrogen pollution	Pollutant-specific cost estimate	Van Grinsven et al. (2013)
Broad ecological costs - costs of air pollution	Pollutant- and country-specific cost estimate	European Environment Agency (2014)
Broad ecological costs - costs of air pollution embodied in trade	Cost estimate	Desaigues et al. (2011)
Broad ecological costs - ecosystem costs of nitrogen pollution	Pollutant-specific cost estimate	Van Grinsven et al. (2013)
Broad ecological costs - costs of climate breakdown	Social cost of carbon	Ricke et al. (2018); Tol (2023)
Broad ecological costs - costs of depleting non-renewable energy resources	Cost estimate	European Commission (2021)
Broad ecological costs - costs of using nuclear power	Cost estimate	Held et al. (2018)

Note: This table only presents the sources used for the EU countries. For the non-EU countries, some of the cost estimates used for compiling non-EU indexes are the same as for the EU countries: the sufficiency threshold for calculating DMUI, the cost estimate for the ecosystem costs of nitrogen pollution, the cost estimate for the costs of air pollution embodied in trade, the social cost of carbon, and the cost estimate for using nuclear power. For the other cost estimates, the sources are presented in sections 5.1.

obscure the actual consequences of these changes. It is therefore important to look at underlying trends in the different ISEW components to identify driving forces behind overall welfare trends. The dataset that is presented next to this report allows to do so for both the EU and its different Member States.

6.1.2 Limitations of our methodology - Component-specific remarks

In this section we highlight a number of component-specific limitations that can serve ISEW scholars in the future to continuously improve the methodology of welfare measures.

A first component-specific limitation relates to the non-defensive government expenditures. As discussed by Van der Slycken and Bleys (2023), it could be interesting to look deeper into the broad categories of expenditures included in this component to ensure that only non-defensive expenditures on non-durable goods are included, and also to distinguish between the type of expenditures included in the $ISEW_{BCE}$ and the $ISEW_{BCPA}$ based on whether they are impacting the population's welfare only today or also in the future. However, due to a lack of more detailed data, these adjustments could not be included in this study and the total value of the three expenditures presented in section 3.3.4 are included in both ISEWs.

A second component-specific limitation relates to the component about the value of the Defensive, Intermediate and Rehabilitative expenditures (DIRE). As pointed out by Van der Slycken and Bleys (2023), within the direct and indirect costs of road accidents calculated by Bickel et al. (2006), not all costs are experienced in the present, some of the costs will be experienced in the future. The costs experienced in the future should not be included when calculating the $ISEW_{BCE}$, but due to a lack of data for costs experienced in the present only, the same cost estimates have to be used in both ISEWs even if it is not ideal.

A third component-specific remark relates to the component measuring the welfare losses from income inequality. Here, we use data on the income of different income deciles to calculate the correction factor for consumption expenditures. Ideally, one should focus on consumption data per decile, but we did not find a suitable data source for this that provides time series across all EU27 countries for the study period at hand (1995-2020). Next, our estimation method, based on Talberth and Weisdorf (2017) and Van der Slycken and Bleys (2023) does not include a correction for the societal preference on income (in)equality as we only take into account the decreasing marginal utility of income. Previous studies used either the Gini coefficient or the the Atkinson index - a measure of inequality that is based on a societal preference about income equality - to estimate the welfare losses from income inequality, and have different results for the component. One could explore the possibility of combining both arguments to correct for welfare losses from income inequality (decreasing marginal utility and societal preferences for equality) into this component.

A fourth component-specific limitation relates to the narrow ecological costs, and more specifically, to the costs of air pollution. The cost estimates used to monetize the emissions of air pollutants are taken from a study by the European Environment Agency (2014) and are assumed to be constant in our study. However, this is not the recommendation given by the authors who specify that "the damage cost values per tonne pollutant will change with time and should therefore not be assumed to be constant." (European Environment Agency, 2014, p. 59). Still, since we only have data for these cost estimates for one year, it is not possible to add a variation of the cost estimates over time. This should be investigated in future studies.

A fifth component-specific limitation is related to the Broad Ecological Costs (BEC). This component is made up of five different subcomponents. Still, when comparing the variables that are included in the BEC to the variables included in different environmental models, we see that many environmental variables are overlooked. For example, when comparing our BEC to the planetary boundaries model (Richardson et al., 2023), we see that the $ISEW_{BCPA}$ only includes variables related to two out of the nine boundaries that are identified in that model - i.e., climate change and biogeochemical flows. The other boundaries identified in the planetary boundaries model are not at all included in the broad ecological costs, which indicates that the value of the ecological costs included in our $ISEW_{BCPA}$ is probably lower than what they are in reality. Indeed, if all the planetary boundaries, especially the ones that are transgressed, were included in our measure of broad ecological costs, they would certainly be (much) higher than the ones that are included in our $ISEW_{BCPA}$ at the moment. Again, this is something that should be taken into account in future research to try and have an even better representation of the actual ecological costs. Here, it is essential to have robust and (widely) accepted cost estimates for all planetary boundaries as these are often lacking for environmental problems that have been studied less in environmental economics.

6.2 Data availability and limitations

This section reviews the availability of data for the different ISEW components and presents the different choices that had to be made during the data collection, touching upon certain data limitations in the process. We also briefly consider the timeliness of data.

To ensure clarity, we distinguish between data collection efforts for EU and non-EU countries. The discussion on non-EU data collection explores how easily the methodology outlined in this report can be applied to non-EU countries to obtain data that is comparable across nations.

6.2.1 EU data collection

The data for compiling the two ISEW indexes was sourced from various places, with some components easier to compile than others. For instance, data for the non-defensive government expenditures and the shadow economy was readily available from sources like Eurostat (2024g) and Elgin et al. (2021) and Eurostat (2024e), making these components simple to compile. The net capital investments component was also straightforward, with most data easily sourced from AMECO (2023d), requiring minimal extrapolation.

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In contrast, the most challenging component to compile was the value of unpaid work. While population data was easy to obtain from Eurostat (2023f), time use and market wage data were far more difficult, often missing a high number of data points and requiring extensive extrapolation and interpolation. Additionally, the earnings data from Eurostat (2023g) was only available every four years and from 2002 onwards, necessitating further estimation.

Other components, such as individual consumption expenditures and defensive, intermediate, and rehabilitative expenditures, were moderately challenging. While data for these components was generally available, some parts required additional computation and extrapolation. For example, data for services of consumer durables and costs of road accidents needed adjustments and supplementation from national sources. Additionally, not all cost estimates used in these components were available for all EU27 countries (e.g., Bickel et al. (2006) for the costs of road accidents) requiring additional assumptions on how to estimate them for countries that were not covered in the original studies.

The welfare losses from income inequality were easier to compute, with data largely available, though some elements, like the inequality adjustment index, required more complex calculations due to incomplete data series and the high volume of data involved. Similarly, the narrow ecological costs component, despite involving multiple subcomponents, was relatively simple to compile, as most data was readily available, though some extrapolation was necessary for earlier years.

Finally, the broad ecological costs component, despite its complexity, was relatively straightforward to collect. Data for air pollution, nitrogen pollution, greenhouse gas emissions, and footprint emissions were mostly accessible - with European Environment Agency (2024), UNEP (2024) and Friedlingstein et al. (2023) being a relatively complete sources, though adjustments were needed for specific items like emissions from navigation and land use change. The social cost of carbon, sourced from Ricke et al. (2018), required careful selection from various estimates, but overall, the component was manageable. Data for depletion of non-renewable energy resources and nuclear power use was also readily available, with minor complications in estimating cost values.

In short, most of the data needed to compile the components and indexes was collected relatively easily. However, some data gaps required us to make choices, often interpolating or extrapolating missing data in the most appropriate way based on available information. These adjustments were mainly needed for the early years of the study period, as data availability improved toward the end. To compile ISEWs annually, it is crucial that all necessary data are updated regularly. Although data availability improved later in the period, some variables were only available up to 2020 or 2021 during data collection (March to December 2023 for EU countries), which could cause gaps in future index compilation. Additionally, data from studies, like the shadow economy estimates, are updated less frequently than data from statistical offices.

6.2.2 Non-EU data collection

The efforts to collect data for non-EU countries (section 5.1) aimed to determine the feasibility of applying the same methodology as used for EU countries to compile ISEWs and achieve comparable results. Here, we compare the ease of data collection for non-EU countries to that of the EU. We also briefly reflect on the comparability of EU and non-EU welfare estimates based on the data used.

For the EU, the easiest components to calculate were non-defensive government expenditures, the value of the shadow economy, and net capital investments due to the availability of data. Similarly, for the UK, US, and South Africa, calculating the value of the shadow economy was straightforward, with data directly available from sources like Elgin et al. (2021). These components are highly comparable to those for EU countries. Net capital investments were also easy to compile for the UK and US, with data from the same sources as the EU, making them fully comparable. Non-defensive government expenditures were classified as “easy” for the UK and US, with data available from the OECD, though South Africa required more effort due to less accessible yearly publications.

The most challenging EU component was unpaid work, and it was similarly difficult for the UK, US, and South Africa. Population data was readily available from OECD (2023d), but time use data varied by source including Eurostat (2023h), Gershuny et al. (2020) and OECD (2023e), and required extensive interpolation and extrapolation. Replacement wages for unpaid work also came from multiple sources and still had many missing data points, complicating data collection and reducing comparability between countries.

The remaining EU components were moderately difficult to compile. For non-EU countries, AIC data and

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costs of consumer durables were relatively easy to collect, with comparable data sources in OECD (2024h) and OECD (2024i) respectively. However, older data for calculating services from consumer durables was more accessible for the US than for the UK or South Africa, requiring extrapolation.

The component measuring defensive, intermediate, and rehabilitative expenditures was easier to compile for the UK and US, using OECD data. However, South Africa lacked detailed data, making this component incomplete and less comparable. The number of road accidents were straightforward for the UK and US, but valuing them was more complicated because of differences in cost estimates across sources, reducing comparability.

Welfare losses from income inequality were moderately challenging to compute. Net consumption data was readily available for the UK and US, but South Africa lacked sufficient data. Income per decile was accessible for the UK through Eurostat (2024b), allowing the calculation of DMUI following the same steps as for EU countries. However, the methodology required small adjustments for the US, using income per quintile instead, complicating comparability.

The narrow ecological costs component was relatively easy to compile for the UK and US, with emissions data available from comparable sources for the current costs of air pollution and the ecosystem costs of nitrogen pollution. However, no data was found to estimate the costs of extreme weather events in a comparable way to the EU countries, yet, as this subcomponent is not the quantitatively most important one, we still argue that cautious comparisons can be made between the narrow ecological costs in EU countries and the UK and the US. This is not the case for South Africa for which we lack data on both emissions and cost estimates.

The broad ecological costs component was more difficult to estimate due to the many variables involved. Nonetheless, data for air pollution, nitrogen pollution, climate breakdown, non-renewable energy depletion, and use of nuclear power for electricity generation was collected relatively easily for the UK and US from similar sources as the EU, though with some differences in emissions data and cost estimates. South Africa faced more challenges, especially with missing emissions data, preventing the computation of this component and hence the compilation of its $ISEW_{BCPA}$.

In summary, the ISEWs for South Africa could not be compiled due to significant data gaps, particularly in ecological costs and basic data like expenditures on defensive, intermediate, and rehabilitative services, as well as net capital investments. This highlights that the lack of crucial data can prevent ISEW compilation for some (mostly non-OECD) countries. For the UK and US, the comparability of their ISEWs with EU countries is mixed. The $ISEW_{BCE}$ is not fully comparable because a subcomponent of narrow ecological costs is missing for both the UK and US. Although the size of this subcomponent is minor, it cannot simply be disregarded. The $ISEW_{BCPA}$ is more comparable, as all necessary data was collected, but caution is needed when comparing countries due to potential differences in cost estimates, such as for the costs of road accidents and ecological costs.

The lack of standardized data complicates compiling comparable ISEWs for non-EU countries. Monetizing components is also more challenging, as cost estimates for non-EU countries often come from national sources with varying methodologies. In addition, as data release timings impact the precision of the ISEW, yearly compiling ISEWs for non-EU countries would be more difficult due to reliance on a higher number of (mostly national) data sources.

6.3 The future of the ISEW

The limitations discussed above highlight the need for caution when interpreting welfare trends and, more importantly, underscore the necessity for further research and methodological improvements in the ISEW. Alternative measures of welfare such as the ISEW provide valuable insights to both policy-makers and economists, making it crucial to continue studying and refining them.

Alternative welfare measures such as the ISEWs we outline in this report, are powerful tools for measuring economic progress, offering a comprehensive macroeconomic cost-benefit analysis that addresses many of GDP's shortcomings when the latter is wrongfully used as a welfare measure. They provide a more balanced view by considering both the benefits and costs of economic activities. Moreover, ISEWs are intuitive, easily interpretable, and can be broken down to analyze the significance and trends of individual (sub)components.

This study represents the most extensive effort to date in standardizing the compilation of ISEWs across countries, simultaneously adhering to clear theoretical frameworks by distinguishing between $ISEW_{BCE}$ and

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$ISEW_{BCPA}$. It incorporates the latest methodological advancements and introduces improvements, hence contributing to the ongoing process of standardizing and enhancing ISEWs.

The limitations mentioned above should inspire further efforts to refine and standardize alternative economic welfare measures such as the ISEW. The authors of this report are committed to this goal, for instance, through the organization of a workshop with statisticians, policy-makers and technical experts as part of the MERGE project to advance ISEW methodologies.

7 Conclusion

This report presents the first standardized compilation of the Index of Sustainable Economic Welfare (ISEW) for the EU27, its Member States, the UK, and the US, marking the first study to apply a consistent methodology across such a large group of countries, both within and outside the EU. It presents two ISEW variants: $ISEW_{BCE}$, which focuses on the benefits and costs currently experienced within a specific country, and $ISEW_{BCPA}$, which considers the benefits and costs of present activities, accounting for both current impacts and those projected into the future, and this both domestically and internationally. The two ISEWs share most components but differ in their treatment of ecological costs and capital investments. The $ISEW_{BCE}$ accounts only for the ecological costs from past and present activities that are experienced today (narrow ecological costs) and excludes capital investments. In contrast, the $ISEW_{BCPA}$ includes both the ecological costs from current activities, impacting today, the future, and other countries (broad ecological costs), as well as net capital investments.

Our findings reveal that the ISEWs follow a different trend compared to GDP. In the EU27 and most Member States, per capita ISEWs increased less between 1995 and 2020 than GDP per capita. For instance, the EU27 saw $ISEW_{BCE}$ and $ISEW_{BCPA}$ rise by 15.21% and 16.95%, respectively, while GDP grew by 34.99%. During economic crises, the decline in GDP was sharper than the drop in welfare measures, due in part to reduced ecological costs and, during the COVID-19 crisis, a decrease in welfare losses from income inequality in addition to the reduced ecological costs. These results underscore the importance of considering both the benefits and costs of economic activities in macroeconomic policy design. Further analysis of the welfare trends will be conducted in Task 2.2 of the ToBe project exploring different drivers behind the trends in the ISEWs.

We also found that certain ISEW components play a more significant role in welfare estimates across most EU countries. The most important positive contributors include individual consumption expenditures and the value of unpaid work. Conversely, welfare losses from income inequality is a major negative factor, particularly in the $ISEW_{BCE}$, while broad ecological costs have the most substantial negative impact on $ISEW_{BCPA}$.

Similar patterns were observed in the UK and the US, where ISEWs and GDP all increased, though $ISEW_{BCE}$ grew less than GDP in both countries. However, in the UK, $ISEW_{BCPA}$ outpaced GDP growth, unlike in the US and EU. The key components impacting ISEWs in the UK and US mirror those in the EU.

Regarding Max-Neef's threshold hypothesis (Max-Neef, 1995), while it held true for some individual EU countries and the UK, it could not be confirmed for the EU27 as a whole. This suggests that economic growth has not yet become uneconomic. However, the ISEWs' ecological costs overlook significant environmental issues, leading to an underestimation of related welfare losses. This urges one to be cautious when making statements on the threshold hypothesis.

In conclusion, the alternative macroeconomic measures reported here provide more accurate representations of welfare than GDP by incorporating both the benefits and costs of economic activities. This report demonstrates the feasibility of compiling ISEWs across different countries using a consistent methodology, making cross-country welfare comparisons possible. The findings encourage further exploration of the factors driving welfare and GDP, which will be pursued in the ToBe project, and support continued efforts to improve and standardize the ISEW methodology, as planned within a workshop in the MERGE project.[38]

[38] https://mergeproject.eu

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Data availability

The datasets generated and analyzed in the framework of the current study are available in the Zenodo repository, DOI: 10.5281/zenodo.13365452. These datasets are available under the CC-BY license. These datasets present the values of the two ISEWs (in total and in 'per capita' terms), the values of the components of these indexes (also in total and in 'per capita' terms), as well as the values of the subcomponents (only in total). More details about the data collected to compile the ISEWs are available upon request.

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A Appendix A: Detailed country profiles

This appendix presents a detailed country profile for each individual EU Member States. In these country profiles, the evolution of the components of the ISEWs is analysed in greater detail.

Table 2 presents a definition of the different components included in the ISEWs and is useful to understand better the country profiles in this appendix.

A.1 Austria

Figure A.1.1 shows the evolution of the two ISEWs and gdp in Austria as well as the evolution of the components of the ISEWs. Tables A.1.1 and A.1.2 show the annual growth rates of the welfare measures, gdp, and components during different subperiods as well as over the whole study period. Table A.1.2 additionally shows the average importance of each component in calculating the two welfare measures.[39]

First, comparing the overall evolution of the ISEWs to that of gdp, we see from figure A.1.1 and table A.1.1 that bce and gdp slightly increased over the whole period while bcpa remained quite stable. Indeed, gdp increased by 28.70% in total over the whole period while bce increased by 10.21%. However, the growth rate of bcpa over the whole period is only 1.20%. The growth rates and importance of the components presented in table A.1.2 can be used to explain the trend of each of the welfare measure and the difference between them as well as the difference compared to gdp growth. Regarding the difference with gdp growth over the whole period, the two welfare measures increased more slowly because we see that the different costs included in the welfare measures (DIRE, welfare losses from income inequality, NEC and BEC) increased over time, reducing the growth rate of the welfare measures but not impacting the growth rate of gdp since they are not taken into account for gdp. Regarding the difference of growth rate between the two welfare measures, we see that it mainly comes from the different impacts of the components decreasing the value of the welfare measures, especially the ecological costs. Indeed, the increase of the benefits has a similar positive impact on both measures.

Tables A.1.1 and A.1.2 allow us to compare the growth rates of gdp and of the welfare measures in different subperiods and see which component(s) influenced these differences. In general, what we see is that for periods with high(er) economic growth, gdp is increasing more than the welfare measures because of rising costs of inequality that partially offset the increasing private consumption expenditures. These effects can indeed be seen for the period between 1995 and 2001, 2001 and 2008, and 2014 and 2019. On the contrary, for periods with low(er) economic growth, the welfare measures outperform gdp by increasing more or decreasing less than gdp because during these periods of lower economic growth, we see a decrease in ecological costs. These effects can indeed be seen for the period between 2008 and 2011 (the financial crisis and its aftermath) where the narrow ecological costs decreased a lot, or during the COVID-19 crisis (2019-2020), where both the narrow and broad ecological costs decreased significantly.

Looking at table A.1.1, it is also possible to identify the subperiods during which the growth rate of bce was most different from bcpa's growth rate. Table A.1.2 can be used to explain why these growth rates differ. Between 2001 and 2008, bce increased slightly but bcpa decreased. The difference in growth rates during that period is mainly caused by the strong increase in broad ecological costs that had a negative impact on bcpa. This increase in broad ecological costs was mainly driven by a strong increase of the costs of climate breakdown during that period, itself caused by strong increases in GHG emissions and especially in the CO_2 emissions from biomass and the emissions from international aviation as well as the increase in social costs of carbon.

Between 2014 and 2019, the trends took opposite directions, with bce decreasing slightly while bcpa increased. This period was marked by only small increases in some positive components and even a decrease

[39] This average importance is calculated by adding up the importance of each component for each year and dividing this sum by 26. The importance of each component for each year is calculated by comparing the importance of that component to the importance of the other positive or negative components for each year, hence following the formula: importance component X in year Y = value of component X in year Y / sum of all positive or negative components in year Y. The sum of all positive components includes the values of unpaid work, individual consumption expenditures, shadow economy, non-defensive government expenditures, and additionally also net investments for bcpa. Hence 4 components for bce and 5 components for bcpa. The sum of all negative components includes the values of defensive, intermediate and rehabilitative expenditures, welfare losses from income inequality and narrow or broad ecological costs for bce and bcpa respectively. Hence 3 components for each ISEW.

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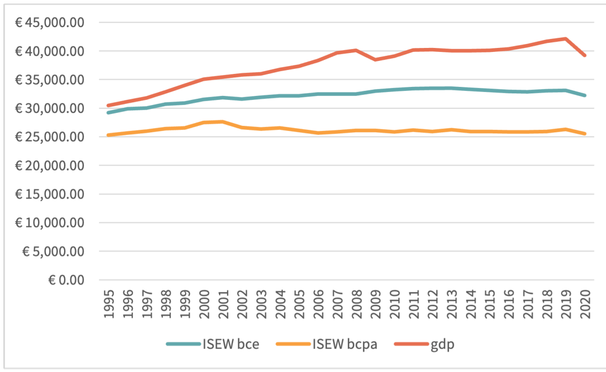
in the non-defensive government consumption, accompanied by an increase in welfare losses from income inequality. The decrease in other negative components and NEC was not sufficient to avoid a decrease in bce. However, bcpa increased during that period because these low increases and decreases were countered by an increase in net investments.

Figure A.1.1: Evolution of the ISEWs and gdp (panel A) and evolution of the components (panel B) in Austria for the period 1995-2020 (measured in € in 2015 prices).

Panel A



Panel B

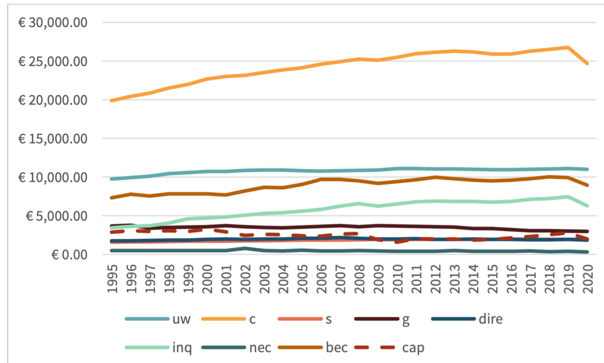


Table A.1.1: Annual and total growth rates of the ISEWs and gdp in Austria (in %).

	bce	**bcpa**	**gdp**
1995-2001	1.46	1.49	2.53
2001-2008	0.26	-0.80	1.80
2008-2011	0.96	0.12	0.02
2011-2014	-0.12	-0.35	-0.07
2014-2019	-0.11	0.30	1.02
2019-2020	-2.72	-2.81	-6.93
1995-2020 (total)	0.39 (10.21)	0.05 (1.20)	1.01 (28.70)

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Table A.1.2: Annual growth rates and importance of the components in Austria (in %)

	uw	ci	s	gc	direp	inq	nec	bec	k
1995-2001	1.57	2.46	1.51	0.17	2.10	5.78	-0.44	0.78	0.31
2001-2008	0.21	1.34	1.31	-0.60	0.61	4.52	-0.02	3.09	-1.34
2008-2011	0.65	0.92	0.69	0.28	-1.30	1.04	-6.14	0.49	-8.49
2011-2014	-0.30	0.28	0.49	-2.37	-0.65	0.27	-0.03	-0.16	-3.36
2014-2019	0.25	0.42	0.05	-1.99	-0.57	1.74	-0.57	0.71	8.41
2019-2020	-1.12	-7.66	1.13	-1.57	-3.33	-15.79	-14.51	-9.85	-27.59
1995-2020 (total)	0.48 (12.72)	0.87 (24.10)	0.92 (25.82)	-0.84 (-19.05)	0.19 (4.74)	2.43 (82.30)	-1.60 (-33.25)	0.81 (22.32)	-1.45 (-30.51)
Average importance in bce	26.77	60.01	4.56	8.66	24.25	69.87	5.88	/	/
Average importance in bcpa	25.21	56.54	4.30	8.15	11.86	34.35	/	53.80	5.80

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A.2 Belgium

In figure A.2.1, the evolution of the two welfare measures and of gdp are presented in the left panel. This figure is completed by table A.2.1, presenting the annual growth rates of these three measures over the whole period and in different subperiods. Panel B of figure A.2.1 presents the evolution of the absolute values of the components. Table A.2.2 complements this figure by presenting the annual growth rates of these components, in addition to their relative importance when calculating the two welfare measures.

Panel A of figure A.2.1 and the last row of table A.2.1 show that the two welfare measured increased over the whole period, and with very similar rates. Indeed, bce increased by 13.37% over the whole period while bcpa increased by 12.13%. The two welfare measures however increased less than half as much as gdp did because gdp increased by 30.01% in total. This big difference between the growth rate of the welfare measures and that of gdp shows that the additional components included in the welfare measures had an important impact. Most importantly, over the whole period, the increase in welfare losses from income inequality, the decrease of the non-defensive government expenditures, and the small increase in the broad ecological costs seem to be the cause of the lower growth rate of the welfare measures. The impact from the different components also explains the small difference between the evolution of the two welfare measures, as explained later.

Looking at the growth rates of gdp and of the two welfare measures over the different subperiods, presented in table A.2.1, some general conclusions can be drawn. During periods of high(er) economic growth, such as between 1995 and 2001, 2001 and 2008, and 2014-2019, gdp is increasing faster than the two welfare measures. The lower increase of the welfare measures in these three subperiods is linked to increases of the costs of inequality which are cancelling out increases in individual consumption. During the periods of low(er) economic growth, such as during the 'crisis years' of 2008-2011 and 2019-2020, we see that the welfare measures are doing better than gdp by increasing during the first subperiod and decreasing less than gdp during the second subperiod. In both cases, the increase or lower decrease of the welfare measures is linked to decreasing narrow and broad ecological costs.

By looking at tables A.2.1 and A.2.2, it is also possible to compare the growth rates of the two welfare measures in the different subperiods and to determine which (sub)components caused this difference. The only subperiod where we see a difference in trend between the two welfare measures is between the years 2001 and 2008. During this subperiod, bce is increasing while bcpa is slight decreasing. This difference in growth rates is due to the fact that the NEC are decreasing, leading to an increase in bce, while the BEC are increasing, leading to a decrease in bcpa. This increase in BEC is caused by an increase in the costs of climate breakdown during that subperiod. The increase in costs of climate breakdown in mainly lead by increasing CO_2 emissions from biomass and increasing GHG emissions linked to international navigation.

Between the years 2011 and 2014, both welfare measures had a positive annual growth rate, but bce's was very low compared to that of bcpa. In both cases, the growth rates are relatively low because of decreases or low increases of the components positively impacting the welfare measures. These negative trends were partially countered by decreases in the narrow and broad ecological costs, explaining why the growth rates are positive. Still, the growth of bcpa is higher than that of bce because of the small increase in net investments during that period.

Table A.2.1: Annual and total growth rates of the ISEWs and gdp in Belgium (in %).

	bce	**bcpa**	**gdp**
1995-2001	1.47	1.55	2.34
2001-2008	0.91	-0.08	1.62
2008-2011	0.89	1.46	-0.21
2011-2014	0.01	0.87	0.38
2014-2019	-0.23	-0.21	1.30
2019-2020	-3.99	-3.09	-5.72
1995-2020 (total)	0.50 (13.37)	0.46 (12.13)	1.06 (30.01)

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Figure A.2.1: Evolution of the ISEWs and gdp (panel A) and evolution of the components (panel B) in Belgium for the period 1995-2020 (measured in € in 2015 prices).

