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Beyond GDP: alternative measures of economic welfare for the EU-15

Jonas Van der Slycken

Supervisor: Prof. Dr. Brent Bleys

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To billions of climate and environmental justice activists

may we dismantle the billionaire's wealth,

for a life-sustaining society and

a good life for all.

Salut!

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List of abbreviations

AAI: Adjusted Atkinson Index
AI: Atkinson Index
AIC: Actual Individual Consumption
BBP: Bruto Binnenlands product
BCE: Benefits and Costs Experienced
bce: per capita Benefits and Costs Experienced
BCPA: Benefits and Costs of Present Economic Activities
bcpa: per capita Benefits and Costs of Present Economic Activities
BEC : broad ecological costs
C_i : individual consumption
CBA: Cost-Benefit Analysis
CEA: Cost-Effectiveness Analysis
CO2: carbon dioxide
$DIRE_p$: defensive, intermediate and rehabilitative private expenditures
DMUI: diminishing marginal utility of income
EHI: extended Hicksian income
EU-15: The 15 Member States of the European Union as of December 31, 2003.
EWM: Economic Welfare Measures
EWM: Economische Welvaartsmaatstaven
G_c : non-defensive collective government consumption
GDP: Gross Domestic Product
gdp: per capita Gross Domestic Product
GNP: Gross National Product
GHG: greenhouse gasses
GPI: Genuine Progress Indicator
INQ : welfare losses from income inequality
ISEW: Index of Sustainable Economic Welfare
LULUCF: Land Use, Land-Use Change and Forestry
NEC : narrow ecological costs
NNP: Net National Product
NPISHs: Non-Profit Institutions Serving Households
S : shadow economy
SCC: Social Cost of Carbon
SDG: Sustainable Development Goal
SNA: System of National Accounts
UK: United Kingdom
UW : unpaid work
ΔK : capital adjustment

Summary

Gross Domestic Product (GDP) is the 'world's most powerful number' (Fioramonti, 2013) and is 'probably the largest information failure in the world' (van den Bergh, 2009) because despite the fact that GDP is widely criticized, it is still influential in politics, economics, policy-making and society (van den Bergh, 2009). According to van den Bergh, this "GDP paradox" can be explained by recognizing that many economists accept the GDP-criticism but deny its importance. Over the last decade, calls have been made to urgently move beyond GDP as it is a bad indicator for social welfare, societal well-being or economic progress (Stiglitz et al., 2009, 2018; Costanza et al., 2014, Kubiszewski et al., 2013; Hoekstra, 2019). As a way to guide the transition away from GDP, countries should adopt new metrics (Costanza et al., 2014) to measure economic welfare. This thesis contributes to the field of (alternative) economic welfare measures (EWM) with a focus on the Index of Sustainable Economic Welfare (ISEW) and Genuine Progress Indicator (GPI). Chapter 1 elaborates on the theoretical and conceptual welfare framework of these measures. Chapter 2 standardizes and improves EWM's methodologies. Chapter 3 estimates the welfare levels for the EU-15 based on a comparable methodology. Finally, Chapter 4 investigates whether these EWM are able to reveal a threshold point and social and biophysical limits to growth.

Chapter 1 explores the theoretical foundation(s) of these EWM. The ISEW and GPI are often argued to lack a sound theoretical foundation. However, we observe that the initial ISEW by Daly and Cobb (1989) was jointly inspired by Hicksian and Fisherian income. Welfare's experiential nature is Fisher-inspired, whereas seeing the consumption of community capital (e.g. the ecosystem) as a cost is Hicks-inspired. As most scholars do not recognize this double theoretical foundation, they have found it difficult to deal with welfare's time and boundary issues. Elaborating on this duality, we have put forward two welfare interpretations with distinct time and boundary dimensions to address time and boundary complexities. EWM can be seen as either capturing the benefits and costs experienced (BCE), or as reflecting the benefits and costs of present economic activities (BCPA). The former interpretation only takes into account what is currently experienced within domestic borders: it excludes future costs, costs shifted abroad and capital changes. BCPA has broader time and boundary dimensions, and thus also includes the costs shifted in time and space and capital changes as they all are benefits and costs arising from current economic activities. Recent developments reveal that EWM are converging toward the ex post established experiential Fisherian foundation and the BCE-interpretation. Yet, we argue that this is not the only way forward as the BCPA-perspective offers an alternative viewpoint to account for the costs of present activities shifted abroad or

to the future such as those involved in climate disruption, irrespective of whether they are currently "experienced" or not.

The second chapter builds on the different welfare interpretations set forth in the first chapter. Two EWM with distinct time and boundary effects are calculated for Belgium: the BCE and BCPA. This EWM-compilation is the first to include the welfare benefits of the shadow economy and to employ a sufficiency threshold to calculate the welfare losses from income inequality. Other methodological novelties for the broader BCPA include a consumption footprint view for greenhouse gas emissions and air pollution by accounting for the emissions embodied in trade, and the registration of the climate impacts of aviation and shipping. Belgium's welfare measured by both indicators improved from 1995 to 2018: BCE per capita improved by 15% and BCPA per capita enhanced by 18%, which is about half of the growth in GDP per capita by 30%. Furthermore, the aggregate trend over time masks that the per capita welfare losses from income inequality and the per capita broader ecological costs in BCPA have increased by, respectively, 89.9% and 6.8%. Yet, these trends are outweighed or compensated by increasing benefits from consumption. As there are substantial ecological costs shifted in time and space, we suggest to account for ecological cost-shifting by using the BCPA-view when calculating EWM because it is more informative for policy-makers. A careful reflection on EWM's design and use is needed to stimulate future studies' policy-guiding and transformative potential.

Next, we estimate both EWM for the EU-15 as a whole and all individual countries from 1995 to 2018 in *Chapter 3*. For the EU-15, GDP per capita improved by about 31% over time, yet, GDP and EWM diverged as BCE and BCPA per capita improved by 13% and 17%. By 2018, the EU-15 had entirely recovered from the financial crisis from a GDP-perspective but not from a welfare view. The financial crisis and its recovery had a different impact on GDP and EWM. In contrast to GDP, the response in EWM to the crisis in 2009 was delayed in some countries: their per capita BCPA only fell during the economic GDP-recovery in 2010 as the broader ecological costs increased. At the level of the EU-15, the broader ecological costs decreased in 2009 but increased again in 2010 during an environmentally more polluting GDP-recovery. Our results thus indicate that a post-COVID agenda needs to aim for a green and just economic recovery that is centered around welfare and a move beyond GDP that prioritizes human well-being within planetary boundaries without growth. Despite the overall improvements over the entire period, GDP per capita barely improved after 2007: it only fully recovered from the financial crisis in 2018, when the EU-15's GDP per capita reached its maximum value that was slightly higher than its pre-crisis level. The EU-15's welfare per capita already peaked right before the financial crisis in 2006 for BCE and in 2007 for BCPA. In 2018, BCE per capita and

BCPA per capita were respectively 1.5% and 1.8% lower than their maximum values. As a consequence, we found no conclusive evidence for the EU-15 as a whole regarding the threshold hypothesis (i.e. the existence of a threshold beyond which continued GDP growth reduces welfare). However, we found evidence of thresholds in Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain, Sweden and the UK, where the per capita welfare levels were at least 5% lower in 2018 compared to their maximum welfare value.

In *Chapter* 4, we revisited the debate about the threshold hypothesis. Concerns over social limits and biophysical limits to growth have led scholars to belief that the social benefits indicated by GDP growth would evaporate when a more comprehensive measure of economic welfare is used to evaluate economic performance. By applying the principles of diminishing marginal benefits and increasing marginal cost at the macroeconomic level, EWM can be used to indicate the point beyond which economic growth becomes uneconomic growth, i.e. further growth brings more costs than benefits. Pursuing growth beyond this point is suboptimal. Due to the limits to growth, EWM are expected to indicate a threshold point in a time series of welfare results beyond which continued GDP growth reduces welfare. The EU-15's results do not provide conclusive evidence for the threshold hypothesis from 1995 to 2018 as EWM only indicate that welfare has been stagnating after the financial crisis of 2008 and 2009. After the financial crisis, as incomes grow, the growth in individual consumption is not translated into welfare. Our methodology that makes use of a sufficiency threshold thus signals there are social limits to growth: "keeping up with the Joneses" or aggregate consumption growth yields little welfare gains beyond a certain point because of the diminishing marginal utility of income. This stagnation in welfare is not caused by the existence of biophysical limits to growth, since the broader ecological costs have not increased substantially. Yet, as the EU-15 has transgressed planetary boundaries, one would expect that the broader ecological costs would have increased substantially. We believe the absence of clear biophysical limits is potentially a shortcoming of the current methodology since the number of ecological items is limited and the cost estimates of most ecological items do not change over time, which makes it difficult to capture deteriorating or improving environmental conditions. Yet, this absence is only partly a methodological shortcoming because the advances made in this dissertation tried to account for the biophysical limits by improving the valuation of the ecological costs, for instance, by updating and revising upwardly the cost estimates for climate disruption and nonrenewable energy resources depletion. Besides a potential shortcoming of the current methodology, the absence of clear biophysical limits could also be related to the way of looking at and using EWM.

Since evaluating economic performance should not be reduced to merely balancing the monetized benefits and costs, we suggested to be cautious about the aggregate welfare trend and to de-emphasize it. Instead, EWM should adopt a disaggregate approach to verify whether issues such as the welfare losses from income inequality and ecological costs are reduced. We proposed a user guide to facilitate EWM's use and transformative potential. Finally, we articulated a narrative of living well within planetary limits, so that EWM may be a starting point to move beyond GDP and growth.

Samenvatting

Het Bruto Binnenlands Product (BBP) is 'het meest invloedrijke getal ter wereld' (Fioramonti, 2013) en is 'waarschijnlijk de grootste informatiefaling in de wereld' (van den Bergh, 2009). De reden hiervoor is dat het BBP ondanks wijdverspreide kritiek nog steeds belangrijk is in de politiek, de economie, beleidsvoering en de samenleving (van den Bergh, 2009). Volgens van den Bergh valt deze "BBP-paradox" te verklaren doordat vele economen de BBP-kritiek erkennen maar het belang ervan ontkennen. Het afgelopen decennium werd er dringend opgeroepen om voorbij het BBP te gaan aangezien het een slechte indicator is voor maatschappelijke welvaart, maatschappelijk welzijn en economische vooruitgang (Stiglitz et al., 2009, 2018; Costanza et al., 2014, Kubiszewski et al., 2013; Hoekstra, 2019). Om de transitie weg van het BBP te begeleiden, dienen landen nieuwe maatstaven te omarmen (Costanza et al., 2014) om economische welvaart te meten. Deze thesis levert een bijdrage aan het gebied van (alternatieve) economische welvaartsmaatstaven (EWM) met een focus op de Index voor Duurzame Economische Welvaart (*Index of Sustainable Economic Welfare*, ISEW) en *Genuine Progress Indicator* (GPI). Hoofdstuk 1 gaat dieper in op hun theoretisch en conceptueel kader. Hoofdstuk 2 standaardiseert en verbetert de methodologie van EWM. Hoofdstuk 3 schat de welvaartsniveaus voor de EU-15 op basis van een vergelijkbare methodologie. Tenslotte, onderzoekt Hoofdstuk 4 of EWM een drempelpunt en sociale en biofysische grenzen aan de groei kunnen signaleren.

Hoofdstuk 1 verkent de theoretische fundamenten van deze EWM. Er wordt vaak geargumenteerd dat de ISEW en GPI een gedegen theoretisch fundament ontbreken. Toch observeren we dat de initiële ISEW van Daly en Cobb (1989) gebaseerd was op zowel Hicksiaans als Fisheriaans inkomen. De 'experientiële' of ervaringsgerichte aard van welvaart komt van Fisher, terwijl het zien van de consumptie van gemeenschapskapitaal (bv. het ecosysteem) als een kost geïnspireerd is door Hicks. Aangezien de meeste welvaartsonderzoekers deze dubbele theoretische fundering niet erkennen, hadden ze het moeilijk om op een gepaste wijze om te gaan met de ruimte- en tijdsaspecten van welvaart. Verder bouwend op dit dubbel theoretisch fundament, hebben we twee welvaartsinterpretaties met verschillende ruimte- en tijdsdimensies vooropgesteld om de complexiteit van temporele en ruimtelijke welvaartsaspecten te omvatten. EWM kunnen gezien worden als de baten en kosten die ervaren worden (*benefits and costs experienced, BCE)* of als de baten en kosten van de huidige economische activiteiten (*benefits and costs of present economic activities, BCPA)*. De eerste interpretatie brengt enkel in rekening wat er vandaag en binnen landsgrenzen ervaren wordt waardoor toekomstige kosten, de kosten doorgeschoven buiten grenzen en kapitaalaanpassingen niet opgenomen worden. BCPA registreert 'alle' kosten en baten van de

huidige activiteiten en hanteert bredere ruimte- en tijdsdimensies. Als een gevolg hiervan, worden de kapitaalaanpassingen en de kosten die doorgeschoven worden in tijd en ruimte in rekening gebracht. Recente evoluties illustreren dat EWM opschuiven naar de ervaringsgerichte Fisheriaanse fundering, die ex post gemaakt werd, en de BCE-interpretatie. Desalniettemin menen we dat dit niet de enige weg vooruit is aangezien de BCPA-interpretatie een alternatief perspectief biedt voor het in rekening brengen van de kosten van huidige activiteiten die naar elders of naar de toekomst doorgeschoven worden zoals het geval is bij klimaatverandering, ongeacht of deze kosten vandaag "ervaren" worden of niet.

Het tweede hoofdstuk bouwt verder op de verschillende welvaartsinterpretaties die vooruitgeschoven werden in het eerste hoofdstuk. Twee EWM met verschillende tijds- en ruimte-aspecten worden berekend voor België: de ervaren baten en kosten en de baten en kosten van huidige activiteiten. Deze welvaartsberekening is de eerste die de welvaartsbijdrage van de schaduweconomie in rekening brengt en gebruik maakt van een sufficiëntiedrempel om de welvaartsverliezen van inkomensongelijkheid te meten. Andere methodologische nieuwigheden voor de bredere BCPA zijn een consumptievoetafdruk voor de uitstoot die in handel vervat zit en het meenemen van de klimaatimpact van de lucht- en scheepvaart. De Belgische welvaart, gemeten via beide indicatoren, verbeterde tussen 1995 en 2018: BCE per capita verbeterde met 15% en BCPA per capita steeg met 18%, wat ongeveer de helft is van de groei in het BBP per capita met 30%. Maar, deze geaggregeerde trend doorheen de tijd verhult dat de (per capita) welvaartsverliezen van inkomensongelijkheid en bredere ecologische kosten in BCPA toegenomen zijn met respectievelijk 89.9% en 6.8%. Deze tendensen werden echter overgecompenseerd door groeiende consumptiebaten. Aangezien er substantiële ecologische kosten doorgeschoven worden in tijd en ruimte, stellen we voor om het doorschuiven van ecologische kosten in rekening te brengen door de BCPA-interpretatie te gebruiken bij het berekenen van EWM omdat dit informatiever is voor beleidsmakers. In toekomstige studies is het nodig om grondig te reflecteren over het ontwerp en gebruik van welvaartsmaatstaven om zo hun beleidsimpact en transformatiepotentieel te stimuleren.

Vervolgens schatten we in *Hoofdstuk 3* beide EWM voor de EU-15 in zijn geheel en voor alle individuele landen van 1995 tot 2018. Voor de EU-15 groeide het BBP per capita met 31% doorheen de tijd, maar de kloof tussen het BBP en EWM werd groter aangezien BCE en BCPA per capita met 13% en 17% toenamen. Tegen 2018 was de EU-15 volledig van de financiële crisis hersteld, bekeken vanuit een BBP-perspectief maar niet vanuit een welvaartsoogpunt. De financiële crisis en het herstel hiervan hadden een andere invloed op het BBP en EWM. In tegenstelling tot het BBP was de welvaartsrespons in sommige landen op de crisis in 2009 vertraagd: hun per capita BCPA daalde enkel tijdens het economische BBP-herstel in 2010 aangezien de bredere ecologische kosten toen stegen. Onze resultaten illustreren bijgevolg dat een post-COVID agenda moet inzetten op een groen en rechtvaardig economisch herstel waarin welvaart centraal staat: een herstel dat voorbij het BBP gaat en menselijk welzijn binnen planetaire grenzen zonder groei vooropstelt. Ondanks de algemene BBP-groei doorheen de periode nam het BBP per capita amper toe na 2007: het BBP per capita herstelde slechts in 2018 volledig van de financiële crisis, wanneer het BBP per capita van de EU-15 haar maximale niveau bereikte dat net hoger was dan het niveau van voor de crisis. De welvaart per capita in de EU-15 piekte voor de financiële crisis in 2006 voor BCE en in 2007 voor BCPA. In 2018 waren BCE en BCPA per capita respectievelijk 1.5% en 1.8% lager dan hun maximale waarden. Bijgevolg vonden we voor de EU-15 als geheel geen sluitend bewijs voor de drempelhypothese (i.e. het bestaan van een drempelpunt vanaf wanneer verdere BBP-groei zich vertaalt in een welvaartsdaling). Desalniettemin vonden we bewijs voor het bestaan van drempelpunten in Griekenland, Ierland, Italië, Luxemburg, Nederland, Portugal, Spanje, Zweden en het Verenigd Koninkrijk, waar de per capita welvaartsniveaus minstens 5% lager waren in 2018 in vergelijking met hun maximale welvaartsniveaus.

In *Hoofdstuk 4*, herbekijken we het debat over de drempelhypothese. Door bezorgdheden over sociale en biofysische grenzen aan groei menen onderzoekers dat de sociale vooruitgang, aangeduid door BBP-groei, zou verdwijnen wanneer een ruimere welvaartsmaatstaf gebruikt wordt om economische prestaties te evalueren. Door de principes van dalende marginale meeropbrengsten en toenemende marginale kosten toe te passen op macro-economisch niveau kunnen EWM gebruikt worden om het punt aan te duiden vanaf wanneer economische groei oneconomische groei wordt en dus wanneer verdere groei meer kosten dan baten met zich meebrengt. Voorbij dit punt groei nastreven, is suboptimaal. Doordat er grenzen zijn aan groei wordt er van EWM verwacht dat ze in een tijdreeks van welvaartsresultaten een drempelpunt aanduiden vanaf wanneer verdere BBP-groei leidt tot een welvaartsdaling. De resultaten voor de EU-15 geven geen sluitend bewijs voor de drempelhypothese van 1995 tot 2018 aangezien EWM enkel duiden op een welvaartsstagnatie na de financiële crisis van 2008 en 2009. Na de financiële crisis, wanneer de inkomens toenamen, vertaalde groei in individuele consumptie zich niet in welvaart. Bijgevolg duidt onze methodologie, die gebruik maakt van een sufficiëntiedrempel, aan dat er sociale grenzen zijn aan groei: "*keeping up with the Joneses"* of geaggregeerde consumptiegroei boven een bepaald punt brengt weinig welvaartswinsten met zich mee door het principe van het dalend marginaal nut van inkomen. Deze welvaartsstagnatie wordt niet veroorzaakt door biofysische grenzen aan de groei aangezien de bredere ecologische kosten slechts in geringe mate toenamen. Doordat de EU-15 planetaire grenzen overschreden heeft, zou men echter verwachten dat de bredere ecologische kosten substantieel toegenomen zouden zijn. We menen dat het achterwege blijven van biofysische grenzen een mogelijke tekortkoming is van de huidige methodologie aangezien het aantal ecologische componenten beperkt is en de kostenschattingen van de meeste ecologische componenten niet wijzigen doorheen de tijd, wat het moeilijk maakt om slechter of beter wordende milieuomstandigheden te vatten. Toch is het uitblijven van biofysische grenzen slechts gedeeltelijk een methodologische beperking. In dit proefschrift werden immers stappen gezet om rekening te houden met biofysische limieten door de waarderingsmethoden voor ecologische kosten te verbeteren, bijvoorbeeld door de kostenschattingen voor klimaatverstoring en de uitputting van niet-hernieuwbare grondstoffen aan te passen en naar boven bij te stellen. Naast een mogelijke tekortkoming van de huidige methodologie kan de afwezigheid van biofysische grenzen ook gerelateerd zijn aan de manier waarop EWM gehanteerd worden.

Aangezien het evalueren van de economische prestaties niet gereduceerd hoeft te worden tot het wegen van monetaire kosten en baten, stelden we voor om de geaggregeerde welvaartstrend voorzichtig te interpreteren en er minder belang aan te hechten. EWM moeten daarentegen een gedesaggregeerde aanpak hanteren om bijvoorbeeld te verifiëren of de welvaartsverliezen van inkomensongelijkheid en de ecologische kosten afnemen. We suggereerden een gebruikshandleiding om het gebruik en transformatiepotentieel van EWM te verhogen. Tot slot zorgden we voor een narratief *goed leven binnen planetaire grenzen* zodat EWM een startpunt kunnen zijn om de stap voorbij het BBP en voorbij groei te zetten.

Introduction

A. Beyond GDP

In the 1930s, the predecessors of our current Systems of National Accounts (SNA) were established. Under the auspices of the United Nations, the SNA became the international statistical standard for economic accounting. These accounts provide the basic methodology and language to calculate an economy's Gross Domestic Product (GDP), which indicates the monetary value of final goods and services of domestic market production. Over the years several methodological revisions were carried out. In 2014, for instance, the inclusion of prostitution and drugs were standardized in the calculation of the GDP of the European Union. Yet, these revisions and updates sometimes can be seen as arbitrary or biased because, to date, other non-market activities such as unpaid household work remain excluded from an economy's production boundary when calculating GDP (DeRock, 2019). By dividing a country's GDP by its population, one obtains the per capita GDP. When corrected for purchasing power differences between countries, this measure is often used to approximate social welfare and hence, GDP per capita often serves as a measure for the living standards in a specific country and to rank countries in terms of development. Nevertheless, Simon Kuznets warned from the very beginning of the use of the National Accounts that "the welfare of a nation can scarcely be inferred from a measurement of national income" (Kuznets, 1934, p. 7). Also Moses Abramovitz (1958) came to a similar conclusion: "we must be highly skeptical of the view that long term changes in the rate of growth of welfare can be gauged even roughly from changes in the rate of growth of output".

In 1968, United States Senator Robert Kennedy warned in a memorable speech at the University of Kansas that the GDP measures everything, except that what makes life worthwhile – GDP "counts air pollution and cigarette advertising, and ambulances to clear our highways of carnage. It counts special locks for our doors and the jails for the people who break them. It counts the destruction of the redwood and the loss of our natural wonder in chaotic sprawl. It counts napalm and counts nuclear warheads and armored cars for the police to fight the riots in our cities. It counts Whitman's rifle and Speck's knife, and the television programs which glorify violence in order to sell toys to our children. Yet the gross national product does not allow for the health of our children, the quality of their education or the joy of their play. It does not include the beauty of our poetry or the strength of our marriages, the intelligence of our public debate or the integrity of our public officials. It measures neither our wit nor our courage, neither our wisdom nor our learning, neither our compassion nor our devotion to our country, it measures everything in short, except that which makes life worthwhile." A few years later, Nordhaus and Tobin (1972) emphasize that in the 1960s growth in GDP has become dominant in economics, politics and society. As they write in 1972: "A long decade ago, economic growth was the reigning fashion of political economy. It was simultaneously the hottest subject of economic theory and research, a slogan eagerly claimed by politicians of all stripes, and a serious objective of the policies of governments."

Despite the warnings of Kuznets, Kennedy and many others on GDP's deficiencies, GDP is today still widely used as a measure of social welfare by media, policy makers and economists, which is probably causing the 'largest information failure' in the world (van den Bergh, 2009). According to van den Bergh, the key to understand this "GDP paradox" lies in recognizing that many economists accept the GDP-criticism but they refute its relevance. GDP is a flawed welfare indicator because it omits important aspects of welfare and it does not discriminate against the 'goods' and 'bads' of economic activity. Leisure, unpaid work, care work, household work and volunteering work are not counted. Moreover, GDP and per capita GDP give no indication about the distribution of income. Furthermore, the clean-up costs of plastic nurdles in the delta of a river enter positively in GDP, while a forest is only valuable from a GDP-perspective if it is cut down. Finally, the GDP fails to register externalities such as environmental degradation and pollution as a cost of the economic process. For all these reasons, the "Beyond GDP" literature emphasizes the need to measure economic performance and social progress differently by focusing on well-being and sustainability (Stiglitz et al., 2009, 2018; Costanza et al., 2014; Kubiszewski et al., 2013; Hoekstra, 2019; Coscieme et al., 2020).

B. Economic welfare measures

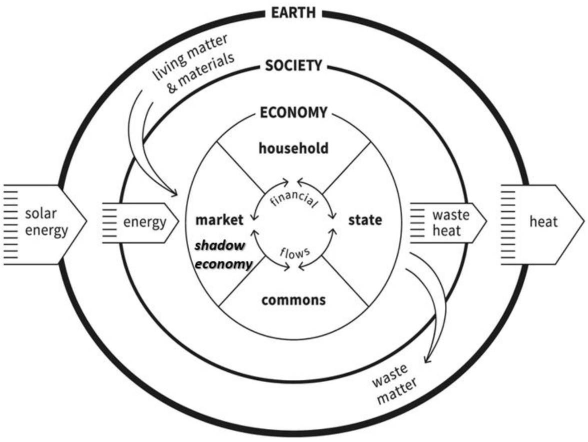
Within the "Beyond GDP" literature, many alternative indicators and methodologies have been proposed to measure the concepts well-being, welfare and sustainability such as life satisfaction, equivalent incomes, Environmentally Adjusted Net Domestic Product, Genuine Savings, Inclusive Wealth Index, composite indicators, ecological footprints and dashboards of sustainable development indicators. One particular part of this literature focuses on providing alternatives to GDP. From the 1970s onwards, economic welfare measures (EWM) were devised in response to GDP's shortcomings when used as a welfare measure. Examples of such alternatives include Nordhaus and Tobin's (1972) Measure of Economic Welfare, Zolotas' (1981) Index of the Economic Aspects of Welfare and Daly and Cobb's (1989) Index of Sustainable Economic Welfare (ISEW). Nowadays, the ISEW is also known as the Genuine Progress Indicator (GPI). While there is a broader debate on the measurement of welfare, well-being or sustainable development – see, for instance, the approaches mentioned in Meadows (1998), Dasgupta and Mäler (2000), Dasgupta (2009), van den Bergh (2009), Fleurbaey (2009), Bleys (2012), O'Neill (2012), Munda (2015), O'Neill et al. (2018) and

Hoekstra (2019) – in this thesis we refer to *welfare*, *economic welfare measures* and *alternative measures of economic welfare* as what is being measured by the ISEW and GPI.