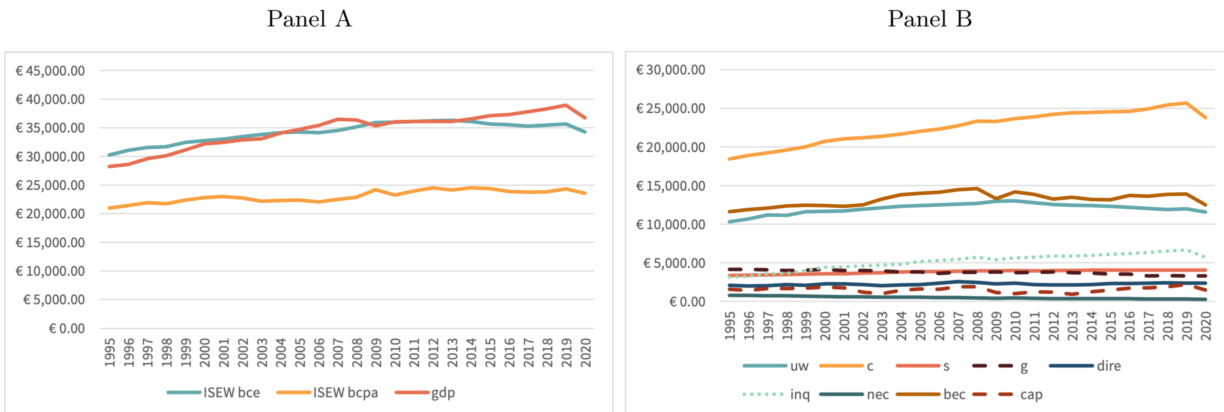

Table A.2.2: Annual growth rates and importance of the components in Belgium (in %)

	uw	ci	s	gc	direp	inq	nec	bec	k
1995-2001	2.13	2.23	1.13	-0.64	1.56	5.91	-4.46	0.98	1.59
2001-2008	1.16	1.50	1.38	-0.90	0.94	3.55	-3.80	2.47	1.13
2008-2011	0.25	0.79	0.18	-0.09	-3.44	0.15	-4.80	-1.74	-12.33
2011-2014	-1.02	0.77	0.76	-0.74	-0.08	1.17	-2.68	-1.59	0.03
2014-2019	-0.69	0.97	0.11	-2.13	1.51	2.34	-3.03	1.03	11.40
2019-2020	-3.70	-7.28	-0.70	-0.14	0.49	-13.79	-4.29	-9.98	-32.07
1995-2020 (total)	0.45 (11.83)	1.03 (29.18)	0.76 (20.93)	-0.94 (-21.01)	0.52 (13.98)	2.41 (81.37)	-3.81 (-62.17)	0.30 (7.74)	-0.27 (-6.54)
Average importance in bce	28.59	53.30	9.08	9.02	28.70	64.62	6.68	/	/
Average importance in bcpa	27.59	51.44	8.76	8.70	10.95	24.81	/	64.24	3.51

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A.3 Bulgaria

The evolution of the welfare measures and their components as well as the evolution of gdp in Bulgaria during the period studied are presented in figure A.3.1. Tables A.3.1 and A.3.2 give more details about the evolution of these measures and components by presenting the annual growth rates during different subperiods and over the whole period as well as the average importance of the components in calculating the welfare measures. Table A.3.1 presents some empty cells for the growth rate of bcpa in the first two subperiods and over the entire period studied because the absolute values of bcpa are negative for the years 1995 to 2006, making the calculation of the growth rates in those (sub)periods impossible. Still, from the absolute numbers, it is clear that these growth rates are positive.

Panel A of figure A.3.1 shows that the whole period, bcpa is lower than the two other measures while bce is almost equal to gdp the whole time. Additionally, table A.3.1 presents the growth rates of the three measures and shows that bce and gdp also had a very similar total increase over the whole period, with respective total growth rates of 97.32% and 97.73%. The total growth rate of bcpa is also positive but cannot be calculated because of the negative values of bcpa at the beginning of the period studied (1995-2006). Still, from the graph showing the evolution of the measures, it can be deducted that bcpa grew at least as much as the two other measures over the whole period.

Table A.3.2 allows to explain the difference of growth rates for the welfare measures and gdp in different subperiods. The subperiods between 2001 and 2008 and between 2014 and 2019 exhibit a relatively high economic growth. During these two periods, the growth rate of gdp was higher than that of the two welfare measures. In both cases, the lower increase of the welfare measures was mainly due to increases in the welfare losses from income inequality, which are countering some of the increase in individual consumption. On the contrary, during the subperiods between 1995 and 2001 and between 2019 and 2020, there was a lower economic growth. Between 1995 and 2001, even if the growth rate of bcpa cannot be calculated, it can be seen from figure A.3.1 that it is increasing. Similarly, bce is also increasing during that subperiod. The two welfare measures are outperforming gdp in that subperiod because of decreases in the narrow and broad ecological costs as well as in the welfare losses from income inequality. Between 2019 and 2020, the two welfare measures are again doing better than gdp with bce decreasing less than gdp and bcpa increasing. The decrease in the welfare losses from income inequality again explains the better evolution of the welfare measures during that subperiod. Regarding the ecological costs, the increase of the narrow ecological costs explains the decrease in bce while the decrease in broad ecological costs explains the increase in bcpa.

Focusing on the growth rates of bce and bcpa, it is also possible to explain the differences by looking at the growth rates of the components in the different subperiods. Between the years 2008 and 2011, bcpa decreased significantly while bce increased slightly. This difference in growth rates is also entirely caused by the big decrease in net investments during those years. In the following years, between 2011 and 2014, bce's growth rate remained relatively similar while bcpa increased a lot. The difference between the growth rates of the two welfare measures in this case comes from two subcomponents. First, the increase in net investments certainly played a role in increasing bcpa. Secondly, the decrease in the broad ecological costs also lead to that big increase. The decrease in broad ecological costs in that period is due, among other things, to the big decrease in the costs of air pollution during that period. These costs of air pollution were mainly driven by an important decrease in the production-based costs of air pollution, mainly caused by a reduction in SO_x emissions.

Finally, the period between 2019 and 2020 also presents different growth rates for the two welfare measures, with bce decreasing while bcpa increased. This difference is again caused by the the difference in evolution of the ecological costs, with the narrow ecological costs increasing while the broad ecological costs decreased. The increase in the narrow ecological costs was mainly caused by an increase of the ecosystem costs of nitrogen pollution. The decrease in the broad ecological costs was mainly caused by decreases in the costs of climate breakdown and in the costs of depleting non-renewable energy resources. The decrease in the costs of climate breakdown mainly comes from a decrease in the footprint linked to emissions embodied in trade and to a decrease in emissions from international aviation during these years. The decrease in the costs of depleting non-renewable resources is fully due to a decrease in primary energy consumption between 2019 and 2020.

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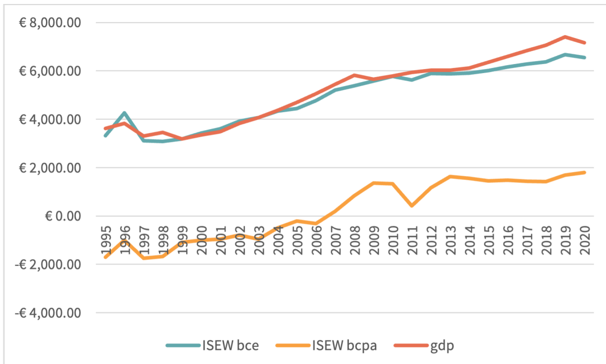
Figure A.3.1: Evolution of the ISEWs and gdp (panel A) and evolution of the components (panel B) in Bulgaria for the period 1995-2020 (measured in € in 2015 prices).

Panel A



Panel B

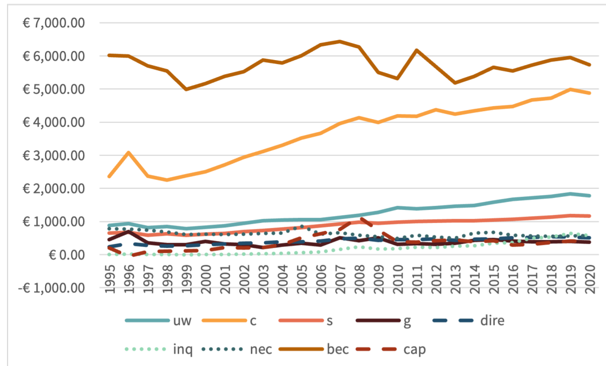


Table A.3.1: Annual and total growth rates of the ISEWs and gdp in Bulgaria (in %)

	bce	bcpa	gdp
1995-2001	1.39	* (+)	-0.60
2001-2008	5.90	* (+)	7.55
2008-2011	1.39	-20.63	0.74
2011-2014	1.68	54.94	0.95
2014-2019	2.46	1.65	3.89
2019-2020	-1.66	6.23	-3.29
1995-2020 (total)	2.76 (97.32)	* (+)	2.76 (97.73)

Note: * is used when the (annual) growth rate of the component cannot be calculated because of a negative value at the beginning and/or at the end of the (sub)period studied. The (+) or (−) in these cells indicates whether the component increased (+) or decreased (−) during the (sub)period.

Table A.3.2: Annual growth rates and importance of the components in Bulgaria (in %)

	uw	ci	s	gc	direp	inq	nec	bec	k
1995-2001	-0.32	2.29	-0.11	-5.38	4.84	-6.64	-3.99	-1.82	0.60
2001-2008	4.57	6.22	6.14	3.69	6.45	74.59	-0.47	2.21	27.28
2008-2011	5.30	0.35	0.78	-7.91	-3.10	-1.71	0.05	-0.57	-30.74
2011-2014	2.48	1.29	0.97	9.28	0.81	5.81	3.21	-4.40	1.14
2014-2019	4.35	2.83	2.75	-1.20	3.05	19.29	-2.88	2.01	1.09
2019-2020	-3.53	-2.13	-0.46	-5.91	-4.56	-11.64	1.73	-3.68	-3.06
1995-2020 (total)	2.84 (101.17)	2.94 (106.52)	2.40 (80.96)	-0.72 (-16.48)	3.06 (112.66)	19.07 (7760.33)	-1.23 (-26.60)	-0.19 (-4.67)	2.76 (97.44)
Average importance in bce	19.88	59.45	14.25	6.42	33.45	13.27	53.29	/	/
Average importance in bcpa	18.84	56.27	13.49	6.10	6.46	2.87	/	90.68	5.30

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A.4 Croatia

Figure A.4.1 presents the evolution of the values of the two welfare measures and gdp between 1995 and 2020 as well as the evolution of the absolute values of the components over the same period. Tables A.4.1 and A.4.2 complete this country profile by presenting the annual growth rates of the three measures and of the components for the entire period studied as well as for several subperiods. The second table also presents the average importance of the different components in calculating the welfare measures.

From panel A in figure A.4.1 and from the last row in table A.4.1, it can be seen that over the period studied, the three measures increased at different rates. The value of gdp increased more than the two welfare measures, with a total growth rate of 78.06%, while bce and bcpa increased by 54.64 and 35.42% in total, respectively. From table A.4.2 and panel B of figure A.4.1, it can already be seen that the lower growth rate of the welfare measures is mainly due to strong increases in the welfare losses from income inequality over the period studied. Other components evolution such as increases in the value of the defensive, intermediate and rehabilitative expenditures and in ecological costs are also linked to lower growth rates of the welfare measures.

The difference between the growth rates of the welfare measures and of gdp can be explained in more details by looking at the growth rates during different subperiods. In general when gdp is increasing, it is increasing more than the two welfare measures. This conclusion can be seen between 1995 and 2001 and between 2014 and 2019. The higher increase of gdp during those subperiods is mainly caused by increases in the welfare losses from income inequality. Between 2001 and 2008, the conclusion is not completely met because even though bce is again increasing less than gdp, bcpa is increasing more than gdp. This higher increase in bcpa during this subperiod is due to a relatively strong increase in the net investments. Similarly, in general, when gdp is decreasing, it is decreasing more than the two welfare measures. This second conclusion is seen in the subperiods between 2011 and 2014 and between 2019 and 2020. During the first subperiod, the decrease in the narrow and broad ecological costs offset the decrease in the benenfits, especially for bcpa. During the COVID-19 crisis, the two welfare measures also decreased, but at a lower rate than gdp because of a relatively strong decrease in welfare losses from income inequality. During the financial crisis, between 2008 and 2011, the conclusion is not met for bcpa because it decreased more during that subperiod. This stronger decrease in bcpa is due to relatively strong decreases in net investments, negatively offsetting the decrease in broad ecological costs. Lastly, it is interesting to see from panel A of figure A.4.1 that the absolute value of bce is higher than the absolute value of gdp during the whole period studied even though gdp increased more than bce.

Using these two tables, it is also possible to explain the differences in growth rates for the two welfare measures. We focus on three interesting subperiods of table A.4.1. First, between the years 2011 and 2014, the two welfare measures had opposite trends because bce decreased while bcpa increased. Most of the benefits decreased during that subperiod, causing the small decrease in bce. However, for bcpa, these decreases were offset by a decrease in the broad ecological costs. This decrease in BEC is mainly caused by a decrease in the ecosystem costs of nitrogen pollution, mainly lead by a decrease in the consumption of inorganic fertilizers during that period. A decrease in the costs of air pollution, mainly lead by a decrease in the costs of air pollution embodied in trade, also participated to the decrease of BEC during that subperiod.

Secondly, between 1995 and 2001, the two welfare measures increased, but at different rates because bce increased more than bcpa. Bcpa increased less during that subperiod because the net investments decreased during that period. Additionally, the broad ecological costs increased more than the narrow ones, also leading to a lower increase in bcpa. The higher increase in BEC is mainly caused by an increase in the costs of climate breakdown, itself mainly caused by the footprint emissions embodied in trade.

Thirdly, between 2008 and 2011, the two measures decreased at different rates, with bcpa decreasing more than bce. The higher decrease in bcpa during that subperiod is again mainly caused by a relatively strong decrease in net investments.

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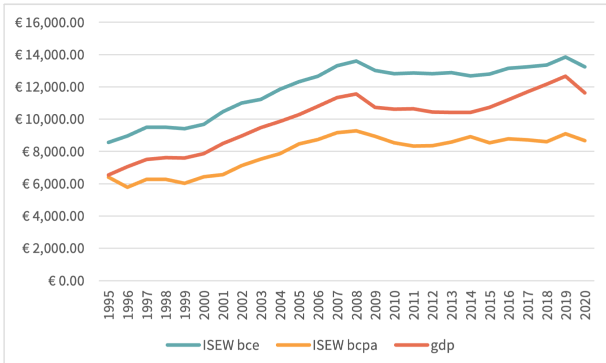
Figure A.4.1: Evolution of the ISEWs and gdp (panel A) and evolution of the components (panel B) in Croatia for the period 1995-2020 (measured in € in 2015 prices).



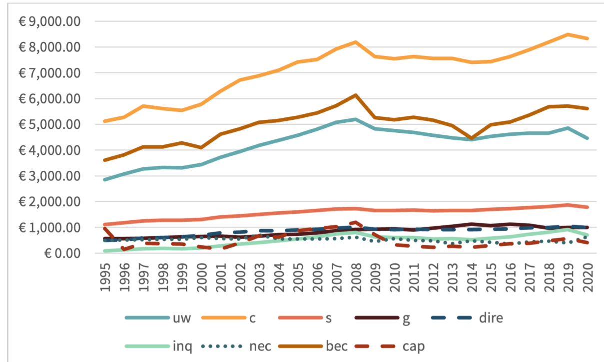


Table A.4.1: Annual and total growth rates of the ISEWs and gdp in Croatia (in %)

	bce	bcpa	gdp
1995-2001	3.39	0.43	4.46
2001-2008	3.82	5.07	4.52
2008-2011	-1.85	-3.51	-2.73
2011-2014	-0.45	2.27	-0.72
2014-2019	1.78	0.39	3.99
2019-2020	-4.41	-4.75	-8.17
1995-2020 (total)	1.76 (54.64)	1.22 (35.42)	2.33 (78.06)

Table A.4.2: Annual growth rates and importance of the components in Croatia (in %)

	uw	ci	s	gc	direp	inq	nec	bec	k
1995-2001	4.56	3.49	3.89	2.97	7.78	20.48	2.32	4.17	-25.90
2001-2008	4.85	3.85	3.02	4.60	3.70	16.17	1.32	4.15	33.56
2008-2011	-3.38	-2.36	-1.26	-0.64	-2.96	-9.02	-7.56	-4.91	-39.07
2011-2014	-1.96	-0.96	-0.29	8.03	-0.05	-4.81	-0.56	-5.38	-5.46
2014-2019	1.92	2.75	2.50	-2.44	2.58	12.03	-4.05	5.03	19.80
2019-2020	-8.04	-1.83	-4.62	0.18	-4.14	-23.65	61.57	-1.64	-27.57
1995-2020 (total)	1.81 (56.57)	1.97 (62.77)	1.88 (59.45)	2.35 (78.92)	2.83 (100.77)	8.47 (663.72)	1.00 (28.36)	1.78 (55.50)	-3.33 (-57.12)
Average importance in bce	30.93	51.64	11.39	6.04	45.68	25.33	28.99	/	/
Average importance in bcpa	29.86	49.84	11.00	5.83	13.42	7.56	/	79.02	3.47

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A.5 Cyprus

The evolution of the two welfare measures and gdp as well as that of the components of the welfare measures can be found in figure A.5.1. Additionally, tables A.5.1 and A.5.2 give more details about the annual growth rates of the measures and components for selected subperiods and the entire study period. Table A.5.2 is dedicated to the different ISEW components and also presents their average importance in calculating the value of the welfare measures.

Panel A in figure A.5.1 and the last row of table A.5.1 allow to compare the evolution of the two welfare measures and of gdp over the period studied. During that period, gdp increased by 38.50% in total, which is higher than the total increases of the two welfare measures which are equal to 29.63% for bce and to 30.89% for bcpa. Panel B of figure A.5.1 and the last row of table A.5.2 show that the lower increase in the welfare measures is mainly due to an increase in welfare losses from income inequality over the period studied.

Looking more closely at the growth rates of gdp and of the welfare measures during selected subperiods, we see that it is difficult to draw general conclusions for the difference between the growth rates of the welfare measures and gdp. Most of the time, the growth rate of gdp is in-between the growth rates of bce and bcpa, except between 2008 and 2011, between 2014 and 2019, and between 2019 and 2020. During the subperiods between 2008 and 2011 and 2019 and 2020, gdp decreased more than the two welfare measures, which could lead to the conclusion that during crises, accompanied by lower economic growth, gdp decreases more strongly than the welfare measures. Indeed, during the financial crisis, bce and bcpa also decreased, but at a lower rate than gdp, and during the COVID-19 crisis, bce decreased at a lower rate than gdp while bcpa even increased. In both cases, the welfare measures had a better growth rate than gdp because of decreases in both narrow and broad ecological costs. Between 2014 and 2019, gdp increased more than bce and bcpa because, among other things, welfare losses from income inequality increased during that subperiod, negatively impacting the values of bce and bcpa. It is not possible to draw a general conclusion about the cases where the growth rate of gdp is between the growth rate of bce and bcpa because it is due to different reasons in the different subperiods.

The growth rates of the two welfare measures also differ in the selected subperiods and the growth rates of the components shown in table A.5.2 can be used to explain these differences. Between 2019 and 2020, the difference between the growth rates of bce and bcpa was highest, with bce decreasing and bcpa increasing. This difference is due to the fact that the negative growth rate of most of the benefits was offset more in bcpa than in bce, as the decrease in the broad ecological costs was about twice as high as in the decrease in the narrow ones, and additionally the net investments increased in 2020. The higher decrease in the broad ecological costs was mainly due to (i) decreases in the costs of climate breakdown which in turn were mainly caused by the strong decrease in the footprint emissions embodied in trade, and (ii) decreases in the costs of depleting non-renewable energy resources, caused by a decrease in the primary energy consumption.

During the other subperiods, the growth rates of bce and bcpa are evolving in the same direction and at similar rates. The growth rates between the years 2011 and 2014, even if they are quite similar, are the most different growth rates in the subperiods where the two welfare measures are evolving in the same direction (both increasing or both decreasing). During that subperiod, the two welfare measures decreased, but bcpa decreased more than bce. The higher decrease in bcpa is mainly caused by a strong decrease in the net investments and by a slightly lower decrease in broad ecological costs than in the narrow ones.

Table A.5.1: Annual and total growth rates of the ISEWs and gdp in Cyprus (in %)

	bce	**bcpa**	**gdp**
1995-2001	2.87	1.57	2.80
2001-2008	2.23	2.86	2.66
2008-2011	-0.43	-0.87	-2.38
2011-2014	-3.26	-5.96	-4.64
2014-2019	1.39	2.85	4.94
2019-2020	-2.11	4.95	-4.86
1995-2020 (total)	1.04 (29.63)	1.08 (30.89)	1.31 (38.50)

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Figure A.5.1: Evolution of the ISEWs and gdp (panel A) and evolution of the components (panel B) in Cyprus for the period 1995-2020 (measured in € in 2015 prices).

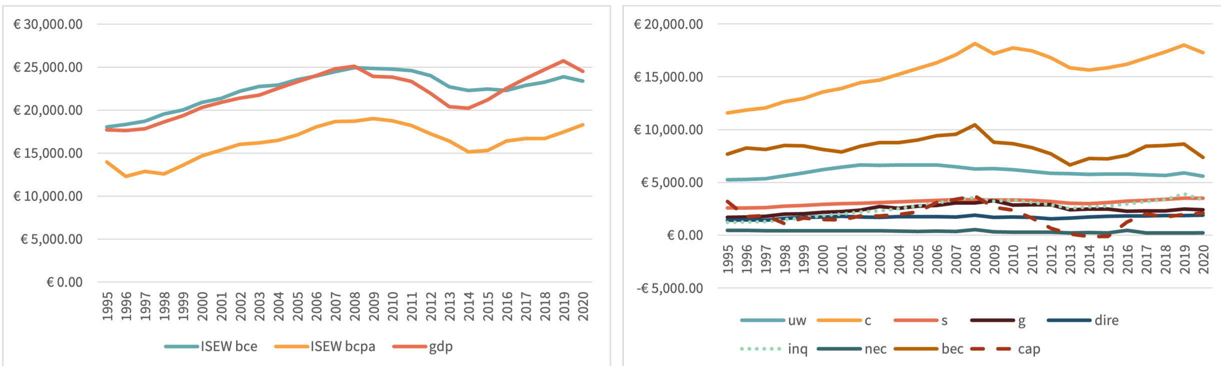


Table A.5.2: Annual growth rates and importance of the components in Cyprus (in %)

	uw	ci	s	gc	direp	inq	nec	bec	k
1995-2001	3.44	3.13	2.36	4.90	3.95	8.69	-0.48	0.45	-12.40
2001-2008	-0.38	3.87	1.84	4.54	0.61	8.63	2.61	4.09	14.42
2008-2011	-1.28	-1.28	-0.83	-2.02	-3.35	-4.53	-17.52	-7.43	-24.30
2011-2014	-1.46	-3.57	-3.09	-5.15	0.27	-4.79	-6.17	-4.33	* (−)
2014-2019	0.39	2.82	3.27	-0.02	1.87	7.83	-0.87	3.51	* (+)
2019-2020	-4.89	-3.93	-0.46	-2.71	0.63	-14.55	-7.38	-14.35	7.45
1995-2020 (total)	0.25 (6.46)	1.62 (49.52)	1.23 (35.61)	1.41 (41.77)	1.13 (32.37)	4.14 (175.40)	-2.91 (-52.18)	-0.16 (-3.86)	-1.65 (-33.99)
Average importance in bce	22.39	57.05	11.53	9.03	37.47	54.55	7.98	/	/
Average importance in bcpa	21.00	53.56	10.82	8.47	13.58	20.30	/	66.12	6.14

Note: * is used when the annual growth rate of the component cannot be calculated because of a negative value at the beginning and/or at the end of the (sub)period studied. The (+) or (−) in these cells indicates whether the component increased (+) or decreased (−) during the (sub)period.

A.6 Czechia

Panels A and B in figure A.6.1 respectively show the evolution of gdp, bce and bcpa and the evolution of the absolute value of the components of the welfare measures over the period studied. Two tables, tables A.6.1 and A.6.2, give more details about the evolution of these variables by showing the annual growth rates for the entire period and selected subperiods. The importance of the components in calculating the size of the welfare measures is also presented in table A.6.2.

Between 1995 and 2020, the period studied here, gdp increased by 69.94% in total, which is lower than the increase of 85.57% for bce and of 1185% for bcpa. As can be seen in panel A of figure A.6.1, the very high increase in bcpa is mainly caused by its very low values at the beginning of the period studied. As the last row of table A.6.2 and panel B of figure A.6.1 show, the higher increase in the welfare measures is mainly caused by the strong increase in the value of unpaid work over the period studied. We also see that there was a very big increase in the welfare losses from income inequality over the whole period, but that this negative impact was offset by the positive impact of the increase in the different components having a positive impact on the welfare measures.

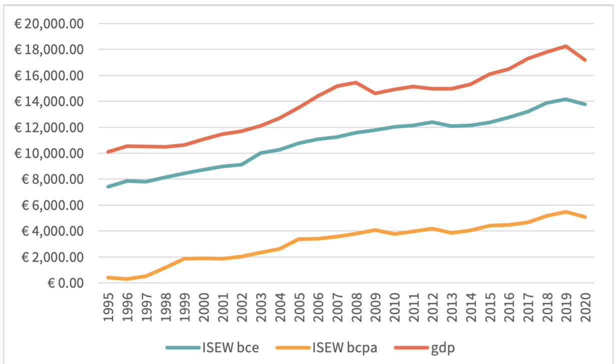
Looking at the growth rates of the measures and of the components for different selected subperiods allows to gain more insights regarding the difference in the growth rates of gdp and of the welfare measures. During periods of high(er) economic growth, bcpa is increasing faster than gdp, while bce sometimes increases faster and sometimes slower than gdp. Hence, the two welfare measures are compared to gdp separately. Starting with bcpa, the higher increase in bcpa is found in most of the subperiods, between 1995 and 2001, 2001 and 2008, 2011 and 2014, and 2014 and 2019. For the two first subperiods (1995-2001 and 2001-2008), it is important to keep in mind that the relatively lower values of bcpa at the beginning of these periods strongly influence its growth rate. Indeed, the very high growth rates of bcpa during those subperiods cannot really be explained by looking at the growth rates of the components in these subperiods, indicating that the low values at the beginning of the subperiods play a very important role in explaining the high growth rates of bcpa. More precisely, between 1995 and 2001, the small decrease in the broad ecological costs can partly explain the higher growth rate in bcpa but is not high enough to completely explain the very high difference between gdp and bcpa growth rates on its own. Similarly, the increase in net investments between 2001 and 2008 can partly explain the higher bcpa growth rate but it is not sufficiently high to fully cause the difference between gdp and bcpa growth rates. For the two other subperiods, between 2011 and 2014 and between 2014 and 2019, the low absolute values of bcpa play a relatively less important role. Again, looking at the components, we see that the decrease in BEC can partly explain the higher growth rate of bcpa compared to gdp between 2011 and 2014, while for the subperiod 2014-2019, it is the increase in net investments that can explain bcpa's higher increase. During the financial crisis (2008-2011), the fact that bcpa increased while gdp decreased is again mainly explained by the fact that the broad ecological costs decreased. The COVID-19 crisis is the only subperiod where bcpa decreased more than gdp and it is mainly due to the big decrease in net investments during that period.

The relationship between bce and gdp is less constant than that between bcpa and gdp because it is different in different periods. However, it is still possible to distinguish a pattern. In most subperiods where gdp is increasing, it is increasing more than bce. This is only not the case for the first subperiod (1995-2001), where bce is increasing more than gdp, due to the decrease in the narrow ecological costs. For the periods where bce is growing less fast than gdp - between 2001 and 2008, between 2011 and 2014, and between 2014 and 2019, it is mostly due to increases in welfare losses from income inequality that are not offset by other components. In the two remaining subperiods - between 2008 and 2011 and between 2019 and 2020, gdp decreased. During the first subperiods, bce still increased and in the second one, it decreased at a lower rate than gdp. In both cases, bce is evolving better than gdp because of a decrease in the narrow ecological costs.

Tables A.6.1 and A.6.2 can also be used to look more closely at the difference of growth rates of bce and bcpa. One important thing that can be seen from table A.6.1 is that the two welfare measures are always evolving in the same direction, increasing in every subperiod, except between 2019 and 2020 where they both decreased. In almost every period, bcpa changes more quickly than bce by having a more positive or more negative growth rate. For example, between 2019 and 2020, bcpa decreased more than bce and as can be seen from table A.6.2, this is mainly due to the relatively big decrease in net investments during that period. For almost all the other subperiods, bcpa is increasing more than bce and one important factor that causes this difference is the fact that the absolute values of bcpa are lower than the absolute values of bce, causing the growth rates of bcpa to be higher, especially at the beginning of the period studied. Indeed, in most of the subperiods, the difference in growth rates can hardly be explained by the growth rates of the components, confirming the high impact of the difference in absolute values on the growth rates. Only in the subperiod between 2014 and 2019, the higher growth rate of bcpa can be explained by an increase in net investments. There is only one subperiod, between 2008 and 2011, during which bcpa increased less than bce. This lower increase in bcpa can mainly be explained by a relatively strong decrease in net investments during that period.

Figure A.6.1: Evolution of the ISEWs and gdp (panel A) and evolution of the components (panel B) in Czechia for the period 1995-2020 (measured in € in 2015 prices).

Panel A



Panel B

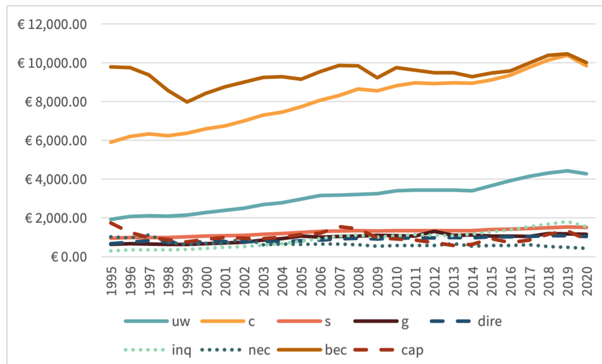


Table A.6.1: Annual and total growth rates of the ISEWs and gdp in Czechia (in %)

	bce	**bcpa**	**gdp**
1995-2001	3.23	29.50	2.12
2001-2008	3.70	10.69	4.34
2008-2011	1.56	1.43	-0.66
2011-2014	0.02	0.74	0.39
2014-2019	3.11	6.26	3.59
2019-2020	-2.70	-7.35	-5.89
1995-2020 (total)	2.50 (85.57)	10.75 (1185.52)	2.14 (69.94)

Table A.6.2: Annual growth rates and importance of the components in Czechia (in %)

	uw	ci	s	gc	direp	inq	nec	bec	k
1995-2001	3.65	2.22	2.09	1.81	2.39	7.76	-6.72	-1.81	-9.10
2001-2008	4.37	3.65	3.13	6.14	3.09	12.93	-1.14	1.67	5.59
2008-2011	2.19	1.18	0.24	0.00	0.08	0.47	-1.90	-0.77	-15.71
2011-2014	-0.34	-0.09	-0.05	1.82	0.51	0.49	-2.29	-1.20	-9.39
2014-2019	5.41	3.04	2.54	0.88	1.92	9.43	-2.37	2.44	15.61
2019-2020	-3.25	-5.26	-1.43	-1.50	-3.51	-14.76	-8.88	-4.37	-32.94
1995-2020 (total)	3.25 (122.43)	2.06 (66.63)	1.84 (57.91)	2.46 (83.56)	1.74 (53.93)	6.69 (404.85)	-3.30 (-56.74)	0.09 (2.33)	-2.66 (-49.06)
Average importance in bce	22.87	60.61	9.44	7.08	36.16	35.45	28.39	/	/
Average importance in bcpa	21.23	56.20	8.75	6.57	7.90	8.01	/	84.09	7.25

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A.7 Denmark

In figure A.7.1, we can see the evolution of gdp in comparison to the evolution of bce and bcpa over the period studied in panel A. In panel B of the same figure, we can see the evolution of the components included in the welfare measures, also giving an idea about their importance for the value of the indexes. The average importance of these components is presented in table A.7.2, which also presents the annual growth rates of the components for selected subperiods. The same subperiods are used for presenting the annual growth rates of the three measures in table A.7.1.

As can be seen from figure panel A of figure A.7.1 and from the last row of table A.7.1, gdp is the measure that increased the most over the period studied, followed by bcpa and then bce. The total growth rate of gdp was 28.65% while bcpa and bce grew by 27.71 an d 18.04%, respectively. The lower total increase for the two welfare measures is mainly caused by an increase of the welfare losses from income inequality during the period studied, while the higher total increase for bcpa compared to bce is explained by the important increase in net investments. Interestingly, gdp and bce are relatively close to each other for the whole period studied, with bce being most of the time higher then gdp.

Table A.7.2 allows to understand better the difference in the growth rates of gdp and of the welfare measures. First, from table A.7.1, we see that when there is low economic growth, during crises, gdp is decreasing more than bce and bcpa. Indeed, during the financial crisis (2008-2011), gdp decreased while bce and bcpa continued to increase. This increase in the welfare measures is due to the fact that during that subperiod, the ecological costs decreased and welfare losses from income inequality also slightly decreased. During the COVID-19 crisis (2019-2020), bce decreased less than gdp and bcpa even continued to increase. The increase in bcpa during that subperiod is caused by the decrease of the broad ecological costs and the increase in net investments. Surprisingly, the narrow ecological costs increased during that subperiod, but the decrease in welfare losses from inequality offset that negative impact, leading bce to decrease less than gdp. On the contrary, in most cases, when there is higher economic growth during a subperiod, gdp is increasing more than bce and bcpa. This finding is present between 1995 and 2001, between 2011 and 2014, and between 2014 and 2019. During these subperiods, welfare losses from income inequality increased, explaining the lower increase of the welfare measures. Additionally, between 2011 and 2014, most of the benefits decreased, further reducing the growth rate of the welfare measures. Between 2001 and 2008, all measures are increasing but gdp is increasing the least. This finding is due to a lower increase in welfare losses from income inequality as well as a decrease in narrow ecological costs, increasing bce and to an increase in net investments, increasing bcpa.

The growth rates of bce and bcpa can also be compared using tables A.7.1 and A.7.2. During two of the selected subperiods - between 2011 and 2014 and between 2019 and 2020, bce and bcpa evolved in opposite directions, with bce decreasing and bcpa increasing. Between 2011 and 2014, the big increase in net investments is clearly driving the growth rate of bcpa. Between 2019 and 2020, the increase in net investments also partially explains the increase in bcpa. However, in that subperiod, the fact that the broad ecological costs decreased while the narrow ecological costs increased is also part of the explanation for the difference between the growth rate of bcpa and that of bce. The decrease in BEC is mainly due to a decrease in the costs of depleting non-renewable energy resources, caused by a decrease in primary energy consumption. The decrease of the costs of climate breakdown also explain the decrease in BEC and was mainly caused by a strong decrease in the emissions from international aviation. The increase in NEC is mainly due to the fact there were no costs of extreme weather events in 2019 but there were some in 2020, leading to an increase in these costs.

During the remaining subperiods, bce and bcpa both increased, at different rates. When bcpa increased more than bce during a period, such as between 1995 and 2001 and between 2014 and 2019, it was mainly caused by an increase in net investments. In other periods, bce increased more than bcpa, especially between 2008 and 2011, mainly because of a strong decrease in net investments. Between 2001 and 2008, bce increase more than bcpa because the broad ecological costs increased during that period while the narrow ones decreased. The increase in BEC was mainly caused by an increase in the costs of air pollution, itself mainly caused by a strong increase in the costs of emissions embodied in trade.

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Figure A.7.1: Evolution of the ISEWs and gdp (panel A) and evolution of the components (panel B) in Denmark for the period 1995-2020 (measured in € in 2015 prices).

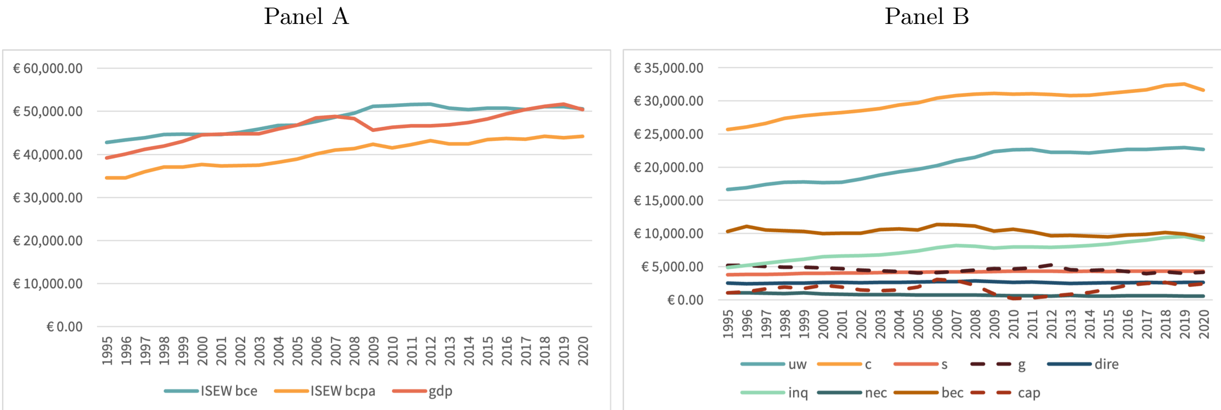

Table A.7.1: Annual and total growth rates of the ISEWs and gdp in Denmark (in %)

	bce	bcpa	gdp
1995-2001	0.70	1.29	2.21
2001-2008	1.50	1.46	1.10
2008-2011	1.34	0.74	-1.12
2011-2014	-0.76	0.16	0.52
2014-2019	0.26	0.66	1.74
2019-2020	-1.05	0.66	-2.40
1995-2020 (total)	0.67 (18.04)	0.98 (27.71)	1.01 (28.65)

Table A.7.2: Annual growth rates and importance of the components in Denmark (in %)

	uw	ci	s	gc	direp	inq	nec	bec	k
1995-2001	1.03	1.62	1.16	-1.63	0.67	5.16	-3.98	-0.46	10.56
2001-2008	2.78	1.35	0.64	-0.71	1.25	2.88	-2.22	1.46	1.88
2008-2011	1.84	0.08	0.68	2.51	-1.91	-0.37	-3.22	-2.62	-49.28
2011-2014	-0.76	-0.28	0.03	-2.80	-2.00	0.96	-4.07	-2.09	57.15
2014-2019	0.70	1.10	0.05	-1.97	0.85	3.12	-0.39	0.56	14.43
2019-2020	-1.22	-2.91	0.01	3.46	-0.30	-5.88	2.88	-5.37	12.92
1995-2020 (total)	1.24 (36.03)	0.84 (23.23)	0.55 (14.77)	-0.89 (-20.10)	0.19 (4.86)	2.47 (84.16)	-2.43 (-45.93)	-0.38 (-9.17)	3.45 (133.53)
Average importance in bce	34.57	50.62	7.06	7.76	24.27	68.76	6.97	/	/
Average importance in bcpa	33.63	49.23	6.86	7.55	12.79	36.55	/	50.67	2.73

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A.8 Estonia

Figure A.8.1 presents two panels, representing the evolution of bce, bcpa and gdp and the evolution of the components of the welfare measures, respectively. Additionally, tables A.8.1 and A.8.2 present the annual growth rates of gdp and the welfare measures and the annual growth rates of the components, respectively. The annual growth rates for the entire period and selected (sub)periods are presented in these tables, along with the average importance of the components in table A.8.2.

From the last row of table A.8.1, we learn that bcpa is the measure that increased the most over the period studied, with a growth rate of 1052.23%. The second highest total growth rate is for gdp, with a total growth rate of 183.86%. The lowest growth rate is the one for bce, with a total growth rate of 133.88% over the whole period. Even if these growth rates can be classified from highest to lowest, it is important to note that these are all quite high growth rates. A second important thing to keep in mind when looking at the growth rates of the measures is that the fact that bcpa is quite a lot lower than the two other measures, causes its growth rates to be higher. Indeed, the very high total growth rate of bcpa is mainly caused by the fact that its absolute value at the beginning of the study are quite low. Looking at the total growth rates of the components in table A.8.2, we see that most of the components have really high total growth rates, but the total growth rates of welfare losses from income inequality is the highest, explaining why bce increased less than gdp over the whole period. The high total growth rate of net investments is an additional explanation to the fact that bcpa increased more than gdp over the period studied.

Comparing the growth rates of gdp, bce and bcpa in selected subperiods allows to know more about the difference in the evolution of these measures over the period studied. The first thing to note is that the growth rates of bcpa are the most extreme, either positively or negatively, for each subperiod. Hence, during subperiods with high(er) economic growth, we see that gdp increased more than bce every time, but compared to bcpa, gdp only increased more than bcpa between 2011 and 2014. The lower growth rate of bce in these periods of positive economic growth - between 1995 and 2001, 2001 and 2008, 2011 and 2014, 2014 and 2019, is mainly caused by relatively strong increases in the welfare losses from income inequality. The combination of the increase of the welfare losses from income inequality and of an increase in the broad ecological costs cause bcpa to decreased between 2011 and 2014 while the other two measures increased. During the other periods of positive gdp growth, bcpa increased even more, mainly because of positive growth rates in net investments, and the fact that the absolute values of bcpa are relatively low. During subperiods with negative gdp growth, during the financial and the COVID-19 crises, bce performed better than gdp by decreasing less during the financial crisis and even increasing during the COVID-19 crisis. This better performance of bce is due to a combination of a decrease in narrow ecological costs and in welfare losses from income inequality. This decrease in welfare losses from income inequality, in combination with a decrease in broad ecological costs and an increase in net investments, also led to a positive growth rate during the COVID-19 crisis for bcpa. However, bcpa decreased more than the two other measures during the financial crisis, mainly because of a combination of a decrease in net investments and an increase in broad ecological costs.

The growth rates of bce and bcpa can also be compared when looking at tables A.8.1 and A.8.2. The only subperiod where the two welfare measures evolved in opposite direction is between 2011 and 2014, with an increase in bce and a decrease bcpa. This difference in growth rates is mainly caused by the fact that the broad ecological costs increased while the narrow ecological costs decreased during that period. The increase in BEC is mainly caused by an increase in the costs of climate breakdown, itseld mainly due to an increase in the emissions from international navigation during that subperiod. During the other subperiods, the two welfare measures evolved in the same direction, but with bcpa changing more significantly than bce. For the subperiods with an increase in the measures, the higher growth rate for bcpa is mainly due to increasing net investments. Similarly, between 2008 and 2011, when both measures decreased, bcpa decreased more because of a decrease in net investments.

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Figure A.8.1: Evolution of the ISEWs and gdp (panel A) and evolution of the components (panel B) in Estonia for the period 1995-2020 (measured in € in 2015 prices).

Panel A Panel B

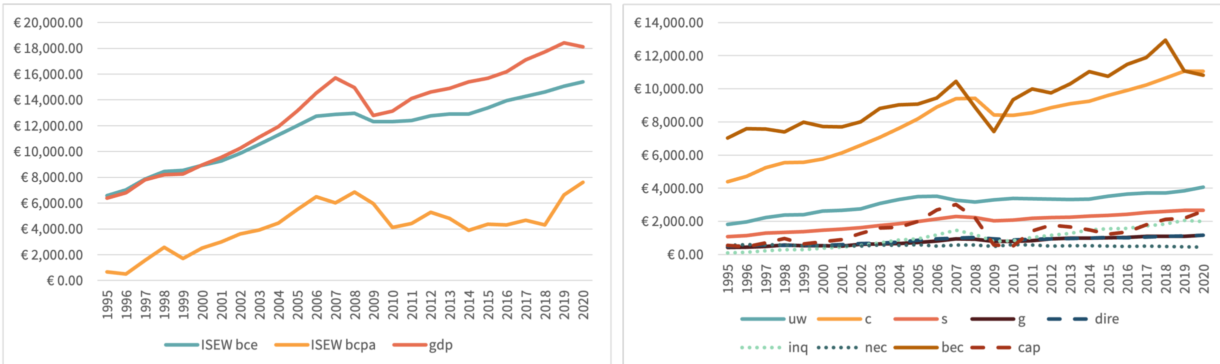

Table A.8.1: Annual and total growth rates of the ISEWs and gdp in Estonia (in %)

	bce	**bcpa**	**gdp**
1995-2001	5.89	28.65	6.94
2001-2008	4.88	12.51	6.62
2008-2011	-1.42	-13.56	-1.89
2011-2014	1.29	-4.20	2.92
2014-2019	3.14	11.26	3.65
2019-2020	2.27	15.06	-1.65
1995-2020 (total)	3.46 (133.88)	10.27 (1052.23)	4.26 (183.86)

Table A.8.2: Annual growth rates and importance of the components in Estonia (in %)

	uw	**ci**	**s**	**gc**	**direp**	**inq**	**nec**	**bec**	**k**
1995-2001	6.55	5.69	6.10	3.28	3.77	27.87	-1.09	1.51	8.31
2001-2008	2.47	6.36	5.45	8.58	7.88	15.02	1.41	2.08	13.77
2008-2011	1.84	-3.21	-0.85	-2.72	-3.56	-5.01	-0.47	3.94	-13.53
2011-2014	-0.15	2.67	2.08	5.68	2.50	13.30	-2.55	3.37	1.58
2014-2019	2.83	3.63	2.88	2.02	2.42	6.50	-2.76	0.08	7.95
2019-2020	6.15	-0.05	0.19	5.97	4.66	-3.34	-5.23	-2.30	19.47
1995-2020 (total)	3.26 (122.77)	3.76 (151.65)	3.70 (147.78)	4.13 (174.88)	3.60 (141.92)	12.55 (1822.93)	-1.01 (-22.36)	1.74 (53.79)	6.41 (372.97)
Average importance in bce	22.69	57.55	14.14	5.62	36.31	37.99	25.70	/	/
Average importance in bcpa	20.63	52.29	12.85	5.11	7.45	8.26	/	84.29	9.12

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A.9 Finland

The evolution of the values of gdp, bce and bcpa between 1995 and 2020, the period studied here, is presented in panel A of figure A.9.1. In addition to that, panel B presents the evolution of the absolute values of the components. Tables A.9.1 and A.9.2 present the annual growth rates of the three measures and of the components, respectively, for selected subperiods and the entire period. Table A.9.2 additionally shows the average importance of each components for calculating the value of the welfare measures.

Panel A of figure A.9.1 shows that gdp and bce have similar absolute values over the whole period, but that gdp increased more than bce in total. This finding is also confirmed by the last row of table A.9.1 as we see that gdp had a total growth rate of 50.24% over the period studied, while bce increased by 34.05%. The values of bcpa are lower over the whole period, but its growth rate is in between the one of bce and gdp, with a total growth rate of 45.36% over the whole period. As shown in table A.9.2, the growth rates of bce and bcpa are lower than that of gdp for the whole period because of a large overall increase in the welfare losses from income inequality. The difference in total growth rates of bce and bcpa is explained by the high increase in net investments over the whole period.

Tables A.9.1 and A.9.2 can be used to study the difference in growth rates between gdp and the welfare measures in different selected subperiods. It can be seen that during periods of positive economic growth, such as between 1995 and 2001 and between 2014 and 2019, gdp is increasing more than the two welfare measures. The lower increase of the welfare measures in these subperiods is mainly caused by increasing welfare losses from income inequality during these subperiods. Another thing that can be concluded from these two tables is that during subperiods with negative economic growth, gdp is decreasing more than the welfare measures. Indeed, during these subperiods, welfare is either increasing or decreasing less than gdp. The better performance of the welfare measures during these subperiods are mainly due to decreased narrow and broad ecological costs.

These two tables can also be used to compare the growth rates of bce and bcpa. Between 2019 and 2020, the two measures evolved in a different direction, with bce decreasing and bcpa increasing. This difference is mainly due to the fact that the decrease in broad ecological costs was higher than the decrease in narrow ecological costs. This higher decrease in broad ecological costs is mainly due to a decrease in the costs of climate breakdown, mainly driven by a strong decrease in emissions from international aviation.

In the other subperiods, bce and bcpa evolved in the same direction and at relatively similar rates. In every case, bcpa is changing more than bce by either increasing more or decreasing more. The higher increase or decrease in bcpa compared to bce is generally caused by changes in net investments, which either increase the value of bcpa or decrease it.

Figure A.9.1: Evolution of the ISEWs and gdp (panel A) and evolution of the components (panel B) in Finland for the period 1995-2020 (measured in € in 2015 prices).

Panel A

Panel B

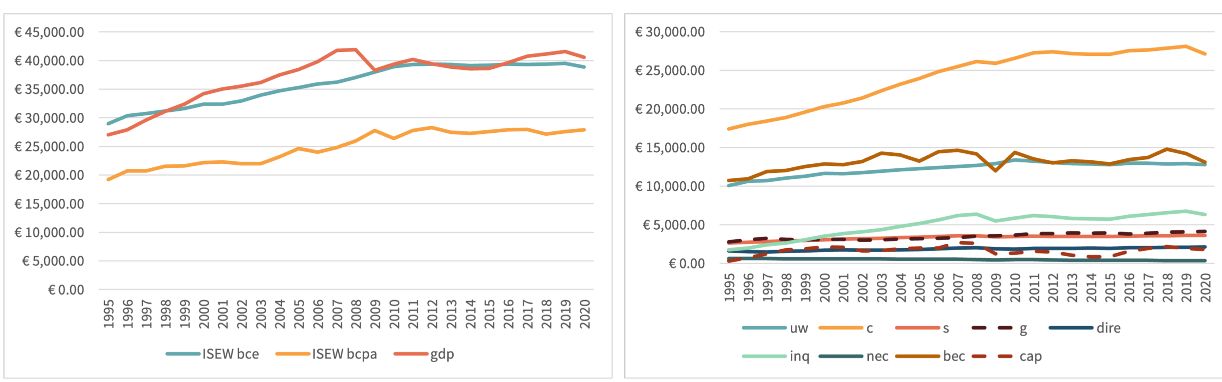

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Table A.9.1: Annual and total growth rates of the ISEWs and gdp in Finland (in %)

	bce	bcpa	gdp
1995-2001	1.88	2.52	4.42
2001-2008	1.92	2.20	2.60
2008-2011	2.00	2.36	-1.38
2011-2014	-0.16	-0.68	-1.35
2014-2019	0.21	0.25	1.53
2019-2020	-1.68	1.08	-2.49
1995-2020 (total)	1.18 (34.05)	1.51 (45.36)	1.64 (50.24)

Table A.9.2: Annual growth rates and importance of the components in Finland (in %)

	uw	ci	s	gc	direp	inq	nec	bec	k
1995-2001	2.40	2.97	2.87	1.74	1.76	14.04	-1.01	2.94	34.96
2001-2008	1.25	3.35	1.93	1.85	2.06	7.42	-1.96	1.48	3.20
2008-2011	1.48	1.38	-0.49	3.21	-1.59	-0.95	-1.96	-1.49	-14.82
2011-2014	-0.97	-0.23	-0.49	0.03	0.99	-2.43	-3.77	-0.96	-17.83
2014-2019	0.06	0.76	0.74	0.95	0.64	3.20	-2.45	1.59	17.13
2019-2020	-1.05	-3.55	-0.09	1.73	2.20	-6.38	-3.78	-8.04	-8.60
1995-2020 (total)	0.95 (26.65)	1.79 (55.66)	1.25 (36.26)	1.58 (47.98)	1.14 (32.66)	5.25 (259.12)	-2.12 (-41.53)	0.79 (21.81)	6.82 (420.64)
Average importance in bce	28.52	55.63	7.74	8.11	26.35	65.95	7.69	/	/
Average importance in bcpa	27.48	53.59	7.46	7.82	9.34	24.14	/	66.52	3.66

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A.10 France

Figure A.10.1 presents two panels, one showing the evolution of gdp, bce and bcpa between 1995 and 2020, the period studied, and another showing the evolution of the components of the welfare measures over the same period. Two tables also show the annual growth rates of the three measures, table A.10.1, and of the components, table A.10.2. The second table also presents an estimation of the average importance of the components in calculating the value of the welfare measures.

Panel A of figure A.10.1 and the last row of table A.10.1 show that gdp increased more than the two welfare measures over the period studied. Indeed, gdp increased by 20.43% in total while the bce and bcpa had a relatively low total increase of 5.08% and 8.23%, respectively. As can be seen from table A.10.2 and panel B of figure A.10.1, the lower increase of the welfare measures compared to gdp is principally due to the increase in welfare losses from income inequality between 1995 and 2020. Over the period studied, gdp and bce had very similar values while bcpa had lower values, increasing its growth rates.

Looking at tables A.10.1 and A.10.2, we can look more closely at the evolution of the welfare measures and of gdp over the period studied by studying different subperiods. What can be seen from table A.10.1 is that, when there is negative economic growth, during the crises (between 2008 and 2011 and between 2019 and 2020), gdp decreased more than the welfare measures. Indeed, during the financial crisis (2008-2011), the welfare measures even increased, mainly because of the decrease in the narrow and broad ecological costs. During the COVID-19 crisis, the welfare measures decreased, but at a lower rate than gdp because of a combination of decreases in the narrow and broad ecological costs as well as in the welfare losses from income inequality. In periods of positive economic growth, gdp generally increased more than bce and bcpa, this is the case for the years between 1995 and 2001, between 2001 and 2008, and 2014 and 2019. The lower growth rates of the welfare measures was mainly due to an increase in the welfare losses from income inequality during these subperiods.

Tables A.10.1 and A.10.2 also allow to compare the growth rates of bce and bcpa and understand why they differ. The subperiod between 2014 and 2019 is the period where there was the biggest difference between the two welfare measures because they evolved in different directions. The value of bce decreased and the value of bcpa increased during that subperiod. The difference between the evolution of the two welfare measures during that subperiod is due to the fact that the narrow ecological costs increased while the broad ecological costs decreased. Additionally, there was an increase in net investments during that period, adding to the increase in bcpa. The main driving force behind the increase of the NEC is an increase in the costs of extreme weather events between 2014 and 2019. This increase is not reflected in the broad ecological costs and on the contrary, the BEC decreased principally because of a decrease in the costs of air pollution. These costs of air pollution decreased because of relatively similar decreases in the costs of air pollution from production and those embodied in trade. The costs of air pollution from production principally decreased because of a relatively strong decrease in the emissions of sulphur oxides.

In the other subperiods, the two welfare measures evolved in the same direction and at similar rates, with bcpa generally changing a bit more than bce and having a higher positive growth rate, or a more negative growth rate than bce. These small differences in growth rates are generally due to small differences in the growth rates of narrow and broad ecological costs or due to big changes net investments over the subperiod, as between the years 2019 and 2020 where the big decrease in net investments leads to a lower growth rate for bcpa than for bce.

Table A.10.1: Annual and total growth rates of the ISEWs and gdp in France (in %)

	bce	**bcpa**	**gdp**
1995-2001	1.07	1.52	2.30
2001-2008	-0.07	-0.25	0.95
2008-2011	0.78	0.50	-0.11
2011-2014	0.51	0.96	0.01
2014-2019	-0.07	0.30	1.33
2019-2020	-4.38	-5.11	-7.69
1995-2020 (total)	0.20 (5.08)	0.32 (8.23)	0.75 (20.43)

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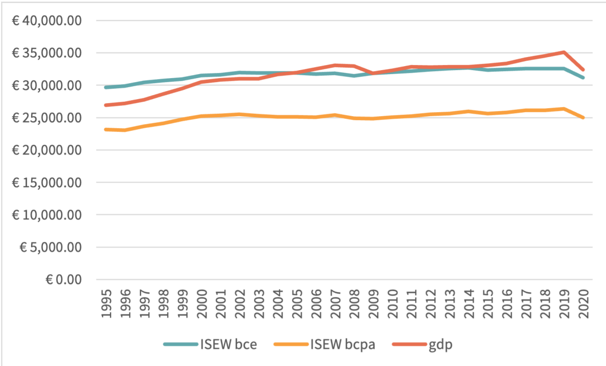
Figure A.10.1: Evolution of the ISEWs and gdp (panel A) and evolution of the components (panel B) in France for the period 1995-2020 (measured in € in 2015 prices).

Panel A



Panel B

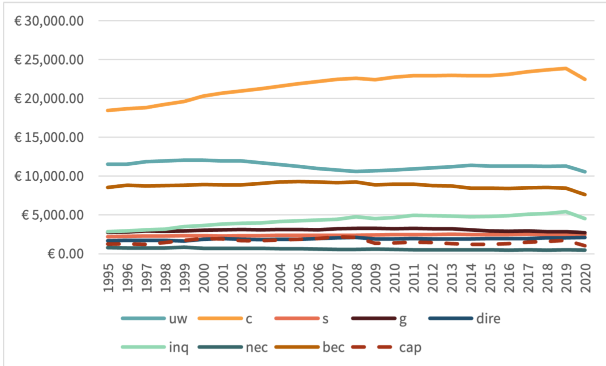


Table A.10.2: Annual growth rates and importance of the components in France (in %)

	uw	ci	s	gc	direp	inq	nec	bec	k
1995-2001	0.56	1.94	0.73	2.07	2.48	4.98	-1.79	0.61	7.02
2001-2008	-1.66	1.29	0.50	0.71	1.33	3.20	-2.90	0.58	1.41
2008-2011	0.97	0.48	1.10	-0.07	-2.89	1.33	-2.72	-1.13	-11.19
2011-2014	1.36	-0.03	0.29	-1.90	-0.82	-1.09	-1.07	-1.91	-6.03
2014-2019	-0.12	0.82	0.10	-1.58	1.42	2.54	0.13	-0.01	7.15
2019-2020	-6.51	-5.96	-0.32	-4.37	3.04	-16.17	-9.84	-9.77	-40.05
1995-2020 (total)	-0.35 (-8.44)	0.79 (21.86)	0.49 (12.99)	-0.04 (-1.11)	0.91 (25.52)	1.89 (59.68)	-2.08 (-40.92)	-0.47 (-11.12)	-0.81 (-18.48)
Average importance in bce	29.52	56.38	6.23	7.87	28.07	62.69	9.24	/	/
Average importance in bcpa	28.37	54.19	5.98	7.57	12.67	28.49	/	58.84	3.90

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A.11 Germany

The evolution of gdp between 1995 and 2020 is presented in panel A of figure A.11.1 together with the evolution of bce and of bcpa to allow to compare them. In the second panel of that figure, the evolution of the different components of the welfare measures are presented. Additionally, tables A.11.1 and A.11.2 present the annual growth rates of the total measures and of the components for the period studied as well as for selected subperiods. The second table also includes the average importance of each components for the two welfare measures.

First looking at the overall trend of gdp and the welfare measures, we can see from the last row of table A.11.1 and in panel A of figure A.11.1 that gdp is the measure that increased the most over the period studied. Indeed, gdp increased by 31.39% in total, while the two welfare measures only increased at low rates of 8.10% for bce and 6.73% for bcpa. The lower total increase of the welfare measures can be explained by looking at the components and seeing that welfare losses from income inequality, which have a relatively high importance in the two welfare measures, is the one that changed the most over the period studied. The value of the welfare losses increased over the period studied, which has a negative impact on the values of bce and bcpa, hence explaining their lower growth rates.

The difference between the growth rates of gdp and of the welfare measures can also be analysed for different subperiods to draw some possible conclusions about the relationship between the evolution of gdp and of welfare. This analysis can be made using tables A.11.1 and A.11.2. During the COVID-19 crisis (2019-2020), all measures decreased but gdp is the one that decreased the most. The two welfare measures decreased less than gdp principally due to a combination of a decrease in the narrow and broad ecological costs as well as a decrease of the welfare losses from income inequality. However, during the financial crisis (2008-2011), we see that all measures increased, with gdp surprisingly increasing more than the welfare measures. The lower increase of bce and bcpa is mainly caused by the fact that, the decrease in ecological costs during the crisis was offset by an increase in welfare losses from income inequality. The same explanation can be used to explain the higher gdp growth rates during the subperiods between 2001 and 2008 and between 2011 and 2014, leading to the conclusion that, generally, the increase of welfare losses from income inequality play a significant role in decreasing welfare in periods of positive economic growth. Still, for bcpa, an increase in net investments can offset the increase in welfare losses from income inequality and lead to a higher growth rate for bcpa than for gdp, as between the years 2014 and 2019.