We interpret EWM as macro-economic monetary welfare measures that capture the *benefits and costs of economic activity*. On the benefits side, EWM value the contributions from unpaid work, the market, state and shadow economy as they are all different means to satisfy people's needs and wants. Here, the *inputs* used for the production of welfare such as individual consumption expenditures, collective government expenditures, estimates for unpaid household work and the shadow economy are valued and aggregated. Yet, EWM do not count all consumption expenditures as beneficial to welfare – consumption expenditures are, for instance, adjusted according to the principle of diminishing marginal utility of income since an extra dollar of income or consumption gives less satisfaction to people with high incomes than it does to people with low incomes. On the costs side, the social and ecological costs caused by the economic process are also included, since these indicators see the economy as embedded in society and in the Earth System. Accounting for ecological costs such as environmental degradation and natural capital depreciation serves as a way to factor in the ultimate costs of economy activity. This is considered necessary because the matter and energy obtained from the ecosystem are the ultimate means upon which economic activity depends on.

The conceptual framework used in this dissertation to study EWM draws on the pre-analytic vision of ecological economics, in which the embeddedness of the economy takes centre stage. Fig. 1 gives a graphical illustration of seeing the economy as 'embedded': the economy-in-society-in-the-ecosystem. This figure also highlights how EWM take on a broader perspective on "the economy" by not only focusing on market activities (as is done in GDP), but by also including the contributions of unpaid work, the state and shadow economy and by making explicit the links between the economic subsystem and the social and ecological domains.

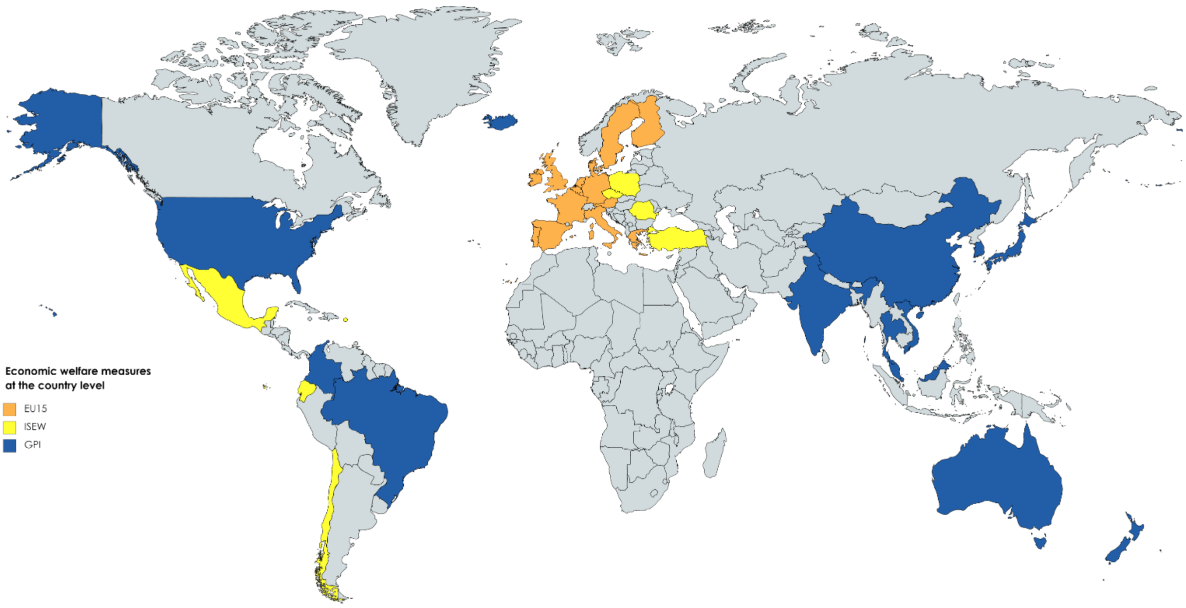
Figure 1: The embedded economy.



Source: adapted from Raworth (2017).

Over the last thirty years, the ISEW and GPI have been calculated for many countries, regions and cities all over the world including all countries in the EU-15, except for Denmark and Ireland – see Bleys and Van der Slycken (2019) for an overview of these studies. Fig. 2 illustrates that welfare studies have mostly been compiled for high-income economies, as welfare studies in the global South are scarce. Based on the empirical results of the first welfare studies for high-income countries in the early 1990s, Manfred Max-Neef (1995), a renowned ecological economist, formulated the "threshold hypothesis" that states: "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." Based on the outcomes of EWM studies in the Asia-Pacific region, the threshold hypothesis was reformulated by Lawn and Clarke (2010) into a "contracting threshold hypothesis" which states that: "as the economies of the Asia-Pacific region in the world collectively expand in a globalized economic environment, there is a contraction over time in the threshold level of per capita GDP." Consequently, the threshold point of low and middle income countries occurs at a much lower welfare level than high-income countries are currently enjoying. A study estimating the global GPI based on the welfare results from 17 countries (containing 53% of global population and 57% of global GDP) from 1950 to 2003 found that global GPI per capita peaked in 1978 (Kubiszewski et al., 2013), as illustrated in Fig. 3. This welfare peak comes 8 years after that the global Ecological Footprint exceeded global biocapacity in 1970.

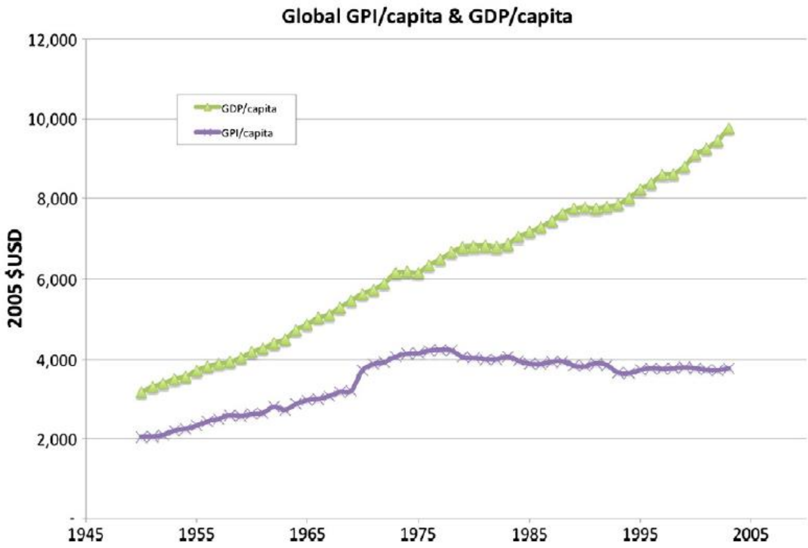
Figure 2: World map with the economic welfare measures compiled in this dissertation and in earlier studies (anno 2021).



Source: a list of the country studies was obtained from Bleys and Van der Slycken (2019), which was adapted and updated based on own findings.

Note: This dissertation is the first study that has calculated economic welfare measures for Denmark and Ireland.

Figure 3: Global GPI per capita and GDP per capital (in 2005 US dollars).

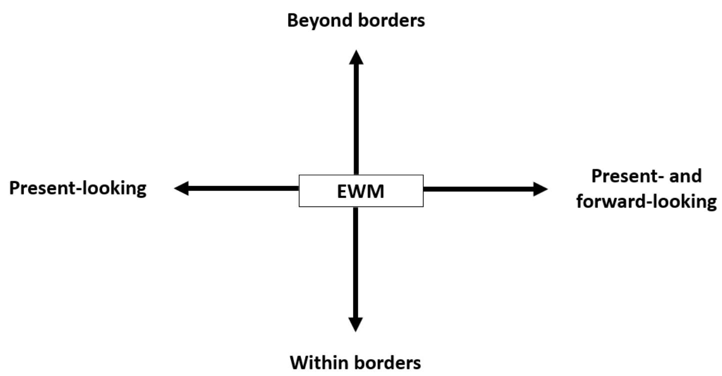


Source: Kubiszewski et al. (2013).

Due to their specific design EWM are potentially capable of guiding economies and societies on a just transition toward living well within limits by providing an alternative to move beyond GDP. Yet, to date, the ISEW and GPI have had little impact on policy-making (Bleys and Whitby, 2015; Corlet Walker and Jackson, 2019). However, small steps are being taken in economic analysis and policy-making in Germany, Maryland (US) and Flanders (Belgium), for instance. There is increasing political interest in EWM in Germany. In 2009, the National Welfare Index, which is a variant of the ISEW and GPI, was created with support of the Federal Ministry of Environment, while the NWI was compiled at the state level in 2011 in response to a political demand for it (Held et al., 2018). In the US state of Maryland the calculation of the GPI got high level support from its former governor so that Maryland's GPI got compiled from 2010 onwards, yet, this support fell after a change of governor (Hayden and Wilson, 2018). While in Flanders, the northern Dutch-speaking part of Belgium, the ISEW was used as a headline indicator in Pact2020 to measure progress toward the goal to turn Flanders into a competitive and versatile knowledge economy that creates welfare in a sustainable way. There was no target set for 2020, but Pact2020 aimed to increase the Flemish ISEW per capita (Bleys and Whitby, 2015). In Canada, it was more difficult to move beyond GDP. The GPI was calculated for the provinces Nova Scotia and Alberta. Yet, Hayden and Wilson's (2016) study about the Canadian experience of moving beyond GDP, which was broader than the GPI alone, suggests that alternative indicators are not a transformative force by themselves, since "the widespread use of new indicators is more accurately seen a product of political and social movement efforts to expand the role of non-economic values in policy-making and in society more generally".

Over the years, a number of theoretical, conceptual and methodological shortcomings of the EWM have been identified. First, some scholars are critical of the monetization approach that EWM employ and the reductionism involved in combining different values in a single aggregate measure. Second, there are no generally accepted EWM, due to a lack of agreement on how to define and operationalize welfare. EWM are on some occasions seen as measuring current, experiential welfare, and on others as measures of sustainable economic welfare – see, for instance, the discussions in Neumayer (1999), Harris (2007), Brennan (2008, 2013), Lawn (2008, 2013) and Talberth and Weisdorf (2017). This lack of consensus and the related discussions are related to the rather ambiguous theoretical foundation of the original ISEW that was inspired both by Fisherian income and Hicksian income. A third shortcoming is related to the first one, namely that there is a lack of clear procedures to deal with forward-looking and beyond border issues. Different perspectives exist on economic welfare measures' time and geographical boundaries, as illustrated by Fig. 4. Some authors want to measure 'current welfare' and adopt a present-looking perspective, while others adopt a more forward-looking approach by including the future benefits and costs of present economic activities such as the costs of climate disruption and net capital growth. When it comes to EWM's geographical borders, some scholars suggest to only look within domestic borders, while others propose to adopt a broader viewpoint by also registering the environmental impacts that are caused by present economic activities, but shifted beyond geographical borders. Examples of these cross-boundary issues are the greenhouse gas emissions embodied in trade related to domestic consumption and the climate disruption damages caused to the rest of the world. Finally, almost all compilations of EWM to date are single country efforts that use slightly different methodologies regarding the items included and the valuation methods, which leads to conceptual vagueness. As a result, the comparability of EWM studies among different countries is low (Bleys and Whitby, 2015).

Figure 4: Economic welfare measures' time and boundary dimensions.



C. Research questions

This thesis focuses on economic welfare measures such as the ISEW and GPI, and contributes to the EWM literature by addressing theoretical, conceptual and methodological issues in four distinct ways. First, we will investigate how welfare measures should deal with welfare's time and boundary issues by exploring the conceptual and theoretical framework behind economic welfare measures. Based on these theoretical and conceptual insights, a theoretically and conceptually sound "2.0" methodology for the EWM is developed in a second step. This framework will consist of a standard set of economic welfare components and up-to-date valuation methods for all of its items. Afterwards, the "2.0" methodology will be applied to the EU-15 and its countries to explore whether the EU-15 has been faring well with growth from 1995 to 2018. Finally, we will investigate whether the EWM results of the EU-15 give evidence in favor of the threshold hypothesis, i.e. a point after which continued growth results in a diminution of welfare. The thesis will address the following four research questions:

- What are the different theoretical income concepts that inspire different views on economic welfare measures? What do these income concepts mean in terms of welfare interpretations? What are their implications for cross-time and cross-boundary issues?
- How can these theoretical, conceptual and interpretational insights be translated into an applicable and standardized “2.0 methodology”?
- Has the EU-15 been faring well with growth? Do the welfare results of the EU-15 give evidence in favor of the threshold hypothesis or not?
- Are the ISEW and GPI able to reveal social and biophysical limits to growth? What can we learn from an in-depth analysis of the threshold hypothesis for the EU-15?

D. Outline of the dissertation

This dissertation consists of four chapters. Chapter 1 is a conceptual exploration and critical inquiry into the theoretical foundation(s) of economic welfare measures such as the Index of Sustainable Economic Welfare (ISEW) and Genuine Progress Indicator (GPI). Fisherian income and Hicksian income are investigated and confirmed as theoretical foundations. Next, two different welfare interpretations – the benefits and costs experienced and the benefits and costs of present economic activities – are put forward to clearly define and distinguish welfare’s distinct time and boundary dimensions. Finally, the chapter concludes that recent developments toward the current experiential welfare interpretation that looks within borders are not the only way forward, since economic welfare measures can also be seen as capturing the benefits and costs of present economic activities, including the benefits and costs shifted in time and space.

Based on these insights and the dual welfare interpretation, Chapter 2 calculates two different welfare measures with distinct time and boundary views for Belgium. One measure, the benefits and costs experienced, only includes the current ecological costs within borders and excludes capital change. The other welfare indicator, the benefits and costs of present economic activities, includes capital changes and the ecological costs shifted in time and space because these are benefits and costs originating from present activities. This chapter also introduces novel EWM items such as the shadow economy and proposes several methodological advances (e.g. accounting for the greenhouse gas emissions embodied in trade and a sufficiency threshold to account for the diminishing marginal utility of income).

Chapter 3 calculates two welfare measures, the benefits and costs experienced and the benefits and costs of present activities, for the EU-15 and its countries from 1995 to 2018 using a comparable methodology and standardized data. Moreover, the welfare evolution over time and the welfare drivers are discussed. Furthermore, it is suggested to adopt a disaggregated approach to analyze welfare results, since the aggregate welfare trend should be treated with caution, especially since the ecological costs within the EU-15 increased (slightly) over time.

In Chapter 4, the welfare results for the EU-15 are scrutinized to determine whether we find evidence for the threshold hypothesis. We cannot clearly determine a threshold point after which growth results in a diminution of welfare. Yet, we do observe that during the last decade a welfare plateau has been reached that is in particular due to the diminishing marginal returns to income. As a consequence, income increases lead to less than proportional welfare gains. This plateauing does, however, not imply that welfare cannot be improved in the future. In a just and sustainable transition, social and environmental policies can bring down the welfare losses from income inequality and the ecological costs, which could result in welfare improvements. Next, we conclude to be cautious while interpreting the aggregate welfare trend and put forward a "user guide" for welfare measures, that will help to overcome problems with interpretation that are related to compensability and incommensurability.

Finally, the findings of these four chapters are combined in the conclusion. It is suggested that in future studies should always report disaggregated data and that welfare measures should be complemented with a set of social and biophysical indicators to measure whether societies are living well within planetary limits. While economic welfare measures still struggle with methodological imperfections, they do provide important insights on the benefits and costs of economic activities and hence are to be preferred over GDP. Or, as Daly and Farley (2004, p. 243) suggest after Amartya Sen: "it is better to be vaguely right than precisely wrong".

Chapter 1 : A conceptual exploration and critical inquiry into the theoretical foundation(s) of economic welfare measures.[1]

1. Introduction

In response to misuse of the Gross Domestic Product (GDP) as a welfare indicator, Daly and Cobb (1989) developed the Index of Sustainable Economic Welfare (ISEW) to provide better information on economic welfare.[2] Economic welfare measures (EWM), such as the ISEW and the Genuine Progress Indicator (GPI), offer information on "the contribution of a nation's economy to the overall level of well-being enjoyed by its citizens (Bleys, 2012). They typically do so by seeing the economy as 'embedded': the economy-in-society-in-the-ecosystem. EWM do not only take a broader perspective on the economy subsystem compared to GDP (that only focusses on market activities), but EWM also make explicit the links between the economic subsystem and the social and ecological domains. Over the next thirty years, EWM have been compiled for countries, regions and cities all over the globe – see Bleys & Whitby (2015) and Long & Ji (2019) for an overview. Soon after the development of the first EWM, however, critics such as Neumayer (1999) pointed out that these measures were lacking a sound theoretical foundation, whereas Hanley et al. (1999) described the ISEW as making a number of ad hoc adjustments to the national income accounts to reflect a broader welfare concept. It was not until the turn of the century that the ISEW was connected to Fisher's concepts of income and capital by Lawn and Sanders (1999) and Lawn (2003).

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[1] This paper is co-authored with Brent Bleys (Ghent University) and is published in *Ecological Economics*. We would like to thank our colleagues Bart Defloor and Freddy Heylen for their comments on earlier drafts of this work and two anonymous referees for their valuable suggestions to improve this article. Finally, we are grateful for the insightful discussions with the participants of the Belgian Environmental Economist Day in Ghent (2018), the conferences of the European Society for Ecological Economics in Budapest (2017) and Turku (2019), the International Forum for Well-Being in Grenoble (2018), and the International Degrowth Conference in Malmö (2018).

[2] GDP, indicating the monetary value of goods and services of domestic market production, has been criticized from its start as being a social welfare proxy. Kuznets warned in 1934, the very beginning of the use National Accounts, that "the welfare of a nation can scarcely be inferred from a measurement of national income…" (Kuznets, 1934, p. 7). Over the years, prominent economists further fueled this critique (Galbraith, 1958; Mishan, 1967, Nordhaus & Tobin, 1972; Leipert, 1986; Daly & Cobb, 1989; Max-Neef, 1995; Fleurbaey, 2009; Stiglitz, Sen and Fitoussi, 2009; Kubiszewski et al., 2013; Costanza et al., 2014; Jackson, 2017). GDP (per capita) is dismal for approximating economic welfare, as it overlooks many important welfare aspects by only focusing on market activities. Despite GDP's obvious and well-known shortcomings, it is still widely used by economists, media and policy makers as a welfare indicator. GDP's omnipresence is probably causing the 'largest information failure' in the world (van den Bergh, 2009).

In his seminal paper, Lawn (2003) meticulously explained how every item included could be consistent with Fisher's concepts, thus potentially providing the ISEW and related measures with a theoretically sound foundation. However, EWM also have been defined as measures of sustainable economic welfare that are tightly linked to Hicks' (1939) maximum sustainable consumption – e.g. Harris (2007) even considers Hicksian income to be superior compared to Fisherian income. To date, Fisherian psychic income is the most commonly used theoretical foundation to underpin EWM (in e.g. Lawn, 2003; Bleys, 2008; Brennan, 2013; Lawn, 2013; Talberth & Weisdorf, 2017; O'Mahony et al., 2018; Kenny et al., 2019; Long & Ji, 2019). Fisher (1906) stressed the psychic or experiential nature of income and relates income to the subjective satisfactions consumption causes in the human psyche. By turning to psychic income to underpin welfare exercises, EWM would reveal information about the net benefits a nation's citizens are experiencing from economic activities, after deducting for instance the costs of air pollution, noise pollution and of commuting to work from the consumption benefits. EWM do more than just registering the traditional net psychic income as they also account, for instance, for the costs caused to the ecosystem. In fact, EWM are based on an extended version of Fisher's income-capital distinction (Lawn, 2008) or on the 'entropic net psychic income' (Brennan, 2008). This entropic extension results in registering the ecosystem services that are sacrificed in the economic process as a cost in EWM.

Despite the theoretical debate moving in the direction of Fisherian income, a clear interpretational consensus on what EWM are capturing, is missing in the field. Table 1 illustrates this by outlining a number of welfare statements of leading scholars. The emphasis we added in this overview highlights that these scholars understand, define and explain EWM differently. Sometimes, EWM are said to capture what is being enjoyed at a particular point in time or as being related to the costs and benefits experienced at a particular point in time. Here, the experiential nature of EWM is stressed, which is directly related to Fisher's *psychic* income. On other occasions, EWM are linked to the value added to nature, to counting the depreciation of community capital as a cost, to the impacts of economic growth or to the consequences of economic activity. In these diverse statements, two welfare interpretations can be detected. The first interpretation sees EWM as what is currently being experienced, whereas the second relates EWM to the costs and benefits caused by present economic activities. Current activities may bring (benefits and) costs abroad and in the future that are not necessarily experienced by a nation's citizens in the present.

Table 1: Various statements by key practitioners on what economic welfare measures are capturing.

Lawn (2003)	"The sustainable economic welfare implied here is the welfare a nation enjoys at a *particular point in time* given the impact of past and present activities" (p. 106).
Posner and Costanza (2011)	"The GPI uses monetary valuation to assess the *impacts of economic growth* on sustainable welfare. GPI is an indicator that goes beyond measuring the quantity of economic activity to include details about quality, … " (p. 2, emphasis added).
Kubiszewski et al. (2013)	"…, the GPI is designed to measure the economic welfare generated by economic activity, essentially counting the *depreciation of community capital as an economic cost*." (p. 57). "Economic activity, it should be recognized, is undertaken to generate a level of *economic welfare greater than what can be provided by natural capital* alone." (p. 58, emphasis added).
Talberth and Weisdorf (2017)	"The Genuine Progress Indicator is a monetary measure of economic welfare for a given population in a given year that accounts for *benefits and costs experienced* by that population in association with investment, production, trade, and consumption of goods and services" (p. 3, emphasis added).
Held et al. (2018)	"Taking the deficiencies of GDP as a starting point for consideration, those indices try to capture the *consequences of economic activities on current welfare* in a more comprehensive way, especially with regard to social and environmental issues. Therefore, monetized costs and benefits are aggregated across social, environmental and economic dimensions into one single indicator." (p. 392, emphasis added).

To make things worse, many EWM studies avoid looking into the theoretical foundations of the measures, and focus exclusively on estimating an additional EMW time series. As a result, these studies make implicit and inconsistent time and boundary choices (i.e. deciding between forward-looking or present-looking perspective and between a within and beyond boundary view). This lack of standardization regarding time and boundary issues hinders the policy-impacting potential of EWM (Bleys & Whitby, 2015). Therefore, the purpose of this paper is to revisit the theory behind the EWM. Section 2 revisits the theoretical foundations of EWM and introduces with Hicksian and Fisherian income two concepts that provide EWM with a (double) theoretical underpinning. Section 3 relates this double theoretical foundation to the existence of two distinct ways to interpret EWM and connects each interpretation to a time and boundary perspective. The conclusion proposes a way forward towards a more consistent standardization in the field.

2. Revisiting economic welfare measures' theoretical foundation(s)

For terminological clarity, we want to stress the distinction between 'income' and 'welfare'. In this paper, *welfare* is used to refer to practically compiled measures such as the ISEW and GPI, whereas *income* is related to the theoretical income concepts which provide EWM with a certain theoretical base. In this section we will scrutinize the theoretical foundations of EWM. First, we will introduce Hicks' and Fisher's income concepts, as they underlie the theoretical discussions on EWM. Afterwards we will explain how extended versions of these theoretical income notions are translated in EWM and explore the ex post theoretical foundation developed by Lawn (2003) based on Fisherian income. Finally, we will discuss the linkages between the ISEW, Hicksian and Fisherian income.

2.1 Income concepts underlying EWM

Daly and Cobb (1989) first turned to Hicksian income when developing the ISEW, while later on, Lawn (2003) connected EWM to Fisher's psychic income notion and his distinction between income and capital. It is important to have a clear view on both income concepts in order to understand how EWM relate to these.

2.1.1 Hicksian income

In his book "Value and Capital", Sir John Hicks explored the concept of income. Hicks (1939, p. 172) explains income as:

"The purpose of income calculations in practical affairs is to give people an indication of the amount which they can consume without impoverishing themselves. Following out this idea, it would seem that we ought to define a man's income as the maximum value which he can consume during a week, and still expect to be as well of at the end of the week as he was at the beginning. Thus, when a person saves, he plans to be better off in the future; when he lives beyond his income, he plans to be worse off. Remembering that the practical purpose of income is to serve as a guide for prudent conduct, I think it is fairly clear that this is what the central meaning must be."

Hicks' central income criterion is avoiding impoverishment to maintain consumption over time. The practical difficulty, however, lies in operationalizing this principle. A practical attempt to capture this central meaning can be found in his so-called 'Income No. 1', which is "…the maximum amount which can be spent during a period if there is to be an expectation of maintaining intact the capital value of prospective receipts (in money terms)." (p. 173). Hicks gives an example in which an individual with a capital sum only spends the interest yield on her capital. By limiting income to the yield on capital, the capital stock remains intact over the considered time period. The importance to "keep capital intact" is derived from this income approximation.[3] This *ex ante* income expectation has a counterpart that is realized *ex post* by including unexpected profits or losses. According to Hicks, especially the *ex post* variant of Income No. 1 is important and it equals consumption plus capital accumulation (Hicks, 1939). This version is commonly referred to as 'Hicksian income', and it should be noted this is different from Hicks' central income notion that is forward-looking.

2.1.2 Fisherian income

Fisher (1906) defines psychic income as "the stream of consciousness of any human being. All his conscious life, from his birth to his death, constitutes his subjective income. Sensations, thought, feelings, volitions, and all psychical events, in fact, are part of this income stream. All these conscious experiences which are desirable are positive items of income, or services; all which are undesirable are negative items, or disservices." (p. 168). Positive income is related to using wealth (i.e. consumption). However, economic activity is not only yielding desirable benefits or services (i.e. the enjoyment of psychic income), it also brings undesirable disservices or psychic outgo like the labor cost or effort. Fisher explains this cost item can be "labor, anxiety, trouble, annoyance, and all the other subjective experiences of an undesirable nature which are necessary in order that the experiences of an agreeable nature may be secured" (p. 175). This negative psychic income or psychic outgo is netted from the (positive) psychic income to obtain the 'net psychic income'.[4, 5] The net income is what ultimately remains uncancelled in the human psyche and is labeled as 'uncancelled benefits'.

To determine what counts as psychic income, Fisher's distinction between income and capital is crucial: psychic income flows should be recorded but not the changes in capital stocks. The basic premise is that consumption and not investment is important as it yields satisfactory services. Of course, investments also play a role but they will only help to maintain the stock from which consumptive services may flow in coming periods. While Fisherian income would count the entire amount of actual consumption as income, even though if this would be capital consumption (Mates, 2004), this would not be the case for Hicksian income.

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[3] In other income variants, No. 2 and No. 3, Hicks considered changing interest rates and price expectations. Throughout his quest to properly define income, Hicks pondered about *ex ante* expectations and *ex post* realizations of the maximum amount that can be consumed and about individual income and social income.

[4] In the dominant economic jargon psychic income and psychic outgo are known as utility and disutility.

[5] Psychic outgo items embodied in the ISEW are for instance noise pollution and the costs of commuting to work.

Hicksian income accounts for capital accumulation or decumulation and would not count capital consumption or depreciation as income, since Hicks' stresses the importance to keep capital intact.