Finally, the different growth rates for bce and bcpa in the selected subperiods can also be explained by looking at the growth rate of the components. In all subperiods, the growth rates of bce and bcpa are evolving in the same direction and at similar rates. The growth rates were the most different in the years between 2001 and 2008 and between 2014 and 2019. Between the years 2001 and 2008, the two welfare measures decreased, with a higher decrease for bcpa than for bce. The higher decrease for bcpa than for bce is primarily due to the decrease in net investments during this subperiod. Between 2014 and 2019, the two welfare measures increased. Again, bcpa increased more than bce, which is also mainly due to an increase in net investments during that subperiod.

Table A.11.1: Annual and total growth rates of the ISEWs and gdp in Germany (in %)

	bce	**bcpa**	**gdp**
1995-2001	1.64	1.81	1.70
2001-2008	-0.29	-1.04	1.25
2008-2011	0.47	0.54	1.52
2011-2014	-0.61	-0.79	0.79
2014-2019	0.49	1.16	1.13
2019-2020	-1.96	-1.91	-3.94
1995-2020 (total)	0.31 (8.10)	0.26 (6.73)	1.10 (31.39)

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Figure A.11.1: Evolution of the ISEWs and gdp (panel A) and evolution of the components (panel B) in Germany for the period 1995-2020 (measured in € in 2015 prices).

Panel A Panel B

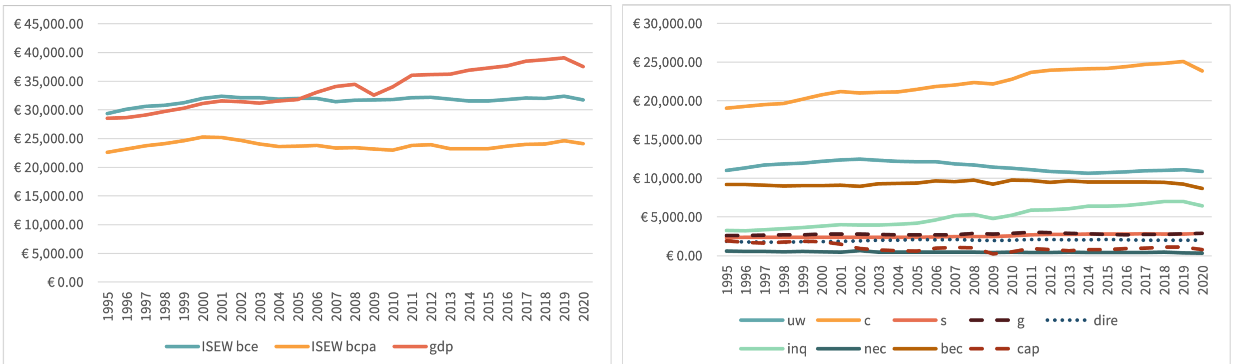

Table A.11.2: Annual growth rates and importance of the components in Germany (in %)

	uw	ci	s	gc	direp	inq	nec	bec	k
1995-2001	1.95	1.76	0.14	1.03	0.26	3.37	-3.42	-0.18	-4.10
2001-2008	-0.80	0.79	0.80	0.57	0.91	4.15	-0.70	0.99	-5.08
2008-2011	-1.77	1.91	2.75	1.77	1.38	3.38	-2.05	-0.14	-2.86
2011-2014	-1.41	0.62	1.08	-2.16	-0.58	2.79	-1.26	-0.69	-6.11
2014-2019	0.85	0.76	-0.10	-0.20	-0.44	1.88	-0.97	-0.59	7.51
2019-2020	-2.11	-4.85	3.73	2.01	-0.84	-8.06	-18.56	-6.09	-29.17
1995-2020 (total)	-0.06 (-1.56)	0.90 (25.00)	0.84 (23.27)	0.39 (10.30)	0.29 (7.52)	2.74 (96.39)	-2.42 (-45.79)	-0.23 (-5.68)	-3.44 (-58.34)
Average importance in bce	29.51	56.84	6.52	7.13	27.05	66.37	6.58	/	/
Average importance in bcpa	28.70	55.33	6.35	6.93	12.12	30.28	/	57.60	2.69

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A.12 Greece

Figure A.12.1 presents two panels, showing the evolution of different variables between 1995 and 2020. In panel A, the evolution of gdp, bce and bcpa are presented, while panel B shows the evolution of the components of the welfare measures. On one hand, table A.12.1 complements panel A by showing the annual growth rates of the three measures for the whole period as well as for selected subperiods. On the other hand, table A.12.2 complements panel B by showing the annual growth rates of the components for the whole period and selected subperiods, as well as a measures of the average importance of each component in the value of the welfare measure.

Panel A of figure A.12.1 shows that the three measures - gdp, bce, bcpa - all increased until around 2008 and then decreased, leading to relatively stable measures in total. Indeed, gdp had the lowest total growth rate of 8.03% over the studied period, bcpa had the second lowest growth rate of 9.03% over the studied period, and bce had the highest (but still not very high) growth rate of 11.58% over the studied period. From table A.12.2, we can see that the higher growth rates of the welfare measures is principally due to the decrease in ecological costs over the period studied. Regarding the absolute values of the measures, we see that their ranking remains the same for the whole period, with bcpa being the lowest, gdp being in the middle, and bce being the highest.

A similar exercise of comparing growth rates between gdp and the welfare measures can be done for selected subperiods using tables A.12.1 and A.12.2. One thing that can be seen from these tables is that during crises, gdp decreased more than the welfare measures. Indeed, during the financial crisis (2008-2011), gdp decreased more than bce and bcpa, primarily because the narrow and broad ecological costs as well as the welfare losses from income inequality decreased a lot during that subperiod, reducing the decrease in welfare. During the COVID-19 crisis (2019-2020), gdp also decreased more than the welfare measures. In this case, bcpa had a smaller decrease because of the decrease in broad ecological costs and of the strong decrease in welfare losses from income inequality. However, the lower decrease in bce can only be explained by the strong decrease in welfare losses from income inequality, which is quite important for calculating the value of bce. However, we cannot conclude that during negative economic growth gdp always decreases more than the welfare measures because in the aftermath of the financial crisis (2011-2014), the three measures continued to decrease but gdp decreased less than the two welfare measures. The welfare measures decreased more than gdp in this period because some of the benefits decreased more than in the previous period and the decrease in the welfare losses from income inequality and in ecological costs was less important than during the previous period. In two of the three subperiods with positive gdp growth, gdp increased more than the two welfare measures. In these subperiods, the increase of the welfare measures was lower than the increase of gdp mainly because of increasing welfare losses from income inequality, especially between 1995 and 2001, and because of slightly increasing ecological costs, especially between 2014 and 2019.

The two tables can also be used to compare the growth rates of the welfare measures. In one of the subperiods, between 2014 and 2019, bce decreased while bcpa increased. This is the only subperiod during which the two measures evolved in an opposite direction. During this subperiod, bce decreased because of a small increase in the narrow ecological costs primarily caused by an increase in the costs of extreme weather events. The broad ecological costs also increased during that period, but less than the narrow ones. The small increase in the broad ecological cost was primarily caused by small increases in the ecosystem cost of nitrogen pollution and in the costs of climate breakdown. The first increase was principally due to an increase in the consumption of inorganic fertilizers, while the second increase was primarily caused by increases of emissions from international aviation and navigation. Additionally, an increase in net investments also participated to the overall increase of bcpa.

In the other subperiods, the two welfare measures evolved in the same direction and at similar rates. Still, between 2008 and 2011, bcpa decreased quite a lot more than bce, primarily because of a strong decrease in net investments during this subperiod which only impacted the value of bcpa. On the contrary, between 2019 and 2020, bce decreased quite a lot more than bcpa because there was a strong increase in the narrow ecological costs, mainly driven by a very strong increase of the costs of extreme weather events during that period, while the broad ecological costs decreased, mainly because of a decrease in the costs of depleting non-renewable energy resources, and there was an increase in net investments.

Figure A.12.1: Evolution of the ISEWs and gdp (panel A) and evolution of the components (panel B) in Greece for the period 1995-2020 (measured in € in 2015 prices).

Panel A
Panel B

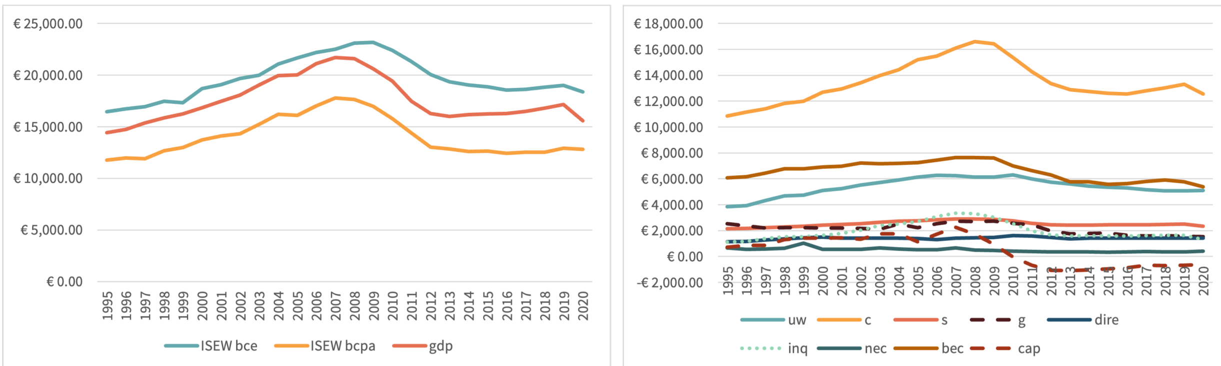

Table A.12.1: Annual and total growth rates of the ISEWs and gdp in Greece (in %)

	bce	bcpa	gdp
1995-2001	2.48	3.09	3.24
2001-2008	2.76	3.25	3.10
2008-2011	-2.63	-6.58	-6.85
2011-2014	-3.70	-4.36	-2.51
2014-2019	-0.03	0.51	1.16
2019-2020	-3.34	-0.80	-9.17
1995-2020 (total)	0.44 (11.58)	0.35 (9.03)	0.31 (8.03)

Table A.12.2: Annual growth rates and importance of the components in Greece (in %)

	uw	ci	s	gc	direp	inq	nec	bec	k
1995-2001	5.20	2.98	2.50	-2.37	3.87	8.07	-2.69	2.31	12.60
2001-2008	2.32	3.63	2.22	2.96	0.28	9.19	-1.94	1.31	2.47
2008-2011	-0.86	-4.91	-3.96	-3.19	2.92	-15.62	-7.81	-4.69	* (−)
2011-2014	-3.11	-3.75	-1.68	-9.84	-3.98	-6.75	-2.61	-4.56	* (−)
2014-2019	-1.34	0.88	0.51	-2.88	0.11	0.45	0.74	0.07	* (+)
2019-2020	0.29	-5.71	-5.96	-1.69	0.88	-21.29	14.67	-7.02	* (+)
1995-2020 (total)	1.12 (32.20)	0.58 (15.60)	0.38 (9.90)	-2.02 (-40.01)	0.91 (25.38)	0.58 (15.59)	-1.78 (-36.24)	-0.50 (-11.79)	* (−)
Average importance in bce	22.88	57.21	10.75	9.15	37.18	49.63	13.20	/	/
Average importance in bcpa	22.54	56.30	10.58	8.96	14.33	19.38	/	66.28	1.62

Note: * is used when the annual growth rate of the component cannot be calculated because of a negative value at the beginning and/or at the end of the (sub)period studied. The (+) or (−) in these cells indicates whether the component increased (+) or decreased (−) during the (sub)period.

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A.13 Hungary

Figure A.13.1 presents the evolution of gdp, bce and bcpa between 1995 and 2020 in one panel, and the evolution of the components of the welfare measures over the same period in another panel. Tables A.13.1 and A.13.2 present the annual growth rates of these different variables for the period studied and for selected subperiods. Additionally, table A.13.2 presents the average importance of the components of the welfare measures.

From the evolution of gdp, bce and bcpa presented in panel A of figure A.13.1 and from the last row of table A.13.1, we can see that all the measures increased quite a lot during the period studied. Given the lower values of bcpa, especially at the beginning of the period, this welfare measure had the highest growth rate of 294.05% for the whole period. The values of gdp and bce are very similar for the whole period, leading to similar growth rates for the two measures but with gdp increasing more than bce because of the growth rate of 87.77% for gdp and 77.62% for bce. The lower growth rate of bce is primarily due to the high increase in welfare losses from income inequality between 1995 and 2020. This increase of welfare losses of income inequality also impacted the growth rate of bcpa, but this negative impact was offset by the very high increase in net investments over the years. Still, it is important to remember that the relatively lower values of bcpa during the whole period also participates to its higher growth rates.

The growth rates of the welfare measures and of gdp also differed in the different subperiods selected. It is difficult to draw general conclusions regarding the similarity or dissimilarity of the growth rates of the welfare measures and gdp because of the differences in every subperiod. Analysing the reasons for the difference between the growth rates for the subperiods where they differ the most is still interesting. For example, during the COVID-19 crisis (2019-2020), gdp decreased more than bce and bcpa even though the two welfare measures also decreased during that period. The main reason for the lower decrease of the welfare measures is the relatively high decrease in welfare losses from income inequality during that period. Interestingly, bcpa often has higher - more positive or more negative - growth rates than bce and gdp. This difference is for example seen between 2011 and 2014. In that period, the higher growth rate of bcpa is mainly due to a high increase in net investments. Besides the impact of the lower values of bcpa, this increase also explains the higher growth rate of bcpa between 1995 and 2001 and between 2001 and 2008. Similarly, between 2008 and 2011, bcpa decreased more than the two other measures, mainly because of a strong decrease in net investments.

Continuing the comparison between growth rates but focusing only on the welfare measures, we indeed see that bcpa has more 'extreme' growth rates than bce in every subperiod. At the beginning of the period studied, this difference is significantly caused by the fact that the values of bcpa are lower than those of bce, but also to some extent because of increases in net investments. Between 2008 and 2011, the growth rate of bcpa is indeed more extreme than that of bce, but also goes in the opposite direction because bce increased during that period, while bcpa decreased. During that subperiod, the main explanation for the decrease in bcpa is again the growth rate of net investments, which strongly decreased during that period. The investments increased a lot in the following subperiod (2008-2014), again leading to a much higher growth rate of bcpa. However in that period, the decrease in broad ecological costs also played a role in increasing the growth rate of bcpa. During that period, even though the ecosystem costs of nitrogen pollution increased (explaining the increase in NEC), the decrease in the costs of air pollution led to a decrease in BEC. This decrease was mainly due to a decrease in the costs of air pollution embodied in trade. In the remaining periods, bcpa changed a bit less extremely compared to bce, but again the difference between the growth rate of the two welfare measures was strongly influenced by the changes in net investments.

Figure A.13.1: Evolution of the ISEWs and gdp (panel A) and evolution of the components (panel B) in Hungary for the period 1995-2020 (measured in € in 2015 prices).

Panel A　　　　Panel B

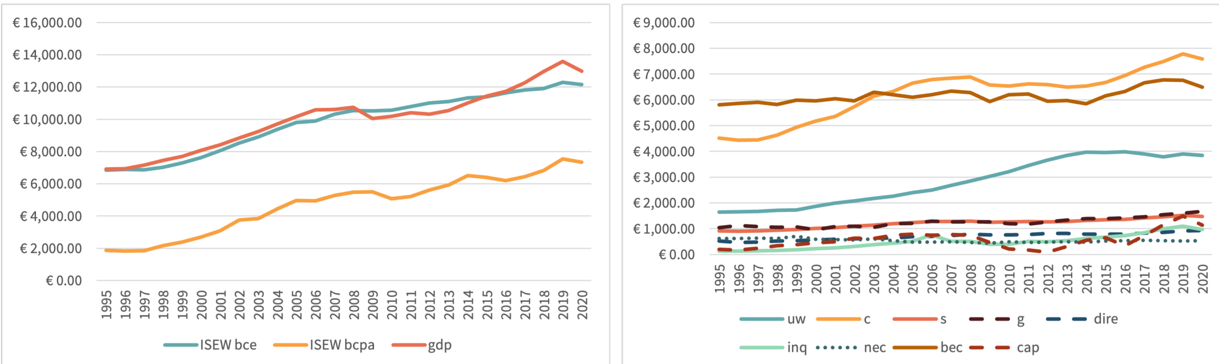

Table A.13.1: Annual and total growth rates of the ISEWs and gdp in Hungary (in %)

	bce	**bcpa**	**gdp**
1995-2001	2.75	8.73	3.34
2001-2008	3.93	8.56	3.55
2008-2011	0.77	-1.65	-1.10
2011-2014	1.65	7.82	1.94
2014-2019	1.64	2.98	4.30
2019-2020	-1.16	-2.86	-4.50
1995-2020 (total)	2.32 (77.62)	5.64 (294.05)	2.55 (87.77)

Table A.13.2: Annual growth rates and importance of the components in Hungary (in %)

	uw	**ci**	**s**	**gc**	**direp**	**inq**	**nec**	**bec**	**k**
1995-2001	3.31	2.87	2.36	0.64	2.12	12.89	-1.21	0.69	16.09
2001-2008	5.22	3.66	3.15	2.30	4.15	10.18	-3.14	0.55	5.96
2008-2011	6.61	-1.32	-0.62	-2.11	-0.27	-0.76	0.42	-0.32	-38.84
2011-2014	4.76	-0.43	1.06	5.63	0.38	7.30	1.11	-2.07	47.64
2014-2019	-0.35	3.59	2.90	2.84	2.98	12.00	1.65	2.92	21.91
2019-2020	-1.51	-2.57	-2.38	4.11	2.01	-10.80	2.56	-3.79	-23.05
1995-2020 (total)	3.46 (134.13)	2.10 (67.98)	1.97 (63.01)	1.93 (61.30)	2.35 (78.74)	8.53 (674.22)	-0.57 (-13.31)	0.45 (11.93)	7.14 (460.16)
Average importance in bce	24.07	54.35	10.59	10.99	40.61	26.58	32.81	/	/
Average importance in bcpa	23.00	51.88	10.11	10.50	9.51	6.51	/	83.98	4.51

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A.14 Ireland

Panel A of figure A.14.1 presents the evolution of gdp, bce and bcpa between 1995 and 2020, the period of interest here. In the same figure, panel B presents the evolution of the components of the two welfare measures over the same period. The annual growth rates of the three measures and of the components for the same period and for selected subperiods are additionally presented in tables A.14.1 and A.14.2. The second table also presents the average importance of the value of the different components in calculating the value of the welfare measures.

Panel A of figure A.14.1 shows that the three measures started from a relatively similar level but that gdp increased a lot more than the welfare measures, with a total growth rate of 181.44% over the period studied, causing it to become a lot higher than the welfare measures. The two welfare measures kept similar values over the whole period but bcpa still increased quite a lot more than bce, with an increase of 50.44% for bcpa and of 14.08% for bce. The high growth rate of bcpa mainly comes from a big increase towards the end of the period, as can be seen on panel A of figure A.14.1. Looking at table A.14.2, we can see that the lower total growth rates for the welfare measures is mainly due to the high increase in welfare losses from income inequality over the years, while the higher increase in bcpa is principally due to high increases in net investments. This second conclusion is also clearly visible in panel B of figure A.14.1.

Using tables A.14.1 and A.14.2, it is possible to see better how the evolution of gdp compared to the evolution of the welfare measures during the period studied, by looking into specific subperiods. In all but one subperiod, gdp changed more than the welfare measures by either increasing more or decreasing more. Indeed, during the financial crisis (2008-2011), the only period during which gdp decreased, gdp decreased more than the welfare measures because bcpa decreased less and bce even increased. The lower decrease and increase of the welfare measures was due to a combination of decreasing narrow and broad ecological costs and welfare losses from income inequality. These findings can however not be applied to the COVID-19 crisis (2019-2020) because during that subperiod, gdp increased while the two welfare measures decreased. In that subperiod, the increase in narrow ecological costs and the decrease in net investment can explain the decreases in bce and bcpa. In the other periods where gdp increased more than the welfare measures, it was caused by the increase in welfare losses from income inequality negatively impacting the welfare measures. No general conclusion can be given about the comparison between the growth rates of the welfare measures and of gdp, but what can be said is that the value of the ecological costs, of the welfare losses from income inequality, and of the net investments play an important role in determining the growth rate of the welfare measures, as indicated by their average importance.

The difference of growth rates for the two welfare measures in the different subperiods is also interesting to study. The subperiods with different directions in the growth rate and with very different growth rates are particularly interesting. The first subperiod with a different direction in the growth rates is between 2008 and 2011. During that period, bce increased while bcpa decreased. This result is principally caused by the strong decrease in net investments during that subperiod.

During the two following subperiods (2011-2014 and 2014-2019), there were also diverging growth rates for the two welfare measures, with a decrease in bce and an increase in bcpa. While in the two periods the increase in bcpa is principally caused by relatively strong increases in net investments, the decrease in bce is mainly caused by the increase of narrow ecological costs, due to a strong increase in the costs of extreme weather events, during the first subperiod and by a high increase in welfare losses from income inequality in the second subperiod.

Finally, between 2019 and 2020, the two welfare measures evolved in the same direction by both decreasing, but the decrease in bcpa was much stronger than the decrease in bce. Again, this higher decrease in bcpa is mainly linked to a strong decrease in net investments during that subperiod.

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Figure A.14.1: Evolution of the ISEWs and gdp (panel A) and evolution of the components (panel B) in Ireland for the period 1995-2020 (measured in € in 2015 prices).

Panel A Panel B

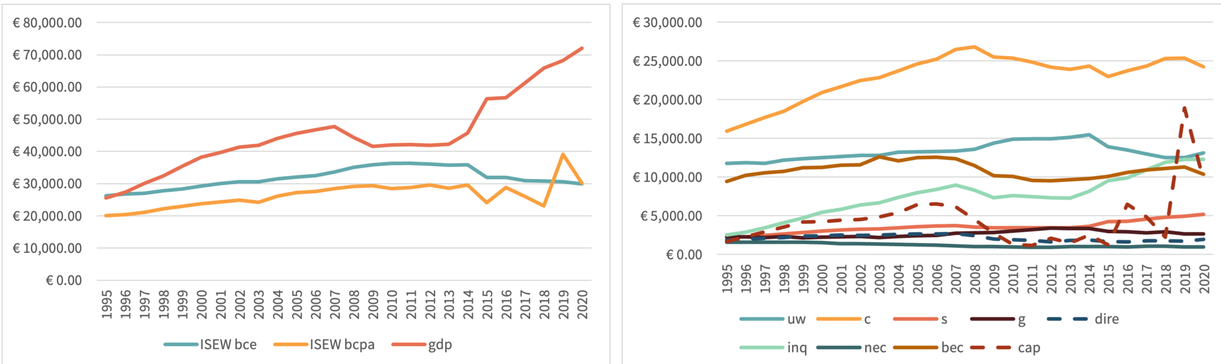


Table A.14.1: Annual and total growth rates of the ISEWs and gdp in Ireland (in %)

	bce	bcpa	gdp
1995-2001	2.28	3.28	7.58
2001-2008	2.23	2.60	1.61
2008-2011	1.15	-0.40	-1.71
2011-2014	-0.43	0.87	2.73
2014-2019	-3.14	5.77	8.33
2019-2020	-1.95	-22.85	5.68
1995-2020 (total)	0.53 (14.08)	1.65 (50.44)	4.23 (181.44)

Table A.14.2: Annual growth rates and importance of the components in Ireland (in %)

	uw	ci	s	gc	direp	inq	nec	bec	k
1995-2001	1.20	5.28	6.38	-0.24	5.10	14.88	-1.67	3.41	17.50
2001-2008	1.03	3.09	1.77	2.95	-0.60	5.22	-4.46	-0.07	0.37
2008-2011	3.23	-2.53	-0.91	4.70	-9.06	-3.47	-3.43	-5.85	-36.30
2011-2014	1.13	-0.68	1.77	1.69	0.69	2.92	3.94	0.76	28.74
2014-2019	-4.13	0.82	6.19	-4.50	-1.30	8.52	-1.44	2.91	49.89
2019-2020	4.49	-4.44	4.96	-0.45	14.07	0.05	1.66	-8.42	-49.18
1995-2020 (total)	0.42 (11.11)	1.69 (52.15)	3.53 (138.13)	0.57 (15.33)	0.23 (6.02)	6.52 (384.64)	-1.84 (-37.21)	0.38 (9.88)	7.23 (472.29)
Average importance in bce	31.49	53.97	8.28	6.26	20.67	67.08	12.25	/	/
Average importance in bcpa	28.69	49.01	7.49	5.71	10.51	35.57	/	53.93	9.10

A.15 Italy

In figure A.15.1, the evolution of gdp, bce and bcpa is presented in panel A, while the evolution of the components of the welfare measures is shown in panel B. The evolution of these different variables is presented for the period 1995 to 2020, which is the period of interest in this study. To complement these figures, the annual growth rates of the different variables are presented in tables A.15.1 and A.15.2. The annual growth rates are presented for the entire period studied as well as for selected subperiods. In the table presenting the annual growth rates of the components of the welfare measures, the importance of these components for calculating the value of each of the welfare measures is also presented.

From panel A in figure A.15.1, we can see that the two welfare measures decreased over the period studied, while gdp seems to have been stagnating. These two findings are confirmed by the last row of table A.15.1 presenting the total growth rate of each measure. In that table, we see that indeed gdp only had a really low total growth rate of 0.04% over the whole period, while bce and bcpa both decreased with respective growth rates of -9.70 and -15.41% over the whole period. From table A.15.2 also showing the total growth rate of the different components over the period studied, we see that the two welfare measures decreased for different reasons but mainly because of decreases in the value of government consumption and in the value of unpaid work, which given their importance, offset the decrease in ecological costs. Additionally, for bcpa, the decrease in net investments certainly played a role in explaining its higher decrease.

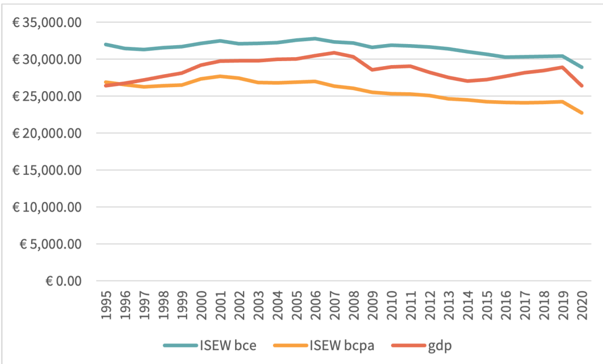
Looking at table A.15.1 allows to know how the three measures evolved over selected subperiods. As already seen in panel A of figure A.15.1, we see that the two welfare measures decreased during the whole period because of decreases in almost all of the selected subperiods. On the contrary, gdp stagnated over the whole period because of some subperiods showing positive growth rates and others showing negative growth rates. Interestingly, in periods of negative economic growth, during the financial crisis and its aftermath (2008-2011 and 2011-2014) and during the COVID-19 crisis (2019-2020), gdp decreased even more than the two welfare measures. In these three subperiods, the lower decrease of the welfare measures was principally due to a combination of decreases in the narrow and broad ecological costs as well as in the welfare losses from income inequality. During the remaining periods, the periods of positive economic growth, the very low increase and the decreases in welfare measures were due to a combination of different factors. Still the increases of welfare losses from income inequality during these subperiods can mainly explain these growth rates given their rates of increase and their importance for the welfare measures.

Finally, comparing the growth rates of the two welfare measures by looking at the growth rates presented in table A.15.1, we see that in all subperiods, the two welfare measures evolved in the same direction: increasing between 1995 and 2001 and decreasing in all the remaining subperiods. In most periods, bcpa experienced stronger changes than bce by increasing or decreasing more. The two subperiods with the highest difference between the two growth rates were during the financial (2008-2011) and COVID-19 (2019-2020) crises. In these two subperiods, the main reason for bcpa to decrease more than bce was a strong decrease in net investments.

The only subperiod during which bcpa decreased less than bce was between 2014 and 2019. During this subperiod, the narrow and the broad ecological costs both increased. The narrow ecological costs increased more than the broad ones, explaining why bce decreased more than bcpa in that subperiod. The higher increase in NEC between 2014 and 2019 was caused by a very strong increase in the costs of extreme weather events. Additionally, bcpa decreased less than bce because there was an increase in net investments during that period, having a positive impact on bcpa.

Figure A.15.1: Evolution of the ISEWs and gdp (panel A) and evolution of the components (panel B) in Italy for the period 1995-2020 (measured in € in 2015 prices).

Panel A



Panel B

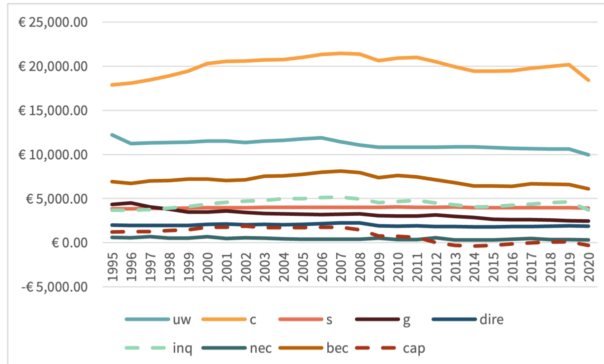


Table A.15.1: Annual and total growth rates of the ISEWs and gdp in Italy (in %)

	bce	bcpa	gdp
1995-2001	0.25	0.48	2.01
2001-2008	-0.14	-0.85	0.28
2008-2011	-0.38	-1.05	-1.40
2011-2014	-0.82	-1.02	-2.39
2014-2019	-0.40	-0.20	1.35
2019-2020	-4.97	-6.19	-8.70
1995-2020 (total)	-0.41 (-9.70)	-0.67 (-15.41)	0.00 (0.04)

Table A.15.2: Annual growth rates and importance of the components in Italy (in %)

	uw	ci	s	gc	direp	inq	nec	bec	k
1995-2001	-0.96	2.36	0.59	-3.20	0.83	3.67	-3.60	0.34	6.47
2001-2008	-0.58	0.55	0.16	-1.24	0.73	1.19	-3.10	1.72	-2.61
2008-2011	-0.74	-0.58	-0.10	-2.71	-4.70	-1.26	-2.67	-2.01	-26.49
2011-2014	0.16	-2.56	-0.26	-1.75	-2.54	-5.52	-3.90	-4.82	* (−)
2014-2019	-0.45	0.77	0.02	-2.82	1.30	2.80	2.21	0.53	* (+)
2019-2020	-6.03	-8.78	-1.16	-1.49	-0.74	-19.95	-13.55	-7.32	* (−)
1995-2020 (total)	-0.80 (-18.22)	0.12 (2.99)	0.10 (2.60)	-2.28 (-43.79)	-0.25 (-6.18)	0.03 (0.63)	-2.67 (-49.21)	-0.48 (-11.24)	* (−)
Average importance in bce	29.04	52.21	10.36	8.38	28.78	64.59	6.63	/	/
Average importance in bcpa	28.42	51.11	10.15	8.19	14.60	32.77	/	52.64	2.14

Note: * is used when the annual growth rate of the component cannot be calculated because of a negative value at the beginning and/or at the end of the (sub)period studied. The (+) or (−) in these cells indicates whether the component increased (+) or decreased (−) during the (sub)period.

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A.16 Latvia

The evolution of gdp, bce, and bcpa is presented in panel A of figure A.16.1. In panel B of the same figure, the evolution of the different components of the welfare measures is presented. In both cases, the period presented is between 1995 and 2020. The growth rates of gdp and of the two welfare measures over the same period and for selected subperiods are presented in table A.16.1. Similarly, table A.16.2 presents the annual growth rates of the different components of the two welfare measures, along with an indication of the average importance of each component in calculating the value of the welfare measures.

From panel A in figure A.16.1, we see that gdp as well as the two welfare measures increased between 1995 and 2020, but at different rates. The last row of table A.16.1 indeed shows that gdp is the measure that increased the most, with a total growth rate of 217.28% over the period studied. The second highest growth rate is the growth rate of bce, which increased by 165.20% in total over the whole period. Finally, bcpa had the lowest, but still quite high, increase with a total increase of 145.86% over the period studied. Panel B of figure A.16.1 and table A.16.2 show that the relatively lower increase of the two welfare measures is primarily due to a strong increase of welfare losses from income inequality over the years. Additionally, for bcpa, the high increase of the broad ecological costs, as clearly shown in figure A.16.1, is another important reason for the lower increase of bcpa. One last thing that can be seen in figure A.16.1 and is important to take into account when comparing the evolution of bcpa to that of bce and gdp is that the values of bcpa are relatively lower than the values of bce and of gdp, which leads to higher relative growth rates for bcpa.

The growth rates of gdp and of the two welfare measures can also be compared and explained for different subperiods using tables A.16.1 and A.16.2. It is difficult to draw general conclusions regarding the comparison of the growth rates of welfare measures and of gdp because the relationship between the growth rates of the different measures is different in the different subperiods. Still, in most of the subperiods, bcpa has the strongest changes, while bce has the smallest changes in those subperiods. During crises, as between 2008 and 2011 and between 2019 and 2020, gdp decreased. During the first subperiod (2008-2011), bcpa also decreased because of a strong decrease in net investments, leading to a decrease even higher than that of gdp. On the contrary, bce increased during that period because the welfare losses from income inequality, which are very important for this welfare measure, decreased a lot during that subperiod. During the second crisis subperiod (2019-2020), gdp decreased again, but more than the two welfare measures. Indeed, the two welfare measures also decreased during that period, but less than gdp primarily because of a decrease in welfare losses from income inequality during those years. In most of the periods with positive gdp growth, such as between 1995 and 2001 or between 2001 and 2008, welfare losses from income inequality increased a lot, leading to the increase in bce to be lower than that of gdp. The lower values of bcpa render the comparison of its growth rate with gdp in those subperiods more complicated. Still, the increase in welfare losses from income inequality also negatively impacted this welfare measure.

The growth rates of the two welfare measures can also be compared and analysed to understand what are the main reasons of these differences in growth rates. Tables A.16.1 and A.16.2 can be used to that end. For this comparison, it is important to remember that the lowest values of bcpa lead to relatively higher growth rates. The first thing that can be seen from table A.16.1 is that, except between 2019 and 2020, bcpa changed more strongly than bce, no matter whether the measures were increasing or decreasing. Indeed, the second thing that can be seen in table A.16.1 is that in the periods between 2008 and 2011 and between 2011 and 2014, the two measures diverged because of the increase in bce and the decrease in bcpa, but in both cases, bcpa still changed more strongly than bce. Following from these divergences in the direction of the changes of the two welfare measures, these two subperiods are also the subperiods where the growth rates of bce and bcpa differed the most. Between 2008 and 2011, the strong decrease in bcpa can be explained by a combination of decreases in net investments as well as increases in the broad ecological costs, while between 2011 and 2014, only the increase in the broad ecological costs negatively impacted bcpa. The narrow ecological costs also increased during those subperiods, but the broad ecological costs increased more because of, among others, increases in the costs of climate breakdown. Between 2008 and 2011, the increase in the costs of climate breakdown was mainly due to an increase in the emissions from international aviation, while between 2011 and 2014, it was mainly caused by increases in CO_2 emissions from biomass.

Figure A.16.1: Evolution of the ISEWs and gdp (panel A) and evolution of the components (panel B) in Latvia for the period 1995-2020 (measured in € in 2015 prices).

Panel A

Panel B

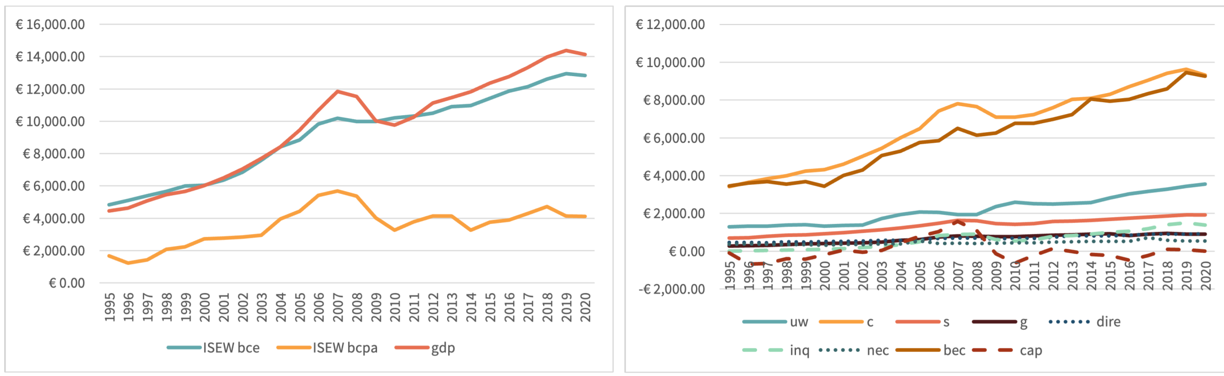

Table A.16.1: Annual and total growth rates of the ISEWs and gdp in Latvia (in %)

	bce	bcpa	gdp
1995-2001	4.66	8.75	6.47
2001-2008	6.68	9.90	8.59
2008-2011	1.06	-10.98	-3.89
2011-2014	2.06	-4.82	4.87
2014-2019	3.37	4.84	4.01
2019-2020	-0.93	-0.38	-1.84
1995-2020 (total)	3.98 (165.20)	3.66 (145.86)	4.73 (217.28)

Table A.16.2: Annual growth rates and importance of the components in Latvia (in %)

	uw	ci	s	gc	direp	inq	nec	bec	k
1995-2001	1.00	5.04	5.90	7.47	1.91	54.01	-0.64	2.51	* (+)
2001-2008	5.09	7.52	7.43	9.59	4.29	30.90	1.79	6.27	51.01
2008-2011	9.08	-1.88	-3.14	0.66	-1.17	-13.27	3.15	3.25	* (−)
2011-2014	0.68	3.84	3.67	3.37	6.31	15.66	4.28	5.97	* (+)
2014-2019	5.90	3.54	3.26	0.16	2.22	10.32	1.34	3.26	* (+)
2019-2020	3.48	-3.21	0.00	-0.85	3.92	-7.66	0.43	-1.91	-93.17
1995-2020 (total)	4.12 (174.30)	4.08 (171.96)	4.16 (176.98)	4.88 (229.41)	2.85 (102.13)	21.64 (13283.13)	1.51 (45.52)	4.02 (167.80)	* (+)
Average importance in bce	20.08	61.34	12.56	6.03	41.62	29.78	28.60	/	/
Average importance in bcpa	20.26	61.67	12.62	6.05	9.55	7.15	/	83.30	-0.59

Note: * is used when the annual growth rate of the component cannot be calculated because of a negative value at the beginning and/or at the end of the (sub)period studied. The (+) or (−) in these cells indicates whether the component increased (+) or decreased (−) during the (sub)period.

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A.17 Lithuania

Figure A.17.1 presents the evolution of different variables between 1995 and 2020, the period of interest in this study. In panel A, the variables presented are gdp, bce and bcpa. In panel B, the variables presented are the components of the welfare measures. To complement panel A, table A.17.1 presents the annual growth rates of the three measures for the whole period as well as for selected subperiods. Similarly, to complement panel B, table A.17.1 presents the annual growth rates for the differents components for the whole period and selected subperiods. Additionally, this second table shows the average importance of the different components in calculating the value of the welfare measures.

By showing the evolution of gdp, bce and bcpa in the same figure, panel A of figure A.17.1 allows to compare the evolution of these three measures. On this figure, we can see that all the measures increased quite a lot between 1995 and 2020. We can also see that bce and gdp had similar values over the whole period while bcpa had relatively lower values for this period, increasing its relative growth rates. The last row of table A.17.1 confirms that all the measures increased a lot during the period studied. The highest total growth rate was the one for bcpa, which increased by 2851.22% over the years. This extremely high growth rate confirms that the low values of bcpa, especially at the beginning of the period studied, lead to relatively higher growth rates that are comparable to the other growth rates with difficulty. The second highest growth rate is that of gdp, with a total growth rate of 251.04% over the period. Lastly, bce also increased a lot over the whole period, but less than the two other measures, with a growth rate of 160.39% over the period. Looking at table A.17.2, we see that welfare losses from income inequality is the component that increased the most over the period studied, which is one of the main explanations for the lower total growth rate of bce compared to gdp.

Tables A.17.1 and A.17.2, by showing the annual growth rates of the variables for different selected subperiods, allows to compare the growth rates of the three measures further. During the two crises that happened during the period studied, the financial crisis between 2008 and 2011 and the COVID-19 crisis between 2019 and 2020, we see that gdp decreased. In these two subperiods, the welfare measures outperformed gdp because bce decreased less than gdp, while bcpa increased, and during the COVID-19 crisis (2019-2020), the two welfare measures increased. From table A.17.2, we can see that the main reason for gdp to decrease more than the welfare measures in these two periods is that welfare losses from income inequality decreased, which positively impacted the welfare measures. In the subperiods between the crises (2011-2014 and 2014-2019), there was positive economic growth during which gdp increased more than the two welfare measures. The big increases in welfare losses from income inequality and the increases in the narrow and broad ecological costs are the main reasons why the welfare measures increased less than gdp, especially given their importance for the welfare measures. During the subperiods before the financial crisis (1995-2001 and 2001-2008), a similar explanation can be given when comparing the growth rates of bce and gdp. In those periods, bce increased less than gdp and again, the main reason for this lower increase is that there were important increases in welfare losses from income inequality during those years. The welfare losses from income inequality also negatively impacted bcpa, but the very low values at the beginning of the period make the growth rates difficult to compare with those of bce and gdp.

The growth rates of the two welfare measures can also be compared, using the same two tables. As shown in table A.17.1, the growth rates of the two welfare measures are quite different from each other in many subperiods. However, they evolved in opposite directions only in one of these subperiods, between 2008 and 2011. During this subperiod, bce decreased while bcpa increased. Looking at table A.17.2, we see that the the narrow ecological costs increased during that period, while the broad ecological costs decreased, explaining the divergence of the growth rates. More precisely, the narrow ecological costs increased because the ecosystem costs of nitrogen pollution, driven by an increase in the consumption of inorganic fertilizers, increased during that subperiod. The broad ecological costs were also impacted by the increase in the ecosystem costs of nitrogen pollution, but the decrease in three other subcomponents offset this impact. Indeed, between 2008 and 2011, there was big decrease in the costs of nuclear power use because from 2010 onwards, there was no nuclear electricity production anymore in Lithuania, bringing these costs to zero. Additionally, the costs of depleting non-renewable energy resources also decreased because of a reduction of primary energy use. Finally, a last important reason for the decrease in broad ecological costs is the decrease in the costs of air pollution, mainly led by a big decrease in the costs of air pollution embodied in trade, especially coming from the costs from consumption.

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In the remaining subperiods, the two welfare measures increased, but at different rates. In the first subperiods, the growth rates are not really comparable because of the low values of bcpa. However, looking at the change in the welfare measures between 2019 and 2020, we see that bcpa increased more than bce. The higher increase of bcpa during that subperiod is again due to the fact that the narrow ecological costs increased while the broad ones decreased. Again, the increase in NEC is due to an increase in the ecosystem costs of nitrogen pollution, itself due to increases in the consumption of inorganic fertilizers and in the emissions of NH_3, during that subperiod. Similarly, the broad ecological costs mainly decreased due to a decrease in the costs of air pollution. This decrease again came from a decrease in the costs of air pollution embodied in trade because of a decrease in the costs from consumption.

Figure A.17.1: Evolution of the ISEWs and gdp (panel A) and evolution of the components (panel B) in Lithuania for the period 1995-2020 (measured in € in 2015 prices).

Panel A Panel B

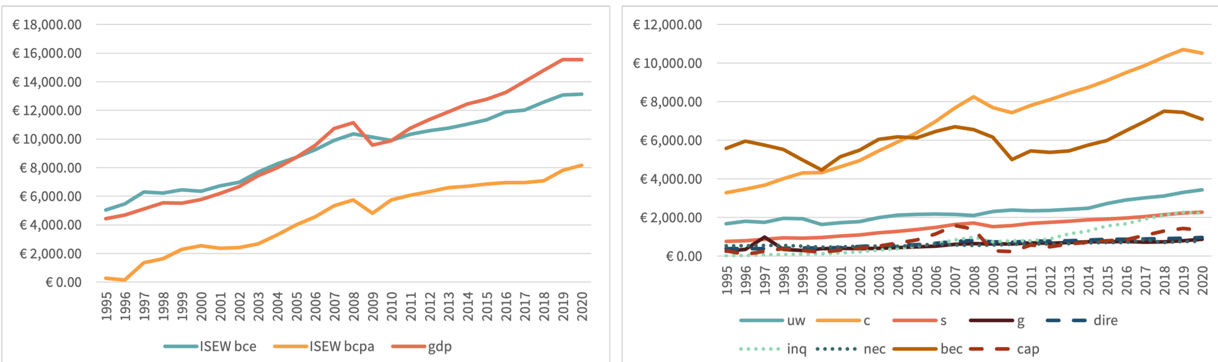

Table A.17.1: Annual and total growth rates of the ISEWs and gdp in Lithuania (in %)

	bce	**bcpa**	**gdp**
1995-2001	4.89	42.95	5.73
2001-2008	6.37	13.57	8.77
2008-2011	-0.08	1.83	-1.14
2011-2014	2.21	3.30	4.91
2014-2019	3.47	3.15	4.58
2019-2020	0.46	4.44	-0.02
1995-2020 (total)	3.90 (160.39)	14.50 (2851.22)	5.15 (251.04)

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Table A.17.2: Annual growth rates and importance of the components in Lithuania (in %)

	uw	**ci**	**s**	**gc**	**direp**	**inq**	**nec**	**bec**	**k**
1995-2001	0.55	5.86	5.28	7.96	2.60	37.24	-1.73	-1.32	1.91
2001-2008	2.78	8.62	7.42	6.92	9.12	29.64	2.09	3.49	23.60
2008-2011	3.70	-1.83	-0.35	2.02	-1.79	-6.57	4.13	-5.92	-25.67
2011-2014	1.88	3.87	3.67	2.67	2.45	17.79	3.03	1.70	7.78
2014-2019	5.79	4.12	3.62	1.34	2.16	11.70	1.91	5.38	14.96
2019-2020	4.48	-1.79	1.41	8.89	4.52	-2.56	1.93	-4.93	-6.63
1995-2020 (total)	2.90 (104.46)	4.76 (219.88)	4.50 (200.22)	5.00 (238.30)	3.81 (154.57)	19.87 (9186.36)	1.47 (43.97)	0.96 (27.00)	6.44 (375.91)
Average importance in bce	21.01	60.61	13.12	5.27	34.33	31.95	33.72	/	/
Average importance in bcpa	19.91	57.28	12.40	4.99	8.86	9.98	/	81.17	5.42

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A.18 Luxembourg

The evolution of gdp, bce and bcpa is presented in panel A of figure A.18.1. Next to that, panel B shows the evolution of the different components of the welfare measures. In the two panels, the evolution of the variables is presented for the period studied in this report, from 1995 to 2020. Figure A.18.1 is complemented by two tables: table A.18.1 presenting the annaul growth rates of gdp, bce and bcpa for the whole period as well as for selected subperiods, and table A.18.2 presenting the annual growth rates of the components for the same (sub)periods and a measure of the average importance of each component for the value of the welfare measures.

From panel A of figure A.18.1, the first thing that can be noted is that over the whole period, the three measures had a stable ranking with gdp being much higher than the welfare measures and the welfare measures having similar values, with bce always being higher than bcpa. This 'ranking' of the measures and especially the difference in level should be kept in mind when comparing the growth rates of the measures because the lower values of bce and bcpa lead to higher relative growth rates for these measures. Looking at that figure, we also see that gdp increased more than the welfare measures over the period studied. Indeed, gdp had a total growth rate of 38.42% over the whole period while bce and bcpa respectively increased by 4.05 and 16.40% over the whole period. Looking at table A.18.2, we see that the lower overall increase in the welfare measures is mainly due to an increase in welfare losses from income inequality, an important component for the value of the welfare measures, over the years. These increases and importance are also clearly visible in panel B of figure A.18.1.

Using tables A.18.1 and A.18.2, we can also compare the growth rates of gdp and of the welfare measures for selected subperiods. It is interesting to see that in the subperiods before and after the financial crisis, between the years 2001 and 2008 and 2011 and 2014, the two welfare measures decreased while gdp increased. Between 2001 and 2008, the decrease in bce and bcpa can mainly be explained by an increase in welfare losses from income inequality. Additionally, the increase in broad ecological costs further decreased bcpa. However, between 2011 and 2014, welfare losses from income inequality decreased. The decrease in the welfare measures during this subperiod is then explained by a combination of changes, including decreases in non-defensive government expenditures, in the value of unpaid work, and in the value of individual consumption. During the financial crisis (2008-2011), the trends were reversed with a decrease in gdp and an increase in welfare measures. The increase in welfare measures during this subperiod was mainly caused by decreases in the narrow and broad ecological costs, combined with a small decrease in welfare losses from income inequality. Interestingly, the results during the COVID-19 crisis were different, with all measures decreasing and gdp decreasing the least during that subperiod. Indeed, even though the narrow and broad ecological costs as well as welfare losses from income inequality decreased during that period, all the positive components such as individual consumption expenditures and the value of unpaid work also decreased a lot, offsetting the decrease in the ecological costs and leading to relatively higher decreases. For this subperiod, it is also important to keep in mind that the values of bce and bcpa are a lot lower than the values of gdp at the end of the period studied, which leads to relatively higher growth rates for the welfare measures, also for the negative growth rates. These differences in the comparison between the growth rate of gdp and of the welfare measures indicate that it is difficult to draw general conclusions about the different of growth rates between gdp and the welfare measures.

Finally, the growth rates of the two welfare measures can also be compared using tables A.18.1 and A.18.2. First, we see that in every subperiod selected, the two welfare measures evolved in the same direction. In five of the six subperiods selected, bcpa changed more than bce by either increasing more or decreasing more. Between 1995 and 2001, bcpa indeed increased more than bce did. In this subperiod, the difference appeared because of an increase in net investments, positively impacting bcpa. However, in the two other subperiods with a higher increase of bcpa (2008-2011 and 2014-2019), we see that the higher increase was due to a higher decrease in the broad ecological costs than in narrow ecological costs. Between 2008 and 2011, the higher decrease in BEC was due to a relatively high decrease in costs of climate breakdown caused by a strong decreases in the footprint emissions embodied in trade. Between 2014 and 2019, the BEC decreased more than NEC because of relatively strong decreases in the costs of air pollution, coming from a reduction in the emissions from production, as well as in the ecosystem costs of nitrogen pollution, due to a strong decrease of emission of NO_x. These two decreases also impacted the value of the narrow ecological costs, but a very strong increase in the costs of extreme weather events offset that impact.

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The subperiod between 2011 and 2014 is the only one during which bce change more than bcpa, by decreasing more. Even though the narrow ecological costs decreased more than the broad ecological costs during that period, an increase in net investments led bcpa to decrease less than bce in the end.

Figure A.18.1: Evolution of the ISEWs and gdp (panel A) and evolution of the components (panel B) in Luxembourg for the period 1995-2020 (measured in € in 2015 prices).

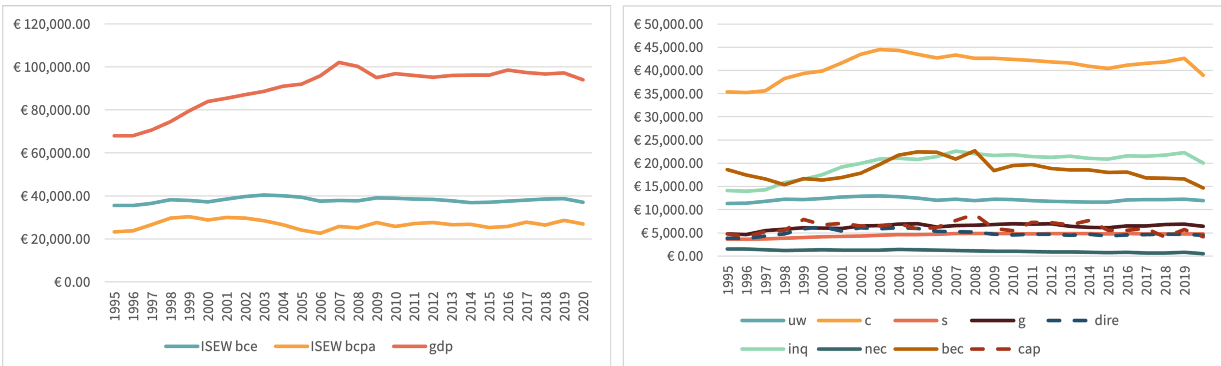

Table A.18.1: Annual and total growth rates of the ISEWs and gdp in Luxembourg (in %)

	bce	bcpa	gdp
1995-2001	1.36	4.36	3.88
2001-2008	-0.34	-2.52	2.31
2008-2011	0.80	2.59	-1.39
2011-2014	-1.46	-0.35	0.07
2014-2019	0.96	1.33	0.19
2019-2020	-4.41	-5.61	-3.21
1995-2020 (total)	0.16 (4.05)	0.61 (16.40)	1.31 (38.42)

Table A.18.2: Annual growth rates and importance of the components in Luxembourg (in %)

	uw	ci	s	gc	direp	inq	nec	bec	k
1995-2001	1.95	2.74	2.73	3.76	5.90	5.28	-2.82	-1.61	6.75
2001-2008	-0.87	0.34	2.11	1.49	-0.64	2.03	-2.41	4.28	3.58
2008-2011	0.11	-0.37	-0.76	1.36	-3.20	-0.90	-3.19	-4.53	-6.95
2011-2014	-1.03	-0.97	0.36	-3.64	0.29	-0.70	-6.70	-2.10	1.57
2014-2019	1.14	0.80	-0.08	2.22	-0.06	1.17	-0.48	-2.18	-5.53
2019-2020	-2.64	-8.59	-0.14	-6.91	-5.25	-10.14	-31.22	-11.74	-28.00
1995-2020 (total)	0.23 (5.80)	0.38 (10.00)	1.17 (33.69)	1.17 (33.89)	0.62 (16.59)	1.42 (42.20)	-4.10 (-64.86)	-0.96 (-21.48)	-0.57 (-13.42)
Average importance in bce	18.97	64.14	7.03	9.86	19.22	76.51	4.27	/	/
Average importance in bcpa	17.31	58.50	6.41	8.99	11.50	45.80	/	42.70	8.79

A.19 Malta

Figure A.19.1 contains two panels. Panel A presents the evolution of gdp and of the two welfare measures for the period 1995 to 2020. Panel B presents the evolution of the components of the welfare measures over the same period. Table A.19.1 presents the annual growth rates of the three measures shown in panel A, for the full period as well as selected subperiods. Similarly, table A.19.2 presents the annual growth rates of the components of the welfare measures for the full period and for selected subperiods. In this second table, the last two rows also present the average importance of each component in each of the welfare measures.

In panel A of figure A.19.1, we can see that gdp increased more than the two other measures and that bcpa even slightly decreased over the period studied, leading bcpa to be quite a lot lower than gdp and bce at the end of the period. These findings are confirmed by the last row of table A.19.1, showing that gdp increased by 82.31% over the period studied, bce increased by 42.08%, and bcpa decreased by 5.59% over the years. Table A.19.2 shows that the lower growth rate of bce is mainly due to an increase in welfare losses from income inequality over the years. This increase also negatively impacted bcpa, and combined with an increase in the broad ecological costs which is clearly visible in panel B of figure A.19.1, it led to the decrease of bcpa over the period studied.

Looking at tables A.19.1 and A.19.2, we can compare the growth rates of the welfare measures to that of gdp for selected subperiods. We can see that gdp only decreased during the COVID-19 crisis (2019-2020) and that this decrease was higher than the decrease in the two welfare measures. Indeed, the welfare measures decreased less than gdp because during that period, the narrow and broad ecological costs as well as the welfare losses from income inequality decreased quite a lot, having a positive impact on the values of welfare. In the remaining subperiods, gdp increased at different rates. In most of these subperiods (2001-2008, 2011-2014 and 2014-2019), gdp increased more than the welfare measures. The lower increase of the welfare measures in these subperiods was mainly due to increases in welfare losses from income inequality. Finally, it is interesting to see that during the financial crisis (2008-2011), only bcpa decreased. The increase in bcpa during that subperiod was principally due to an increase of the broad ecological costs and a decrease of the net investments. The value of bce however did not decrease because of the fall in the value of the narrow ecological costs.

Finally, comparing the growth rate of bce and of bcpa in the selected subperiods, we see that in two of the six subperiods (2008-2011 and 2014-2019), the direction of the change in the welfare measures diverged because bce increased while bcpa decreased. These divergences explain the difference in trends seen in panel A of figure A.19.1. In these two subperiods, the decrease in bcpa was mainly due to an increase of the broad ecological costs, but this increase was caused by changes in different subcomponents in each period. Between 2008 and 2011, the increase in BEC was principally caused by an increase in the costs of climate breakdown, coming from increases in CO_2 emissions from biomass, footprint emissions embodied in trade, and emissions from international navigation. Between 2014 and 2019, the increase in BEC was primarily due to an increase in the costs of air pollution linked to a big increase in the costs of air pollution embodied in trade.

In the other periods, the two welfare measures evolved in the same direction but at different rates. For example, between 2011 and 2014, bcpa increased more than bce. In this case, the higher increase of bcpa was mainly caused by an increase in net investments. On the contrary, between 1995 and 2001, bcpa increased less than bce. Changes in net investments also played a role here because their decrease negatively impacted the value of bcpa, but what had an even more important impact on the value of bcpa was the increase in broad ecological costs. During this subperiod, these costs increased because of an increase in the costs of climate breakdown, mainly coming from increases in footpint emissions embodied in trade and CO_2 emissions from biomass.

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Figure A.19.1: Evolution of the ISEWs and gdp (panel A) and evolution of the components (panel B) in Malta for the period 1995-2020 (measured in € in 2015 prices).