2.2 An extended version of Hicksian income (EHI)

In their book "For the Common Good: Redirecting the Economy toward Community, the Environment, and a Sustainable Future", Daly and Cobb (1989) scrutinize the misplaced concreteness of GDP as a measure of economic success. In doing so, the authors propose to make two departures from GDP. The first departure involves turning to Hicksian income as a better income concept. GDP cannot serve as an approximation for Hicksian income since a nation will ultimately be impoverished if it consumes its entire GDP. Part of GDP simply serves to overcome depreciation of human-made capital and cannot be consumed without being worse off in the next period. By subtracting depreciation from GDP, Net Domestic Product (NDP) or its variant Net National Product (NNP) is obtained.[6] This NNP is most commonly regarded as (a basic) approximation of Hicksian income as per Asheim (1994) and Hartwick (1994). Nordhaus (1995) explains this narrow Hicksian income can easily be expanded to incorporate natural capital by subtracting resource depletion and environmental degradation as is done in integrated environmental and economic accounts. The need to subtract the value of using raw materials and capital equipment to obtain a nation's net product was already expressed by Kuznets (1934).

Daly and Cobb (1989) go beyond the basic interpretation of equating Hicksian income to NNP. They argue that NNP is not capable of adequately reflecting the maximum amount of consumption that can be sustained over time since (a) the current produced NNP involves transformations in the biophysical world that are ecologically unsustainable, and (b) NNP includes defensive expenditures, which are intermediate expenditures to protect ourselves from the adverse, future impacts of economic production. Leipert (1989) defines defensive expenditures as "… outlays with which the attempt is made to eliminate, mitigate, neutralize, or anticipate and avoid damages and deterioration that the economic process of industrial societies has caused to living, working, and environmental conditions. They serve only to restore, reapproach, or defend a status (say, a specific environmental quality, secure income, or certain benefits of consumption) that has been lost or compromised by negative impacts of the economic and social process." (p. 844). By including ecologically unsustainable transformations and defensive expenditures, the NNP thus overestimates the amount of ultimate, true consumption that is valued for its own sake. Therefore, Daly

[6] In their writings Daly and Cobb (1994) still refer to Gross National Product (GNP) and NNP, which are two terms that were used before GNP was replaced by GDP. We prefer to stick to Daly and Cobb's original terminology of NNP.

and Cobb propose to adjust NNP by (a) expanding depreciation to cover the depletion of natural capital stocks and (b) deducting defensive expenditures. The extended approximation of Hicksian income (EHI) can be represented as:

$$Extended\ Hicksian\ income = GNP - DHC - D - DNC \qquad (1)$$

In Eq. (1) GNP = Gross National Product, DHC = depreciation of human-made capital, D = defensive expenditures, DNC = depletion of natural capital. GNP minus DHC simply equals NNP.

2.3 An extended version of Fisher's distinction between income and capital

Daly and Cobb (1989) move beyond the extended proxy of Hicksian income by addressing more of GDP's deficiencies in a second departure from the measure. They develop the Index of Sustainable Economic Welfare as a new measure of economic welfare that aims to quantify "the positive contribution of the economy to social welfare" (p. 76). Although the authors did not relate their ISEW to Fisherian income, it was done so by Lawn (2003) in his ex post theoretical framing that he claimed to be superior to Hicksian income. In his work, Lawn puts forward an extended version of Fisherian income to take into account ecosystem services.

2.3.1 The Index of Sustainable Economic Welfare

A second departure from GDP in Daly and Cobb (1989) involves the development of a new measure of economic welfare: the ISEW. In doing so, the authors go beyond EHI by including additional welfare related items such as income inequality and the value of not commodified work. These ISEW items were not connected to Hicksian income by Daly and Cobb.

When developing the ISEW Daly and Cobb drew on previous welfare compilations, i.e. Nordhaus and Tobin's (1972) Measure of Economic Welfare (MEW) and Zolotas' (1981) Index of Economic Aspects of Welfare (EAW). They selected items from both indices, while also incorporating new items in the ISEW. In line with the previous measures, the ISEW starts from personal consumption expenditures and adds the value of household work. Daly and Cobb's measure is, however, the first to account for income inequality.[7] In line with Zolotas, defensive private expenditures on health and education are subtracted while non-defensive

[7] This section takes the second edition of Daly and Cobb's "For the Common Good" in 1994 as a starting point. After a discussion and review of the original ISEW, Cobb and Cobb (1994) dropped a number of items in the 1989-ISEW, such as the cost of urbanization and advertising. Moreover, the 1994-version introduced the cost of personal pollution control and ozone layer depletion as new welfare items into the index.

public expenditures are added. Other private defensive expenditures that are deducted include expenditures on personal pollution control and car accidents.[8] Daly and Cobb include numerous items related to environmental degradation and natural capital depreciation (i.e. air, water, and noise pollution; depletion of non-renewable resources; loss of farmlands and wetlands; long-term environmental damage; cost of ozone layer depletion). Similar to net investment in Nordhaus and Tobin's sustainable MEW, Daly and Cobb account for net capital growth. Moreover, the change in the net international position is incorporated to indicate whether the source of a nation's capital accumulation is domestic or foreign. Daly and Cobb assume that advanced capitalist societies require long-term national self-reliance to sustain their welfare levels.[9] Finally, the ISEW also includes the services from consumer durables and the services from the public capital stock ('services from highways and streets'). A way to mathematically represent the 1994-ISEW, based on Jackson et al. (1997) can be found in Eq. (2):

$$ISEW = C_p - INQ + H + ND_g - D_p + \Delta K - E - N \qquad (2)$$

In Eq. (2) C_p = personal consumption, INQ = losses from income inequality, H = domestic labour, ND_g = non-defensive government expenditures, D_p = defensive private expenditures, ΔK = capital adjustments, E = environmental degradation and N = depreciation of natural capital.

2.3.2 Lawn's ex post theoretical framework

Lawn and Sanders (1999) and Lawn (2003) related the items in Daly and Cobb's second departure to Fisher's concepts of income and capital. Lawn (2003) regards this Fisherian view to be logically superior to a Hicksian perspective that is used to calculate an adjusted GDP such as EHI. Lawn argues that the EHI is a better approximation of Hicksian income than GDP, but that it is not without its flaws. The EHI overlooks welfare aspects such as the cost of reduced leisure time, the cost of commuting, the cost of crime and family breakdown, the value of volunteer and non-paid household work and the welfare losses related to income inequality. Moreover, the EHI "… counts all additions to human-made capital as current income, it wrongly conflates the services rendered by capital (income) and the capital that renders them." (Lawn, 2003, p. 111).

[8] Nonetheless, not all scholars agree that defensive expenses should be subtracted in a welfare measure (e.g. Mäler, 1991 and Hamilton, 1996).

[9] This component would indicate whether a nation's capital formation is based on net lending (if positive) or on net borrowing (if negative). A positive change means an increase in capital assets, whereas negative changes indicate capital formation is based on foreign wealth that must be repaid with interest (Daly & Cobb, 1994).

Lawn (2003) believes Fisher's view is superior since Hicksian income is mistakenly connected to the quantity of production and consumption, whereas welfare depends on the 'psychic enjoyment of life' according to Lawn; a view for which Lawn finds support in the work of Georgescu-Roegen (1971) and Daly (1979). Nordhaus (2000) also favors Fisherian income, as he explains that while Hicksian income – consumption plus capital accumulation – is an important measure of current production, it has no clear welfare meaning.[10] Daly and Cobb themselves did not relate the ISEW to Fisherian income as Lawn did in his ex post theoretical framing. However, Daly and Cobb did refer to Fisherian income as having some interesting welfare features: "In Fisher's view nearly all consumer goods are classed as capital or wealth, and their consumption represents depreciation. For Fisher, welfare is the service (the psychic sense of want satisfaction) rendered by this wealth …" (1994, p. 67). Lawn (2013) states that Daly should be credited for having Fisher's income-capital distinction in mind when developing the ISEW and for seeing Fisherian income as suitable for measuring a nation's welfare. Lawn quotes Daly (1988, p. 54) to support his argument: "It seems to me that Irving Fisher's way of looking at things is eminently sensible, coherent, and logical".

Yet, Lawn's (2003) view on Fisher's psychic income was criticized. Brennan (2013) reasoned that this approach is limited as EWM "do not prudently factor-in measures of investment and depreciation of 'human-health capital'". Brennan argues that in a more advanced version of Fisher's concept it is needed to account "for some sort of change in the stock (or 'fund') of human-health capital since type of capital is crucial for enjoying psychic services. Lawn (2013) in contrast, reasons that Brennan's suggestion of accounting for changes in human-health capital would violate Fisher's distinction between income and capital. According to Lawn, the failure of EWM to fully account for changes in human-health capital should not be compromised as it is not a theoretical weakness. This failure is at most a methodological shortcoming that can be addressed by some methodological improvements that would lead to more accurate Fisherian EWM (Lawn, 2013).

[10] Among the most important drawbacks of Hicksian income Nordhaus states that it excludes nonmarket activity and a population's health status and labels intangible investments in human capital and technology as consumption. Yet, it should be noted that Lawn (2003) and Nordhaus (2000) interpret and operationalize Fisherian income differently.

2.3.3 An extended version of Fisher's distinction between income and capital

As articulated in Section 2.1.2, Fisher stops his analysis after he obtained the net psychic income or the uncancelled benefits. Nevertheless, one could also account for the 'uncancelled costs' or ultimate costs of the economic process: the input of low entropic resources and the output of high entropic waste. One should not forget that the ecosystem is the ultimate source that makes economic activity possible. Nature's stock of wealth is not only continuously delivering source services such as matter and energy, it also provides sink services to assimilate waste, and offers life-support services such as a stable climate.[11] These ecosystem flows are necessary to maintain the ever depreciating human-made capital, and are lost, used up or sacrificed in the economic process (Lawn, 2003, 2008). For this reason, Daly's (1979) view of seeing lost natural capital services needed to maintain human-made capital as uncancelled costs provides the rationale behind the environmental cost side of EWM (Lawn, 2008, 2013). By also accounting for uncancelled costs one does not arrive at the net psychic income, but one gets the 'entropic net psychic income', as Brennan (2008) calls it. By augmenting the net psychic income by this uncancelled cost account, Lawn (2008) explains that EWM are based on an extended version of Fisher's income-capital distinction.

The costs and benefits that ultimately remain in respectively the ecosystem and the human body are said to be 'uncancelled', because all in-between interactions cancel out as each transaction of primary resources, intermediate goods, or final products pair a buying with a selling act of the same monetary amount. Or in accounting terms: debit equals credit. The uncancelled benefits can be directly related to Fisher. However, the fact that EWM are based on an extended version of Fisher's income-capital distinction raises the question whether the uncancelled costs are in line with Fisher's original view. As explained before, in Fisher's original writings, the only ultimate cost of production was the cost of labor and not the ecosystem services sacrificed. Fisher (1906, p.175) adds: "… if the term "labor" be not itself sufficiently broad, labor, anxiety, trouble, annoyance, and all the other subjective experiences of an undesirable nature which are necessary in order that the experiences of an agreeable nature may be secured." Nonetheless, it should be noted that Tobin (2005, p. 211) clarifies Fisher's concept of capital "… embraces all stocks of material objects that yield services that human beings like. Thus Fisher would include: *land and other natural resources* as well as reproducible goods; objects owned by households and governments as well as by businesses; houses and other consumer durable goods as well as producers' durables; objects whose

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[11] Section 2.2 already introduced how Kuznets also would deduct the use of raw materials to arrive at a nation's net product. Albeit limited in scope to only source services, the underlying rationale and procedure to calculate the cost account of EWM is comparable to what Kuznets proposed.

yields are always in kind, like houses occupied by their owners, as well as those yields are marketed for cash; the bodies of human beings – perhaps their minds too – as well as non-human objects.” The emphasis we added discloses Fisher would see the ecosystem as capital. As a consequence, the positive services flowing from the ecosystem’s functioning should be recorded from Fisher’s income-capital perspective.

Today, it is impossible to know Fisher’s thoughts on which categories he would classify as costs of production. Fisher regrets in his memoir that his insistence of seeing income as actual consumption made him lose approval for his income concept and settled that consumption plus capital accumulation is a useful income definition (Tobin, 2005). Perhaps, now that biophysical limits to growth have been detected (Meadows et al., 1972) and planetary boundaries are being crossed (Steffen et al., 2015), Fisher might see ecosystem costs as ultimate uncancelled costs of the production process and may agree with the procedure of deducting lost natural capital services as a way to account for the accumulation or decumulation of natural capital in EWM.

2.4 The Index of Sustainable Economic Welfare: a double theoretical foundation?

Even though Daly and Cobb (1999) stated that their two departures from GDP should be kept separate, a comparison between the extended Hicksian income (EHI) in Eq. (1) and the ISEW in Eq. 2 learns that Daly and Cobb’s ISEW was at least partially inspired by the extended approximation of Hicksian income since the features they attribute to this version are mimicked in the ISEW. Firstly, the ISEW also subtracts defensive expenditures and adds non-defensive government expenditures. Secondly, the costs of environmental degradation and depreciation of natural capital are deductions within the ISEW, which corresponds to depletion of natural capital in Eq. (1). Thirdly, the ISEW captures net capital investment, just as EHI does. By deducting the depreciation of human-made capital from GNP in Eq. (1), the investments needed to overcome depreciation are not counted. However, if investments exceed capital depreciation, positive net investments contributing to the accumulation of the stock producer goods will be registered in EHI. As such, it accounts for ‘capital accumulation’. The ISEW traces changes in producer capital stocks by accounting for *net capital growth*. However, compared to EHI this item is calculated differently, “…as the increase in the stock of producer goods above the amount required to keep the quantity of producer goods per worker intact” (Lawn, 2003, p. 114). The above comparison illustrates that the ISEW shares characteristics with the extended version of Hicksian income. This, in turn, could explain why Talberth and Weisdorf (2017) regard sustainable economic welfare as tightly linked to Hicks’ (1939) maximum sustainable income and why Stockhammer et al. (1997) stated that “the ISEW follows Hicks … , but also goes further” (p. 22). The ISEW goes further by accounting for the value of household labor, leisure, income inequality, commuting, etc. As explained in Section 2.3 these items and the psychic services from consumption are connected to Fisherian income.

The analysis above demonstrates that EWM are no perfect replicas of either Fisherian nor Hicksian income as they incorporate more welfare items than one could expect based on each of these original income notions separately. EWM go beyond Hicksian maximum sustainable income and can be linked to an extended version of Fisher's net psychic income. Nonetheless, we explained how certain items have been inspired by Fisherian or Hicksian income and can be seen from an experiential Fisherian view or from a Hicksian perspective. That is why we argue that Fisher's income concept meets Hicks' income notion in practice. This provides EWM with a double theoretical foundation, even though the Hicksian connection is often overlooked in recent work, as EWM are nowadays mostly entirely framed from a Fisherian perspective.

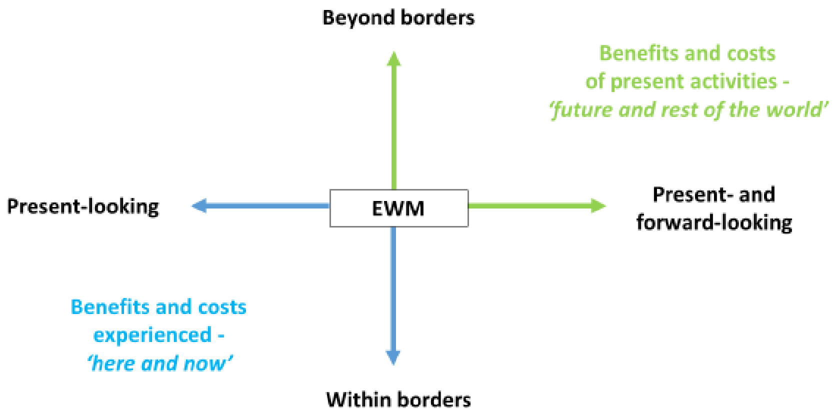
3. A conceptual investigation of economic welfare measures

The double theoretical foundation raises many questions. How can both income concepts be combined in EWM? Fisherian income is often regarded as being superior compared to Hicksian income, however, there are some difficulties with the Fisherian foundation. Should the 'extended version of Fisherian income', in which ecosystem services lost during the economic process (i.e. the uncancelled costs), be psychic and in line with Fisher's income-capital distinction or not? Do defensive expenditures not yield positive experiences? Is accounting for capital changes such as net capital growth reconcilable with Fisherian income? These are issues that keep practitioners puzzling and divided, as already demonstrated by the different statements on what EWM are capturing in Table 1. We believe the double theoretical foundation is based on the existence of two different ways to interpret EWM with distinct time and boundary implications. As we will explain in Section 3.1, EWM can be seen as the *benefits and costs experienced* or as the *benefits and costs of present economic activities*. Both interpretations imply different time and boundary choices and would treat ecosystem costs, capital changes and defensive expenditures differently, as we will see in Section 3.2. Afterwards, we will discuss how recent 2.0 studies are converging toward the experiential interpretation as a way to comply with the ex post Fisherian foundation. However, based on our two interpretational concepts, we will argue that this is not the only way forward when standardizing EWM.

3.1 Two distinct welfare interpretations

In this section we will introduce two ways of interpreting EWM and link each approach to specific time and boundary dimensions. Welfare seen as benefits and costs experienced looks at what is experienced 'here and now'. This implies a present and within border perspective. However, welfare understood as the benefits and costs of present activities has a contemporaneous and forward looking perspective, since present activities also bring costs and benefits in the future. Moreover, present activities cause costs to the rest of the world, so this approach takes a beyond boundary viewpoint. Fig. 5 illustrates each welfare interpretation's time and boundary implications.

Figure 5: Two types of economic welfare measures with their distinct time and boundary dimensions.



Note: The vertical axis depicts the boundary perspective, whereas the horizontal axis reveals the time dimension. Benefits and costs experienced implies a within border perspective and takes a contemporaneous perspective on experiences: it registers what is experienced *'here and now'*. Whereas, the benefits and costs of present activities have a beyond boundary viewpoint and take a present- and forward-looking perspective by also incorporating the costs (and benefits) present activities cause to the *'future and the rest of the world'*.

3.1.1 Benefits and costs experienced (BCE)

The BCE-view is inspired by Fisher's psychic income and reveals information about the welfare citizens experience at this moment. Lawn (2003), for instance, states that EWM are defined as 'the welfare enjoyed at a particular point in time', and that they "convey useful information about the current manifestations and immediate effects of present and past activities, [while] they reveal much less about the future impact of current activities" (p. 116). As Lawn (2008, p. 71) clarifies: "… future consumption possibilities locked up in current wealth are not part of a nation's current welfare." Therefore, it might be useful to have a supplemental index that incorporates the future costs and benefits of present economic activities (Lawn, 2003; Lawn & Clarke, 2008). Here, welfare has a contemporaneous perspective; it is thus not forward-looking and it does not include future costs and benefits of present activities, since the focus is on present experiences (see Fig. 5). This means that costs and benefits should only be registered when they are experienced. Recording psychic flows is based on the idea that (a) EWM should only trace services from capital stocks and not mere additions to or subtractions from stocks, and (b) the (dis)investments that are affecting the stocks (e.g. investments in the stock of producer goods), will impact on future flows of services that will be registered in next periods.

This experiential perspective takes an inward perspective when it comes to the boundary dimension (see Fig. 5). The BCE-view only looks at the effects felt within domestic borders, since the impacts of present activities that are shifted beyond borders are not experienced by a nation's citizens. Bagstad et al. (2014), for instance, argue that a within border perspective would "… be more consistent with the aims of the GPI to capture the true costs and values of economic activity within a political or geographic boundary" (p. 481). These authors suggest to account for ecological, social and economic costs of imported hazardous and radioactive waste. By doing so EWM would reveal what is experienced within a certain region.

3.1.2 Benefits and costs of present activities (BCPA)

The BCPA-approach focuses on present economic activities and accounts for both the present and future benefits and costs of these activities. It follows a(n) (extended) Hicksian view, since the consumption of community capital (i.e. human-made or natural capital) is labelled as a cost (Kubiszewski et al., 2013) instead of registering social and ecological costs positively (as in GDP and NNP). This view does not discriminate against future costs and benefits of present activities that violate Fisher's distinction between income and capital such as investments since future costs and capital changes should be seen as the costs and benefits of present economic activities. As a consequence, the BCPA-perspective has both a contemporaneous view on present activities and a forward-looking perspective (see Fig. 5). This forward-looking perspective is not be confused with reflecting future consumption possibilities since EWM (both BCE and BCPA) do not try to capture future consumption.[12]

[12] One exception can be found in Stockhammer et al. (1997), who tried to connect net capital growth to the increase in future consumption possibilities by multiplying net capital growth with the productivity of capital. As a result, future consumption (im)possibilities are allocated to the present period.

In a similar way that economic activities bring costs that are not necessarily experienced in the present, present activities also causes costs beyond domestic borders since the effects of certain items (e.g. resource depletion and climate disruption) do not discriminate against borders. In a global, entangled economy, nations are no closed economies. Countries trade not just goods and services, but also transboundary 'externalities'. For instance, the United Nations Handbook on National Accounting on Integrated Environmental and Economic Accounting (SEEA) (UN, 1993, p. 77) recognizes that: "Exports include not only cross-boundary product flows to foreign economies (as in SNA) but also flows representing the uses of, and the effects on, the natural environment of other countries by the domestic economy".

The BCPA-view looks beyond boundaries (see Fig. 5) and would account for the costs that present activities cause in other regions, just as the Ecological Footprint framework does (see e.g. Wackernagel & Rees, 1996). Clarke (2007), for instance explains: "As with GDP, the GPI is concerned only with a particular physical location. Yet, it may be more effective if the GPI was freed from these physical boundaries in a similar manner to GNI [Gross National Income]. The GPI should be concerned more with the *'ownership' of the costs and benefits* associated with economic growth than with the 'location' of those costs and benefits. Those that derive the most benefit from exploitation of the environment are often physically removed from the location of that damage. The GPI does not consider the net consumers of the negative externalities of environmental costs, merely the producers. Currently, however, the structure of the GPI allows a nation to enjoy, without penalty, the benefits of importing goods from countries which bear a disproportionately large cost of environmental degradation. This results in an overstatement of the real progress experienced by the country importing 'dirty goods'." (p. 91, emphasis added).

Several scholars (e.g. Lawn & Clarke, 2008; Posner & Costanza, 2011; Kubiszewski et al., 2013) have pointed out that EWM fail to properly tackle transboundary issues. Hong Kong's upward welfare trend, for instance, can be partially explained by the relocation of heavily polluting industries to China (Delang & Yu, 2014), while Japan's case illustrates that heavily depending on imports results in low costs of domestic resource depletion (Makino, 2008) even though Japan and other resource-poor countries deplete global stocks. From a within boundary perspective, the welfare of these countries is higher than if they would account for environmental costs shifted beyond boundaries. Therefore, the BCPA-perspective with its beyond boundary perspective answers to the calls raised by Clarke (2007) and Makino (2008) for calculating open economy EWM.

3.2 Welfare items seen from two interpretational perspectives: an application

This conceptual exploration illustrates the need to reflect on where to draw EWM's time and geographical boundaries. Clearly considering and stating which welfare interpretation and thus which time and boundary perspectives are chosen, is vital to know how EWM are operationalized. Both welfare interpretations and their time and boundary implications are not perfectly replicated in welfare studies since scholars often have to make pragmatic choices because of data availability, practitioners could (unknowingly) try to combine experiential welfare elements and cost-benefit aspects of present activities in a single welfare study. Using a marginal social cost of carbon to estimate the cost of climate disruption, for instance, is not compatible with an experiential, *'here and now'* view since this cost estimate embodies future and global costs. In order to illustrate both interpretations, we will explain how the items *net capital growth, climate disruption, resource depletion* and *defensive expenditures* would be dealt with differently from a BCE- and BCPA-perspective. Table 2 gives an overview.

- *Net capital growth* aligns with the BCPA-interpretation: a negative (positive) net capital adjustment is a(n) decrease (increase) of a nation's productive capacity and to be seen as a cost (benefit) of present economic activities. Lawn (2003) argued that an increase in a nation's productive capacity (i.e. investments in human-made capital above the minimum requirement to keep the stock of producer goods per worker intact) is a benefit. This is a benefit of present activities and does, however, not constitute a present experience since this increased productive capacity will lead to future consumption experiences registered in the future, as pointed out by Bleys (2008). Yet this adjustment does not matches the BCE-view. To be in line with the ex post established Fisherian income-capital distinction, one should report psychic income flows but not changes in capital stocks. Therefore, it is no surprise Bleys (2008) pointed out that capital change items like *net capital growth* (and *change in net international position)* are inconsistent with Fisher's income-capital distinction. That is why, these items should not be included in BCE-studies.
- The *costs of climate disruption*, previously referred to as long-term environmental damage, can be calculated in two ways. The BCPA-perspective would account for the costs that present activities cause today and in the future, both domestically and in the rest of the world. These damages are linked to the current emissions of greenhouse gasses (GHG), either domestically emitted, or, preferably, also taking into account the net GHG imports or exports related to international trade. The BCE-interpretation, on the other hand, would incorporate only the costs that are already experienced at this moment and within domestic borders. These costs are typically linked to the impacts of climate disruption that are currently felt (e.g. extreme weather events, droughts, …).

- The rationale for including *non-renewable resource depletion* is evident from a BCPA-view since it is a cost of present activities as the natural capital stock is being depleted by these activities. This depletion can be seen from two viewpoints, depending whether the country involved has resource endowments or not. Resource-rich countries deplete their national energy stocks via present extraction activities, whereas resource-poor countries' present activities are depleting global energy stocks via the domestic combustion of imported fossil fuels. Yet, in both cases, resource depletion is a cost of present activities and should be accounted for. However, the inclusion of resource depletion is less evident from a BCE-perspective: what is currently experienced from the ongoing depletion of non-renewable energy (and by extension of arable land, water, etc.)? Will resource depletion not result later on in reduced consumption and lower experiences?
- Deducting *defensive expenditures* classifies them as a cost of present economic activities instead of counting them positively in GDP or NNP. Leipert (1989) explains that defensive expenditures are additional macroeconomic costs and should be registered as such in the GNP. Nonetheless, defensive expenditures "… are certainly not superfluous in the short term. They are under the given socio-economic and ecological conditions, both necessary and useful" (Leipert, 1986, p. 116). This would imply that defensive expenditures on for instance personal pollution control, air filters, locks could be part of an EWM from a BCE-perspective. Yet, from a BCPA-view, defensive expenditures should be deducted in EWM as they should be regarded as costs of current activities.

Table 2: Welfare items seen from two interpretational perspectives.

Welfare items	*Benefits and costs experienced (BCE)*	*Benefits and costs of present activities (BCPA)*
Net capital growth	Omit	Include
Climate disruption	Damages currently experienced within borders	Damages caused to the future and rest of the world
Resource depletion	What is currently experienced within borders?	Depletion is a cost of present activities and to be accounted for.
Defensive expenditures	Include	Subtract defensive expenditures of present activities, since they are a cost.