Panel A | Panel B

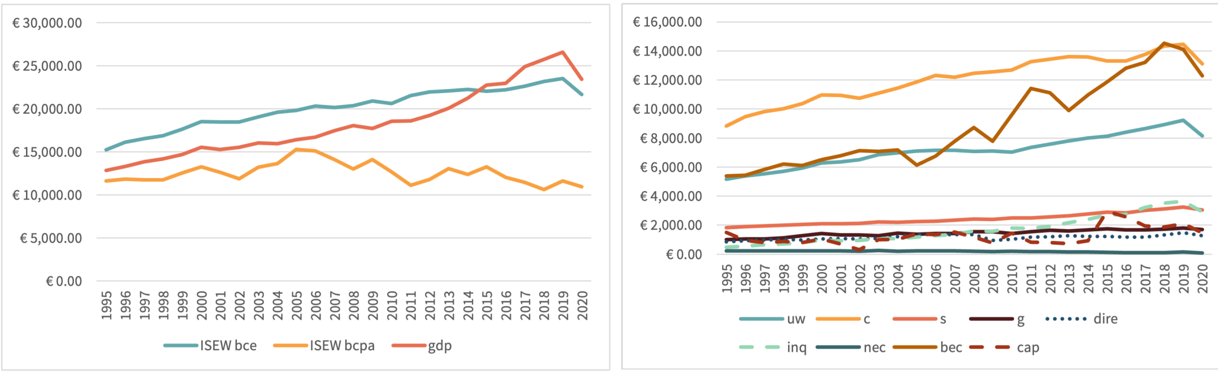

Table A.19.1: Annual and total growth rates of the ISEWs and gdp in Malta (in %)

	bce	**bcpa**	**gdp**
1995-2001	3.25	1.42	2.90
2001-2008	1.38	0.42	2.43
2008-2011	1.88	-5.12	1.00
2011-2014	1.13	3.65	4.53
2014-2019	1.10	-1.20	4.59
2019-2020	-7.74	-5.89	-11.82
1995-2020 (total)	1.41 (42.08)	-0.23 (-5.59)	2.43 (82.31)

Table A.19.2: Annual growth rates and importance of the components in Malta (in %)

	uw	**ci**	**s**	**gc**	**direp**	**inq**	**nec**	**bec**	**k**
1995-2001	3.48	3.63	2.42	4.57	3.64	11.76	-0.84	3.89	-11.96
2001-2008	1.57	1.89	2.01	2.27	3.47	8.04	-0.90	3.66	7.54
2008-2011	1.20	2.07	1.02	-0.09	-5.04	3.61	-5.42	9.37	-10.92
2011-2014	2.88	0.83	3.52	2.97	1.91	10.54	-5.05	-1.31	4.30
2014-2019	2.91	1.26	3.25	1.48	3.61	8.69	-1.04	5.15	17.54
2019-2020	-11.86	-9.38	-6.12	-6.51	-12.58	-19.57	-36.42	-12.83	-29.70
1995-2020 (total)	1.83 (57.29)	1.60 (48.54)	2.08 (67.15)	2.09 (67.66)	1.60 (48.77)	7.53 (513.87)	-3.70 (-61.00)	3.35 (127.95)	-0.08 (-1.93)
Average importance in bce	30.85	52.35	10.52	6.29	40.93	51.83	7.24	/	/
Average importance in bcpa	29.27	49.70	9.98	5.97	10.59	13.37	/	76.05	5.08

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A.20 The Netherlands

Figure A.20.1 presents the evolution of gdp, bce and bcpa in panel A and the evolution of the components of the welfare measures in panel B. The period presented in these figures is between 1995 and 2020, the period studied in this report. Table A.20.1 presents the annual growth rates of the three measures for the whole period as well as for selected subperiods. This table complements panel A of figure A.20.1 by giving more details about the evolution of the three measures. Similarly, table A.20.2 gives more details about the evolution of the components of the welfare measures by presenting their annual growth rates over the whole period and for selected subperiods, as well as a measure of their average importance in calculating the values of the welfare measures.

The overall evolution of gdp, bce and bcpa can be compared by looking at panel A in figure A.20.1 and at the last row of table A.20.1. First, we see that the two welfare measures changed less than gdp between 1995 and 2020, with low total growth rates of 1.61% for bce and 5.27% for bcpa and a higher total growth rate of 37.37% for gdp over the whole period. Since the two welfare measures started at a lower level than gdp and increased less, they both remained below the gdp level for the entire period. Looking at table A.20.2 can give an indication about the changes in the components that led the growth rate measures to increase less than gdp. In that table, we see that over the whole period, there was a strong increase in welfare losses from income inequality. This important increase, also clearly visible in panel B of figure A.20.1, is certainly one of the main reasons why the welfare measures increased less than gdp over the whole period. This conclusion is also reinforced by the fact that this component has a relativey high average importance for the value of the welfare measures.

The difference of growth rates between the welfare measures and gdp can be further analysed by looking at the annual growth rates in subperiods presented in table A.20.1. This table first shows that during periods of higher economic growth, gdp increased more than the two welfare measures. This result can be seen in subperiods 1995 to 2001, 2001 to 2008, and 2014 to 2019. During these subperiods, the welfare measures even sometimes decreased. The growth rates of the components presented in table A.20.2 can be used to understand why the welfare measures increased less than gdp or even decreased during these subperiods. During these three periods, it can be seen that welfare losses from income inequality are increasing, which has a negative impact on the welfare measures. Given the average importance of this component, this increase is one of the main reasons why the welfare increased less or decreased during these subperiods. However, other components also pay a role in this overall evolution. For example, we can see that the value of unpaid work and of individual consumption expenditures did not increase much during these subperiods, especially between 2001 and 2008 and between 2014 and 2019, which also plays an important role for the changes in welfare measures. During the periods of negative economic growth, the comparison between the growth rate of gdp and of the welfare measures is different in each subperiod. Indeed, during the financial crisis (2008-2011), gdp decreased more than bce but less than bcpa, between 2011 and 2014, gdp decreased less than the two welfare measures, and during the COVID-19 crisis (2019-2020), gdp decreased more than the two welfare measures. In these three subperiods, we see that a decrease in narrow and broad ecological costs as well as in welfare losses from income inequality can explain why the welfare measures decreased less than gdp. However, between 2011 and 2014, decreases in most of the components positively impacting the welfare measures were not sufficiently countered by the decrease in the components negatively impacting bce and bcpa, leading to them to decrease more than gdp. Finally, big decreases in net investments have an important negative impact on bcpa.

The growth rates of the two welfare measures also differ in the different subperiods, as shown in table A.20.1. It is interesting to compare the periods in which these growth rates differed the most, starting with the subperiod between 2014 and 2019, when bcpa increased while bce decreased. The opposite direction of the growth rates between 2014 and 2019 can be explained by looking at the growth rates of the components in table A.20.2 where we see that even though the broad ecological costs increased, the strong increase in net investments led to an increase in bcpa. The high increase in net investments was sufficient to overcome the increase of the welfare losses from income inequality and have an increase in bcpa, but no change in the other components was strong enough to counter this increase for bce, leading to a decrease in that welfare measure.

Another subperiod during which the growth rates of bce and bcpa were different is between 2001 and 2008. During this subperiods, the two measures decreased, but bcpa decreased at a higher rate than bce.

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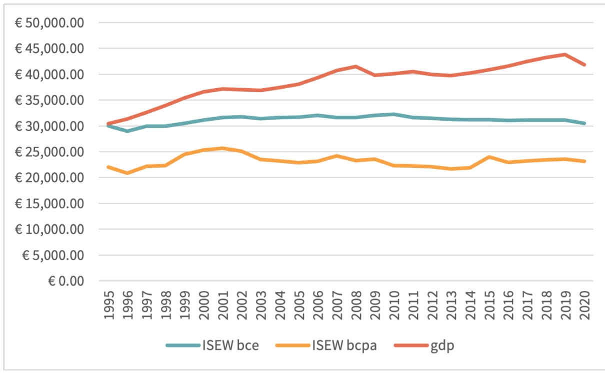
Despite a small increase in net investments during that subperiod, bcpa decreased more than bce because the broad ecological costs increased during that period, while the narrow ecological costs decreased, mainly driven by a decrease in the costs of air pollution. On the contrary, the increase in the broad ecological costs was mainly driven by an increase in the costs of climate breakdown. This increase was itself principally caused by an increase in the CO_2 emissions from biomass.

Figure A.20.1: Evolution of the ISEWs and gdp (panel A) and evolution of the components (panel B) in the Netherlands for the period 1995-2020 (measured in € in 2015 prices).

Panel A



Panel B

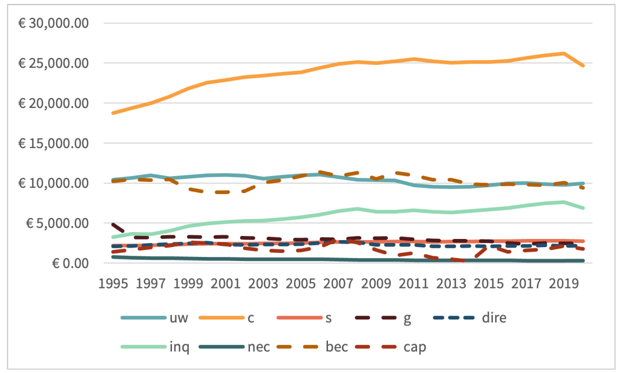


Table A.20.1: Annual and total growth rates of the ISEWs and gdp in the Netherlands (in %)

	bce	**bcpa**	**gdp**
1995-2001	0.86	2.61	3.38
2001-2008	-0.01	-1.39	1.59
2008-2011	-0.02	-1.48	-0.79
2011-2014	-0.43	-0.58	-0.26
2014-2019	-0.01	1.51	1.73
2019-2020	-2.05	-1.80	-4.58
1995-2020 (total)	0.06 (1.61)	0.21 (5.27)	1.28 (37.37)

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Table A.20.2: Annual growth rates and importance of the components in the Netherlands (in %)

	uw	ci	s	gc	direp	inq	nec	bec	k
1995-2001	0.97	3.36	1.75	-6.07	1.72	7.91	-5.97	-2.37	8.93
2001-2008	-0.79	1.36	1.40	-0.55	1.73	4.00	-3.14	3.53	0.95
2008-2011	-2.29	0.44	0.14	-2.33	-4.31	-0.87	-4.59	-0.97	-20.77
2011-2014	-0.54	-0.49	0.27	-2.02	-2.51	-0.37	-2.90	-3.43	-43.77
2014-2019	0.45	0.83	0.78	-2.34	0.34	3.14	-1.82	0.34	57.11
2019-2020	1.98	-5.71	-1.87	0.29	0.85	-9.45	-1.40	-6.06	-18.08
1995-2020 (total)	-0.16 (-4.02)	1.10 (31.55)	0.94 (26.37)	-2.61 (-48.40)	0.16 (4.00)	3.04 (111.63)	-3.64 (-60.44)	-0.32 (-7.77)	0.86 (23.75)
Average importance in bce	26.14	59.79	6.44	7.64	27.08	67.34	5.58	/	/
Average importance in bcpa	25.03	57.32	6.17	7.32	12.56	31.67	/	55.77	4.15

A.21 Poland

The evolution of gdp, bce and bcpa between 1995 and 2020 is presented in panel A of figure A.21.1. This figure also presents a panel showing the evolution of the components of the welfare measures for the same period in panel B. Table A.21.1 presents the annual growth rates of gdp, bce and bcpa for the whole period studied and for subperiods. Similarly, table A.21.2 present the annual growth rates of the components of the welfare measures for the period and studied and selected subperiods, as well as the measure of the average importance of the different components in calculating the value of the welfare measures.

From panel A in figure A.21.1, we can first see that the values of gdp and bce are very close to each other over the whole period studied, while the values of bcpa are much lower and even negative in the first years of the period studied (in 1995 and 1996). Throughout the analysis of the evolution of the welfare measures, it is important to keep in mind that the low values of bcpa have an impact on its growth rates by increasing them. The second thing that can be seen from panel A is that all three measures increased a lot between 1995 and 2020. Indeed, table A.21.1 shows that gdp increased by 162% over the whole period and bce increased by 151.46% over that period. The total growth rate of bcpa cannot be calculated because of the negative value of bcpa in 1995, but the difference in the absolute values of bcpa indicate that it increased at least as much as the two other measures. The growth rates in table A.21.2 can be used to understand why bce increased less than gdp between 1995 and 2020. In that table, we see that there was a very strong increase in welfare losses from income inequality over the period studied (this increase can also be seen in panel B of figure A.21.1), which is one of the main reasons why bce increased less than gdp.

Next to the evolution over the whole period studied, it is also interesting to see how the growth rates of the different measures compare in different subperiods. This can be done by looking at tables A.21.1 and A.21.2. Given the very low values of bcpa, making its growth rates much higher than that of the two other measures and hence less easily comparable, we mainly focus on the comparison between the growth rate of bce and of gdp. A comparison between bce and bcpa follows after this discussion. Interestingly, we see that bce and gdp decreased in only one of the selected subperiods, during the COVID-19 crisis (2019-2020). During that period, gdp decreased more than bce and this difference was mainly due to a relatively important decrease in welfare losses from income inequality during that period. During the other subperiods, the growth rates of bce and gdp are always quite high but there is no general pattern in their difference because in some subperiods (1995-2001 and 2008-2001), bce increased more than gdp, while in the other subperiods (2001-2008, 2011-2014 and 2014-2019), bce increased less than gdp. Still, during the two subperiods with a higher increase in bce, we see that the strong increase in welfare losses from income inequality were more than offset by relatively high decreases in narrow ecological costs and relatively high increases in most of the components impacting bce positively (unpaid work, individual consumption expenditures, shadow economy and government consumption). During the subperiods with lower increases in bce, we see that the same components again play the primary roles. Indeed, between 2001 and 2008, the lower increase in bce mainly comes from the lower decrease in the narrow ecological costs and from the lower increases in the components positively impacting bce, which had less power in offsetting the increase in welfare losses from income inequality. Between 2011 and 2014, the decrease in the narrow ecological costs was higher again, but the increase in the components positively impacting bce was again not high enough to completely offset the increase in welfare losses from income inequality. Between 2014 and 2019, the components positively impacting bce increased quite strongly again, but still the lower decrease in narrow ecological costs led to the decrease in welfare losses from income inequality to still be higher than those positive effects, hence having a lower bce increase.

As mentioned before, bce and bcpa had different growth rates in the different subperiods, with bcpa always having a higher growth rate than bce. This higher growth rate is certainly partially due to the fact that bcpa has much lower values than bce, making the growth rates of bcpa relatively higher, but some differences in the components can also explain this difference. It is hence interesting to look deeper into the growth rates of the two welfare measures for some of the selected subperiods. The first subperiod interesting to study is the subperiod between 2019 and 2020, which represents the COVID-19 crisis. During that subperiod, bcpa increased while bce decreased. This difference in growth rates cannot come from the difference of the level of the absolute values and must come from differences in the growth rates of the components. Looking at table A.21.2, we see that during that subperiod, the narrow ecological costs did not change at all while the broad ecological costs decreased. This difference explains why bce decreased while

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bcpa increased during that period. The stagnation of the narrow ecological costs during that period is due to the fact that there was an decrease in the costs of air pollution that was exactly countered by increases in ecosystem costs of nitrogen pollution and costs of extreme weather events. On the contrary, the broad ecological costs decreased because there were decreases in the costs of climate breakdown, mainly caused by decreases in emissions from international navigation, and in the costs of depleting non-renewable energy resources, due to a decrease in primary energy use during that period.

In all the other subperiods, the two welfare measures increased, with bcpa increasing more than bce. For some subperiods, such as between 2001 and 2008, between 2008 and 2011 and between 2011 and 2014, the increase in net investments certainly played an important role in having a higher growth rate of bcpa than for bce. Still, it is important to remember that the difference between the growth rate also partly comes from the difference in absolute values of the measures.

Figure A.21.1: Evolution of the ISEWs and gdp (panel A) and evolution of the components (panel B) in Poland for the period 1995-2020 (measured in € in 2015 prices).

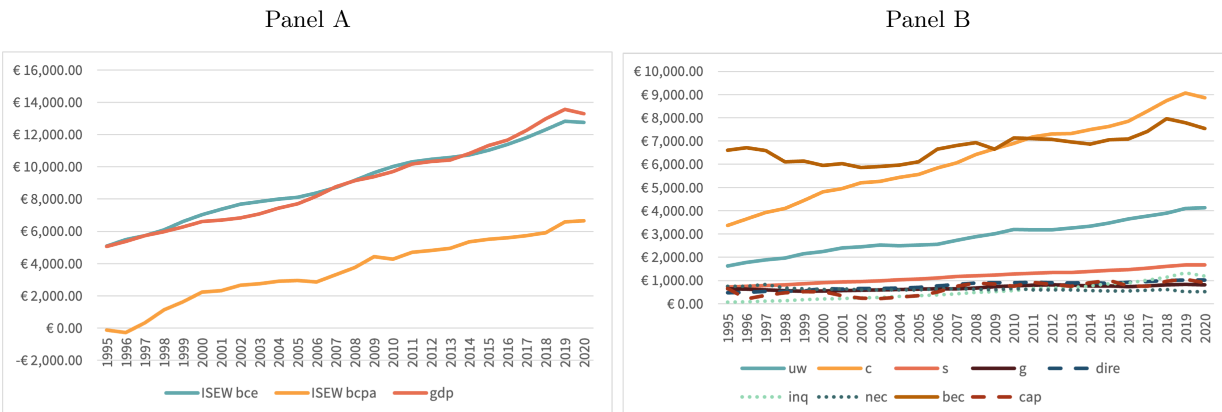

Table A.21.1: Annual and total growth rates of the ISEWs and gdp in Poland (in %)

	bce	bcpa	gdp
1995-2001	6.41	* (+)	4.75
2001-2008	3.18	7.11	4.53
2008-2011	3.94	7.83	3.65
2011-2014	1.42	4.29	2.11
2014-2019	3.58	4.29	4.59
2019-2020	-0.40	0.88	-1.98
1995-2020 (total)	3.76 (151.46)	* (+)	3.93 (162.00)

Note: * is used when the annual growth rate of the component cannot be calculated because of a negative value at the beginning and/or at the end of the (sub)period studied. The (+) or (−) in these cells indicates whether the component increased (+) or decreased (−) during the (sub)period.

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Table A.21.2: Annual growth rates and importance of the components in Poland (in %)

	uw	ci	s	gc	direp	inq	nec	bec	k
1995-2001	6.75	6.63	4.53	-2.13	5.12	23.20	-2.64	-1.53	-10.34
2001-2008	2.60	3.76	3.71	2.82	5.11	11.89	-0.24	2.03	14.70
2008-2011	3.32	3.78	2.99	5.20	0.67	9.83	-1.55	0.78	0.77
2011-2014	1.56	1.42	1.75	-1.16	-0.60	5.44	-2.06	-1.07	-0.09
2014-2019	4.27	3.91	3.69	1.74	2.54	11.52	-1.45	2.51	2.72
2019-2020	0.81	-2.37	0.41	-1.72	-0.97	-9.75	0.00	-3.20	-13.46
1995-2020 (total)	3.80 (154.16)	3.93 (162.40)	3.44 (133.08)	1.01 (28.52)	3.11 (115.15)	12.39 (1755.22)	-1.43 (-30.22)	0.53 (14.03)	1.27 (37.05)
Average importance in bce	26.11	56.66	10.75	6.48	40.62	24.67	34.71	/	/
Average importance in bcpa	24.69	53.58	10.17	6.13	9.60	6.17	/	84.23	5.43

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A.22 Portugal

Figure A.22.1 contains two panels presenting the evolution of the absolute values of different variables between 1995 and 2020. In panel A, we can see the evolution of gdp, bcce and bcpa, while in panel B, we can see the evolution of the components of the two welfare measures. Two tables complement the information presented in that figure by presenting annual growth rates of the different variables for the whole period as well as for selected subperiods. Table A.22.1 complements panel A by showing the annual growth rates of gdp, bce and bcpa. Table A.22.2 complements panel B by presenting the annual growth rates of the different components of the welfare measures as well as a measure of the average importance of these components in calculating the value of the welfare measures.

Panel A of figure A.22.1 allows to compare the evolution and the absolute values of gdp, bce and bcpa. Indeed, we can see that bcpa is lower than the two other measures for the whole period studied, while bce and gdp have very similar values over the whole period. None of the three measures changes much over time, but there seems to be a small increase in all of them. Table A.22.1 confirms that there is a small increase in the three measures, with gdp increasing the most, followed by bce and then bcpa. More precisely, gdp had a total increase of 25.21% between 1995 and 2020, bce increased by 22.04% over that period, and bcpa increased by 11.69% in total during the period studied. The lower growth rates for the welfare measures can be explained by looking at the growth rates of the components. In table A.22.2, we see that between 1995 and 2020, there were increases in the welfare losses from income inequality, impacting the two welfare measures, and in the broad ecological costs, impacting only bcpa. These two components have relatively strong importance for the value of the welfare measures and are hence the main causes for their lower increases over the whole period.

The growth rate of the welfare measures can also be compared to the growth rate of gdp for different subperiods to understand how the three measures evolved over time. First, we can see that during periods of crisis, such as the financial (2008-2011) and COVID-19 (2019-2020) crises, gdp decreased more than the welfare measures. Indeed, between 2008 and 2011, bce and bcpa even increased and between 2019 and 2020, the two welfare measures decreased less than gdp. In both cases, the two welfare measures outperformed gdp because of relatively strong decreases in the narrow and broad ecological costs and in welfare losses from income inequality, all of them positively impacting the two welfare measures. Between 2011 and 2014, gdp continued to decrease and the welfare measures also decreased during that period, but this time, more than gdp. We can see from table A.22.2 that this higher decrease in the welfare measures for that subperiod mainly comes from lower decreases in ecological costs and welfare losses from income inequality as well as decreases in most of the components positively impacting welfare measures, especially the values of individual consumption expenditures and unpaid work. During the other subperiods, all measures increased. Sometimes, gdp increased more than the two welfare measures (1995-2008 and 2014-2019) and sometimes it increased more than bcpa but less than bce (2001-2008). Between 1995 and 2008 and 2014 and 2019, the lower increase of the two welfare measures was mainly due to relatively high increases in welfare losses from income inequality and in ecological costs. Between 2001 and 2008, gdp increased less than bce because the lower increase in welfare losses from income inequality and the higher decrease in narrow ecological costs led bce to increase more, while gdp increase more than bcap because the increase of the broad ecological costs and decrease of net investment led bcpa to increase less.

The growth rates of bce and bcpa are always evolving in the same direction in the different subperiods, but it is interesting to look deeper into some of the subperiods with the highest difference between the two to understand what created this difference. As we saw when comparing the growth rate of gdp to that of the welfare measures, between 2001 and 2008, the two welfare measures increased but bce increased more than bcpa because there was a decrease in net investments during that subperiod and, more importantly, the broad ecological costs increased while the narrow ones decreased. The decrease of the narrow ecological costs during that subperiod mainly came from decreases in the costs of air pollution and in the ecosystem costs of nitrogen pollution, while the increase in the broad ecological costs mainly came from an increase in the costs of climate breakdown, principally coming from an increase in the emissions from international navigation, which offset the positive impact of the decrease in the other subcomponents.

Another subperiod with relatively different growth rates for bce and bcpa is during the financial crisis (2008-2011). During that subperiod, the two welfare measures increased, but bcpa increased more than bce. Looking at table A.22.2, we see that this difference mainly comes from the fact that the broad ecological costs

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decreased a lot more than the narrow ecological costs, hence having a higher positive impact on bcpa. The average importance of the value of the broad ecological costs for bcpa also plays a role in the higher increase of that welfare measure. Even though all the subcomponents of the narrow ecological costs decreased during that subperiod, the broad ecological costs decreased more because there were strong decreases in the costs of climate breakdown and the costs of air pollution. The costs of air pollution in the broad ecological costs decreased more than the costs of air pollution in the narrow ecological costs because there was a stronger decrease in the costs of air pollution embodied in trade, which are not taken into account in the narrow ecological costs. Similarly, the costs climate breakdown decreased because of decreases in the footprint emissions embodied in trade and in the emissions from national LULUCF.

Figure A.22.1: Evolution of the ISEWs and gdp (panel A) and evolution of the components (panel B) in Portugal for the period 1995-2020 (measured in € in 2015 prices).

Panel A | Panel B

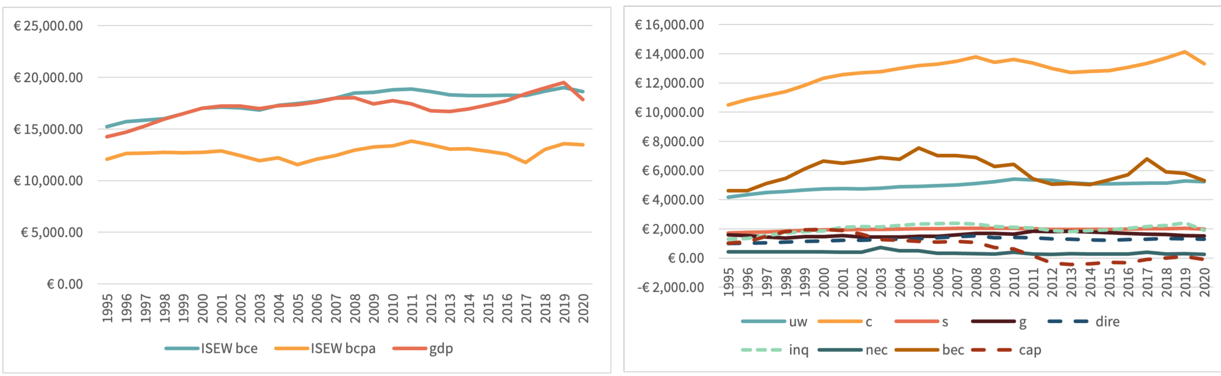

Table A.22.1: Annual and total growth rates of the ISEWs and gdp in Portugal (in %)

	bce	**bcpa**	**gdp**
1995-2001	1.94	1.10	3.18
2001-2008	1.11	0.09	0.67
2008-2011	0.70	2.24	-1.11
2011-2014	-1.10	-1.84	-0.96
2014-2019	0.80	0.73	2.87
2019-2020	-2.06	-0.82	-8.47
1995-2020 (total)	0.80 (22.04)	0.44 (11.69)	0.90 (25.21)

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Table A.22.2: Annual growth rates and importance of the components in Portugal (in %)

	uw	ci	s	gc	direp	inq	nec	bec	k
1995-2001	2.26	3.09	2.07	-0.56	3.36	8.43	-0.93	5.90	10.91
2001-2008	0.99	1.33	0.57	1.35	3.20	1.41	-3.85	0.85	-7.65
2008-2011	1.61	-1.04	-0.07	3.06	-2.40	-3.99	-4.60	-7.70	-49.60
2011-2014	-1.76	-1.44	-0.82	-0.82	-3.98	-3.00	1.38	-2.52	* (−)
2014-2019	0.78	2.02	0.77	-3.00	1.12	5.00	2.38	2.95	* (+)
2019-2020	-0.74	-5.86	-2.75	-1.45	-0.70	-20.40	-18.14	-8.87	* (−)
1995-2020 (total)	0.92 (25.79)	0.96 (27.02)	0.59 (15.80)	-0.16 (-4.04)	1.10 (31.39)	1.56 (47.12)	-2.03 (-40.19)	0.56 (14.86)	* (−)
Average importance in bce	23.27	60.05	9.20	7.48	34.84	55.01	10.15	/	/
Average importance in bcpa	22.49	58.02	8.89	7.24	13.71	21.62	/	64.67	3.37

Note: * is used when the annual growth rate of the component cannot be calculated because of a negative value at the beginning and/or at the end of the (sub)period studied. The (+) or (−) in these cells indicates whether the component increased (+) or decreased (−) during the (sub)period.

A.23 Romania

The evolution of gdp, of bce and of bcpa for the period 1995 to 2020 are presented in panel A of figure A.23.1. In the same figure, panel B presents the evolution of the different components of the welfare measures for the same period. Two tables supplement this figure by giving more details about the evolution of gdp, the two welfare measures, and the components of the ISEWs. Table A.23.1 presents the annual growth rates of gdp, bce and bcpa for the entire period studied and selected subperiods, while table A.23.2 presents the annual growth rates for the same (sub)periods for the different components of the welfare measures. The second table, table A.23.2 additionally presents a measure of the average importance of the different components in calculating the values of the welfare measures.

Panel A of figure A.23.1 shows the evolution of the absolute values of gdp and the two welfare measures, making it possible to compare their evolution. First, we see that the absolute values of bcpa are lower than the values of bce and gdp for the whole period, while bce and gdp have very similar values every year. Throughout the comparison of the growth rates of bcpa and the two other measures, it is important to remember that the lower values of bcpa influence the growth rates of bcpa by making them relatively higher. Secondly, we can see that all the measures increased quite strongly between 1995 and 2020. Table A.23.1 indeed confirms that all the measures increased over time and that gdp and bce had very similar increases, with a total increase of 130.12% for bce and of 137.99% for gdp over the period studied. The total growth rate of bcpa is much higher, with a total growth rate of 733.76% over the study period. As explained, the much higher growth rate of bcpa is strongly influenced by the very low values of bcpa at the beginning of the period studied. Looking at table A.23.2, we can see that the main reason why bce increased slightly less than gdp over the whole period is that there was a very big increase in welfare losses from income inequality between 1995 and 2020, having a negative impact on the welfare measures. Still, the fact that most of the components positively impacting the welfare measures increased a lot over the whole period led to a growth rate that is not so much lower than that of gdp. For bcpa, these different impacts also played a role. Additionally, the increase in net investments between 1995 and 2020 also partially explains the high increase in bcpa.

Tables A.23.1 and A.23.2 also allow to compare the evolution of the welfare measures and gdp in different subperiods. One interesting finding from these tables is that in periods of crises such as the financial (2008 and 2011) and COVID-19 (2019 and 2020) crises, gdp decreased more strongly than the two welfare measures. Between 2008 and 2011, bcpa decreased less than gdp while bce even increased. The fact that the two welfare measures outperformed gdp during this subperiod mainly comes from the fact that there was a decrease in both the narrow and the broad ecological costs and in the welfare losses from income inequality. These three components are all important components for the two welfare measures and their decreases have a positive impact on their values. Between 2019 and 2020, bce decreased less than gdp while bcpa increased, so the two welfare measures again outperformed gdp. In this subperiod, the main reason why the two welfare measures outperformed gdp is that there was again a strong decrease in welfare losses from income inequality. However, in this subperiod, the narrow ecological costs increased, meaning that they are not part of the explanation why bce outperformed gdp.

In the remaining subperiods, gdp and the two welfare measures all increased but the difference between their growth rates differs in the different subperiods. In two subperiods, between 1995 and 2001 and between 2014 and 2019, gdp increased less than bce and bcpa. In both cases, the reasons for the higher increase in welfare measures are different. Between 1995 and 2001, bce and bcpa increased more than gdp mainly because there were decreases in the narrow and broad ecological costs, positively impacting the welfare measures. Between 2014 and 2019, the main cause for the higher increase in bce and bcpa is that there were very high increases in the components positively impacting the welfare measures, especially in the values of unpaid work and individual consumption expenditures, which more than offset the negative impacts coming increases in the welfare losses from income inequality and ecological costs. Finally, between 2001 and 2008 and between 2011 and 2014, gdp increased more than bce but less than bcpa. Between 2001 and 2008, the lower increase in bce is primarily caused by a strong increase in welfare losses from income inequality, which negative impacted the welfare measures, while the stronger increase in bcpa primarily comes from an increase in net investments during that subperiod. Between 2011 and 2014, the increase in welfare losses from income inequality again plays an important role in explaining the lower increase in bce, while for the higher increase for bcpa here mainly comes from higher decreases in broad ecological costs.

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As shown in table A.23.1, bce and bcpa also had different growth rates over the selected subperiods. In all the subperiods where the two welfare measures increased, the growth rate of bcpa was higher than that of bce. In some of these subperiods, between 2001 and 2008 and between 2014 and 2019, the higher increase in bcpa is primarily caused by increases in net investments. In other subperiods where the two measures increased, between 1995 and 2001 and between 2011 and 2014, the higher increase in bcpa mainly comes from a stonger decrease in the broad ecological costs than in the narrow ones. The broad ecological costs decreased more than the narrow ones because of different subcomponents in the two subperiods. Between 1995 and 2001, the higher decrease in broad ecological costs is mainly caused by a relatively strong decrease in the costs of depleting non-renewable energy resources, linked to a decrease in primary energy use, while between 2011 and 2014, the higher decrease in broad ecological costs was principally due to the relatively high decrease in the costs of air pollution, primarily caused by a decrease in the costs of air pollution embodied in trade.

Finally, between 2008 and 2011 and between 2019 and 2020, the two welfare measures evolved in opposite directions. Between 2008 and 2011, bce increased slightly, while bcpa decreased. The decrease in bcpa during that subperiod mainly comes from the relatively strong decrease in net investments. On the contrary, between 2019 and 2020, bce decreased while bcpa increased. Changes in the net investments again played a role in the increase of bcpa, but in this case, changes in the broad ecological costs can also partially explain the difference of growth rates. Indeed, during that subperiod, the narrow ecological costs increased, while the broad ecological costs decreased. The increase in the narrow ecological costs, caused by an increase in the costs of extreme weather events, negatively impacted bce, while the decrease in the broad ecological costs, principally due to a decrease in the costs of climate breakdown mainly linked to a decrease in the emissions from international aviation, positively impacted the value of bcpa.

Figure A.23.1: Evolution of the ISEWs and gdp (panel A) and evolution of the components (panel B) in Romania for the period 1995-2020 (measured in € in 2015 prices).

Panel A

Panel B

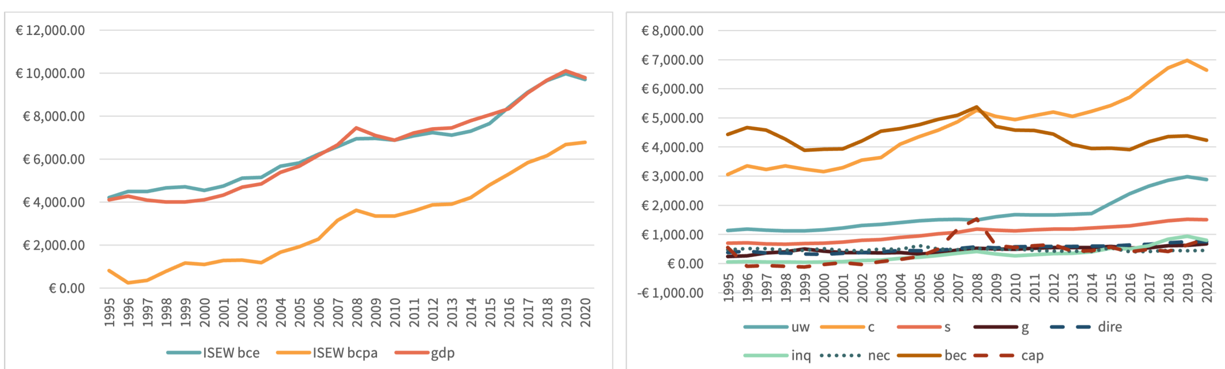

Table A.23.1: Annual and total growth rates of the ISEWs and gdp in Romania (in %)

	bce	bcpa	gdp
1995-2001	1.98	8.04	0.87
2001-2008	5.62	15.89	8.06
2008-2011	0.65	-0.43	-1.03
2011-2014	0.97	5.57	2.52
2014-2019	6.44	9.64	5.37
2019-2020	-2.71	1.48	-3.25
1995-2020 (total)	3.39 (130.12)	8.85 (733.76)	3.53 (137.99)

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Table A.23.2: Annual growth rates and importance of the components in Romania (in %)

	uw	ci	s	gc	direp	inq	nec	bec	k
1995-2001	1.17	1.21	0.89	7.96	-1.09	5.26	-1.08	-1.97	-37.02
2001-2008	2.99	6.94	7.14	4.57	7.03	28.50	2.14	4.56	72.14
2008-2011	3.83	-1.25	-0.66	0.08	0.51	-9.70	-5.00	-5.28	-26.22
2011-2014	0.87	0.99	1.74	2.07	0.80	9.39	-2.04	-4.73	-10.11
2014-2019	11.68	5.95	4.39	2.30	4.51	18.35	1.11	2.09	7.61
2019-2020	-3.35	-4.79	-0.81	9.44	0.72	-14.30	2.39	-3.53	31.48
1995-2020 (total)	3.80 (154.33)	3.14 (116.72)	3.15 (116.88)	4.25 (182.92)	2.74 (96.68)	11.47 (1408.92)	-0.21 (-5.20)	-0.19 (-4.61)	1.76 (54.57)
Average importance in bce	21.28	59.42	13.25	6.05	39.52	21.13	39.35	/	/
Average importance in bcpa	20.41	56.89	12.67	5.82	9.73	5.82	/	84.45	4.21

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A.24 Slovakia

In panel A of figure A.24.1, we can see the evolution of the absolute values of gdp, of bce and of bcpa between 1995 and 2020. In panel B, for the same period, we can see the evolution of the absolute values of the components of the welfare measures. Table A.24.1 complements the information given in panel A by presenting the annual growth rates of the three measures for the entire study period as well as for selected subperiods. Similarly, table A.24.2 complements the information given in panel B by presenting the annual growth rates for the components of the welfare measures for the entire period studied and for selected subperiods. Additionally, that table presents a measure of the average importance of the different components in calculating the value of the of welfare measures.

From the last row of table A.24.1, we can see that all the measures increased a lot between 1995 and 2020. The total growth rates of gdp and bce are quite similar, with a total growth rate of 163.28% for bce and of 133.38% for gdp over the period studied. The growth rate of bcpa is much higher than that of the two other measures, with a total growth rate of 1009.31% over the study period. Still, the extremely high growth rate for bcpa should be interpreted with caution. Indeed, we can see in panel A of figure A.24.1 that the absolute values of bcpa are very low compared to the absolute values of bce and gdp, which are very similar throughout the period studied. The relatively lower values of bcpa for the entire period lead to relatively higher growth rates, especially given the very low values at the beginning of the study. Regardless, the growth rate for gdp is the lowest for the period studied. As can be seen in table A.24.2, the slightly higher increase in bce compared to gdp is mainly caused by the combination a increases in the components positively impacting the welfare measures and a decrease in the narrow ecological costs, which more than offset the strong increase in welfare losses from income inequality. These findings are also visible in panel B of figure A.24.1.

The growth rates of gdp and of the welfare measures can also be compared by looking at the annual growth rates for different subperiods, as presented in table A.24.1. From that table, we can see that in all the selected subperiods, except the one between 2001 and 2008, the growth rate of gdp is lower than that of the two welfare measures. The subperiod between 2019 and 2020 is the only period where gdp decreased, and it is the only measure that decreased during that subperiod because the two welfare measures increased even during that subperiod representing the COVID-19 crisis. The increase of the welfare measures during that period of negative gdp growth is mainly due to a combination of relatively strong decreases in both the narrow and the broad ecological costs as well as in the welfare losses from income inequality, which had positive impacts of the welfare measures, reinforced by the importance of these components for calculating the values of the welfare measures. In the other subperiods (1995-2001, 2008-2011, 2011-2014 and 2014-2019), all the measures are increasing, but gdp is increasing less than the welfare measures. As mentioned before, it is difficult to compare the growth rate of bcpa to the other growth rates because of the relatively lower values of bcpa so the analysis will mainly focus on why bce increased more than gdp during these subperiods. In all the cases, the higher increase in the welfare measures is caused by the fact that the components positively impacting the welfare measures, especially the value of individual consumption expenditures and the value of unpaid work which are the most important ones, increased enough to counter the negative impact coming from the increase in welfare losses from income inequality. Additionally, in most of these subperiods, a decrease in the ecological costs added up to the increase of the positive components, further offsetting the negative impacts from the negative components. Finally, between 2001 and 2008, bce increased less than gdp because the increase in the negative components (welfare losses from income inequality and defensive, intermediate and rehabilitative expenditures) were too high to be offset by the increases in the positive components. Still, bcpa increased more than gdp in that period because it was positively impacted by an increase in net investments during that period.

Table A.24.1 indeed shows that the two welfare measures increased in all the subperiods, but at different rates in the different subperiods and with bcpa always increasing more strongly than bce. For all the subperiods, it is important to remember that the lower values of bcpa also influence its growth rates by increasing them. As such, for the subperiod between 1995 and 2001, the growth rates of the components presented in table A.24.2 cannot explain why bcpa increased more than bce. There was an increase in the broad ecological costs and a decrease in net investments during that subperiod, which negatively impacts the values of bcpa and should have led to a lower increase in bcpa, but these negative impacts were more than offset by the effect of the very low values of bcpa at the beginning of the subperiod. In some of

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these subperiods, the higher increase in bcpa is mainly caused by an increase in net investment during the subperiod. This finding applies to the subperiods between 2001 and 2008 and between 2014 and 2019.

In the other subperiods, the higher increase of bcpa was mainly caused by the changes in broad ecological costs. Between 2011 and 2014 and between 2019 and 2020, the broad ecological costs decreased more than the narrow ecological costs, having a more important positive impact on bcpa than on bce. Between 2011 and 2014, the slightly higher decrease in the broad ecological costs comes from the slight decrease in all the subcomponents, but was mainly due to stronger decreases in the costs of air pollution when the costs of air pollution embodied in trade are taken into account. Between 2019 and 2020, the stronger decrease in broad ecological costs also comes from the decrease in most of the subcomponents but principally from the decrease in the costs of climate breakdown, itself primarily caused by a strong decrease in the emissions from international aviation during that subperiod.

Figure A.24.1: Evolution of the ISEWs and gdp (panel A) and evolution of the components (panel B) in Slovakia for the period 1995-2020 (measured in € in 2015 prices).

Panel A Panel B

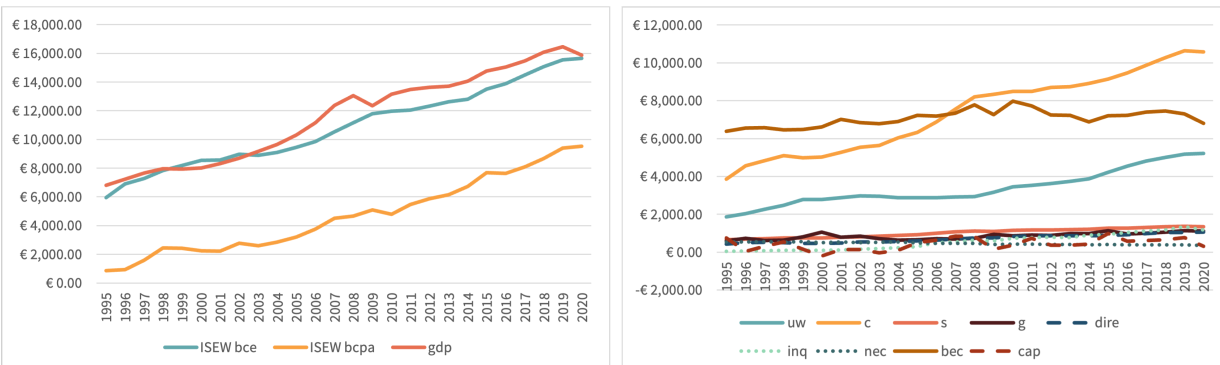

Table A.24.1: Annual and total growth rates of the ISEWs and gdp in Slovakia (in %)

	bce	bcpa	gdp
1995-2001	6.25	17.00	3.39
2001-2008	3.87	11.31	6.68
2008-2011	2.55	5.41	1.08
2011-2014	2.09	7.19	1.40
2014-2019	3.96	6.90	3.18
2019-2020	0.66	1.41	-3.47
1995-2020 (total)	3.95 (163.28)	10.10 (1009.31)	3.45 (133.38)

Table A.24.2: Annual growth rates and importance of the components in Slovakia (in %)

	uw	ci	s	gc	direp	inq	nec	bec	k
1995-2001	7.47	5.31	3.23	4.85	1.98	21.23	-0.19	1.60	-25.42
2001-2008	0.34	6.53	5.24	-0.88	6.22	26.14	-2.08	1.48	30.29
2008-2011	6.26	1.18	1.50	6.94	4.82	6.96	-2.57	-0.26	-4.33
2011-2014	3.24	1.58	1.12	2.49	0.51	5.58	-3.73	-3.80	-16.67
2014-2019	5.89	3.64	2.41	3.15	3.46	8.19	-0.19	1.23	13.09
2019-2020	0.83	-0.59	-1.42	-1.83	3.20	-12.98	-5.40	-6.96	-59.17
1995-2020 (total)	4.20 (179.64)	4.12 (174.09)	2.96 (107.54)	2.57 (88.50)	3.66 (145.58)	14.57 (2896.05)	-1.65 (-34.02)	0.25 (6.48)	-3.41 (-58.03)
Average importance in bce	26.81	58.04	8.20	6.95	41.80	27.51	30.69	/	/
Average importance in bcpa	25.98	56.17	7.94	6.74	8.43	6.23	/	85.33	3.17

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A.25 Slovenia

Figure A.25.1 is divided into two panels. Panel A presents the evolution of gdp, bce and bcpa over the period between 1995 and 2020, the period of interest in this research, while panel B presents the evolution of the components of the welfare measures over the same period. Two tables, table A.25.1 and A.25.2 give more details about the evolution of these variables by presenting their annual growth rates for the entire period studied as well as for selected subperiods. Table A.25.1 presents the annual growth rates for gdp, bce and bcpa, while table A.25.2 presents the annual growth rates for the components of the welfare measures. This second table also shows the average importance of each component in calculating the value of the welfare measures.

Panel A in figure A.25.1 shows that the absolute values of bce and gdp were similar over the whole period studied and the last row of table A.25.1 shows that they increased at a similar rate, with a total growth rate of 66.51% for bce and of 73.30% for gdp over the whole period. On the contrary, the absolute values of bcpa were much lower than those of the two other values for the whole period, and its growth rate was higher, with a total growth rate of 95.41% between 1995 and 2020. The lower absolute values for bcpa were mainly caused by the high absolute values of broad ecological costs. It is important to keep in mind that the fact that these absolute values are lower influence the growth rate of bcpa, making it relatively higher and hence difficult to compare with the growth rates of the two other measures. Comparing the growth rates of gdp and bce, we see that, as shown in table A.25.2, the lower growth rate of bce over the whole period is mainly caused by an increase in the welfare losses from income inequality.

By looking at tables A.25.1 and A.25.2, we can compare the growth rates of the welfare measures and of gdp for the selected subperiods and determine which components led to these differences. During periods of crises, such as during the financial (2008-2011) and COVID-19 (2019-2020) crises, gdp decreased more than the two welfare measures. In both cases, the welfare measures outperformed gdp by decreasing less or increasing (only bce between 2008 and 2011) and these growth rates were mainly caused by a combination of decreases in the welfare losses from income inequality and both narrow and broad ecological costs. On the contrary, between 2011 and 2014, the two welfare measures decreased more than gdp. During that subperiod, welfare losses from income inequality decreased again but there were increases in the narrow and broad ecological costs that more than offset the positive impact from the decline in welfare losses from income inequality. In two subperiods where there were increases in the three measures, gdp increased more than the two welfare measures. This was the case for the subperiods between 2001 and 2008 and between 2014 and 2019. The lower increase in the welfare measures during those subperiods were primarily caused by increases in the welfare losses from income inequality. Between 1995 and 2001, these increases in welfare losses from income inequality were more than offset by positive impacts from a decrease in narrow ecological costs, an increase in net investments and increases in most of the other components impacting the welfare measures positively, leading to higher increases in bce and bcpa than in gdp during that subperiod.

The two welfare measures also evolved at different rates during the selected subperiods. Between 2008 and 2011, the two welfare measures evolved in opposite directions because bce increased while bcpa decreased. This difference in growth rates was mainly caused by a strong decrease in net investments during that subperiod. In all the other subperiods, bce and bcpa evolved in the same direction, with bcpa always having a stronger (more positive or more negative) growth rate than bce. In some subperiods, the difference between the growth rates was higher than in others. For example, between 1995 and 2001, the difference between the growth rates is quite important. During that subperiod, the increase in net investments had a positive impact on bcpa, but the fact that the values of bcpa are lower than those of bce also plays a role in explaining this difference.

Between 2011 and 2014, bcpa decreased more than bce. This difference is mainly caused by the difference in changes in the ecological costs and their importance for the welfare measures. Indeed, both the narrow and the broad ecological costs increased during that subperiod, but the narrow ecological costs increased much more than the broad ecological costs. Still, since the broad ecological costs are more important for calculating the value of bcpa, their increase led to a higher decrease in bcpa than in bce. Additionally, a decrease in the net investment during that subperiod also participated to the decrease in bcpa. It is interesting to look deeper into the narrow and broad ecological costs to understand why the first ones increased so much more than the second ones. The strong increase in the narrow ecological costs was caused by a strong increase in the costs of extreme weather events, while the lower increase in the broad ecological costs mainly

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came from an increase in the costs of climate breakdown, which was partially offset by decreases in other subcomponents. The increase in the costs of climate breakdown during that subperiod was principally due to a strong increase in the emissions from international navigation.

Figure A.25.1: Evolution of the ISEWs and gdp (panel A) and evolution of the components (panel B) in Slovenia for the period 1995-2020 (measured in € in 2015 prices).

Panel A　　　　Panel B

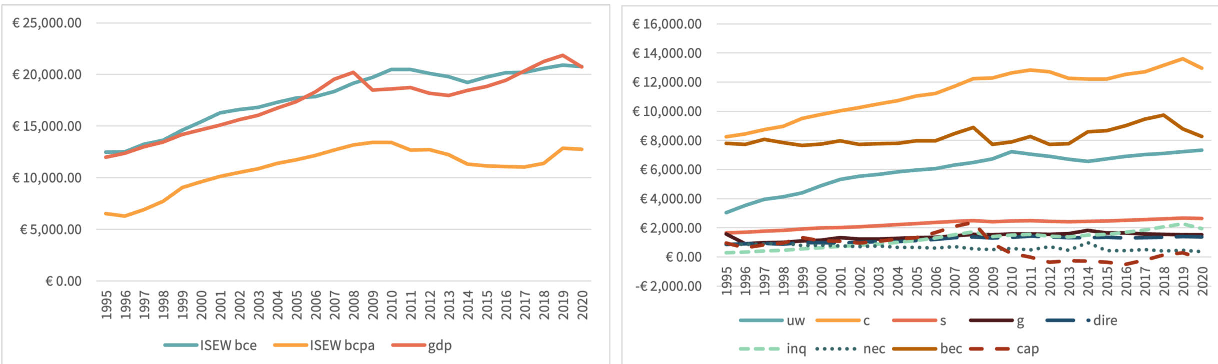

Table A.25.1: Annual and total growth rates of the ISEWs and gdp in Slovenia (in %)

	bce	**bcpa**	**gdp**
1995-2001	4.57	7.63	3.95
2001-2008	2.33	3.80	4.25
2008-2011	2.29	-1.22	-2.51
2011-2014	-2.07	-3.73	-0.50
2014-2019	1.66	2.58	3.44
2019-2020	-0.66	-0.87	-5.05
1995-2020 (total)	2.06 (66.51)	2.72 (95.41)	2.22 (73.30)

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Table A.25.2: Annual growth rates and importance of the components in Slovenia (in %)

	uw	ci	s	gc	direp	inq	nec	bec	k
1995-2001	9.75	3.36	3.42	-2.88	1.57	16.89	-3.12	0.39	2.05
2001-2008	2.88	2.88	3.03	2.33	5.51	13.29	-4.40	1.56	12.01
2008-2011	2.79	1.59	-0.09	0.45	1.41	-3.55	-3.64	-2.35	* (−)
2011-2014	-2.35	-1.67	-0.75	4.96	-2.69	-1.20	25.91	1.28	* (−)
2014-2019	1.95	2.19	1.80	-3.40	1.22	8.72	-13.78	0.42	* (+)
2019-2020	1.39	-4.80	-1.03	-0.17	-2.05	-14.23	-19.92	-5.91	* (−)
1995-2020 (total)	3.58 (140.76)	1.83 (57.26)	1.87 (59.10)	-0.12 (-2.99)	1.89 (59.84)	8.02 (588.77)	-3.49 (-58.87)	0.23 (6.00)	* (−)
Average importance in bce	28.18	54.17	10.89	6.75	39.04	37.87	23.09	/	/
Average importance in bcpa	27.30	52.41	10.53	6.53	11.12	11.14	/	77.74	3.22

Note: * is used when the annual growth rate of the component cannot be calculated because of a negative value at the beginning and/or at the end of the (sub)period studied. The (+) or (−) in these cells indicates whether the component increased (+) or decreased (−) during the (sub)period.

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A.26 Spain

The evolution of gdp, bce and bcpa for the period between 1995 and 2020 is presented in panel A of figure A.26.1. In that figure, panel B also presents the evolution of the components of the welfare measures for the same period. The annual growth rates of gdp, bce and bcpa for the entire period studied and for selected subperiods are presented in table A.26.1 to give more details about the evolution of gdp, bce and bcpa presented in panel A. Similarly, the annual growth rates of the components of the welfare measures are presented in table A.26.2 for the entire period studied and for the selected subperiods. Additionally, this second table presents a measure of the average importance of each component in calculating the values of the welfare measures.

The last row of table A.26.1 shows the total growth rate of gdp, bce and bcpa between 1995 and 2020. There, we can see that all the measures increased over the period studied, but at different rates. Indeed, gdp had the highest total growth rate, with a total increase of 23.85% over the period studied. The growth rates of bce and bcpa were lower than that, with total growth rates of 9.32% for bce and 4.82% for bcpa over the period studied. The different increases for the different measures are also visible in panel A of figure A.26.1. In that panel, we also see that from 2001 onwards, the values of bce and gdp were very similar, while the values of bcpa are lower for the whole period. From table A.26.2, we can see why the welfare measures increased less than gdp between 1995 and 2020 and we see that the component that mainly explains this difference is the value of welfare losses from income inequality because it increased over the period studied, having a negative impact on the two welfare measures.

Next to comparing the evolution of gdp to that of the welfare measures over the whole period, it is also interesting to compare them in different subperiods to see how the difference in growth rates changed over the period studied. This analysis can be done using tables A.26.1 and A.26.2. First, we can see that in periods of high(er) economic growth, gdp increased more than bce and bcpa. Indeed, during the subperiods between 1995 and 2001, 2001 and 2008 and 2014 and 2019, gdp increased more than the two welfare measures. In all of these three periods, table A.26.2 shows that there was an increase in the welfare losses from income inequality. Given that this components is amongst the most important components negatively impacting the welfare measures, an increase in the welfare losses from income inequality has a negative impact on both bce and bcpa and is the main explanation for the lower increase in welfare measures during these subperiods of positive economic growth. Secondly, we can see that in periods of crisis, such as the financial (2008-2011) and COVID-19 (2019-2020) crises, there was negative economic growth and gdp decreased more strongly than the two welfare measures. This finding also applies to the period directly following the financial crisis, between 2011 and 2014. In these three subperiods, the welfare measures outperformed gdp by decreasing less than gdp (or even increasing, as bce did between 2008 and 2011) for the same main reasons. In these three periods, there were decreases in the welfare losses from income inequality, which had a positive impact on the welfare measures. Additionally, in almost all of these subperiods, there were decreases in both the narrow and the broad ecological costs, which also positively impacted bce and bcpa, respectively. The only exception is that there was a small increase in the narrow ecological costs between 2011 and 2014, but the decrease in welfare losses from income inequality was strong enough that bce still decreased less than gdp during that subperiod. In short, in periods of higher economic growth, bce and bcpa increase less than gdp because of the negative impact of increases in the welfare losses from income inequality, while in periods of lower (even negative economic growth), bce and bcpa outperform gdp because of the positive impacts of decreases in welfare losses from income inequality and in ecological costs.

The growth rates of bce and bcpa also differed between during the period studied and it is interesting to see which components led to these differences in subperiods with the strongest differences. For example, between 2008 and 2011, there was a relatively high difference between the growth rates of the two welfare measures because bce increased while bcpa decreased. During this period, the main component leading to this difference was the value of the net investments, which decreased a lot during that subperiod, having a negative impact on bcpa.

The subperiod between 2014 and 2019 is another period where there was a relatively big difference between the growth rates of bce and bcpa, even if they both increased, bcpa increased more than bce. In this subperiod, the higher increase in bcpa is mainly due to two components. First, there was a relatively strong increase in net investments during that subperiod, having a positive impact on bcpa. Then, both the narrow and the broad ecological costs increased during that subperiod, negatively impacting the two welfare measures, but the increase in the broad ecological costs was lower than the increase in the narrow ecological costs, meaning that the negative impact was higher for bce than for bcpa, leading to the lower growth rate of bce. The higher increase in the narrow ecological costs during that subperiod was caused by a strong increase in the costs of extreme weather events during that subperiod, which only impacted the narrow ecological costs.

Figure A.26.1: Evolution of the ISEWs and gdp (panel A) and evolution of the components (panel B) in Spain for the period 1995-2020 (measured in € in 2015 prices).

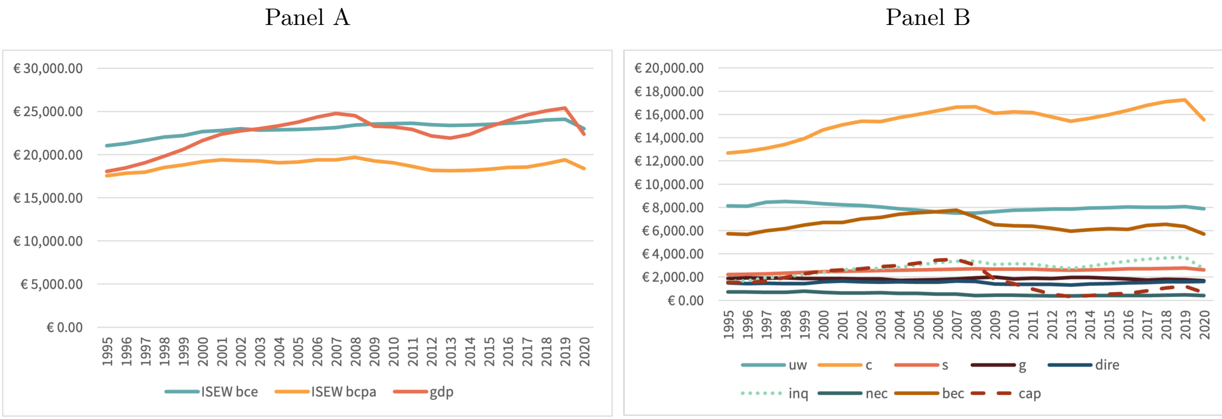

Table A.26.1: Annual and total growth rates of the ISEWs and gdp in Spain (in %)

	bce	bcpa	gdp
1995-2001	1.34	1.67	3.63
2001-2008	0.38	0.22	1.31
2008-2011	0.34	-1.80	-2.19
2011-2014	-0.34	-0.86	-0.90
2014-2019	0.58	1.33	2.64
2019-2020	-4.54	-5.15	-11.99
1995-2020 (total)	0.36 (9.32)	0.19 (4.82)	0.86 (23.85)

Table A.26.2: Annual growth rates and importance of the components in Spain (in %)

	uw	ci	s	gc	direp	inq	nec	bec	k
1995-2001	0.23	2.97	1.95	0.04	1.60	8.28	-1.86	2.57	9.41
2001-2008	-1.30	1.41	1.18	0.35	-0.28	3.62	-6.09	1.01	2.07
2008-2011	1.28	-0.99	-0.42	-0.23	-5.36	-2.40	-0.20	-3.75	-31.57
2011-2014	0.53	-1.05	-0.72	0.84	0.82	-2.02	0.23	-1.69	-24.83
2014-2019	0.37	1.96	1.19	-1.85	2.76	4.84	2.21	0.94	23.89
2019-2020	-2.42	-9.91	-5.59	-5.33	0.40	-27.61	-8.48	-10.47	-44.23
1995-2020 (total)	-0.12 (-2.99)	0.82 (22.72)	0.66 (17.96)	-0.41 (-9.78)	0.30 (7.69)	2.04 (65.81)	-2.10 (-41.21)	-0.03 (-0.72)	-3.24 (-56.15)
Average importance in bce	28.71	55.40	9.21	6.68	31.06	57.74	11.20	/	/
Average importance in bcpa	27.00	52.12	8.67	6.29	13.89	25.95	/	60.16	5.92

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A.27 Sweden

Panel A in figure A.27.1 presents the evolution of the absolute values of gdp, bce and bcpa for the period studied here, between 1995 and 2020. Panel B of the same figure presents the evolution of the absolute values of the components of the welfare measures for the same period. The two tables are giving more details about the evolution of these variables. First, table A.27.1 presents the annual growth rates of gdp, bce and bcpa for the entire period studied and for selected subperiods. Secondly, table A.27.2 presents the annual growth rates of the components of the welfare measures for the same (sub)periods. In addition to presenting the annual growth rates, table A.27.2 also presents a measure of the average importance of each component in calculating the size of the welfare measures.