3.3 Puzzling time and boundary issues: 'experientisation' or 'Fisherisation' is not the only way forward

The contribution of our paper is to point to the existence of two distinct ways of interpreting EWM: as the benefits and costs experienced or as the benefits and costs of present economic activities. Yet, since EWM were ex post connected to an extended version of Fisherian income by Lawn's (2003, 2008) seminal work, most scholars are trying to make EWM compatible with the ex post theoretical foundation by stressing item's experiential nature or making items more experiential, which aligns with the BCE-perspective. This turn to Fisher's income and capital concepts or 'Fisherisation' (as explained in Section 2.3) is leading to quite some confusion on what EWM are actually measuring and to the use of a wide variety of (sometimes inconsistent) valuation methods in the literature as most scholars are not explicit about the time and boundary perspective they take. In this section, we will critically assess the Fisherisation in the EWM literature by focusing on discussions within the GPI 2.0 process on the following items: *net capital growth, climate disruption and resource depletion* and for the method of subtracting ecosystem costs. Yet, this Fisherisation or 'experientisation' may not be the only way forward. In line with our BCPA-view this is not the only way to deal with these items' time and boundary issues since the BCPA-interpretation deals with them differently as argued in Sections 3.1. and 3.2.

The 'Fisherisation' is probably most clear in Talberth and Weisdorf (2017), who try to frame welfare losses caused by present activities in an experiential perspective. The authors account for the 'benefits and costs *experience*d' including the welfare losses *caused* to the future and the rest of the world (emphasis added). They register the disutilities associated with externalities caused to future generations and the rest of the world since "most people also care about adverse effects local economic activity may have on other communities" and as "people also care about conditions and trends facing their children and future generations" (p. 4).[13] Their focus on experiential costs and benefits indicates they are inspired by Fisher's psychic income. Nevertheless, without denying that present generations care for the future and for the rest of the world, it can be questioned to what extent welfare losses caused to future eras and other regions are "experienced" today? Kapp (1950, 1978), for instance, regards externalities as cost-shifting of economic activities, so that one could wonder whether shifting these losses is not simply a way to inflate the own presently enjoyed welfare flow at the expense of others? Passing on costs may increase currently

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[13] Talberth and Weisdorf's (2017) general mathematical representation clearly visualizes their time and boundary extension: $W_t = \frac{1}{N}\sum_{i=1}^{N}[U_i\,(C_i) + U_i\big(\hat{s}(K)\big) - dU_i((UCT) + (-\triangle W_{ROW}) + (-\phi \triangle W_{t+1}))]$.

experienced welfare, yet, from a holistic perspective, the costs are not eliminated, nor reduced. These costs will eventually be paid by someone in society or by the ecosystem. That is why, it would be good accounting to not only register future costs, but also the costs caused abroad in the BCPA-view. Furthermore, evidence from the pro-environmental behavior literature indicates that there is a gap between the environmental knowledge, attitudes, values and awareness people have and actually behaving pro-environmentally (see e.g. Vermeir & Verbeke, 2006). To put it differently, people may care for the environment but simultaneously behave or act in environmentally harmful ways. As such, caring for the future generations or the rest of the world is not enough since actual behavior brings inescapable socio-environmental costs. This makes Talberth and Weisdorf's reasoning potentially flawed, especially from a BCPA-view. The rationale for including resource depletion further exemplifies this point. As explained in Section 3.2 resource depletion is a clear cost of present activities that should be included in BCPA-studies, however, including this item is less evident from a BCE-view. Talberth and Weisdorf are aware of this issue and associate the depletion cost with the disutility from passing costs to future generations or from being an undesirable trend or condition. The authors try to relate resource depletion to current experiential welfare by stating some people care for this disutility and have willingness to pay to prevent this loss (e.g. the premium for goods sustainably produced). Nevertheless, these scholars also wonder if the depletion adjustment should still be included in future studies if it is not better linked to a current [experiential] welfare loss. Pushing this argument further, resource depletion will later on result into reduced consumption and thus lower experiential welfare levels in future periods.

Other scholars also have tried to align the items included in welfare studies with Fisher's income-capital distinction. *Net capital growth* and *change in net international position* were gradually removed in more recent studies (e.g. Bleys, 2008; Talberth and Weisdorf, 2017; O'Mahony et al., 2018; Held et al., 2018) to strengthen EWM experiential base as they are inconsistent with Fisher's income-capital distinction (Bleys, 2008). It is interesting to note that Lawn (2013) also abandoned his initial position of including productivity increases and proposes to capture stocks of human-generated capital in satellite accounts. At the same time, other EWM scholars continue to include one or both of these items which is consistent with the BCPA-view.

Calculating the *costs of climate disruption* is to some extent also prone to experientisation. Most authors (e.g. Jackson, Marks, Ralls, & Stymne, 1997; Talberth et al., 2007; Bleys, 2008; Talberth & Weisdorf, 2017; Held et al., 2018; O'Mahony et al., 2018) calculate this item using a marginal social cost of carbon (MSC). This is related to a BCPA-view since the MSC entails future costs (i.e. global future damage costs caused are discounted to the present). The MSC is multiplied by the current or cumulative emissions related to the domestic combustion of fossil fuels. Yet, Bagstad et al. (2014) suggest to replace this valuation method by other items like the costs of natural disasters, water scarcity, extreme weather events, or other region-specific impacts. This replacement is to be seen from a BCE-view since it focuses on items threatening welfare experienced locally and right now, and not climate related costs caused in time or beyond borders. Next, we believe that the climate disruption item could be improved in future BCPA-studies by accounting for the emissions embodied in trade, in a footprint-like manner. The European Union, for instance, has net embodied imports for carbon (Tukker et al., 2016), while two thirds of the carbon footprint of Flemish consumption is located outside Flanders (Vercalsteren et al., 2017).

Most scholars subtract the costs of lost ecosystem services in EWM. The studies in which the flows from the ecosystem are positively counted for – in line with Fisher's view – are rare. Recently, however, scholars tend to move in the direction of Fisher by experimenting with positively valuing ecosystem services: O'Mahony et al. (2018) value protected Spanish wetlands in a positive manner, Talberth and Weisdorf (2017) value the services offered by natural capital positively by the management cost made to conserve and improve protected terrestrial and aquatic areas, whereas Berik and Gaddis (2011) list the ecosystem services from forests, wetlands, croplands and desert grassland and scrubland in the state of Utah positively.

3.4 Discussion: toward a 2.0 methodology

So far, we put forward a dual welfare interpretation that reveal different perspectives – the experiential interpretation gives information about how well off a region is at the present by looking at what is experienced here and now, while the benefits and costs of present activities interpretation yields information about present economic activities including their future consequences and the costs shifted in time and space. Yet, in future studies, we would suggest to use the benefit and costs of present activities for their policy-guiding potential. If policy-makers would only look at current experiences, then this could mistakenly lead to the conclusion that one can happily enjoy experiences in the present while depleting physical capital and plundering the planet. Our preferred welfare interpretation would be more in line with an ecological economics viewpoint of not restricting the ecological scope to the here and now. This is needed to signal the importance of taking actions in the present to address ecological and climate breakdown and of devising policies such as a carbon border adjustment mechanism to reduce the impact domestic consumption has abroad. Furthermore, it would also treat physical capital consumption as detrimental to welfare.

A comparison of both indicators would thus give an indication of the extent of ecological cost shifting in time and space and of physical capital consumption. Nonetheless, looking at the aggregate level of the BCPA-interpretation alone may not be enough to prevent these adverse trends, as ecosystem destruction and physical capital consumption could be overcompensated by welfare gains recorded elsewhere in the index, for instance by growth in personal consumption expenditures. In this aggregation procedure, crucial welfare information may be lost. Therefore, we suggest to not only look at the aggregate level, but to adopt a dashboard-like approach by also looking independently at the various big welfare categories to verify the trends of consumption, the welfare losses from income inequality, capital adjustments, ecological costs, etc. As such, a dashboard-like approach of the BCPA-interpretation would be best suited to debunk GDP as a policy guide and stimulate prioritizing well-being economies that are faring well without growth, socially just and ecologically healthy.

4. Conclusion

Economic welfare measures (EWM) have been around for over thirty years. Even though voices were raised for a more robust, standardized set of the items included (Lawn, 2003) and for some convention in the valuation of environmental items (Forgie, 2007), EWM's lack of standardization is hindering their policy-making impact (Bleys & Whitby, 2015). We found that this lack of consistency is related to scholar's different understanding and operationalization of what welfare is. Nevertheless, there is consensus among practitioners that EWM provide better welfare information than GDP by distinguishing between the costs and benefits, by extending the analysis beyond market activities and by also looking at the social and ecological spheres in which the economy is embedded. By doing so, proponents argue that EWM are able to debunk (Daly & Cobb, 2007) or dethrone (Stockhammer et al., 1997) GDP as an economic policy indicator. For instance, Ziegler (2007) considers EWM to play a crucial role in undermining the belief large systems of governance have in certain statistics such as GDP that serve as a tool to establish legitimacy and accountability.

In this paper we have revisited EWM's theoretical foundations to foster standardization. The critique that EWM are lacking a solid theoretical foundation is related to the fact that Hicksian income meets Fisher's income concept, which gives EWM a double theoretical foundation. Welfare's experiential nature is derived from Fisher, whereas treating the consumption of community capital as a cost is Hicksian. The novelty of our paper is that we disentangle both income notions and identify two distinct ways to interpret EWM. One interpretation sees welfare as the costs and benefits experienced and does not include capital changes nor future costs, whereas these elements could be registered when EWM are thought of as the benefits and costs of present economic activities. Designing EWM also implies choices on boundary issues, for instance looking within or beyond boundaries regarding the impacts of ecosystem costs. We articulated that a within border view aligns with an experiential welfare standpoint, whereas a beyond boundary perspective matches welfare seen as the costs and benefits of present activities. That is why, our distinction between both interpretations helps to structure the theoretical and conceptual debate and helps to understand the diversity of choices regarding time and boundary issues. Nonetheless, more research is needed to analyze the compatibility between welfare items and each of these welfare interpretations, and to verify which valuation methods need further refinement.

It is ill-acknowledged that EWM have a double theoretical foundation and two different welfare interpretations with distinct time and boundary implications. Most practitioners aim for compatibility with the ex post established Fisherian income theoretical framework and thus with the experiential interpretation (e.g. by omitting capital changes). Yet, following our interpretational understanding, compliance with current experiential welfare is not the only way forward since EWM can also be understood as the costs and benefits of present economic activities. Therefore, it can be seen as artificial when future costs and impacts abroad are explained from an experiential view as in Talberth and Weisdorf (2017). If EWM are a tool for accountability and for disclosing 'invisible' costs caused abroad and in future eras, then there is no logical reason to overlook these costs from a cost-benefit perspective of present activities. Including these costs would be good accounting and would follow Kapp's (1950, 1978) view by framing externalities as cost-shifting.

The diverse welfare interpretations each visualize alternative economic viewpoints. Depending on the purpose of EWM alternative perspectives can be identified. If the goal is to reveal the welfare level domestic citizens are enjoying today, then current experiential welfare can be estimated without taking into account the costs inflicted upon other communities and future generations. This contemporaneous perspective reduces the 'forward-looking' policy-guiding potential of EWM. However, if the purpose is to account for the benefits and costs of present activities and disclose the costs shifted, then good accounting requires an analysis that does not discriminate against jurisdictional boundaries, nor against the future. Here, the BCPA-perspective could broaden the scope of ex ante policy evaluations. This perspective is a better guide to policy-making as it includes the costs shifted in time and space and accounts for the consumption or accumulation of assets. Therefore, the BCPA-interpretation is preferable over the experiential interpretation in future compilations.

In theory, it is clear to define these dimensions and interpretations. However, in practice we see that scholars make inconsistent and pragmatic choices depending on the data and estimates available. In order to improve future studies, it is crucial for scholars to properly reflect on the interpretation taken and to clearly mention which perspectives they take on time and boundary dimensions and where deviations occur. Additionally, these statements would (a) make clear which valuation methods should be used, (b) make welfare studies more consistent and comparable, (c) foster the standardization process, (d) legitimize the use and (e) improve the policy-guiding relevance of EWM. Furthermore, we believe that future studies should adopt a disaggregated dashboard-like approach to monitor welfare categories independently in order to avoid that certain adverse welfare trends are compensated by other welfare gains. Finally, these evolutions could provide economists, media and decision-makers with better welfare information than GDP. As such, standardizing the measurement and reporting of EWM may help to go beyond GDP and promote faring well within planetary limits in a beyond GDP and post-growth transition.

Chapter 2 : Cost-shifting versus "full" accountability: Dealing with cross-time and cross-boundary issues in the ISEW and GPI for Belgium.[14]

1. Introduction

Among economists it is widely acknowledged that GDP is a poor indicator to measure social welfare or social progress (Kuznets, 1934, Max-Neef, 1995; Jackson, 2004; Fleurbaey, 2009; van den Bergh, 2009; Stiglitz et al., 2009, 2018; Costanza et al., 2014; Raworth, 2017; Hoekstra, 2019). Yet paradoxically, GDP is, to date, very influential in economics, public policy, politics and society (van den Bergh, 2009), making it the 'most powerful number' in the world (Fioramonti, 2013). Parallel to the theoretical and empirical criticisms of GDP as a welfare indicator, voices have been raised to adopt alternative measures to evaluate economic performance. Many alternative "Beyond GDP" indicators have been developed over the past decades that aim to measure welfare, well-being, wealth and social progress differently – see, for instance, the approaches mentioned in Dasgupta and Mäler (2000), Dasgupta (2009), van den Bergh (2009), Fleurbaey (2009), Bleys (2012), O'Neill (2012), O'Neill et al. (2018) and Hoekstra (2019).

There is a long tradition of calculating alternative measures of economic welfare. In 1972, Nordhaus and Tobin (1972) constructed a Measure of Economic Welfare, while Daly and Cobb (1989) elaborated on this effort to develop the Index of Sustainable Economic Welfare (ISEW) – a monetary welfare indicator that accounts for the benefits and costs of economic activity. By doing so, it accounts for many of GDP's welfare deficiencies. The ISEW does so by making visible elements that remain hidden from a narrow GDP lens such as unpaid work, inequality and ecological destruction. Over the last thirty years, welfare indicators such as the ISEW and the Genuine Progress Indicator (GPI) have been calculated for many countries and regions all over the world. Yet, to date they have had little impact on policy-making because of their lack of standardization (Bleys and Whitby, 2015). Currently, Economic Welfare Measures such as the ISEW and GPI are being updated and improved to a "2.0 methodology" (Bagstad et al., 2014; Talberth and Weisdorf, 2017).

One of the important issues that remains unresolved is the way(s) to account for cross-time and cross-boundary issues such as ecological costs and physical capital changes (Van der Slycken and Bleys, 2020a).

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[14] This paper is co-authored with Brent Bleys (Ghent University).

The climate change item, for instance, is treated differently in different studies: some scholars suggest to look at the present impacts of climate change within domestic borders, whereas others include future costs and costs abroad. Mostly, EWM do not register cross-boundary issues (well). Yet, scholars have argued to account for the environmental costs that are outsourced to other regions. Furthermore, different views exist on how to account for investments and capital changes: some only register current consumption services flowing from capital stocks, while others also include investments or changes in capital stocks which will contribute to future consumption flows. In order to overcome the existing conceptual unclarity and methodological shortcomings, the ISEW/GPI community needs to scrutinize how to account for cross-time and cross-boundary issues in EWM.[15]

The novelty of this paper is that it calculates two types of EWM for Belgium based on different views of dealing with ecological costs and investments, both with different time and geographical boundaries as introduced in a previous paper (Van der Slycken and Bleys, 2020a). Experiential welfare or the *benefits and costs experienced* only look at the present ecological costs that fall within domestic borders and exclude physical capital changes, while the *benefits and costs of present economic activities* (BCPA) include capital changes and also account for the ecological costs shifted in time and beyond borders. The BCPA are argued to provide policy-makers, politicians, economists, media and the broader public with more detailed welfare information as substantial ecological costs are shifted in time and space. Furthermore, other methodological novelties are introduced in this article as it is the first welfare study that includes: (1) the value added by the shadow economy, (2) an inequality adjustment for the diminishing marginal utility of income that is based on a sufficiency threshold, (3) a consumption footprint view for the emissions embodied in trade, and (4) the climate impacts of aviation and shipping. This study primarily develops and sets forth a “2.0 methodology” that deals with the cross-time and cross-boundary issues in EWM in an application to Belgium as a first step to calculate economic welfare in a standardized way for the EU-15 countries in future research.

Section 2 defines indicators of economic welfare and introduces with the benefits and costs experienced and the benefits and costs of present economic activities two different welfare interpretations with distinct time and boundary dimensions. Section 3 translates these welfare interpretations in two corresponding welfare measures, elaborates on the methodology used to calculate these measures and explains other methodological novelties and improvements. Section 4 discusses Belgium’s overall per capita welfare

[15] In this paper we refer to ‘economic welfare measures’ and ‘indicators of economic welfare’ as the overall, general category of welfare indicators that includes the ISEW, GPI and variants such as the German National Welfare Index.

improvements by 15% and 18% between 1995 and 2018 and its driving trends: growing individual consumption expenditures and increasing welfare losses from income inequality. Since caution is warranted when interpreting the aggregate welfare trend, Section 5 discusses the need to adopt a disaggregated approach. Section 6 illustrates in a sensitivity analysis that our results are robust to different methods and parameter estimates. The paper concludes by discussing that future EWM should account for cost-shifting in time and space in order to guarantee that policy-makers are also informed about the fact that physical capital is being consumed or that economic activity is fueling ecological breakdown.

2. What are alternative indicators of economic welfare measuring?

2.1 Defining economic welfare

While there exist many approaches to measure economic welfare, we refer to *economic welfare* in this paper as what is measured by the ISEW and GPI. Scholars have defined and interpreted welfare – as implied by the ISEW and GPI – differently (Van der Slycken and Bleys, 2020a). Some believe EWM capture sustainable economic welfare or genuine progress, while others argue they allow us to track experiential welfare. We define EWM as macroeconomic monetary welfare measures that account for the benefits and costs of economic activity. They do so by valuing the contributions from unpaid work, the market, state and shadow economy as they are all different means to satisfy people's needs and wants. Furthermore, the social and ecological costs caused by the economic process are also included, since these indicators see the economy as embedded in society and in the Earth System. As a consequence, EWM are potentially capable of guiding economies and societies on a just transition toward living well within limits by providing an alternative to move beyond GDP.

2.2 Dealing with cross-time and cross boundary issues

Designing EWM involves making choices on where to draw the system's boundaries, choices that are ideally made by relying on a theoretical or conceptual framework. It is important to scrutinize the choices made on time and boundary issues in EWM, because a recent theoretical and conceptual review found that the EWM community holds different views on how to deal with cross-time and cross-boundary issues such as ecological costs and capital changes (Van der Slycken and Bleys, 2020a). Without going into detail on the theoretical foundation(s), we will summarize this review's key findings here and propose a boundary convention for the methodological choices in the remainder of this paper.

The different views the EWM community holds on dealing with cross-time and cross-boundary issues is related to the fact that EWM have a double theoretical foundation. Van der Slycken and Bleys (2020a) articulated how Daly and Cobb were jointly inspired by both Hicksian and Fisherian income when creating the first ISEW. Broadly speaking, Fisher emphasizes the experiential nature of income while for Hicks capital consumption does not count as income. This theoretical duality helps to explain the different views scholars have regarding accounting for ecological costs and capital changes and their time and boundary dimensions.

Although Daly and Cobb did not explicitly link their ISEW to either Fisher or Hicks, the ISEW was ex post connected to Fisherian income by Lawn (2003). In his seminal paper, Lawn argued that the ISEW is solidly based on Irving Fisher's concepts of income and capital. According to Fisher's psychic or experiential income concept, only the current experiential consumption services that are flowing from capital stocks count as income. Based on this Fisherian concept, one can see EWM as a specific type of a cost-benefit analysis, namely as the benefits and costs *experienced* (BCE). After the establishment of this ex post theoretical Fisherian foundation, the methodology of EWM was revised – i.e. some 'Fisherisation' or 'experientisation'. First, physical capital changes were removed from EWM as accounting for capital changes is not compatible with Fisherian income. Experiential EWM should only capture current services flowing from capital stocks and thus exclude current additions to capital stocks that will lead to services experienced in future periods. Second, ecological items' boundaries were shifted: scholars aimed for maximum compatibility with Fisher's experiential concept by only including the ecological costs that are currently experienced and felt within domestic borders. Nonetheless, not all authors follow these steps as some still include capital changes and include ecological costs caused beyond borders and in the future.

The 'Fisherisation' of only looking at what is experienced in the present and within domestic borders is not the only way forward, as we argued in our previous paper, since EWM can also be interpreted as the benefits and costs of present activities (BCPA). Following this interpretation, EWM can look at the impacts of present activities by adopting a forward-looking view that also looks beyond borders. This broad interpretation includes capital changes as these are future benefits (or costs if negative) originating from present activities. Including capital changes violates Fisher's distinction between income and capital, yet it aligns with Hicksian income, which can be approximated as the sum of consumption and capital accumulation, i.e. $C + \Delta K$ (Hicks, 1939). By deducting the depreciation of manufactured capital from the gross national product, one obtains the net national product (NNP) that is often seen as a basic version of Hicksian income. Next to this basic version of Hicksian income, there also exists an extended version of

Hicksian income, i.e. green NNP, that also deducts the depletion of natural capital. This extended Hicksian income helps to explain why ecological costs are deducted in EWM. Since the ecological costs of economic activity are not necessarily *experienced*, the broader welfare interpretation should account for the ecological costs shifted in time and space – here we build on Kapp's (1950) work of seeing externalities as "cost-shifting" to the poor, future generations and the ecosystem. Fig. 5 gives an overview of the benefits and costs experienced and the benefits and costs of present activities and their different time and boundary implications.

3. A "2.0 methodology"

These two types of EWM differ for the categories ecological costs and capital adjustments. The benefits and costs experienced only include current ecological costs that are experienced within borders and excludes capital adjustments. While the benefits and costs of present activities include capital changes and also the ecological costs shifted in time and space. As a consequence, BCE can be seen as a *narrow* EWM, while BCPA is a *broad* EWM. Yet, as the general representation of both EWM in the following equations illustrate, they have most of the welfare categories in common:

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

$$BCPA = UW + C_i + S + G_c - DIRE_p - INQ - BEC + \Delta K \quad (4)$$

In Eqs. 3 and 4: UW = unpaid work, C_i = individual consumption, S = shadow economy, G_c = non-defensive collective government consumption, $DIRE_p$ = defensive, intermediate and rehabilitative private expenditures, INQ = welfare losses from income inequality, NEC = narrow ecological costs that are experienced in the present and within domestic borders, BEC = broad ecological costs, including current costs within domestic and the costs shifted in time and space, ΔK = capital adjustment. UW, C_i, S, G_c are valued positively; INQ, $DIRE_p$, NEC and BEC are deducted, whereas ΔK can be either positive or negative. Table 3 gives an overview of the used calculations methods and rationale for every item for both welfare indicators.

In this methodological section, we will comment on the methods employed and methodological improvements for unpaid work (Section 3.1), actual individual consumption (Section 3.2), the shadow economy (Section 3.3), the inequality adjustment (Section 3.4), climate breakdown (Section 3.5), the depletion of non-renewable energy resources (Section 3.6) and net capital growth (Section 3.7). We will not go into detail on every item's valuation method explained in Table 3. A detailed explanation for all items (including data sources) can be found in Appendix A. In Section 6 we will perform a sensitivity analysis for the main methodological changes that we propose.

Table 3: Methodological overview and additional information on two welfare interpretations.

	Items *(category)*	**Method of calculation and** ***additional information***
A	Unpaid work *(UW)*	Total hours of unpaid work x market wages *Unpaid work covers routine housework, shopping, care for household members, care for non-household members, volunteering, travel related to household activities and other unpaid work and is valued using the replacement cost method to find a market substitute.*
B	Actual individual consumption (+) *(C_i)*	B is the sum of the individual consumption expenditures by households and the individual consumption expenditures made by Non-Profit Institutions Serving Households and government.
C	Defensive, intermediate and rehabilitative private expenditures (-) *($DIRE_p$)*	C involves subtracting the following from B: 25% of food and alcohol expenditures, 100% of tobacco and narcotics expenditures, 100% of insurance and financial services expenditures and the cost of road accidents. The latter is calculated by using direct and indirect costs estimates for fatalities and injuries in road accidents. *Defensive expenditures such as insurance expenditures are deducted because they merely serve to defend oneself from the unwanted effects of other economic activities. Intermediate expenditures such as financial services are deducted too, because they are not ultimate consumption. Financial services are at best an intermediate means to final consumption but are by themselves not the ultimate end of economic activity. Rehabilitative expenses after a car accident, for instance, are undertaken to restore to previous, more healthy conditions and are deducted because they are to be seen as costs, not benefits.*
D	Cost of consumer durables (-) *(C_i)*	Current expenditures on durable consumer goods are subtracted.

E	Services of consumer durables (+) *(C_i)*	∑ previous 8 years' consumer durables expenditures x 0,2 *The services are equal to the depreciation and an imputed interest value of the stock of consumer durables.*
F	Shadow economy (+) (S*)*	F approximates the value of the shadow economy. Only 50% is included as welfare-enhancing, to exclude illegal activities and avoid double counting with actual individual consumption and unpaid work.
G	Net consumption	Actual individual consumption – defensive, intermediate and rehabilitative private expenditures – cost of consumer durables + services of consumer durables + shadow economy (B-C-D+E+F)
H	Welfare losses from income inequality (-) *(INQ)*	Inequality adjustment index x net consumption *H uses an inequality adjustment index that is based on the diminishing marginal utility of income and normalizes the correction at a sufficiency threshold.*
I	Non-defensive government expenditures (+) *(G_c)*	100% of government expenditures on general public services, housing and community amenities and recreation, culture and religion are included.
J	Cost of air pollution (-) *(NEC & BEC)*	J is calculated by multiplying annual emissions with cost estimates. *J compiled from a within border (i.e. production) view captures the costs related to the following pollutants PM 2,5, NOx, NH3, SO2 and NMVOC. It is assumed the direct disamenity cost of air pollution in the narrow ecological costs is equal to 20% of this within border cost. In the broader perspective on air pollution, the costs of air pollution embodied in trade from the pollutants PM 2,5 fossil, PM 2,5 bio, NOx, NH3 and SO2 are added to the within border costs.*

K	Ecosystem costs of nitrogen pollution (-) *(NEC & BEC)*	K is calculated by linking cost estimates to annual emissions of NO2 and NH3 and with the use of inorganic fertilizer. *The cost estimates for NO2 and NH3 only cover ecosystem costs in order to avoid double counting of health costs, which are already registered in the costs of air pollution. The ecosystem cost for reactive nitrogen measures the run-off from agricultural sources to rivers and seas. This item is included in both NEC and BEC, as it reflects current ecosystem costs within domestic borders.*
L	Cost of climate breakdown (-) (*BEC)*	L captures the damages related to climate breakdown and is calculated by multiplying a time-varying marginal social cost by the amount of greenhouse gas emissions. The emissions included are domestic emissions, CO2-emissons embodied in trade, emissions from international navigation and aviation, domestic LULUCF-emissions, the emissions related to global land use changes, and biomass emissions. *L is forward looking and looking beyond borders. It is only included in the broad ecological costs.*
M	Cost of extreme weather events (-) *(NEC)*	M is equal to the total amount of uninsured losses as insurance (subtracted as defensive expenditures) helps to 'reduce' the costs from extreme weather events. *M covers uninsured losses to approximate the damages suffered in the present from extreme weather events for the narrow ecological costs.*
N	Depletion of non-renewable energy resources (-) *(BEC)*	N is calculated by multiplying the primary energy consumption by a transition cost that is needed to replace non-renewable resources and achieve an energy efficiency target of 33% by 2030. *N is only included in the broad ecological costs. Using non-renewable energy resources means that resource stocks are being depleted. This item tries to proxy this depletion by using transition costs to replace non-renewable energy resources with a renewable substitute.*
O	Costs of use of nuclear power (-) *(BEC)*	O is calculated by multiplying the amount of nuclear electricity generated by a cost estimate from the German welfare study. *O is forward looking and only fits in the broad ecological costs.*

P	Net capital growth *(ΔK)*	(+)	P is calculated by taking the difference between this year's and previous year's net capital stock. *P only fits in BCPA as net capital growth is seen as a benefit (or cost if negative) of present economic activities.*

3.1 Unpaid work

Economists have long expressed their dissatisfaction with the exclusion of unpaid household work from the System of National Accounts (see, for instance, Waring, 1999, 2003). To date, unpaid household services remain invisible, even though the production boundary of GDP has expanded over time to also include financial services and the informal sector (DeRock, 2019). In contrast to GDP, unpaid household work is included in EWM since the first attempts to measure economic welfare by Nordhaus and Tobin (1972) and Daly and Cobb (1989). EWM typically account for unpaid work as activities like cooking, cleaning or giving childcare as they are also benefits of economic activity. These activities often remain outside formal markets, although they can be commodified as market activities.

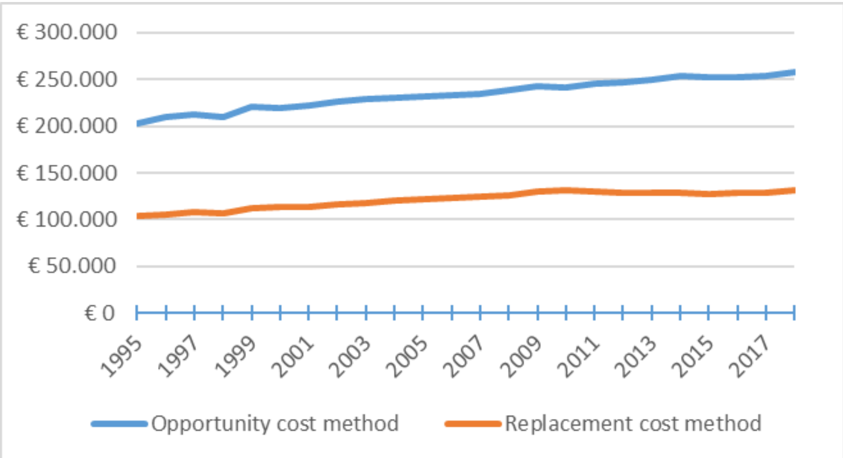
Similar to GDP, private consumption expenditures take a central place in EWM. Most EWM take final consumption expenditures as a starting point after Daly and Cobb's (1989) initial compilation. Yet, Ziegler (2007) argues that Daly and Cobb proposing an index centered around personal consumption in the appendix of a book in which they describe humans as persons-in-community is paradoxical as increasing consumption and commodification in market societies not only tends to erode social relationships, but also reduces them to merely monetary exchanges (Polanyi, 1957). Therefore, we propose to go beyond GDP by also going beyond consumption as a baseline for EWM. The consumption paradox is addressed in this paper by taking unpaid work as baseline to reveal its pivotal role in a society's welfare. Jochimsen and Knobloch (1997) argue that the "maintenance economy", consisting out of the productive and creative (reproductive) activities like ecological processes and the maintenance of physical and social relationships (i.e. "caring activities"), is a key foundation of the current industrial economic system. Proposing an indicator based on unpaid (care) work would be more consistent with seeing humans as "persons-in-community", as caring activities are about maintaining physical and social *relationships*.[16]

We are interested in the *output* services of unpaid work, yet, because of data availability issues time-use inputs are used to calculate this item. The time-use of unpaid work that is included in this study is broader

[16] Furthermore, unpaid work plays a significant role in a person's well-being (Nierling, 2012).

than merely household work as it covers routine housework, shopping, care for household members, care for non-household members, volunteering, travel related to household activities and other unpaid work. Most studies value unpaid work at a replacement cost, i.e. the hourly wage to find a market substitute. However, Brown and Lazarus (2018) use the opportunity cost method, in which unpaid work is valued at average wages. In the replacement cost method, unpaid work is treated as another tradeable commodity, while the opportunity cost method rather values unpaid care work as a valuable, average economic activity as such. We will use the replacement cost method but will perform a sensitivity analysis on the results in Section 6 for the opportunity cost method. Our final replacement cost estimates can be thought of as conservative because low market wages are used, which devalues the importance of unpaid work. Moreover, it assumes the availability of a market substitute, which is not necessarily the case. Feminist economists have critiqued this low replacement cost method as anti-female and anti-care work (Berik, 2018).[17] Fig. 6 illustrates that the opportunity cost method values unpaid work almost twice as high as the replacement cost method but that the trend over time is comparable as they respectively increase by 26.6% and 25.6%.

Figure 6: The value of unpaid work using the opportunity cost and replacement cost method (million, 2010 prices).



3.2 Actual individual consumption

To this base, actual individual consumption (AIC) is added. Previous studies mostly started from household's individual consumption expenditures, which is equal to household's final consumption expenditures on individual services and goods, deducted half of the private expenditures on health and education, and

[17] The replacement cost method is anti-care and anti-feminist since Belgians, for instance, performed on average more unpaid work compared to paid work and women perform more unpaid work than paid work, in contrast to men who spend more time on paid work.

added half of the public expenditures on health and education.[18] Yet, subtracting (adding) a certain fraction of these private (public) expenditures on health and education may be seen as arbitrary. Therefore, this study measures consumption by using the amount of AIC instead of households' individual consumption expenditures.

AIC is defined as individual consumption expenditures made by households plus individual consumption expenditure by government plus individual consumption expenditures by Non-Profit Institutions Serving Households (NPISHs) (see Fig. 7). AIC is equal to what households actually consume to meet their individual needs. Using AIC has several advantages. First, it is a better measure of material well-being compared to GDP and household's individual consumption expenditures, because it captures all of the goods and services consumed by the households, irrespective of whether households pay for it themselves or benefit from it via the expenditures made by NPISHs or the government (Eurostat, 2012). Second, it fosters comparability between countries. This is needed because of country differences in who pays for health and education, for instance. In some countries individuals mostly pay for health and education expenses, whereas in other countries these services are provided to households as social transfers in kind by government in NPISHs (Eurostat, 2012). Finally, it avoids making arbitrary decisions on the defensive fraction of health and education expenses. The defensive expenditures that we deduct from AIC to obtain the welfare category *individual consumption* are, however, determined based on a more solid rationale as explained in Appendix A.

Figure 7: From final consumption expenditure to actual final consumption.

Who pays	**Final consumption expenditure**	**Actual final consumption**	**Who consumes**
Households	Individual consumption expenditure by households	Actual individual consumption	Households individually
NPISHs	Individual consumption expenditure by NPISHs		
General government	Individual consumption expenditure by government		
	Collective consumption expenditure by government	Actual collective consumption	General government (households collectively)

Source: Eurostat (2012).

[18] See, for instance, the welfare measures in Daly and Cobb (1989) and Bleys (2008).

3.3 Shadow economy

So far, while EWM made unpaid work visible, the shadow economy remained invisible although Daly and Cobb (1994) admit that they would like to include the shadow economy (excluding illegal activities) in EWM. From a welfare perspective, it is important to also account for informal market activities because these activities also create value in the form of consumption benefits. Including the item *shadow economy* is needed for meaningful welfare comparisons over time and between countries since the size of the shadow economy declined over time and since there are substantial differences in the size of the informal economy between countries (Kelmanson et al., 2019).

This item is estimated based on a study by Kelmanson et al. (2019), in which the size of the Europe's shadow economy is estimated as a percentage of GDP. Yet, a correction is needed for double counting. Medina and Schneider (2019) illustrate that between 2009 and 2015 35.7 % Germany's shadow economy consists of legally bought material for shadow economy and do-it-yourself activities, illegal activities (smuggling etc.) and do-it-yourself activities and neighbors' help. In order to conservatively approximate the welfare contribution of the shadow economy, we have halved the size of the shadow economy, which we believe is better than taking 100% or excluding the shadow economy altogether. This can be thought of as a conservative estimate to exclude illegal activities, avoid double counting with actual individual consumption and unpaid work and exclude defensive expenditures. As the shadow economy is also treated as consumption and included in net consumption, the value of the shadow economy is also corrected for income inequality using the adjusted Atkinson Index.[19]

3.4 Welfare losses from income inequality

EWM account for the welfare losses from income inequality. Daly and Cobb (1989) build on the principle of diminishing marginal utility of income to argue that a redistribution of income from a rich family to a poor family would benefit overall welfare as the reduction of the rich's utility levels would be lower than the increase in the poor's utility levels.[20] Since EWM measure consumption and not income, this adjustment can be thought of as capturing the use value of consumption by accounting for the diminishing marginal

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[19] Future research could investigate ways of refining this item's valuation methods, for instance distinguishing between consumption and investment. Part of the shadow economy that is included as consumption here, but that is in fact an investment in the physical capital stock should be factored back in as a capital adjustment in BCPA in a similar was as is done with net capital growth in Section 3.7.

[20] What is more, evidence shows that more equal societies perform much better compared to unequal ones on public health, education, well-being, mental ills, violence, etc. (Wilkinson and Pickett, 2009, 2018).

utility of *consumption.* A more equal distribution of consumption would hence also be beneficial for welfare.

Many welfare studies account for income inequality by weighing consumption expenditures via an index based on the Gini coefficient.[21] Yet, this procedure has been criticized as being ad hoc, for not making explicit the scholars' assumption on a society's aversion to inequality (Neumayer, 2000) and for lacking a clear welfare-theoretical interpretation (Dietz and Neumayer, 2006). In contrast, the Atkinson index does take into account society's aversion to inequality, which is why weighing consumption expenditures using the Atkinson Index is the preferred procedure to account for income inequality in welfare measures (Neumayer, 2000; Stymne and Jackson, 2000; Dietz and Neumayer, 2006). This suggestion has been picked up by some scholars (Jackson et al., 1997; Bleys, 2008; Bleys and Van der Slycken, 2019). Recently, Talberth and Weisdorf (2017) proposed another method using an explicit correction for the diminishing marginal utility of income (DMUI). In what follows, we will first discuss the inequality correction based on the Atkinson Index and then the DMUI-adjustment. Both approaches are based on the distribution of income and not on the distribution of consumption because of data availability issues. It is thus assumed that the former distribution is indicative for the latter. Afterwards we will build on Talberth and Weisdorf to present what we believe is the most appropriate way to estimate welfare losses from income inequality in EWM.

3.4.1 The Atkinson Index

A first approach to calculate the welfare losses from income inequality is based on the Atkinson Index (AI). The main advantage of this method over previous methods centered on the Gini coefficient is that the AI is expressed directly in terms of well-being (Stymne and Jackson, 2000) as the AI is based on a social welfare function (Atkinson, 1970). The Atkinson index can be interpreted as "the proportion of the present total income that would be required to achieve the same level of social welfare as at present if incomes were equally distributed" (Atkinson, 1975). Atkinson's (1970) index is calculated as follows:

$$\mathrm{AI} = 1 - [\sum_{i=1}^{n} (y_i/\mu)^{1-\varepsilon} * f(y_i)]^{\frac{1}{1-\varepsilon}} \quad (5)$$

In Eq. 5, y_i is the mean income of the *i*-th group, μ is the mean income of the total population, $f(y_i)$ is the proportion of the population of the i^{th} group, and ε is the weight society gives to the inequality of the income

[21] See, for instance, the recent studies by Kenny et al. (2019) and Held et al. (2018).

distribution.[22] A value of ε equal to 0 would mean that society does not care for inequality, while positive values indicate that society is averse to inequality. A value for AI of 15% indicates that the same level of social welfare could be achieved with only 85% (1-0.15) of the present total income, if incomes were equally distributed. In previous welfare studies a value for ε of 0.8 was used (Jackson et al., 1997; Stymne and Jackson, 2000; Bleys, 2008). Jackson et al. (1997) used 0.8 as a central value as suggested by Pearce and Ulph (1995) based on a study for the UK in which the elasticity of marginal utility of consumption over time was estimated.[23] Yet, in a review of various methods to estimate ε, Latty (2011) suggests that a mid-point value of 1.5 is consistent with estimation methods coming from literature on intertemporal consumption behavior and consumer demand.[24] These values of ε are consistent with what most sociologists would suggest. Schwartz and Winship (1980) articulate that "after reflecting on the different interpretations of ε, most sociologists would agree that when using Atkinson's measure to address normative questions, ε should be between -0.5 and 2.5".

So far, only the direct effects of income inequality on welfare are discussed. Next to these effects, indirect effects such as relative and positional dynamics also affect the welfare level obtained from a given income distribution. An individual's level of well-being does not only depend on one's absolute level of consumption or income, but also on the relative position compared to others. Easterlin (2003) explained that due to social comparison, the effect of consumption increases on well-being are lower than expected. Since each individual's consumption impacts the reference frame others use to compare their consumption, this frame can be thought of as a public good (Frank, 1997). Therefore, it is important for EWM to account for relative income effects. A second benefit of the AI is that it can be adjusted to also account for these effects. Howarth and Kennedy (2016) propose using an adjusted Atkinson index (AAI) that not only corrects for inequality in itself, but also for the impacts of relative income on social comparison and individual well-being. This approach involves a slight expansion of Eq. (5):

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[22] As we use income decile data in this study, the number of groups n is equal to 10. As a consequence Eq. 5 can be simplified as: $\mathrm{AI} = 1 - [\frac{1}{n}\sum_{i=1}^{n}(y_i/\mu)^{1-\varepsilon}]^{\frac{1}{1-\varepsilon}}$.

[23] It is noteworthy that we are interested in the marginal utility of consumption over income groups, rather than over time.

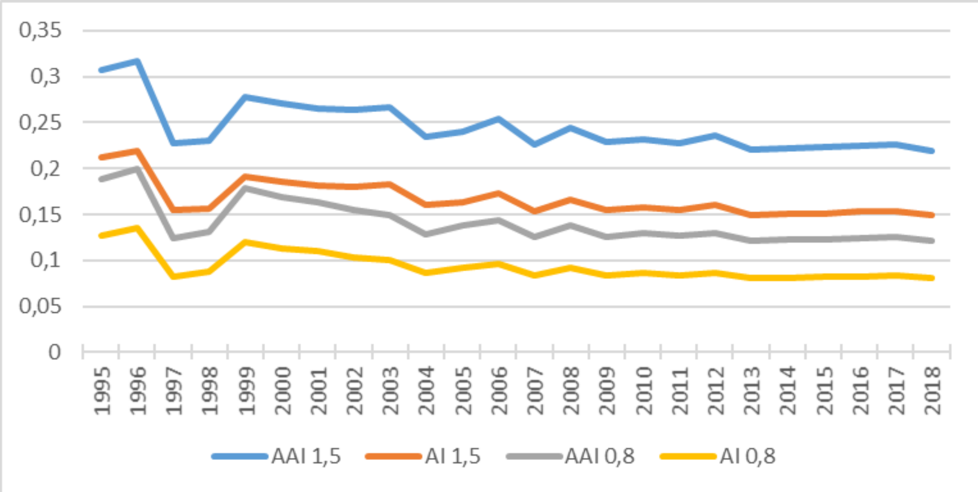
[24] Besides these two estimation methods coming from these two fields, Latty (2011) also investigated estimates for ε based on taxation progressivity and surveyed and revealed risk aversion. However, Latty argues that intertemporal consumption behavior and consumer demand methods deliver the most consistent and methodological sound estimates.

$$\text{AAI} = 1 - [\sum_{i=1}^{n}(y_i/\mu)^{1-\varepsilon} * f(y_i)]^{\frac{1}{(1-\alpha)(1-\varepsilon)}} \quad (6)$$

In Eq. 6, α is a parameter that reflects the weight people give to relative income. It is clear from this equation that if a society gives no weight to relative income and α is 0, Eq. (6) collapses to Eq. (5). In a relative income experiment among Swedish students, Johansson-Stenman et al. (2002) found that the median weight given to positionality lies between 0.2 and 0.5. Howarth and Kennedy (2016) use the center of this range, i.e. 0.35, as value for α in their numerical illustration of the AAI. By departing from an equally distributed income equivalent, the AAI thus captures two separate effects that lead to social welfare losses from income inequality: (1) the absolute effect, captured by the AI, measuring "the failure to direct resources toward individuals with the highest marginal utility of income; and (2) the relative or positional effect, captured by adjusting the AI, recording "the loss of utility that relatively poor individuals experience when their relative social status is reduced" (Howarth and Kennedy, 2016).

To date, no welfare study has made deductions for the diminishing marginal utility of total income growth. Yet, the subjective well-being literature indicates that higher incomes and increases in consumption of goods do not always lead to improvements in well-being (Easterlin, 2003; Frank, 2000; Frey and Stutzer, 2002). This welfare study calculates the AAI to account for relative income effects in a sensitivity analysis for the welfare losses from income inequality in Section 6. The procedure that is used – reducing total consumption expenditures to account for relative effects – is explicit and less arbitrary compared to labelling and deducting a certain fraction of all consumption categories as defensive (see Appendix A). Our preferred estimate in the sensitivity analysis for the AAI uses, after Latty (2011) and Howarth and Kennedy (2016), values for respectively ε and α of 1.5 and 0.35 and is calculated using decile data on household's disposable incomes (as explained in Appendix A). Fig. 8 gives an overview of the effect of these parameter choices on the Atkinson index, and provides a sensitivity analysis compared to the values that were previously used (ε = 0.8 and α = 0). Putting ε equal to 1.5 results in a comparable, yet slightly higher value for the index compared to the case where ε = 0.8 and α = 0.35. Including the parameter α leads to a larger increase: the index rises more sharply when ε = 1.5 compared to when ε = 0.8 because of the relative income parameter. Throughout the studied period, the AI and AAI for Belgium decrease as incomes are more equally distributed. The decreases in these indices imply that smaller fractions of consumption expenditures are seen as welfare losses from income inequality.

Figure 8: The Atkinson Index given various parameter choices for Belgium.



3.4.2 Talberth and Weisdorf's correction for the diminishing marginal utility of income

The adjustment based on the Atkinson Index helps EWM to take inequality into account by indicating how much lower incomes could be if they were equally distributed. Yet, this rationale and method is not so equipped to trace the diminishing marginal utility of income, which was the key motivation for Daly and Cobb (1989) to take inequality into account in the original ISEW. By using the income distribution to weigh consumption, Daly and Cobb (1994, p. 459) acknowledge to implicitly assume that "marginal increases in consumption by the poor are of greater value than marginal increases by the rich". Daly and Cobb deemed this was needed because "it seems likely that marginal increases in consumption bring diminishing returns to satisfaction".

Recently, Talberth and Weisdorf (2017) introduced a new correction in the GPI based on the diminishing marginal utility of income that corresponds to Daly and Cobb's (1994) reasoning. Talberth and Weisdorf make use of an iso-elastic utility function for this adjustment. The authors do so by building on Layard et al. (2008), who estimated the elasticity of marginal utility with respect to income at the individual level using subjective happiness surveys covering 50 countries and time periods between 1972 and 2005. Layard et al. argued that in normative public economics it is important to know how fast the marginal utility of income declines as income increases. This effect is captured by the elasticity, ε, of marginal utility to income. Layard et al. assume ε is constant and that utility, u, is given by:

$$u = \begin{cases} \dfrac{y^{1-\varepsilon} - 1}{1 - \varepsilon}, & \varepsilon \neq 1 \\ \log y, & \varepsilon = 1 \end{cases} \tag{7}$$

In Eq. 7 y is income. In the classical hypothesis where ε = 1, utility declines in proportion of income. Yet, Layard et al. (2008) estimate that ε is equal to 1.26, indicating that the marginal utility of income declines faster than the log of income. ε in Eq. 7 is the same ε as in Eqs. 5 and 6. Layard et al.'s (2008) final estimate of 1.26 is thus slightly lower than Latty's (2011) of 1.5.

Talberth and Weisdorf (2017) use the more conservative ε = 1 to calculate the inequality adjustment. Next, Talberth and Weisdorf's approach introduces an adjustment to Eq. 7. Due to the arbitrariness of the unit of income or utility, Talberth and Weisdorf have normalized utility to the median of income. This introduces a discontinuity in the utility from consumption: persons earning the median of income or less are assumed to enjoy utility equal to their consumption expenditures, however, from the median income onwards utility declines logarithmically. As a result, Talberth and Weisdorf adjust the top two income quintiles logarithmically and use the following formula to obtain the median-income normalized diminishing marginal utility of income adjustment (DMUI):

$$\mathrm{DMUI}\left(x_{i,t}, m_t\right) = m_t * \ln\left(\frac{x_{i,t}}{m_t}\right) + m_t \tag{8}$$

In Eq. (8), $x_{i,t}$ is the income of household i at time t, m_t is median income at time t and ln is the natural logarithm. By taking the sum of the unadjusted incomes of the first three quintiles and the adjusted incomes from the top two quintiles, Talberth and Weisdorf obtain an adjusted income aggregate. This aggregate is divided by the total unadjusted income to obtain the fraction of consumption that remains after inequality adjustment in EWM, while 1 minus this fraction is the share of consumption expenditures that is deducted as welfare losses from income inequality. In their paper, Talberth and Weisdorf articulate that the adjustment could be normalized using other thresholds, such as the poverty threshold (or some multiple thereof), but they do not further pursue these avenues.

3.4.3 Our correction for the diminishing marginal utility of income

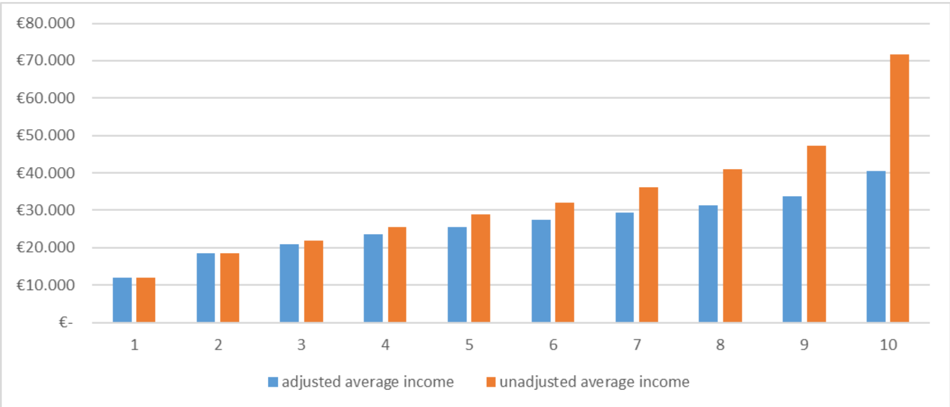
We build on Talberth and Weisdorf's approach but we suggest to normalize the data on a *sufficiency threshold*. We adjust all income deciles greater than the sufficiency threshold and call this adjustment DMUI_s. Introducing a sufficiency threshold that has a fixed absolute value (in constant prices) is a crucial requirement to properly account for the diminishing marginal utility of total income. If one would follow Talberth and Weisdorf's (2017) approach of normalizing at (median) incomes that vary (increase) over time, then this has the effect that the threshold increases as incomes rise such that the proposed adjustment fails to properly correct for the diminishing marginal utility of income.

We use a sufficiency threshold of $20,000 in 2011 prices in line with Hickel (2020) who set forth this threshold in the calculation of his Sustainable Development Index. For Belgium, the threshold is equal to €16,377.88 in 2010 prices, or 53.7% of the median income in 2010.[25] The sufficiency threshold falls for the majority of the study period (1995-2018) within the second decile. As a result, in 2010 – sufficiency threshold in second decile – the top eight deciles are adjusted according to Eq. (9).

$$\mathrm{DMUI}(x_{i,t}, \mathrm{s}) = \mathrm{s} * \ln\left(\frac{x_{i,t}}{s}\right) + \mathrm{s} \tag{9}$$

In Eq. (9), s is a constant sufficiency threshold and $x_{i,t}$ is the average income per decile for decile i at time t. In line with Talberth and Weisdorf (2017) we use the more conservative ε = 1 or the natural logarithm. Fig. 9 graphically illustrates how the income deciles in 2010 are adjusted using our DMUI-adjustment with sufficiency threshold. The adjustment ratio for the diminishing marginal utility, is equal to the ratio between the adjusted average incomes per decile (blue bars) and the unadjusted average incomes per decile (orange bars).

Figure 9: The adjusted and unadjusted average incomes per decile in 2010 for Belgium.

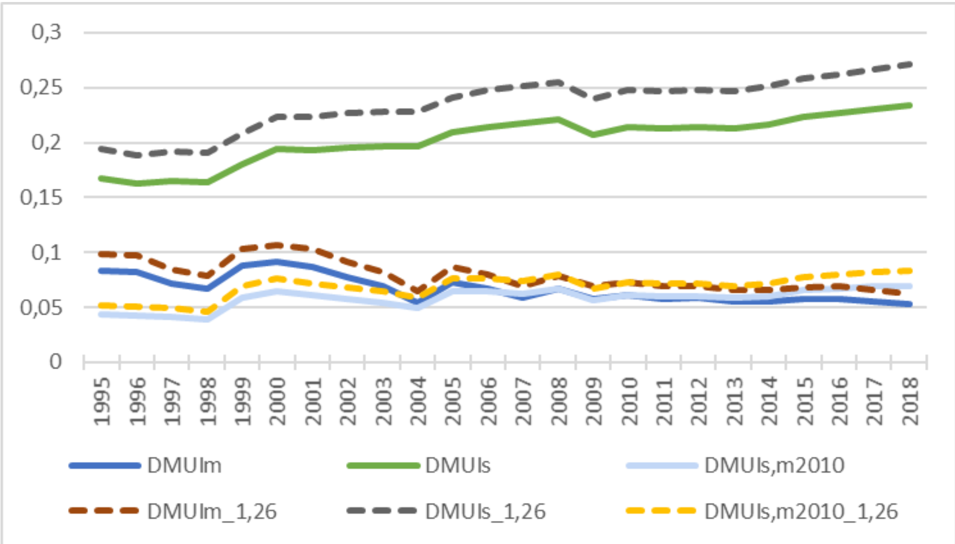


Note: For the first and second decile the 'adjusted' and unadjusted average income are equal because these deciles are not adjusted as the sufficiency threshold lies in the second decile.