In panel A of figure A.27.1, we can see that gdp, bce and bcpa had similar values over the period studied and that the three measures increased between 1995 and 2020. This second finding is confirmed by the last row of table A.27.1 that shows that gdp increased by 50.14% in total over the whole period, while bce increased by 23.56% and bcpa increased by 36.85% in total. This table hence shows that gdp increased more than the welfare measures over the whole period studied and table A.27.2 can be used to understand why it is the case. This second table shows that the component that changed the most over the whole period is the value of the welfare losses from income inequality. This component increased quite strongly between 1995 and 2020, which, especially given its high average importance for the two welfare measures, had a negative impact on them and explains why they increased less than gdp in total.

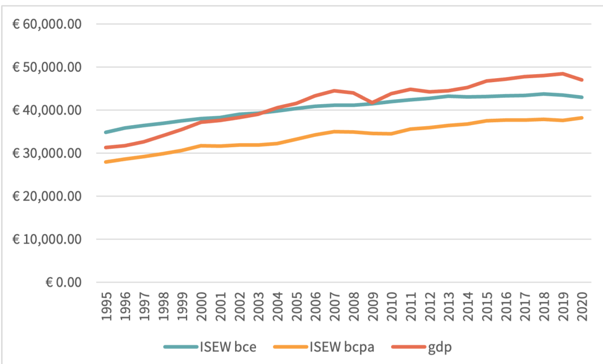
It is also possible to compare the growth rates of gdp to that of the two welfare measures for selected subperiods to have more details about their evolution. From table A.27.1, we can see that in periods of higher economic growth (subperiods 1995-2001, 2001-2008 and 2014-2019), gdp increased more than bce and bcpa. These three subperiods are the subperiods where the welfare losses from income inequality increased the most, which, as seen before, has a negative impact on the welfare measures and is the main reason why gdp increased more than bce and bcpa during these subperiods. On the contrary, during periods of lower, sometimes even negative, economic growth (subperiods 2008-2011 (financial crisis), 2011-2014 and 2019-2020 (COVID-19 crisis)), we see that the welfare measures generally outperformed gdp by increasing more than it or decreasing less. The only exception is for bcpa between 2008 and 2011, when it increased slightly less than gdp, mainly because of an decrease in net investments during that subperiod. During these subperiods of lower economic growth, the welfare measures generally outperformed gdp for similar reasons. In all of these subperiods, welfare losses from income inequality increased less than in the other subperiods, partially explaining why the welfare measures outperformed gdp. During the COVID-19 crisis (2019-2020), welfare losses from income inequality even decreased, having a positive impact on the welfare losses from income inequality. The other components that can explain why the welfare measures outperformed gdp in periods of lower economic growth are the narrow and the broad ecological costs. Indeed in the three subperiods, the broad ecological costs decreased, which had an important positive impact on bcpa. The narrow ecological costs also decreased between 2008 and 2011, partially explaining the higher increase in bce than in gdp. In the other periods, the narrow ecological costs slightly increased, negatively impacting bce, but the other positive impacts offset that small negative impact and still led bce to outperform gdp. In short, in periods of higher economic growth, increases in welfare losses from income inequality led gdp to outperform bce and bcpa, while in periods of lower economic growth, lower increases/decreases in welfare losses from income inequality and decreases in ecological costs led the welfare measures to outperform gdp.

The comparison of the growth rates of the two welfare measures in the different subperiods is also interesting to look at, especially in subperiods with the highest differences in the growth rates. Between 2019 and 2020, the growth rates were the most different because bce decreased while bcpa increased. The increase of bcpa during that period is mainly due to the strong decrease in the broad ecological costs during that period, while the decrease in bce is mainly caused by the fact that the narrow ecological costs slightly increased during that subperiod, not offsetting the negative impacts coming from decreases in most of the components positively impacting the welfare measures. More precisely, the decrease in the broad ecological costs was principally caused by a strong decrease in the costs of use of nuclear power, linked to a decrease in the amount of nuclear electricity generation, while the small increase in the narrow ecological costs was primarily due to an increase in the ecosystem costs of nitrogen pollution, itself mainly caused by an increase in the consumption of inorganic fertilizers.

An other period where the growth rates of bce and bcpa differed quite a lot from each other is the subperiod between 2011 and 2014. During that subperiod, the two welfare measures increased, but bcpa increased more than bce. Again, the difference between the growth rates mainly comes from a difference in the growth rates of the narrow and the broad ecological costs. The narrow ecological costs slightly increased because of an increase in the costs of extreme weather events, while the broad ecological costs decreased, mainly led by a decrease in the costs of air pollution, itself principally caused by a decrease in the costs of air pollution from production and especially decreases of emissions of $PM_2.5$ and SO_x.

Figure A.27.1: Evolution of the ISEWs and gdp (panel A) and evolution of the components (panel B) in Sweden for the period 1995-2020 (measured in € in 2015 prices).

Panel A



Panel B

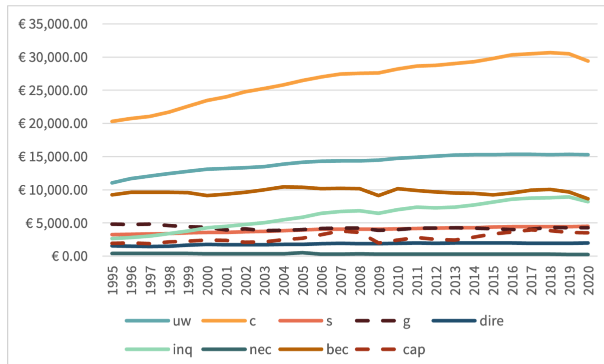


Table A.27.1: Annual and total growth rates of the ISEWs and gdp in Sweden (in %)

	bce	bcpa	gdp
1995-2001	1.58	2.10	3.10
2001-2008	1.06	1.41	2.27
2008-2011	0.95	0.65	0.67
2011-2014	0.57	1.14	0.27
2014-2019	0.17	0.45	1.41
2019-2020	-1.02	1.54	-3.09
1995-2020 (total)	0.85 (23.56)	1.26 (36.85)	1.64 (50.14)

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Table A.27.2: Annual growth rates and importance of the components in Sweden (in %)

	uw	ci	s	gc	direp	inq	nec	bec	k
1995-2001	3.02	2.84	1.77	-3.21	1.75	9.13	-1.52	0.21	3.46
2001-2008	1.19	1.98	1.81	0.93	1.52	6.21	-1.86	1.20	5.89
2008-2011	1.25	1.28	1.00	0.19	0.98	2.65	-3.46	-0.92	-7.46
2011-2014	0.78	0.79	0.97	-0.25	0.87	1.47	0.85	-1.53	0.46
2014-2019	0.07	0.78	0.74	0.32	-0.81	2.91	-2.47	0.41	4.41
2019-2020	-0.21	-3.54	0.33	0.13	3.22	-7.99	0.24	-10.66	-0.24
1995-2020 (total)	1.30 (38.16)	1.49 (44.77)	1.33 (39.00)	-0.46 (-10.89)	1.03 (29.25)	4.62 (209.07)	-1.69 (-34.67)	-0.28 (-6.80)	2.43 (82.11)
Average importance in bce	28.83	54.25	8.12	8.81	23.00	72.39	4.61	/	/
Average importance in bcpa	27.29	51.35	7.69	8.35	10.37	33.96	/	55.67	5.32

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B Appendix B: Summary tables

Table B.1: Summary table for the EU27 and individual countries: absolute values per capita in 1995 and 2020 and total growth rate (gdp, bce, bcpa)

	gdp			bce			bcpa		
	1995	**2020**	**Growth rate**	**1995**	**2020**	**Growth rate**	**1995**	**2020**	**Growth rate**
Austria	€ 30,473.64	€ 39,220.13	28.70%	€ 29,215.68	€ 32,197.91	10.21%	€ 25,266.50	€ 25,568.98	1.20%
Belgium	€ 28,254.92	€ 36,735.49	30.01%	€ 30,224.42	€ 34,264.74	13.37%	€ 20,993.66	€ 23,540.54	12.13%
Bulgaria	€ 3,619.24	€ 7,156.17	97.73%	€ 3,322.43	€ 6,555.97	97.32%	-€ 1,708.93	€ 1,794.26	*
Croatia	€ 6,534.84	€ 11,635.72	78.06%	€ 8,561.49	€ 13,239.77	54.64%	€ 6,401.58	€ 8,669.23	35.42%
Cyprus	€ 17,682.21	€ 24,489.11	38.50%	€ 18,014.34	€ 23,352.26	29.63%	€ 13,972.97	€ 18,289.34	30.89%
Czechia	€ 10,110.98	€ 17,182.73	69.94%	€ 7,420.48	€ 13,770.31	85.57%	€ 395.54	€ 5,084.80	1185.52%
Denmark	€ 39,199.25	€ 50,431.51	28.65%	€ 42,819.22	€ 50,545.05	18.04%	€ 34,580.79	€ 44,162.00	27.71%
Estonia	€ 6,382.20	€ 18,116.72	183.86%	€ 6,580.49	€ 15,390.64	133.88%	€ 661.75	€ 7,624.92	1052.23%
Finland	€ 27,008.18	€ 40,575.77	50.24%	€ 28,972.29	€ 38,838.75	34.05%	€ 19,188.08	€ 27,892.00	45.36%
France	€ 26,912.49	€ 32,410.08	20.43%	€ 29,634.90	€ 31,139.51	5.08%	€ 23,125.45	€ 25,028.42	8.23%
Germany	€ 28,555.10	€ 37,518.00	31.39%	€ 29,343.77	€ 31,720.91	8.10%	€ 22,632.98	€ 24,155.42	6.73%
Greece	€ 14,408.55	€ 15,565.81	8.03%	€ 16,467.58	€ 18,375.28	11.58%	€ 11,751.24	€ 12,812.54	9.03%
Hungary	€ 6,911.18	€ 12,977.30	87.77%	€ 6,837.10	€ 12,143.81	77.62%	€ 1,860.67	€ 7,332.03	294.05%
Ireland	€ 25,595.03	€ 72,033.48	181.44%	€ 26,231.57	€ 29,923.86	14.08%	€ 20,046.81	€ 30,158.01	50.44%
Italy	€ 26,376.44	€ 26,387.73	0.04%	€ 31,984.21	€ 28,881.73	-9.70%	€ 26,883.21	€ 22,739.64	-15.41%
Latvia	€ 4,451.43	€ 14,123.46	217.28%	€ 4,836.45	€ 12,826.17	165.20%	€ 1,674.23	€ 4,116.27	145.86%
Lithuania	€ 4,431.84	€ 15,557.63	251.04%	€ 5,044.64	€ 13,135.63	160.39%	€ 276.36	€ 8,155.91	2851.22%
Luxembourg	€ 67,998.51	€ 94,122.17	38.42%	€ 35,616.53	€ 37,058.54	4.05%	€ 23,256.72	€ 27,071.00	16.40%
Malta	€ 12,856.86	€ 23,439.63	82.31%	€ 15,260.65	€ 21,682.21	42.08%	€ 11,606.69	€ 10,957.52	-5.59%
Netherlands	€ 30,439.38	€ 41,814.23	37.37%	€ 30,033.71	€ 30,518.01	1.61%	€ 21,988.63	€ 23,147.92	5.27%
Poland	€ 5,072.60	€ 13,290.17	162.00%	€ 5,074.05	€ 12,759.20	151.46%	-€ 125.93	€ 6,649.37	*
Portugal	€ 14,255.48	€ 17,849.71	25.21%	€ 15,241.26	€ 18,600.23	22.04%	€ 12,053.37	€ 13,461.97	11.69%
Romania	€ 4,113.00	€ 9,788.48	137.99%	€ 4,218.62	€ 9,707.76	130.12%	€ 813.32	€ 6,781.14	733.76%
Slovakia	€ 6,805.04	€ 15,881.34	133.38%	€ 5,947.82	€ 15,659.65	163.28%	€ 859.72	€ 9,536.90	1009.31%
Slovenia	€ 11,968.10	€ 20,740.96	73.30%	€ 12,463.33	€ 20,752.45	66.51%	€ 6,520.85	€ 12,742.34	95.41%
Spain	€ 18,065.89	€ 22,375.04	23.85%	€ 21,047.84	€ 23,008.53	9.32%	€ 17,553.54	€ 18,400.04	4.82%
Sweden	€ 31,282.68	€ 46,967.59	50.14%	€ 34,795.69	€ 42,994.44	23.56%	€ 27,900.71	€ 38,181.51	36.85%
EU27	€ 20,813.10	€ 28,095.17	34.99%	€ 22,414.62	€ 25,823.79	15.21%	€ 16,763.66	€ 19,604.54	16.95%

Note: * is used when the (annual) growth rate of the component cannot be calculated because of a negative value at the beginning and/or at the end of the (sub)period studied.

Table B.2: Summary table for the EU27 and individual countries: absolute values per capita in 1995 and 2020 and total growth rate (uw, c_i, s)

	uw			ci			s		
	1995	**2020**	**Growth rate**	**1995**	**2020**	**Growth rate**	**1995**	**2020**	**Growth rate**
Austria	€ 9,765.27	€ 11,007.75	12.72%	€ 19,898.31	€ 24,694.36	24.10%	€ 1,577.12	€ 1,984.40	25.82%
Belgium	€ 10,333.98	€ 11,556.04	11.83%	€ 18,428.09	€ 23,805.66	29.18%	€ 3,352.86	€ 4,054.53	20.93%
Bulgaria	€ 882.61	€ 1,775.54	101.17%	€ 2,363.85	€ 4,881.90	106.52%	€ 647.16	€ 1,171.11	80.96%
Croatia	€ 2,849.25	€ 4,460.99	56.57%	€ 5,118.85	€ 8,331.75	62.77%	€ 1,118.14	€ 1,782.86	59.45%
Cyprus	€ 5,258.54	€ 5,598.46	6.46%	€ 11,565.97	€ 17,293.34	49.52%	€ 2,584.68	€ 3,505.04	35.61%
Czechia	€ 1,926.54	€ 4,285.20	122.43%	€ 5,906.45	€ 9,841.97	66.63%	€ 955.85	€ 1,509.41	57.91%
Denmark	€ 16,650.07	€ 22,649.56	36.03%	€ 25,657.23	€ 31,616.47	23.23%	€ 3,754.76	€ 4,309.32	14.77%
Estonia	€ 1,828.53	€ 4,073.34	122.77%	€ 4,396.72	€ 11,064.16	151.65%	€ 1,080.31	€ 2,676.83	147.78%
Finland	€ 10,090.10	€ 12,779.19	26.65%	€ 17,416.99	€ 27,111.65	55.66%	€ 2,655.31	€ 3,618.08	36.26%
France	€ 11,554.24	€ 10,579.29	-8.44%	€ 18,433.90	€ 22,464.42	21.86%	€ 2,204.20	€ 2,490.54	12.99%
Germany	€ 11,032.39	€ 10,860.81	-1.56%	€ 19,080.53	€ 23,850.11	25.00%	€ 2,338.73	€ 2,883.06	23.27%
Greece	€ 3,857.93	€ 5,100.29	32.20%	€ 10,855.76	€ 12,549.46	15.60%	€ 2,138.36	€ 2,350.02	9.90%
Hungary	€ 1,643.54	€ 3,847.95	134.13%	€ 4,518.60	€ 7,590.20	67.98%	€ 909.51	€ 1,482.64	63.01%
Ireland	€ 11,788.44	€ 13,098.43	11.11%	€ 15,927.19	€ 24,232.92	52.15%	€ 2,171.73	€ 5,171.45	138.13%
Italy	€ 12,204.19	€ 9,980.40	-18.22%	€ 17,879.89	€ 18,415.34	2.99%	€ 3,836.38	€ 3,936.16	2.60%
Latvia	€ 1,294.35	€ 3,550.34	174.30%	€ 3,428.03	€ 9,322.83	171.96%	€ 693.64	€ 1,921.24	176.98%
Lithuania	€ 1,684.27	€ 3,443.72	104.46%	€ 3,286.58	€ 10,512.98	219.88%	€ 759.42	€ 2,279.95	200.22%
Luxembourg	€ 11,291.40	€ 11,946.06	5.80%	€ 35,387.69	€ 38,924.70	10.00%	€ 3,583.53	€ 4,790.79	33.69%
Malta	€ 5,174.61	€ 8,138.98	57.29%	€ 8,823.58	€ 13,106.16	48.54%	€ 1,824.65	€ 3,049.82	67.15%
Netherlands	€ 10,396.08	€ 9,978.07	-4.02%	€ 18,765.74	€ 24,685.48	31.55%	€ 2,181.91	€ 2,757.25	26.37%
Poland	€ 1,627.31	€ 4,135.90	154.16%	€ 3,376.29	€ 8,859.26	162.40%	€ 717.65	€ 1,672.72	133.08%
Portugal	€ 4,167.61	€ 5,242.47	25.79%	€ 10,481.15	€ 13,313.52	27.02%	€ 1,720.16	€ 1,991.91	15.80%
Romania	€ 1,135.00	€ 2,886.64	154.33%	€ 3,064.76	€ 6,641.97	116.72%	€ 695.80	€ 1,509.07	116.88%
Slovakia	€ 1,863.43	€ 5,210.86	179.64%	€ 3,861.37	€ 10,583.43	174.09%	€ 648.54	€ 1,345.97	107.54%
Slovenia	€ 3,045.10	€ 7,331.24	140.76%	€ 8,235.52	€ 12,951.37	57.26%	€ 1,655.07	€ 2,633.26	59.10%
Spain	€ 8,122.81	€ 7,880.00	-2.99%	€ 12,669.35	€ 15,547.82	22.72%	€ 2,219.71	€ 2,618.41	17.96%
Sweden	€ 11,068.83	€ 15,292.54	38.16%	€ 20,310.71	€ 29,403.72	44.77%	€ 3,228.37	€ 4,487.51	39.00%
EU27	€ 8,197.06	€ 8,789.04	7.22%	€ 13,914.05	€ 18,305.49	31.56%	€ 2,131.19	€ 2,714.20	27.36%

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Table B.3: Summary table for the EU27 and individual countries: absolute values per capita in 1995 and 2020 and total growth rate (g_c, $dire_p$, inq)

	gc			direp			inq		
	1995	**2020**	**Growth rate**	**1995**	**2020**	**Growth rate**	**1995**	**2020**	**Growth rate**
Austria	€ 3,695.94	€ 2,991.70	-19.05%	€ 1,776.43	€ 1,860.55	4.74%	€ 3,450.42	€ 6,289.95	82.30%
Belgium	€ 4,168.90	€ 3,293.06	-21.01%	€ 2,094.52	€ 2,387.35	13.98%	€ 3,174.95	€ 5,758.33	81.37%
Bulgaria	€ 455.35	€ 380.29	-16.48%	€ 240.34	€ 511.12	112.66%	€ 7.25	€ 569.98	7760.33%
Croatia	€ 560.12	€ 1,002.17	78.92%	€ 499.38	€ 1,002.60	100.77%	€ 91.89	€ 701.77	663.72%
Cyprus	€ 1,689.54	€ 2,395.29	41.77%	€ 1,425.39	€ 1,886.76	32.37%	€ 1,212.65	€ 3,339.69	175.40%
Czechia	€ 631.38	€ 1,158.98	83.56%	€ 674.37	€ 1,038.05	53.93%	€ 306.29	€ 1,546.30	404.85%
Denmark	€ 5,159.93	€ 4,122.60	-20.10%	€ 2,491.12	€ 2,612.17	4.86%	€ 4,877.02	€ 8,981.37	84.16%
Estonia	€ 422.26	€ 1,160.71	174.88%	€ 483.01	€ 1,168.48	141.92%	€ 102.97	€ 1,980.09	1822.93%
Finland	€ 2,804.16	€ 4,149.49	47.98%	€ 1,604.30	€ 2,128.22	32.66%	€ 1,760.84	€ 6,323.61	259.12%
France	€ 2,735.07	€ 2,704.62	-1.11%	€ 1,670.78	€ 2,097.08	25.52%	€ 2,845.47	€ 4,543.68	59.68%
Germany	€ 2,619.43	€ 2,889.15	10.30%	€ 1,852.14	€ 1,991.51	7.52%	€ 3,284.52	€ 6,450.52	96.39%
Greece	€ 2,536.64	€ 1,521.72	-40.01%	€ 1,138.26	€ 1,427.14	25.38%	€ 1,123.44	€ 1,298.61	15.59%
Hungary	€ 1,036.97	€ 1,672.59	61.30%	€ 521.28	€ 931.76	78.74%	€ 126.16	€ 976.79	674.22%
Ireland	€ 2,303.59	€ 2,656.79	15.33%	€ 1,856.76	€ 1,968.49	6.02%	€ 2,534.37	€ 12,282.53	384.64%
Italy	€ 4,353.68	€ 2,447.39	-43.79%	€ 2,013.83	€ 1,889.34	-6.18%	€ 3,684.55	€ 3,707.74	0.63%
Latvia	€ 273.06	€ 899.49	229.41%	€ 462.84	€ 935.53	102.13%	€ 10.31	€ 1,379.99	13283.13%
Lithuania	€ 257.00	€ 869.42	238.30%	€ 383.63	€ 976.61	154.57%	€ 23.94	€ 2,223.49	9186.36%
Luxembourg	€ 4,781.07	€ 6,401.54	33.89%	€ 3,814.02	€ 4,446.82	16.59%	€ 14,077.46	€ 20,018.02	42.20%
Malta	€ 1,009.45	€ 1,692.44	67.66%	€ 863.60	€ 1,284.78	48.77%	€ 477.37	€ 2,930.45	513.87%
Netherlands	€ 4,804.95	€ 2,479.26	-48.40%	€ 2,097.29	€ 2,181.11	4.00%	€ 3,261.13	€ 6,901.66	111.63%
Poland	€ 637.23	€ 818.94	28.52%	€ 469.56	€ 1,010.25	115.15%	€ 64.34	€ 1,193.67	1755.22%
Portugal	€ 1,581.41	€ 1,517.50	-4.04%	€ 989.84	€ 1,300.58	31.39%	€ 1,301.40	€ 1,914.66	47.12%
Romania	€ 241.30	€ 682.69	182.92%	€ 382.36	€ 752.05	96.68%	€ 53.22	€ 802.98	1408.92%
Slovakia	€ 590.58	€ 1,113.21	88.50%	€ 433.95	€ 1,065.68	145.58%	€ 39.04	€ 1,169.77	2896.05%
Slovenia	€ 1,572.81	€ 1,525.74	-2.99%	€ 856.80	€ 1,369.53	59.84%	€ 282.69	€ 1,947.08	588.77%
Spain	€ 1,873.63	€ 1,690.43	-9.78%	€ 1,493.58	€ 1,608.50	7.69%	€ 1,627.38	€ 2,698.30	65.81%
Sweden	€ 4,810.84	€ 4,286.78	-10.89%	€ 1,550.38	€ 2,003.82	29.25%	€ 2,652.33	€ 8,197.66	209.07%
EU27	€ 2,452.10	€ 2,222.32	-9.37%	€ 1,429.98	€ 1,708.76	19.50%	€ 2,182.15	€ 4,097.41	87.77%

Table B.4: Summary table for the EU27 and individual countries: absolute values per capita in 1995 and 2020 and total growth rate (nec, bec, k)

	nec			bec			k		
	1995	2020	Growth rate	1995	2020	Growth rate	1995	2020	Growth rate
Austria	€ 494.12	€ 329.81	-33.25%	€ 7,327.42	€ 8,963.00	22.32%	€ 2,884.12	€ 2,004.25	-30.51%
Belgium	€ 789.94	€ 298.87	-62.17%	€ 11,607.97	€ 12,506.53	7.74%	€ 1,587.27	€ 1,483.45	-6.54%
Bulgaria	€ 778.94	€ 571.76	-26.60%	€ 6,011.82	€ 5,731.36	-4.67%	€ 201.52	€ 397.89	97.44%
Croatia	€ 493.62	€ 633.62	28.36%	€ 3,610.69	€ 5,614.59	55.50%	€ 957.17	€ 410.43	-57.12%
Cyprus	€ 446.36	€ 213.43	-52.18%	€ 7,680.57	€ 7,383.84	-3.86%	€ 3,192.84	€ 2,107.49	-33.99%
Czechia	€ 1,019.08	€ 440.89	-56.74%	€ 9,786.29	€ 10,013.92	2.33%	€ 1,742.27	€ 887.52	-49.06%
Denmark	€ 1,034.62	€ 559.37	-45.93%	€ 10,310.12	€ 9,364.24	-9.17%	€ 1,037.06	€ 2,421.82	133.53%
Estonia	€ 561.35	€ 435.84	-22.36%	€ 7,032.87	€ 10,816.06	53.79%	€ 552.78	€ 2,614.49	372.97%
Finland	€ 629.12	€ 367.82	-41.53%	€ 10,756.79	€ 13,102.73	21.81%	€ 343.46	€ 1,788.16	420.64%
France	€ 776.26	€ 458.59	-40.92%	€ 8,561.83	€ 7,610.03	-11.12%	€ 1,276.12	€ 1,040.34	-18.48%
Germany	€ 590.65	€ 320.20	-45.79%	€ 9,198.45	€ 8,675.91	-5.68%	€ 1,897.02	€ 790.22	-58.34%
Greece	€ 659.42	€ 420.47	-36.24%	€ 6,089.47	€ 5,371.82	-11.79%	€ 713.71	-€ 611.39	*
Hungary	€ 624.09	€ 541.01	-13.31%	€ 5,804.80	€ 6,497.12	11.93%	€ 204.28	€ 1,144.32	460.16%
Ireland	€ 1,568.25	€ 984.71	-37.21%	€ 9,432.95	€ 10,364.77	9.88%	€ 1,679.95	€ 9,614.22	472.29%
Italy	€ 591.55	€ 300.47	-49.21%	€ 6,902.84	€ 6,126.88	-11.24%	€ 1,995.00	-€ 315.69	*
Latvia	€ 379.49	€ 552.21	45.52%	€ 3,460.74	€ 9,267.78	167.80%	-€ 80.96	€ 5.67	*
Lithuania	€ 535.06	€ 770.34	43.97%	€ 5,585.65	€ 7,093.61	27.00%	€ 282.31	€ 1,343.55	375.91%
Luxembourg	€ 1,535.68	€ 539.71	-64.86%	€ 18,662.16	€ 14,654.34	-21.48%	€ 4,766.67	€ 4,127.08	-13.42%
Malta	€ 230.66	€ 89.96	-61.00%	€ 5,393.51	€ 12,294.36	127.95%	€ 1,508.89	€ 1,479.72	-1.93%
Netherlands	€ 756.55	€ 299.28	-60.44%	€ 10,223.56	€ 9,428.94	-7.77%	€ 1,421.93	€ 1,759.58	23.75%
Poland	€ 750.53	€ 523.70	-30.22%	€ 6,609.95	€ 7,537.33	14.03%	€ 659.45	€ 903.80	37.05%
Portugal	€ 417.84	€ 249.93	-40.19%	€ 4,611.98	€ 5,297.20	14.86%	€ 1,006.26	-€ 91.00	*
Romania	€ 482.66	€ 457.58	-5.20%	€ 4,436.51	€ 4,232.07	-4.61%	€ 548.55	€ 847.87	54.57%
Slovakia	€ 543.11	€ 358.35	-34.02%	€ 6,382.67	€ 6,796.52	6.48%	€ 751.45	€ 315.42	-58.03%
Slovenia	€ 905.69	€ 372.55	-58.87%	€ 7,792.56	€ 8,260.26	6.00%	€ 944.40	-€ 122.40	*
Spain	€ 716.70	€ 421.33	-41.21%	€ 5,743.02	€ 5,701.62	-0.72%	€ 1,532.02	€ 671.80	-56.15%
Sweden	€ 420.36	€ 274.63	-34.67%	€ 9,261.65	€ 8,631.92	-6.80%	€ 1,946.31	€ 3,544.35	82.11%
EU27	€ 667.65	€ 401.09	-39.93%	€ 7,599.49	€ 7,525.35	-0.98%	€ 1,280.88	€ 905.02	-29.34%

Note: * is used when the (annual) growth rate of the component cannot be calculated because of a negative value at the beginning and/or at the end of the (sub)period studied.

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