[25] Due to data availability issues, we approximated the median income as the mean of the fifth and sixth income decile.

Next, we will also perform a sensitivity analysis scrutinizing the impact of s and ε. First, we make use of a higher sufficiency level – i.e. a constant threshold equal to the median income in 2010 ($DMUI_{s,m2010}$) of €30,485.28 (2010 prices). Next, we will verify the effect of a higher elasticity of marginal utility to income with ε = 1.26. Finally, in order to investigate the impact of working with a fixed threshold instead of a time-varying one, we will compare our method with Talberth and Weisdorf's approach ($DMUI_m$) that normalizes at the median income level in each year and adjusts the top five income deciles. Fig. 10 illustrates that the evolution of $DMUI_s$, $DMUI_{s,m2010}$ and $DMUI_m$ and of their variants with ε = 1.26.

Figure 10: The adjustment for the diminishing marginal utility given various parameter choices for Belgium.



First, using a fixed versus time-varying threshold results in a different trend over time. The time-varying $DMUI_m$ declines during the considered time period by 37.4%, while $DMUI_s$ and $DMUI_{s,m2010}$ increase by respectively 40.4% and 59.8%. Second, the absolute value of a fixed threshold also impacts the DMUI-adjustment. $DMUI_s$ involves a higher adjustment as on average 20.3% is deducted versus only an average reduction of 5.8% for the higher sufficiency threshold in $DMUI_{s,m2010}$. Third, as expected, using a higher elasticity of ε = 1.26 results in higher proportions of consumption that are deducted. The trends over time are very similar to when the lower elasticity ε = 1 was used – in this case, $DMUI_{m\_1.26}$ declines during the considered time period by 36.6%, while $DMUI_{s\_1.26}$ and $DMUI_{s,m2010\_1.26}$ increase by respectively 39.7% and 59.5%. Finally, it may be concluded that using a fixed threshold to normalize the data captures the diminishing marginal utility of income as total income grows best – this is illustrated by the upward sloping curves for $DMUI_s$ and $DMUI_{s,m2010}$ versus $DMUI_m$ and the curves based on the Atkinson Index in Fig. 8.

In our calculation of BCE and BCPA, we use the $DMUI_s$-adjustment with the lower threshold (s = €16,377.88) and the low elasticity (ε = 1). We use a constant sufficiency threshold in EWM because it is essential to account for the diminishing marginal utility of income (and consumption). We believe that our approach captures the DMUI-effect better compared to the approaches by Talberth and Weisdorf and the (adjusted) Atkinson Index. In the sensitivity analysis in Section 6, we will compare the welfare results from our $DMUI_s$-adjustment with the other methodological and parameter choices for the AI, AAI, and DMUI-adjustments depicted in Figs. 8 and 10.

The DMUI-approaches make use of the distribution of incomes, but it does only do so to measure the diminishing marginal utility of income. The DMUI-corrections do, however, not incorporate a correction for societies' aversion for income inequality as the corrections based on the Atkinson Index do. It is left for future research to determine whether EWM aim to capture societies' aversion for income inequality in addition to the DMUI-correction. Nonetheless, since the DMUI-adjustment also builds on the distribution of income, we continue to label this item *welfare losses from income inequality*.

3.5 Costs of climate breakdown

This item, previously referred to as the 'costs of climate change', has been modified significantly over the years – see O'Mahony et al. (2018) for an overview.[26] Most studies valued this item by linking the emissions related to the domestic consumption of fossil fuels with a social cost of carbon (SCC). Since this SCC measures the damages per metric ton of CO_2 emissions due to associated climate change (Ackerman and Stanton, 2012), most studies thus measure the total climate damages caused by the emissions originating from current economic activity. Nevertheless, in line with EWM's Fisherisation (see Section 2.2), scholars are still discussing how to properly account for 'climate change'. Bagstad et al. (2014) suggested to leave out this item and use substitutes linked more directly to climate change impacts (e.g. the costs of natural disasters and water scarcity), whereas O'Mahony et al. (2018) stipulated the need for a separate approach to distinguish between the future global impact costs related to current domestic emission activities and the current national impacts stemming from past global emissions.

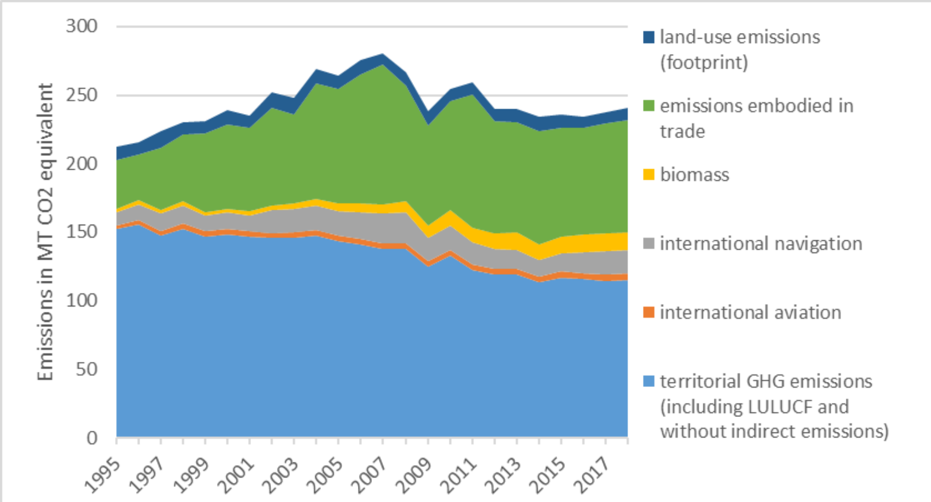
[26] We prefer to use the term climate breakdown instead of a mere change in climate as recent evidence on climate tipping points indicates the threat of rapid and irreversible changes in the climate system that would severely disrupt ecosystems, societies and economies.

The appropriate approach to account for climate breakdown depends on the welfare interpretation and measure used. BCPA includes future and distant costs and thus can make use of a SCC to capture climate change related damages caused by current emissions. However, BCE measures experiences and should only focus on the local and current costs arising from climate change, i.e. the damages suffered. That is why, the item *costs of climate breakdown* is only included in the broader ecological costs. Yet, the new item *costs of extreme weather events,* which approximates the damages suffered 'here and now', is to be included in the narrow ecological costs (see Table 3). The latter item is excluded from BCPA to avoid double counting with the cost of climate breakdown. Neither measures do not account for the costs or investments to adapt to climate change because of a lack of available data. Yet, in theory climate adaptation costs should be deducted from consumption expenses because adaptation costs are a key example of defensive expenditures.

Other methodological novelties regarding the calculation of the cost of climate breakdown are a broader set of emissions beyond territorial GHG-emissions. The quantity of emissions is based on the data countries send to UNFCCC and includes: territorial GHG-emissions (with Land Use, Land-Use Change and Forestry (LULUCF), without indirect CO_2), the emissions from international bunkers (aviation and navigation), and CO_2 emissions from biomass. Furthermore, two types of footprint emissions are added to register the emissions beyond domestic borders that can be related to national consumption. The first type involves the carbon dioxide emissions embodied in goods and services.[27] The second type of footprint emissions relates the land-use change emissions from the Global Carbon Project to Belgium's share in the global land-use consumption footprint using the SCP-HAT provided by UN Environment (2020). A detailed explanation on the quantity of emissions can be found in Appendix A. Fig. 11 provides an overview of the emissions from these different sources and illustrates that total emissions do not follow the steadily decreasing trend of territorial emissions.

[27] These transfer emissions are updated from Peters et al. (2011) in the Global Carbon Project by Friedlingstein et al. (2019).

Figure 11: Greenhouse gas emissions by category (in MT CO_2 equivalent).



These broader set of emissions are linked to a SCC estimate to calculate the damage caused by climate disruption. The SCC estimates available in literature differ significantly. Ackerman and Stanton's (2012) estimates of the SCC in 2010 vary between $28 and $892 in 2007$ per tonne depending on the specific parameter choices such as damage functions, discount rate and climate sensitivity. Climate sensitivity is a parameter that captures the expected long-term temperature increase based a doubling of the concentration of carbon dioxide in the atmosphere. Ackerman and Stanton provide different scenarios with average versus 95th percentile climate sensitivity, Nordhaus versus Hanemann damage estimates at low temperatures, Nordhaus versus Weitzman damage estimates at high temperatures and 3.0 versus 1.5-percent discount rate. There are two ways to obtain discount rates: a descriptive and a prescriptive approach. The former uses an appropriate market interest rate, while the latter sees the discount rate as the sum of a pure time preference and the growth rate of per capita consumption (Ackerman and Stanton, 2012). The link between discount rates, time preferences and consumption growth rates are given by the "Ramsey rule" – see Ackerman et al. (2009) for a comprehensive derivation of this rule. In the absence of uncertainty, the Ramsey rule and discount rate can be obtained from this formula:

$$1 + r = (1 + g)^{\varepsilon}(1 + \rho) \Rightarrow r \approx \rho + \varepsilon g \quad (10)$$

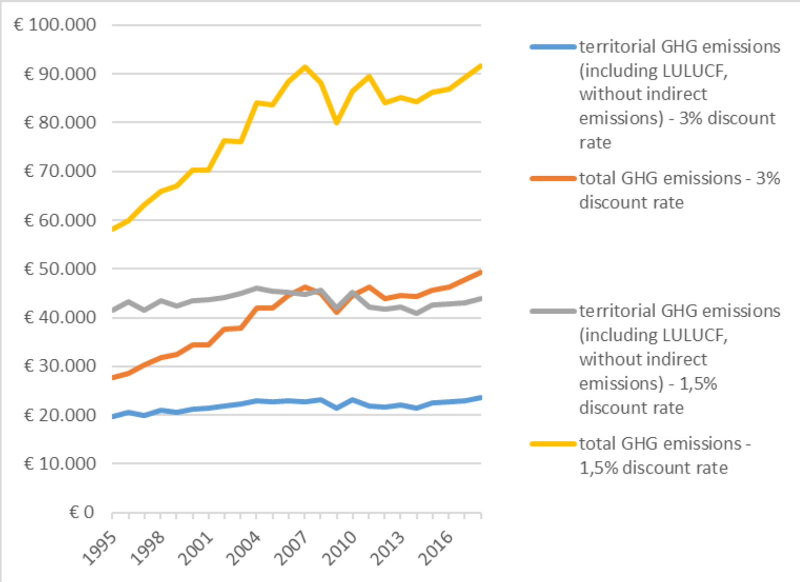
In Eq. 10 r is the discount rate, ρ is the "rate of pure time preference" that is used to discount utility, g is the growth rate of consumption, while ε is the "coefficient of relative risk aversion". The approximation for r holds for small ρ and g. It should be noted that ε is the same parameter ε as was used for the inequality aversion parameter to calculate the Atkinson Index in Section 3.4.1 and for the elasticity of marginal utility to income in Section 3.4.2. So ideally, the assumption on ε used for the inequality correction(s) should be the same as the one used for the SCC.

In the Spanish ISEW-study, O'Mahony et al. (2018) based their estimate on the study by Ackerman and Stanton. O'Mahony et al. used an estimate of \$232 in 2010\$ or €175.37 in 2010€ per tonne of CO_2 (equivalent), which is based on a 3% discount rate, 95th percentile climate sensitivity and Hanemann-Weitzman damage functions. Stern (2006), however, argues in favor of a lower discount rate based on intergenerational equity. In order to suitably measure the future costs and thus discount future costs less, we suggest to use a lower discount rate than O'Mahony et al. We decide to stick to Hanemann-Weitzman damage functions, because the Nordhaus damage functions are severely underestimating the cost of climate change (Keen, 2020). Using the same damage functions, a 1.5% discount rate would lead to SCC-estimates of \$445 and \$892 in 2007\$ (or €340.23 and €681.98 in 2010€), for respectively average and 95th percentile climate sensitivity (Ackerman and Stanton, 2012). As the lowest of these SCC's is almost the double of O'Mahony et al.'s estimate, we use the 2010-estimate based on average climate sensitivity and apply an annual growth rate of 1.45% to obtain time-varying estimates for the years before and after 2010.[28] The discount rate of 1.5%, is similar the 1.4% discount rate proposed by Stern (2006).[29] Fig. 12 illustrates the cost of climate breakdown given various parameter choices.

[28] The annual growth rate of 1.4452407% is obtained by interpolating Ackerman and Stanton's (2012) 2010 values to 2050.

[29] Stern (2006) obtained a 1.4% discount rate as the sum of a 0.1% pure time discount rate and the growth rate of per capita consumption. According to Stern (2006) a 0.1% discount rate indicates a 91% probability for humanity to survive 100 years. Given that more consumption is not desirable from a well-being perspective, one could use Stern's case to argue for using a discount rate of 0.1%. As Ackerman and Stanton (2012) only provide 1.5% and 3% discount rates, this is left for future refinements.

Figure 12: Comparison of the effect of alternative approaches to the cost of climate breakdown (million, 2010 prices).



3.6 Depletion of non-renewable energy resources

The item *depletion of non-renewable energy resources* aims to capture the depletion of non-renewable energy stocks. While the item *costs of climate breakdown* measures the damages caused from greenhouse gas emission related to the combustion of fossil fuels, this item measures the depletion of the natural capital resource stock. The former looks at *sinks*, while the latter focuses on *sources*. In the past, scholars have adopted either a production or a consumption perspective in order to calculate the depletion of non-renewable resources. The former traces the depletion related to the extraction of a country's domestic energy stocks, while the latter measures how a country's domestic resource consumption contributes to the depletion of global energy stocks. The production view looks within borders, whereas the consumption counterpart looks beyond borders. Yet, the key difficulty lies in connecting this item to the experiential welfare interpretation. Talberth and Weisdorf (2017), for instance, wonder if future studies should still include this item if it is not better linked to current experiential welfare. Hence we omit this item in the BCE. Nonetheless, including resource depletion is needed in the BCPA as it is a cost originating from present activities that is passed on to the future.

The common methodology to value this item employs the replacement cost method that captures the investments needed to replace non-renewable energy resources with a renewable substitute – see, for instance, Bleys (2008, 2013) and Held et al. (2018). Yet, Neumayer (2000) was critical of this method because it assumes that all resource depletion needs to be replaced annually. In a response to address this criticism, O'Mahony et al. (2018) put forward the transition cost method, in which the depletion issue as a gradual transition away from non-renewable energy resources in order to meet the climate targets agreed upon in the Paris Agreement.[30] We build on this transition cost method, yet, O'Mahony et al.'s cost estimate is updated as their estimate is based on a not so ambitious scenario to halve global CO_2-emissons by 2050. A recent report by the IPCC (2018) illustrates that more drastic emission cuts are needed in the near present to limit global warming to 1.5°C: global net emissions need to decline by 45% in 2030 (compared to 2010) and the net zero target should be reached in 2050.[31]

The valuation of this item is based on the total energy investments expenditures needed in the European Union under the requirement of meeting certain climate goals agreed upon by the European Council. These targets include an overall GHG emission reduction of at least 40% compared to 1990 and a share of renewable energy in final energy consumption of at least 27%. Moreover, the European Council agreed on the following minimum ambition level for the energy efficiency target: a 27% reduction of primary energy consumption compared to 2007. The investments needed are calculated, given the various policy options for 2030 energy efficiency targets (European Commission, 2016). A mid-value of 33% efficiency target was chosen, which leads to an investment cost of €797.45 (in 2010 prices) per ton of oil equivalent of primary energy consumption. Fig. 13 compares this updated method with the transition cost method by O'Mahony et al. (2018).

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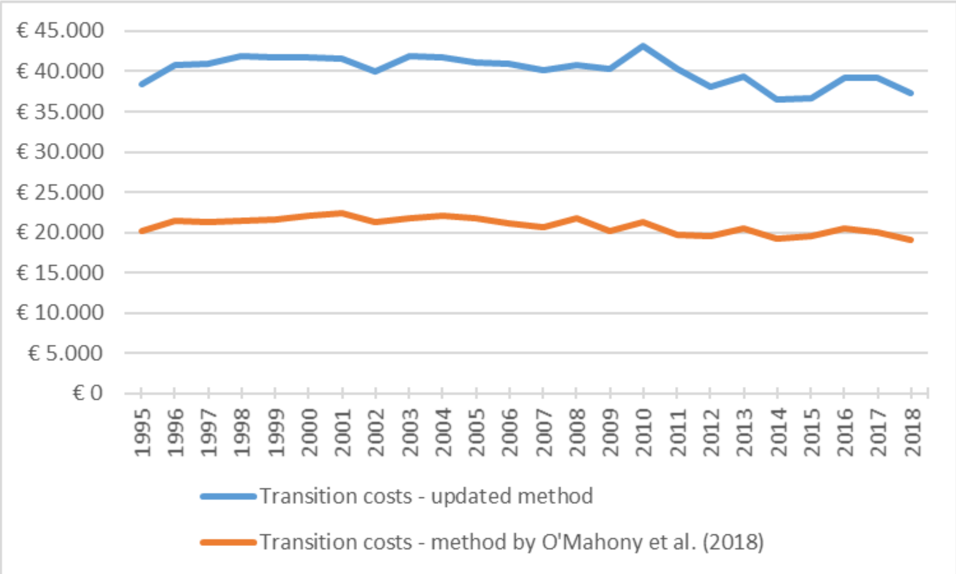
[30] Recent evidence has shown that the remaining carbon budget related to climate change goals of limiting global heating to 1.5 or 2 °C – see, for instance, McGlade and Ekins (2015) and IPCC (2018) – imposes a more imminent limit on using non-renewable resources compared to their depletion. Achieving climate goals requires drastic and rapid reductions in human carbon emissions and phasing out fossil fuels (Rockström et al., 2017; Jackson, 2019), which can be met by an expansion of renewable energy resources (Rockström et al., 2017) together with a lower energy demand (Grubler et al., 2018), or a degrowth scenario (D'Alessandro et al., 2020; Victor, 2012).

[31] As early-industrialized countries have a higher historical responsibility, their net zero targets should be sooner. Jackson (2019), for instance, argues that the United Kingdom should set its target for net zero emissions by 2030 or earlier.

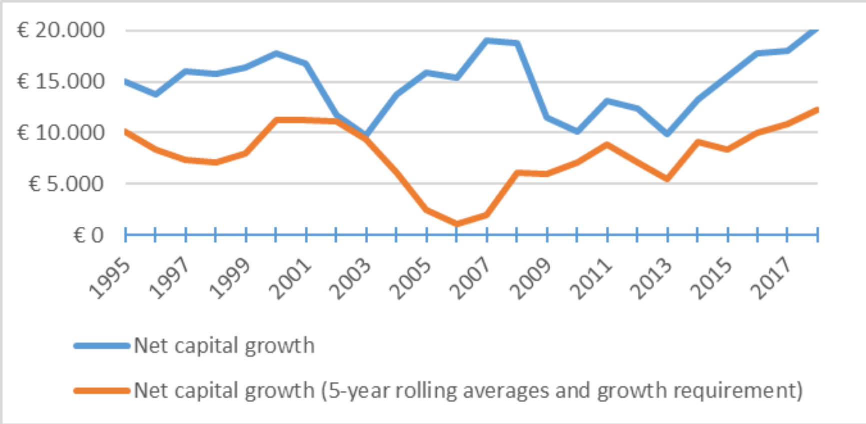
Figure 13: Comparison of the updated and previous transition cost method for the depletion of non-renewable resources (million, 2010 prices).



3.7 Net capital growth

As explained in Section 2, BCPA should include changes in physical capital stocks like *net capital growth* as this is a benefit (or cost if negative) originating from present activities. In contrast to previous studies, this study's net capital growth only traces mere capital adjustments: it breaks with taking 5-year rolling averages and by omitting the growth requirement in this item. Following Hicks' income concept, capital changes should be counted as income. However, by taking 5-year rolling averages to smooth out fluctuations, one is actually treating this item as the services flowing from a stock that would last five years. Furthermore, the net capital growth required to keep the capital stock per worker intact is removed as this procedure is inconsistent with Hicksian income in which raw capital changes are counted. Daly and Cobb (1994) included the capital requirement as they assumed that economic sustainability requires that the amount of capital available for each worker remains constant or even increases. We believe the growth requirement can be omitted based on the grounds that we are not trying to capture sustainability but merely the benefits and costs of present activities and that Hicksian income only includes 'raw' capital changes. Fig. 14 gives on overview of the impact these methodological changes on net capital growth.

Figure 14: Comparison of the effect of an alternative valuation method to net capital growth (million, 2010 prices).



4. Results

This section presents Belgium's economic performance from 1995 until 2018 using BCE and BCPA and analyses the relative importance and changes over time of the various welfare categories. The per capita results of Belgium's BCE, BCPA and GDP are shown in absolute and indexed values in Fig. 15. Hereafter, we will only focus and report per capita values without explicitly referring to it. Hereafter, we use lower case to refer to per capita values, while we use capital letters for aggregate numbers. Throughout the entire period, bcpa is lower than gdp. Bce, in contrast is higher than gdp from 1995 to 2004 and from 2009 until 2013. The absolute difference between bcpa and bce indicates that there are substantial broader ecological costs that are shifted in time and space – without adding the positive capital adjustment to bcpa, the difference would even have been higher. Over the entire period all indicators increased: gdp improved by 30.1%, bcpa by 17.9% and bce by 14.9%, while on average per year gdp grew by 1.31% versus 0.78% for bcpa and 0.65% for bce.

At different time periods, however, there are marked differences between gdp and the welfare indicators as indicated in Table 4. From 1995 to 2007, gdp grows on average by 1.9% per year, versus only 0.86% for bce and 0.24% for bcpa. During and after the financial crisis from 2007 to 2010, bce and bcpa outperformed gdp: gdp declined by 0.46% per year, while bce and bcpa grew by respectively 1.37% and 1.9%. This welfare trend was driven by the fact that individual consumption per capita grew. For bcpa, the higher average annual growth rate comes from the lower starting point to evaluate this consumption growth since the combined effect of the broader ecological costs and capital adjustment per capita was slightly negative (i.e. the declining broader ecological costs per capita were overcompensated by a reduction in the capital adjustment per capita). If we scrutinize the years 2009 and 2010, we observe a lagged effect on bcpa while gdp fell already in 2009. This lag was caused by the fact that the broader ecological costs fell dramatically in 2009, resulting in an upward bcpa-trend, while the economic gdp-recovery in 2010 and the corresponding rising ecological cost made bcpa go down. In constrast to gdp and bcpa, there was not a negative crisis effect on bce, which stagnated at its 2009-level for five years.

During the subsequent eurocrisis from 2010 to 2014, gdp and bce only grew by respectively 0.41% and 0.04% per annum whereas bcpa increased by 1.98% per year because broader ecological costs (per capita) fell dramatically. After the eurocrisis from 2014 to 2018 gdp grew by 1.47% per year, yet, this growth was is lower than the annual growth rate of 1.89% from 1995 to 2007. Contrarily to gdp, bce and bcpa barely improved: bce decreased by 0.02% per year, while bcpa increased by 0.11% per year. Since the financial crisis of 2009, gdp and bcpa grew by respectively 9.8% and 3.7% while bce decreased by 0.3%. These trends in bce and bcpa are mainly caused by welfare growth in 2018. Bce remained almost constant between 2009 and 2014 and fell in 2015, while bcpa diminished between 2014 and 2017.

Figure 15: Welfare and GDP per capita for Belgium in prices of 2010 (left panel) and as index values with 2007 = 100 (right panel).

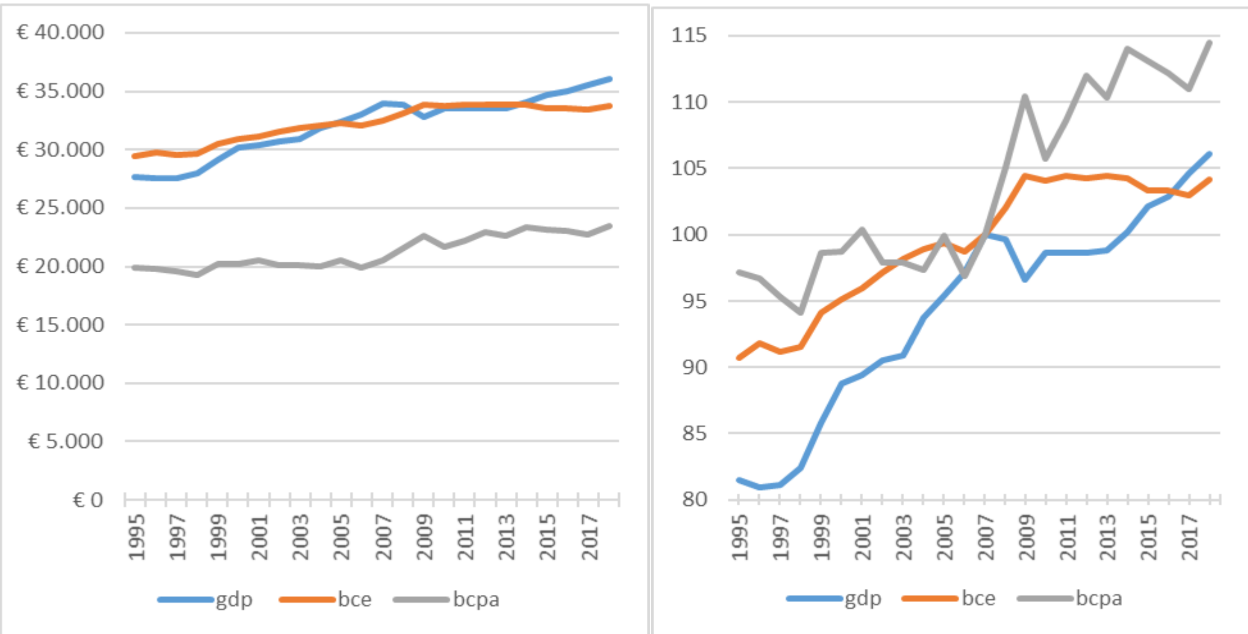


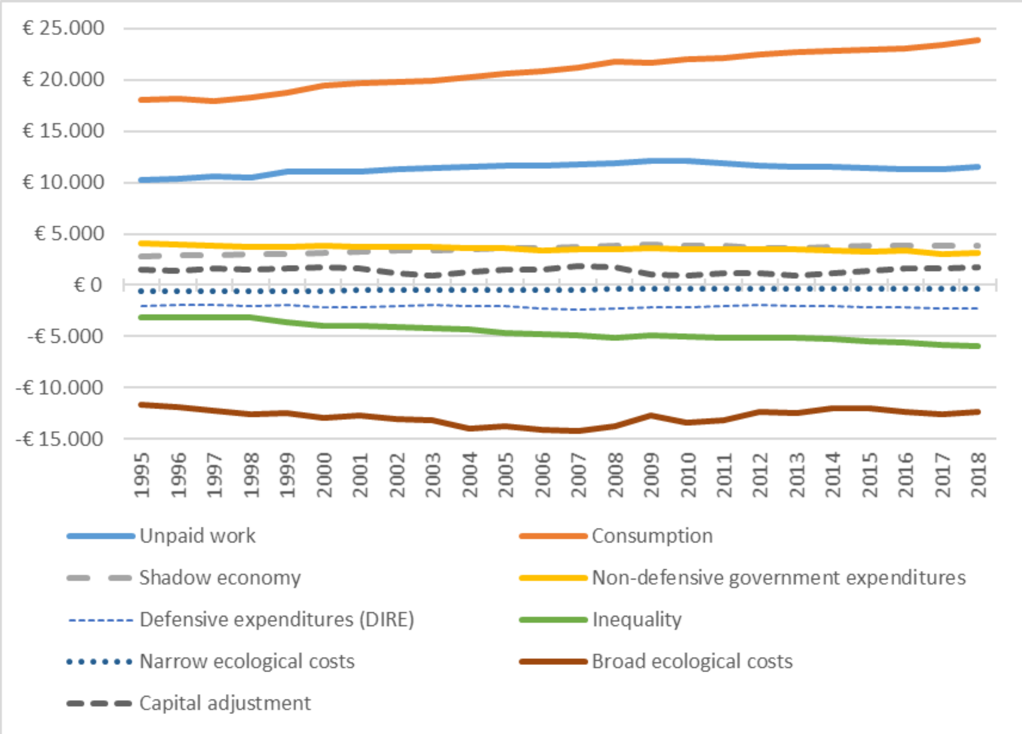
Table 4: Average annual and total growth rates of welfare and GDP per capita.

Time period	gdp	bce	bcpa
1995-2007	1,89	0,86	0,24
2007-2010	-0,46	1,37	1,90
2010-2014	0,41	0,04	1,98
2014-2018	1,47	-0,02	0,11
1995-2018	1,31 *(30,1)*	0,65 *(14,9)*	0,78 *(17,9)*

Note: The brackets indicate the total trend over the entire period, in contrast to the average annual trends in the subperiods.

Furthermore, one must be cautious of the fact that these aggregate welfare trends hide crucial information about evolutions in the different welfare categories (introduced in Eq. 3 and Eq. 4) – especially of those categories that are of minor quantitative importance. Fig. 16 illustrates that unpaid work and net consumption are the most important positive contributors to welfare, while the welfare losses from inequality and broader ecological costs (the latter only for bcpa) are the most important welfare deductions. The value of unpaid work per capita increased over the studied time period by 11.6% (as shown in Table 5) since increasing wages more than compensated a reduction in the time devoted to unpaid work. Individual per capita consumption outpaced unpaid work as it surged by 32.3% over time. Per capita shadow economy even grew by 37.1%, while per capita defensive, intermediate and rehabilitative expenditures only increased by 11.7%. Because of the sharp rise in the welfare losses from income inequality by 89.9%, an increasing part of individual consumption expenditures and the benefits from the shadow economy was not translated into welfare because of the adjustment for the diminishing marginal utility of income. The government's per capita welfare contribution became less important (-23.4%), while for bcpa per capita the capital adjustment increased by 20%. Broad ecological costs per capita increased by 6.8%. This evolution was caused by increases in the time-varying cost estimate (+40%) and greenhouse gas emissions (+13%), which both made the cost of climate breakdown rise by +58%, which outweighed reductions in all other ecological costs. The overall increase in the aggregate broad ecological costs is higher than per capita increases since population grew too (by 12.5%): aggregate broad ecological costs increased by 20.2%. The increase in broad ecological costs contrasts heavily against the per capita narrow ecological costs in bce that fell by 52.4%, which further reduced the – already negligible – quantitative importance of this item.

Figure 16: Positive and negative contributions of per capita welfare categories (2010 prices).



Note: In this figure welfare deductions have been reclassified as negative numbers, even though these categories are deducted as positive numbers in Eq. 3 and 4 to calculate the aggregate welfare level.

Table 5: Annual growth rates of per capita welfare categories during several time periods.

Time period	uw	c_i	s	g_c	$dire_p$	inq	nec	bec	Δk
1995-2007	1,19	1,47	2,49	-1,16	1,37	4,65	-2,57	1,84	1,78
2007-2010	1,03	1,30	1,05	-0,44	-2,56	1,04	-3,48	-1,75	-15,98
2010-2014	-1,23	0,90	-0,37	-0,38	-1,73	1,28	-4,48	-2,76	6,73
2014-2018	-0,08	1,13	0,96	-2,11	2,92	3,11	-1,59	0,93	12,42
1995-2018	0,50 *(11,6)*	1,40 *(32,3)*	1,61 *(37,1)*	-1,02 *(-23,4)*	0,51 *(11,7)*	3,91 *(89,9)*	-2,28 *(-52,4)*	0,29 *(6,8)*	0,87 *(20,0)*

Note: The brackets indicate the total trend over the entire period, in contrast to the average annual trends in the subperiods.

5. Discussion

The EWM compiled in this study (i.e. BCE and BCPA) employ different time and boundary views. If one "would only look at current experiences, then this could mistakenly lead to the conclusion that one can happily enjoy experiences in the present while depleting physical capital and plundering the planet" (Van der Slycken and Bleys, 2020a). Our results suggest, on the one hand, that the negligible narrow ecological costs have decreased. On the other hand, substantial broader ecological costs increased, which indicates that Belgium is increasingly shifting ecological costs in time and space. We would suggest to use the broad perspective on ecological costs as this is more consistent with seeing the economy as embedded in the ecosystem. This view helps to focus on the environmental impacts caused by present economic activities. Instead of overlooking broader ecological costs, "fully accounting" for these costs would better inform policy-makers about the adverse effects of economic activities. This position is shared by Clarke (2007), who argued that EWM should account for the environmental costs that are outsourced to other regions. Moreover, this way, attention is paid to the "margins", that is to those who are marginalized in the growth economy, as recommended by Hanaček et al. (2020). Yet, this study does not account for the social costs shifted to the margins of the growth economy.

Future research could explore various ways to improve the methodology by, for instance, including new components such as integrating the social costs caused abroad or a larger set of ecological costs as it is rather limited. Other ecological costs that could be included in future research are, for instance, noise and odor pollution, the ecosystem services lost due to land use changes or soil erosion and depletion. Future studies could make use of a hedonic model to determine the effect of noise pollution on housing prices (Franck et al., 2014) or of willingness-to-pay estimates for reducing the externalities of noise and odor pollution (Rousseau et al., 2020). The ecosystem services lost because of land use changes could be valued based on the study by Costanza et al. (2014) that values the ecosystem services for different biomes. Another approach to trace land use changes is the human appropriation of net primary production (Haberl et al., 2007; Gingrich et al., 2015), while in BCPA-studies the embodied human appropriation of net primary production can be used to analyze the disconnect between global biomass production and consumption and related land use changes (Erb et al., 2009; Kastner et al., 2015). Furthermore, future studies would also benefit from time-varying and country-specific estimates for the shadow economy, time use, ecological costs and the parameters for the inequality adjustments. Ecological costs are mostly valued using fixed monetary cost estimates, yet, the cost estimate should ideally reflect changing environmental conditions. Moreover, it could be explored what the welfare implications are when using Layard et al.'s (2008) estimate of 1.26 for the elasticity of marginal utility to income, instead of the our more conservative logarithmic adjustment that assumes this elasticity is equal to one. Finally, future research that employs either the Atkinson Index or the adjustment for the diminishing marginal utility of income could try to harmonize the inequality aversion parameter used for the Atkinson Index, the elasticity of marginal utility to income for the adjustment for the diminishing marginal utility of income and the coefficient of relative risk aversion that is used for deriving the discount rate in the computation of the social cost of carbon because these three adjustments make use of the same parameter ε.

6. Sensitivity analysis

The aggregate results presented here should be treated with caution because the results and empirical trends depend on the benefits and costs included in the different components and their relative weights ultimately depend on methodological choices. Therefore, we will change the parameters and the items included to verify whether our results are robust to these changes. In this sensitivity analysis, we will build upon the individual sensitivity studies presented above, and investigate the impacts of including the shadow economy or not, using different valuation methods to value unpaid work, using high and low estimates for the social cost of carbon and adopting O'Mahony et al.'s (2018) transition cost method instead of our higher cost estimate, while we will explore the impact of using different methods and parameters for the inequality correction as explained in Section 3.4. We will focus on BCPA for our sensitivity analysis and we will take this as a benchmark in Table 6 and Fig. 17.

Using the opportunity cost method for unpaid work and a higher SCC of €681.98 (2010 prices) results in the largest absolute changes of bcpa. What is striking is that all sensitivity cases mostly imply a vertically shifting curve and that the relative changes over time during the different time periods are relatively comparable. The only exception is the case where a higher SCC is used, since here the shape and evolution of the curve are different compared to the other cases. With a higher SCC, the effect of increasing and declining GHG emissions is more outspoken. When emissions rise from 1995 to 2007, bcpa declines by 1.39% per year because the costs of climate disruption grow, while all the other curves increase during that period. In the periods from 2007 to 2010 and from 2010 and 2014 bcpa increases on average per year by respectively 1.9% and 1.98%. In the case of a higher SCC, declining emissions have a stronger effect on the declining cost of climate disruption. As a consequence, bcpa increases more rapidly in this case.

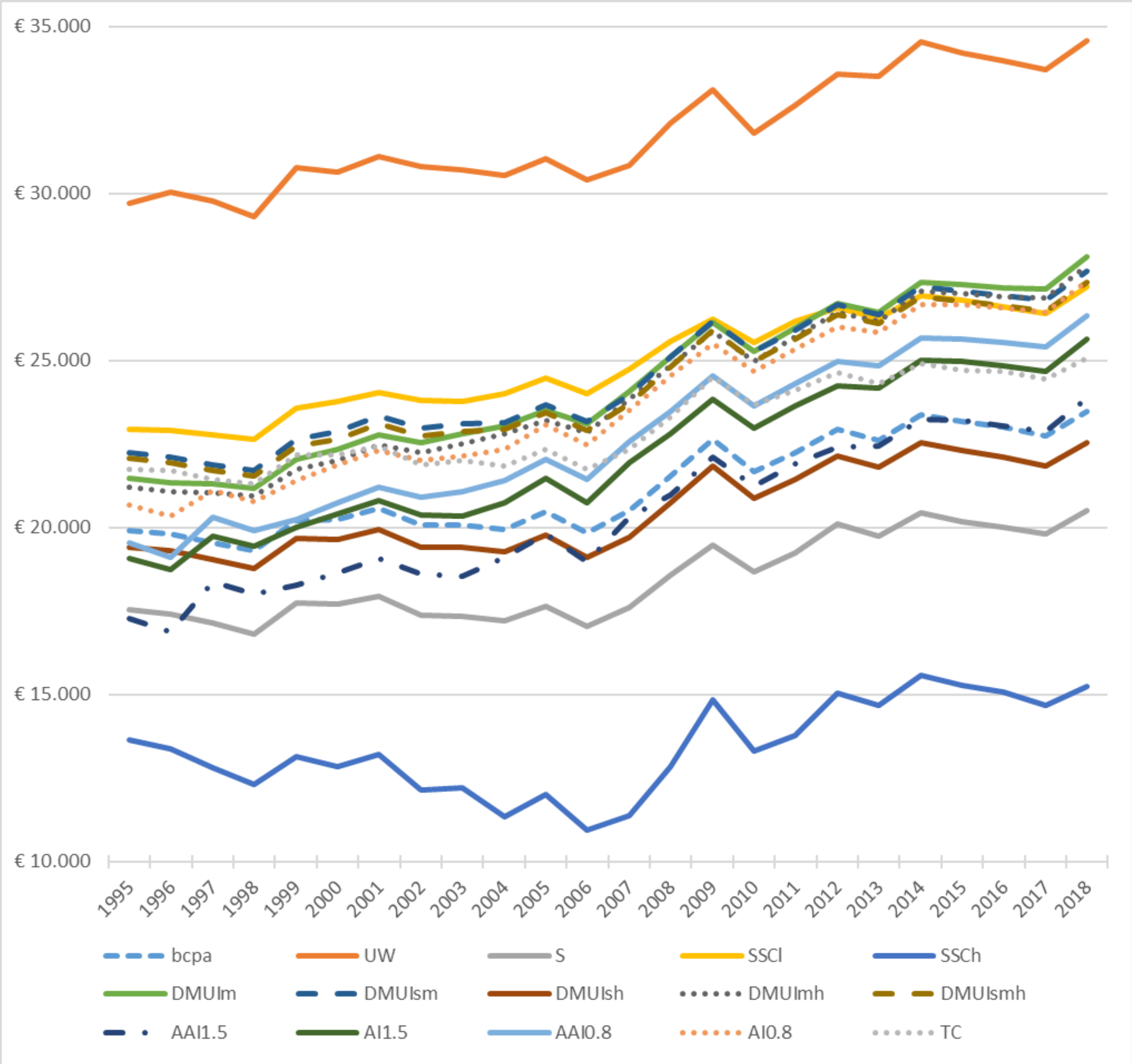
Finally, our DMUI-correction with a constant sufficiency threshold (i.e. $DMUI_s$, but also $DMUI_{sh}$) yields different results compared to the other inequality adjustments as the average annual growth rates and overall growth rates are lower when the sufficiency threshold is used. Yet, the results confirm our belief that using a constant sufficiency threshold is essential to account for the diminishing marginal utility of income (and consumption) since the other approaches fail to properly capture the DMUI-effect.

Table 6: Average annual and total growth rates of various sensitivity checks for BCPA per capita.

Time period	bcpa	UW	S	SSCl	SSCh	DMUIm	DMUIsm	DMUIsh	DMUImh	DMUIsmh	AAI1.5	AI1.5	AAI0.8	AI0.8	TC
1995-2007	0,24	0,32	0,03	0,66	-1,39	1,01	0,66	0,14	1,03	0,62	1,46	1,25	1,30	1,14	0,23
2007-2010	1,90	1,02	2,01	1,04	5,67	1,63	1,77	1,93	1,62	1,78	1,55	1,61	1,57	1,62	2,01
2010-2014	1,98	2,15	2,37	1,38	4,26	2,05	1,92	2,00	2,09	1,93	2,38	2,19	2,16	2,05	1,30
2014-2018	0,11	0,04	0,07	0,23	-0,54	0,71	0,43	0,01	0,72	0,39	0,65	0,65	0,66	0,66	0,16
1995-2018*	17,87	16,44	16,78	18,59	11,67	30,82	24,41	16,16	31,34	23,78	38,14	34,61	34,98	32,45	15,40
1995-2018	0,78	0,71	0,73	0,81	0,51	1,34	1,06	0,70	1,36	1,03	1,66	1,50	1,52	1,41	0,67

Note: The star (*) indicates the total trend over the entire period, in contrast to the average annual trends in the subperiods. The color scale gives per row an indication about the highest and lowest values. UW is the scenario with the opportunity cost method, S is without the shadow economy, SCC_l uses a low social cost of carbon, SCC_h employs a high social cost of carbon, $DMUI_m$ is the DMUI-adjustment with median incomes, $DMUI_{sm}$ is $DMUI_{s,m2010}$, $DMUI_{sh}$ is $DMUI_{s\_1.26}$, $DMUI_{mh}$ is $DMUI_{m\_1.26}$, $DMUI_{smh}$ is $DMUI_{s,m2010\_1.26}$, in AAI1.5 ε = 1.5 and α = 0.35, in AI1.5 ε = 1.5 and α = 0, in AAI0.8 ε = 0.8 and α = 0.35, in AI0.8 ε = 0.8 and α = 0, TC is the scenario that employs the transition cost method by O'Mahony et al. (2018).

Figure 17: A sensitivity analysis for BCPA per capita (2010 prices).



Note: UW is the scenario with the opportunity cost method, S is without the shadow economy, SCC_l uses a low social cost of carbon, SCC_h employs a high social cost of carbon, $DMUI_m$ is the DMUI-adjustment with median incomes, $DMUI_{sm}$ is $DMUI_{s,m2010}$, $DMUI_{sh}$ is $DMUI_{s\_1.26}$, $DMUI_{mh}$ is $DMUI_{m\_1.26}$, $DMUI_{smh}$ is $DMUI_{s,m2010\_1.26}$, in AAI1.5 ε = 1.5 and α = 0.35, in AI1.5 ε = 1.5 and α = 0, in AAI0.8 ε = 0.8 and α = 0.35, in AI0.8 ε = 0.8 and α = 0, TC is the scenario that employs the transition cost method by O'Mahony et al. (2018).

7. Conclusion: toward a 2.0 methodology

This paper contributes to the standardization of the methodology of economic welfare measures (EWM), such as the ISEW and GPI by addressing the cross-time and cross-boundary issues involved and the discussion on Fisherian versus Hicksian income as theoretical underpinnings. Two EWM with distinct time and boundary views to deal with ecosystem costs and physical capital changes are compiled for Belgium from 1995 to 2018: the benefits and costs experienced (BCE) only looks and the present and within domestic borders and the benefits and costs of present economic activities (BCPA) also looks at the impacts of present activities that are shifted in time and space. Other methodological novelties besides our dual welfare approach are that this study is the first to adopt a consumption footprint view for the emissions embodied in trade, to register the climate impacts of aviation and shipping, to include an approximation for the shadow economy and to introduce a sufficiency threshold for consumption expenditures when accounting for the diminishing marginal utility of income.

The results indicate that there are substantial and increasing ecological costs that are shifted in time and space in the BCPA, while the present ecological costs within domestic borders in the BCE are negligible and decreasing. This study found that BCPA and BCE improved over time, just as GDP did. GDP per capita grew by 30%, while BCE per capita rose by 15% and BCPA per capita increased by 18%. We found a lagged effect of the 2009 crisis on BCPA, as it increased in 2009 and decreased in 2010 because ecological costs respectively fell and rose. Furthermore, the positive aggregate welfare evolutions hide that BCE per capita stagnated and then decreased between 2009 and 2017, while BCPA per capita fell between 2014 to 2017. Moreover, caution is needed against the aggregate welfare trend because the broader ecological costs have increased over time. Since important information might get lost during the aggregation procedure, we advise to also look at EWM's disaggregated welfare categories to evaluate economic performance in greater detail.

Future studies should carefully consider the time and boundary views because without careful a reflection, EWM may give the impression that it is possible to fare well while consuming physical capital and fueling ecological breakdown. We argued to use BCPA as it accounts for the ecological costs shifted in time and space, which is more compatible with an ecological economic position of seeing the economy as embedded in the ecosystem, and it accounts for the consumption of physical capital. Such a beyond border viewpoint would better inform policy-making about the impacts abroad and the importance not only to reduce domestic emissions but also to devise policies like a carbon border adjustment tax to reduce the emissions embodied in trade (Van der Slycken and Bleys, 2020a). The BCE are less useful for 'full' accountability or policy-making as it only includes present ecological costs that happen within borders and regard physical capital consumption as beneficial to welfare. We believe that any 2.0 methodology for EWM should take these time and boundary issues into account when evaluating a country's economic performance.

Chapter 3 : Is Europe faring well with growth? Evidence from a welfare comparison in the EU-15 from 1995 to 2018.

1. Introduction

After earlier warnings that GDP should not be used as an indicator to measure social welfare (Kuznets, 1934; Abramovitz, 1958; Okun, 1971), Nordhaus and Tobin (1972) wondered if pursuing growth had become obsolete. Nordhaus and Tobin developed an alternative measure of economic welfare to examine whether the progress indicated by GDP growth would disappear if a different welfare indicator was used. One the one hand, growth is not obsolete because economies are structurally dependent on growth (EEA, 2020). On the other hand, growth as measured by GDP is obsolete, because GDP is not an indicator for social welfare or social progress, which is acknowledged by most economists (van den Bergh, 2009). Without the structural dependence on growth, it makes little sense to continue growing an indicator that is a poor proxy for social welfare. In order to overcome this deadlock, voices have been raised to: (a) to move beyond growth and to redesign economies so they become less dependent on growth and can manage without growth (Raworth, 2017; Jackson, 2017; Victor, 2019) and (b) to move "beyond GDP" as we urgently need to measure what counts for social and economic performance and to focus on designing policies that stimulate well-being and economic welfare in a sustainable way (Stiglitz et al., 2009; Stiglitz et al., 2018).

While there is a broader debate on the measurement of welfare, well-being or sustainable development – see, for instance, the approaches mentioned in Meadows (1998), Dasgupta and Mäler (2000), Dasgupta (2009), van den Bergh (2009), Fleurbaey (2009), Bleys (2012), O'Neill (2012), Munda (2015), O'Neill et al. (2018) and Hoekstra (2019) – we refer to welfare and economic welfare measures (EWM) as what is being measured by the Index of Sustainable Economic Welfare (ISEW) and Genuine Progress Indicator (GPI). The ISEW and GPI were created more than thirty years ago as *alternative* welfare indicators in an effort to debunk GDP and its growth as a key economy policy goal. Nevertheless, to date their impact on policy-making stays limited (Corlet Walker and Jackson, 2019; Bleys and Whitby, 2015). The lack of standardization does not only act as a barrier to impact policy-making, but also makes it difficult to compare welfare estimates across countries (Bleys and Whitby, 2015).

In the past, scholars have made various suggestions to improve the standardization of the methodology of EWM. Some argued to calculate standardized EWM with a limited component list (e.g. Bleys, 2007; Menegaki, 2018) to deal with data constraints. Others tried to adapt the calculation method to the area studied by including components of local importance (e.g. Clarke and Islam, 2005; Ostergaard-Klem and Oleson, 2014; Held et al., 2018) as this would give policy-makers more detailed region-specific information. In order to foster both comparability and customization, it was also suggested to have a *core* component list in the standard welfare measure that can be supplemented with a *periphery* of specific items for regional-specific measures (Brown and Lazarus, 2018; Kenny et al., 2019).

In Europe no attempt has been made to date to measure welfare across European countries or at the European level (Schepelmann et al., 2010). In the past, welfare was compiled for 13 of the 15 EU-15 countries: Austria (Stockhammer et al., 1997), Belgium (Bleys, 2008), Finland (Hoffrén, 2018), France (Nourry, 2008), Germany (Held et al., 2018), Greece (Menegaki and Tsagarakis, 2015), Italy (Armiento, 2018), Luxembourg (Rugani et al., 2018), the Netherlands (Bleys, 2007), Portugal (Beça and Santos, 2014), Spain (O'Mahony et al., 2018), Sweden (Jackson and Stymne, 1996) and the UK (Jackson, 2004).[32] Yet, these country-specific studies lack standardization. To date, Denmark and Ireland are the only EU-15 countries without country-specific welfare estimates.

Some scholars have compiled EWM in a comparable way for a group of countries or states. Menegaki et al. (2017) computed a simplified ISEW for 33 European countries, however, this version differs significantly from the commonly used methodology (Bleys and Van der Slycken, 2019). In order to compile a "comparable GPI", Pais et al. (2019) also used a simplified methodology for 28 OECD countries. Furthermore, Fox and Erickson's (2019) GPI study for fifty states in the United States allows for comparability across states, but only covers one year. Notwithstanding these contributions, a standard study with a 'full' component list that is applied to a group of countries over a considerable time period is still missing. This study addresses this research gap as it is the first that calculates EWM for the group of EU-15 countries over a considerable time period based on a consistent and standard methodology.[33] This welfare study will allow us to explore whether GDP and welfare are coupled in these European countries before, during and after financial crisis. This research will also examine the main welfare drivers and the relative importance of the different welfare categories in economic welfare measures.

This paper is structured as follows: Section 2 discusses the methodology used to calculate welfare in the EU-15 from 1995 to 2018. The third section discusses each countries' welfare evolution and compares it to its GDP, finds that the EU-15 recovered from the financial crisis from a per capita GDP view by 2018, but

[32] I only listed each country's most recent welfare study.

[33] In this paper, I will refer to these 15 countries as 'EU-15' despite the fact that the UK is no longer part of the European Union. 'EU-15' is to be seen as a mere reference to the fifteen countries that were originally part of the EU-15.

not from an economic welfare perspective. In Section 4 we revisit Max-Neef's (1995) threshold hypothesis and argue that our results give no conclusive evidence regarding threshold hypothesis at the aggregate level of the EU-15, however, a welfare peak is found in a majority of the EU-15's countries. Finally, as the ecological costs increased during the GDP-recovery from the financial crisis in 2010, the Section 5 concludes to prioritize a green recovery for a post-COVID transition.

2. A standardized methodology for the EU-15

This paper applies the same methodology as for the Belgian welfare study in Chapter 2, which should allow for meaningful comparisons across the EU-15 from 1995 to 2018. The methodology used can be seen as a core methodology using a full set of EWM-items. Similar to the Belgian study by Van der Slycken and Bleys in Chapter 2, I will calculate two EWM – the *benefits and costs experienced* (BCE) and the *benefits and costs of present economic activities* (BCPA):

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

$$BCPA = UW + C_i + S + G_c - DIRE_p - INQ - BEC + \Delta K \quad (4)$$

In Eqs. 3 and 4: UW = unpaid work, C_i = individual consumption, S = shadow economy, G_c = non-defensive collective government consumption, $DIRE_p$ = defensive, intermediate and rehabilitative private expenditures, INQ = welfare losses from income inequality, NEC = narrow ecological costs that are experienced in the present and within domestic borders, BEC = broad ecological costs, including current costs within domestic and the costs shifted in time and space, ΔK = capital adjustment. UW, C_i, S, G_c are valued positively; INQ, $DIRE_p$, NEC and BEC are deducted, whereas ΔK can be either positive or negative.

Both EWM differ because they are based on two distinct welfare interpretations that are inspired by the income concepts of Fisher and Hicks – without being approximations of these income notions (Van der Slycken and Bleys, 2020a, 2020b). BCE has an experiential interpretation. Following Fisher's psychic income concept, it traces the experiences that are currently experienced within domestic borders. As a consequence, it only includes current ecosystem costs within borders and does not include capital adjustments. Capital adjustments are excluded since Fisher distinguishes between income and capital and a measure based on his psychic income notion should only trace the current services following from capital stocks, but not additions to stocks. BCPA, in contrast, is broader as it accounts for a wider range of benefits and costs coming from present activities. BCPA registers the impacts of present activities, including the impacts shifted in time and space. Therefore, it accounts for the ecological costs shifted abroad and into the future and includes a capital adjustment. Net capital growth is registered because it follows a Hicksian-income view. A detailed explanation for all items (including data sources) can be found in Appendix A, while the monetary and population data used in the compilations can be found in Appendix B.

3. Results

First, I will present and discuss the welfare results for the EU-15 as a whole. In the next subsections, I will analyze and compare the welfare trends for each country.

3.1 Welfare in the EU-15

In order to analyze the overall economic performance of the EU-15 from 1995-2018, I calculated its aggregate GDP, BCE and BCPA by summing the corresponding individual measures across these countries. European aggregate numbers were divided by the EU-15's total population to filter out population trends – the total population increased by 9.7% over the considered period – and obtain per capita figures, which are shown in Fig. 18. In what follows, the analysis focuses on per capita numbers, which are presented in lowercase (i.e. gdp, bce and bcpa), in contrast to aggregate numbers which are in capital letters. I will first elaborate on the EU-15's overall economic performance and its driving factors and then discuss the welfare categories. Detailed growth rates of welfare indicators and categories for the EU-15 can be found in Tables 7 and 8.

During the considered period, gdp is in absolute values higher than both welfare indicators. Bce and bcpa are on average respectively 2.8% and 25.7% lower than gdp. From 1995 to 2018 all measures considered improved, albeit at different rates as shown in Table 7. Gdp outperformed both welfare indicators: gdp grew by 30.8%, bcpa increased by 17%, while bce improved by 12.9%. Over the entire period, gdp increased on average by 1.34% per annum (p.a.) versus 0.74% for bcpa and 0.56% for bce. Throughout the entire period, however, there are notable differences between the evolutions of ewm and gdp. By 2018, the EU-15's gdp had recovered from the financial crisis as it reached the same level as in 2017. Nonetheless, the EU-15 did not recover from the financial crisis from a welfare view as both bce and bcpa were below their 2007-level. Bce reached its period welfare peak of €29,713 in 2006, while bcpa peaked at €22,995 in 2007.

The studied period is split into five periods: 1) from 1995 to 2001 with rapid gdp and welfare growth; 2) from 2001 to 2007 when gdp and welfare improved at lower rates; 3) the financial crisis from 2007 to 2009 when gdp fell more sharply than both welfare measures; 4) the low growth period during the subsequent

Eurocrisis from 2009 to 2013 when gdp outperformed both welfare measures and 5) the post-crises period from 2013 to 2018 when gdp again outperformed bce and bcpa.

Figure 18: Welfare and GDP per capita for the EU-15 in prices of 2010 (left panel) and as index values with 2007 = 100 (right panel).

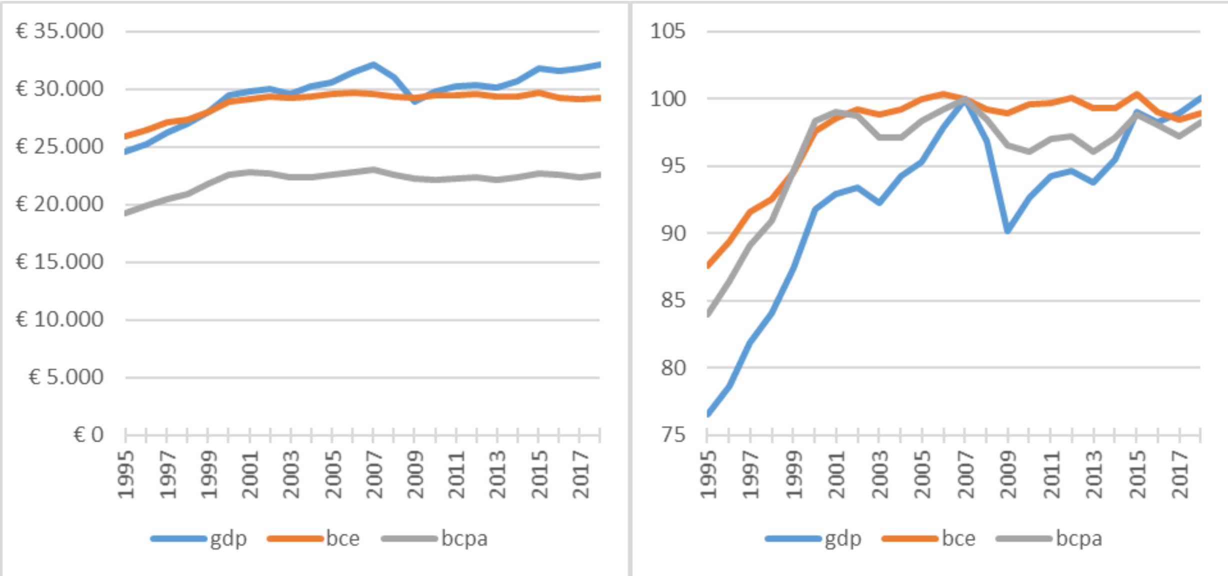


Table 7: Average annual trends of welfare and GDP per capita for the EU-15 (in %).

Time period	gdp	bce	bcpa
1995-2001	3,6	2,1	3,0
2001-2007	1,3	0,2	0,2
2007-2009	-4,9	-0,5	-1,7
2009-2013	1,0	0,1	-0,1
2013-2018	1,3	-0,1	0,4
1995-2018	1,34 *(30,8)*	0,56 *(12,9)*	0,74 *(17,0)*

Note: The brackets indicate the total trend over the entire period, in contrast to the average annual trends in the subperiods.

3.1.1 Period 1: 1995-2001

In this first phase from 1995-2001 welfare and gdp rose sharply: gdp increased by on average 3.6% per annum (p.a.), bce by 2.1% p.a. and bcpa by 3% p.a. This welfare improvement was driven by an increase in individual consumption by €3,587 (i.e. on average +3.6% per year), yet, only a part of this consumption growth was translated into welfare since the welfare losses from income inequality increased by €1,578 (i.e. an increase by 9.9% p.a.). The value of unpaid work is another important factor that helps to explain this period's unique welfare improvement as it increased by €1,091 – on average +2% per year.

3.1.2 Period 2: 2001-2007

In the build-up to the financial crisis from 2001 to 2007, gdp continued to grow, but its growth was slowing down as gdp only grew by on average 1.3% compared to 3.6% before. Welfare growth also slowed down as bce and bcpa only improved by on average 0.2% per year. Individual consumption was again the most important welfare driver: it increased by €1,381 (on average +1.1% p.a.). The value of the shadow economy also increased by €307 (on average +2% p.a.). Yet, the welfare improvements from consumption growth and the shadow economy were partly deducted as welfare losses from income inequality that increased by €934 or 3.7% per year. Gdp reached a peak right before the outbreak of the financial crisis in 2007 at a level of €32,122 that was only reached again in 2018. Bce and bcpa, reached their period maximum in respectively 2006 and 2007.

3.1.3 Period 3: 2007-2009

During the financial crisis from 2007 to 2009, gdp and bcpa both dropped, but the crisis had a stronger negative impact on gdp than on bcpa. Gdp fell sharply by on average 4.9% p.a., while bcpa only dropped by on average 1.7% p.a and bce decreased on average by 0.5% per year. The trends in welfare were mainly caused by reduction in consumption expenditures by €1,307 (-3% p.a.), yet, this consumption decrease was to some extent compensated by reductions the welfare losses from income inequality by €906 (-8.8% p.a.). In the case of bcpa, plummeting capital adjustments strongly help to explain its fall as there was net capital declined by €1,097 (-27.2% p.a.). Yet, the drop in bcpa was tempered because broader ecological costs also fell by €642 (i.e. on average -3.6% p.a.). The narrow ecological cost fell at a higher rate of on average 4.1% per annum, however, this only resulted in a minor absolute reduction of by €34 as they are only a fraction of their broader counterpart.

3.1.4 Period 4: 2009-2013

In the period after the crisis from 2009 to 2013, the Europe's gdp recovered and grew on average by 1% per year. In 2013, gdp, bce and bcpa all declined because of the European sovereign debt crisis. Welfare improved at a slower pace compared to gdp: bcpa decreased and bce increased by 0.1% per year. The welfare evolution was caused by increases in consumption by €599 (i.e. on average +0.7% p.a.), yet this was slightly compensated by increases in the welfare losses from income inequality by €344 or on average 2% per year. Bcpa growth was slightly lower than bce because the financial and Eurocrisis resulted in a capital adjustment that was €385 lower (-10.5% p.a.), however, this trend was tempered because during these crises the broader ecological costs also decreased by €200 (-0.6% p.a.).

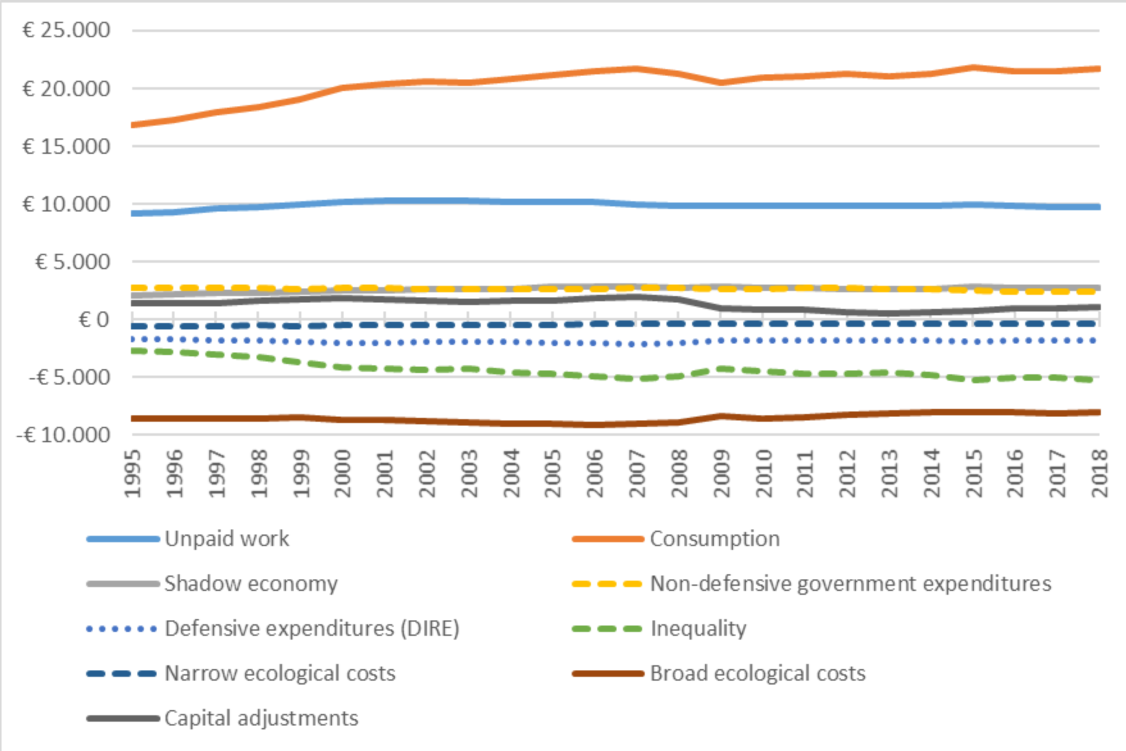
3.1.5 Period 5: 2013-2018

During the last period from 2013-2018, gdp again outperformed welfare: gdp increased by 1.3% p.a., while bcpa increased by 0.4% and bce decreased by 0.1% per year. Bcpa improved more than bce because capital adjustments surged by €504 (i.e. on average +18.8% p.a.). Other drivers in these moderate welfare improvements are consumption gains of €662 (+0.6% p.a.) and the increases in the welfare losses from inequality by €638 (i.e. +2.8% p.a.), which almost entirely compensated the consumption growth. It took until 2018 until gdp was recovered from the financial crisis by reaching its 2007-peak. Yet, bce and bcpa were by the end of the studied period 1.5% and 1.75% lower than their peak values in respectively 2006 and 2007.

3.1.6 A detailed breakdown of the welfare categories

Detailed breakdowns of the EU-15's welfare in absolute values in Fig. 19 and in relative weights of bcpa's per capita welfare contributions and deductions in Fig. 20 illustrate that consumption and unpaid work are the welfare contributions of the highest quantitative importance, while the broader ecological costs and welfare losses from inequality are the largest welfare deductions. Over the studied period, consumption, the welfare losses from income inequality, the shadow economy and unpaid work impacted the welfare trend most. Consumption increased by €4,921 or 29.3%, which only increased its relative weight in the bcpa's positive contributions from 52.2% in 1995 to 57.6% in 2018. The welfare losses from income inequality increased by €2,587 or 97.5%, which indicates that because of the diminishing marginal utility of income only 53.3% of the growth in consumption and the shadow economy is translated into welfare. The shadow economy and unpaid work had increasing positive welfare contributions as they respectively increased by €618 (+29.1%) and €589 (+6.4%) and due to its higher growth rate the shadow economy's relative weight in bcpa's positive welfare contributions increased from 6.6% in 1995 to 2018 7.3% in 2018, while unpaid work's share fell from 28.5% in 1995 to 25.9% in 2018.

Figure 19: Welfare categories for the EU-15 in per capita values (2010 prices).



Note: In this figure welfare deductions have been reclassified as negative numbers, even though these categories are deducted as positive numbers in Eq. 3 and 4 to calculate the aggregate welfare level.

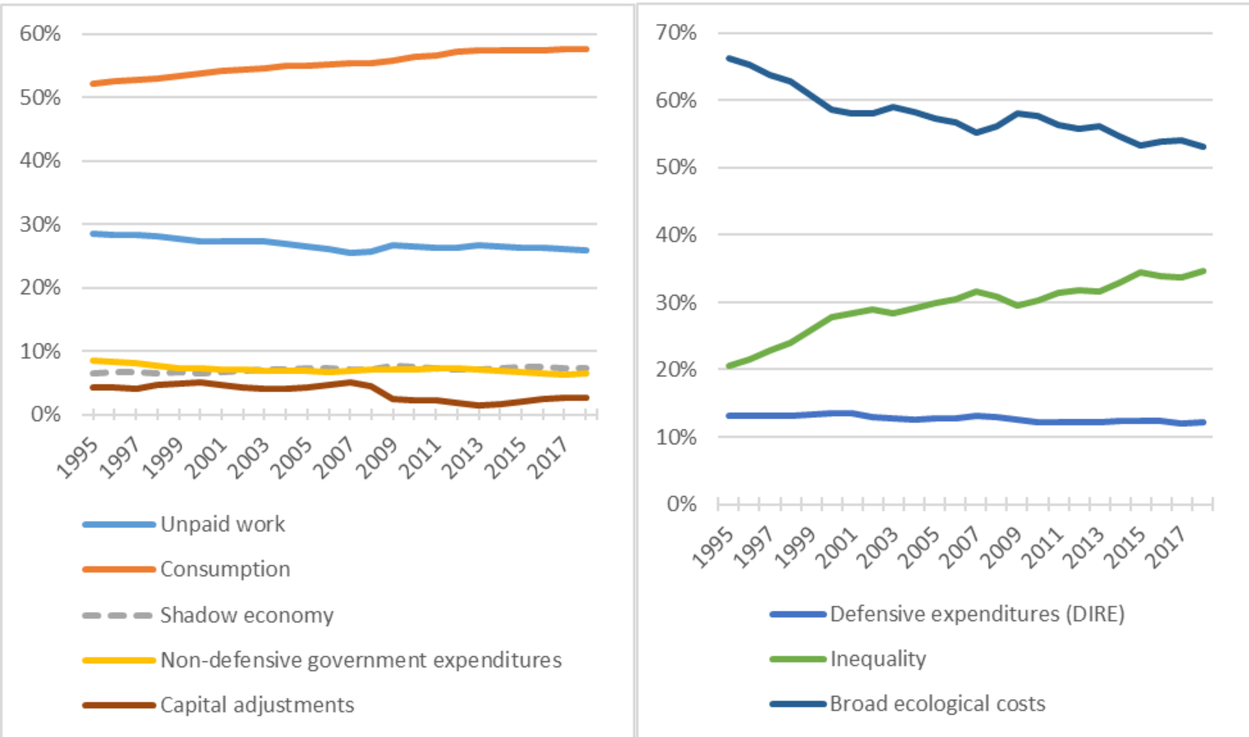
In contrast to bcpa's broader ecological costs, bce's narrow ecological costs are of negligible quantitative importance. Over time both costs fell: the narrow ecological costs decreased by €244 (-42.7%) versus €508 (-5.9%) for their broader counterpart. Since the welfare losses from inequality rose and the broader ecological costs decreased, the former's relative share in bcpa's welfare deductions decreased from 66.3% to 53.2% while the latter's weight increased from 20.69% in the initial year to 34.7% in the final year. The financial crisis made bcpa's capital adjustment decrease, yet, although net capital growth increased by the end of the studied period, it was €313 or 23.1% lower in 2018 than it was in 1995 so that its share in bcpa's positive contributions fell from 4.2% to 2.8%. Finally, government expenditures decreased over time by €318 or 11.6%, while defensive, rehabilitative and intermediate expenditures grew by €129 or 7.6%. The former's share in the positive welfare contributions fell during the considered time period from 8.5% to 6.4%, while the latter's share in the welfare deductions fell by 1 percentage point from 13.2% to 12.1%.

Table 8: Average annual trends of welfare categories per capita for the EU-15 (in %).

Time period	uw	c_i	s	g_c	$dire_p$	inq	nec	bec	Δk
1995-2001	2,0	3,6	3,1	-0,4	2,9	9,9	-2,9	0,2	5,4
2001-2007	-0,5	1,1	2,0	0,1	1,1	3,7	-2,3	0,7	2,1
2007-2009	-0,8	-3,0	-0,4	-1,4	-7,7	-8,8	-4,1	-3,6	-27,2
2009-2013	0,0	0,7	-1,8	0,0	-0,2	2,0	-1,3	-0,6	-10,5
2013-2018	-0,1	0,6	1,0	-1,6	0,5	2,8	-1,6	-0,3	18,8
	0,28	1,27	1,27	-0,50	0,33	4,24	-1,86	-0,26	-1,01
1995-2018	*(6,4)*	*(29,3)*	*(29,1)*	*(-11,6)*	*(7,6)*	*(97,5)*	*(-42,7)*	*(-5,9)*	*(-23,1)*

Note: The brackets indicate the total trend over the entire period, in contrast to the average annual trends in the subperiods.

Figure 20: Relative weight of per capita BCPA's welfare contributions (left panel) and welfare deductions (right panel) from 1995 to 2018.



3.2 Welfare in the EU-15 countries

In this section, I will discuss the EU-15-countries' welfare and gdp trend for the period 1995-2018. Detailed calculations of bce, bcpa, welfare categories and individual items can be found in Appendix B. Table 9 gives an overview of the relative changes over time of each country's gdp, bce, bcpa and its welfare categories.

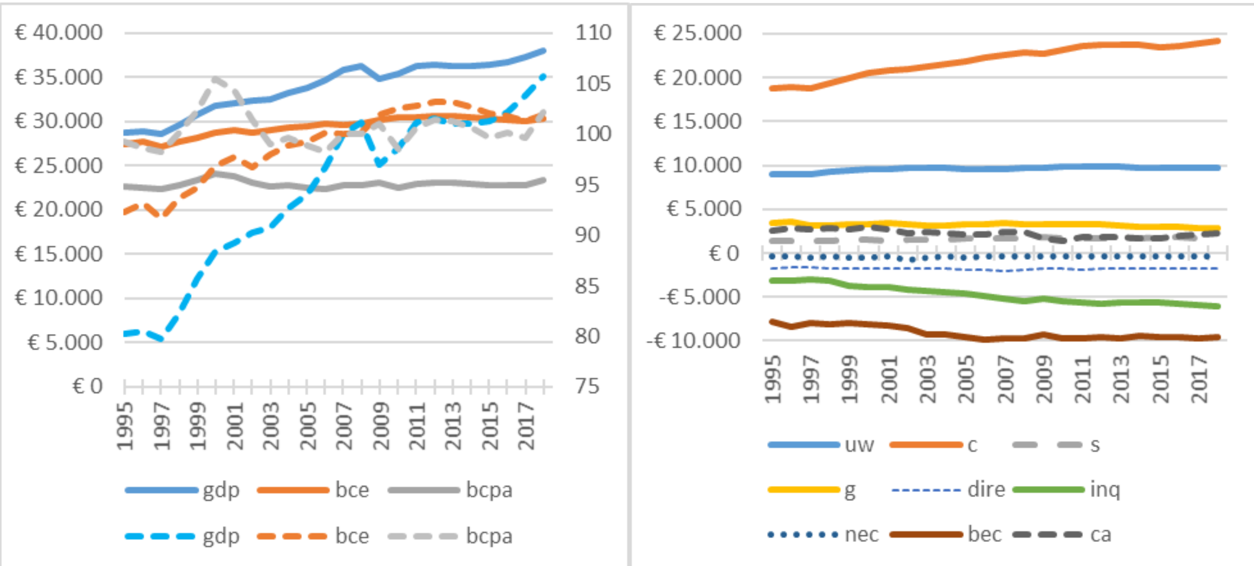
Table 9: Relative changes in percentage from 1995 to 2018 of gdp, bce, bcpa, and the welfare categories (per capita values, 2010 prices) for all countries and the EU-15.

	gdp	bce	bcpa	uw	c	s	g	dire	inq	new	bec	ca
EU-15	30,8	12,9	17,0	6,4	29,3	29,1	-11,6	7,6	97,5	-42,7	-5,9	-23,1
Austria	31,9	10,5	2,9	8,0	28,7	32,1	-19,4	4,1	97,3	-24,5	22,5	-13,6
Belgium	30,1	14,9	17,9	11,6	32,3	37,1	-23,4	11,7	89,9	-52,4	6,8	20,0
Denmark	27,4	14,3	24,4	24,1	23,1	30,7	-18,1	2,8	86,0	-33,7	-4,0	186,5
Finland	46,2	33,1	48,1	26,3	52,7	44,9	36,8	22,0	232,6	-38,0	23,1	538,2
France	27,7	18,0	28,0	14,1	28,2	24,8	9,3	18,0	83,4	-40,2	-7,5	23,5
Germany	29,5	7,3	7,5	-3,5	24,9	38,2	0,6	2,5	96,8	-33,4	-4,3	-40,6
Greece	4,8	2,4	-6,8	21,2	4,0	5,5	-44,4	0,9	3,9	-46,7	-7,5	-206,9
Ireland	180,7	42,4	45,7	47,8	73,4	178,0	29,2	3,1	522,4	-34,3	0,2	-111,2
Italy	18,7	5,2	2,0	1,1	21,8	19,6	-34,7	2,0	58,3	-42,6	-4,1	-93,9
Luxembourg	40,1	3,5	-47,1	6,0	8,2	36,5	38,4	0,8	49,3	-57,7	49,9	-3,6
Netherlands	35,7	-3,0	1,2	-16,6	32,3	34,7	-50,6	0,2	107,0	-57,3	-12,1	19,5
Portugal	29,8	35,5	31,5	72,1	27,8	29,1	0,7	32,2	63,9	-39,5	13,4	-97,1
Spain	35,9	10,4	4,7	-6,1	31,4	27,4	-5,7	3,3	112,5	-39,1	10,5	-37,0
Sweden	39,4	18,7	34,1	33,5	35,0	36,1	-18,3	12,4	160,0	-34,8	-5,8	109,0
UK	33,3	26,7	53,5	21,8	39,4	27,2	16,2	11,7	122,8	-59,4	-25,3	-8,3

Note: The color scale indicates per column the highest values in shades of green and the lowest values in shades of red.

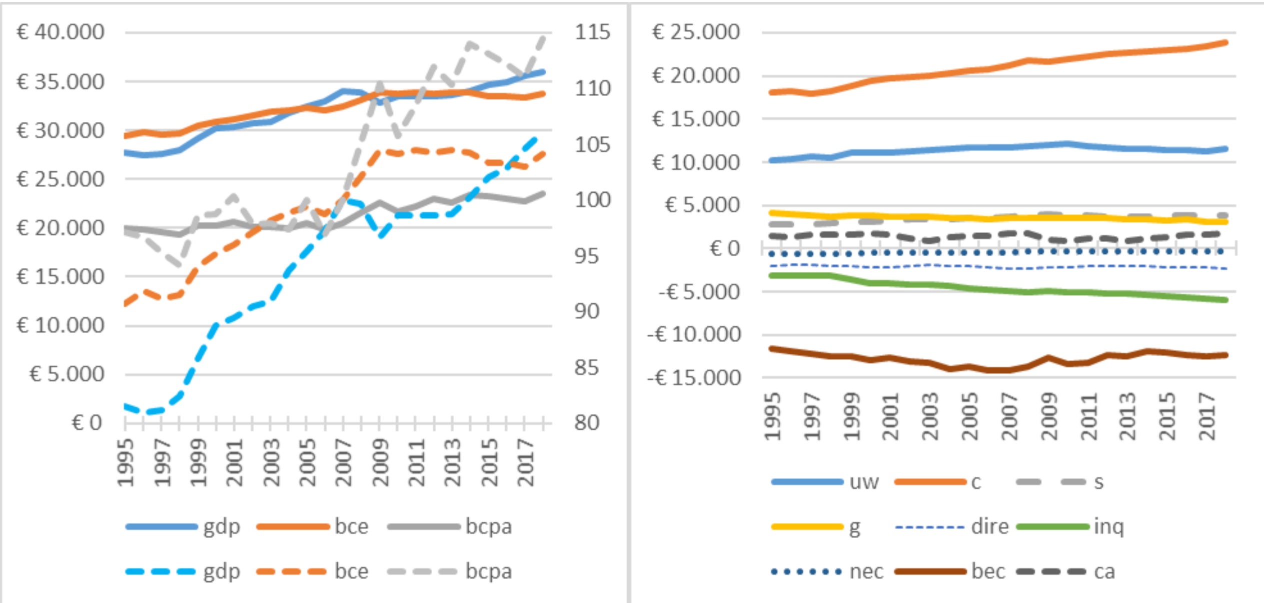
Austria's bce increased by 10.5% and its bcpa only grew by 2.9% over the study period. This welfare improvement is much lower than its gdp growth (+31.9%). Gdp reached its maximum level in 2018, whereas bce and bcpa reached their period peak in respectively 2013 and 2000, as indicated in Fig. 21. Austria's bcpa dropped in 2002 and 2003 by respectively 2.8% and 2.4% because the broader ecological costs (+13%) increased rapidly. The financial crisis had a strong impact on gdp that fell by 4.1% in 2009, but had no negative effect on bce (+1.75%) and bcpa (+1.05%). However, the crisis had a delayed impact on bcpa that decreased by 2.5% in 2010 mainly because the broader ecological costs increased by 4.9% during a polluting gdp-recovery. After recovering in 2010 and 2011, gdp stagnated from 2012 to 2015. Bce and bcpa declined from 2012 to 2017. In 2018, all three measures improved. Bcpa jumped up by 2.6% in 2018 since individual consumption grew by 1.1%, while the broader ecological costs decreased by 2.2% and net capital grew by 8.2%.

Figure 21: Austria's GDP, BCE and BCPA per capita in absolute values (left axis) and index values with 2007 = 100 (right axis) on the left panel and the evolution of the welfare categories in per capita values on the right panel. All values are in 2010 prices.



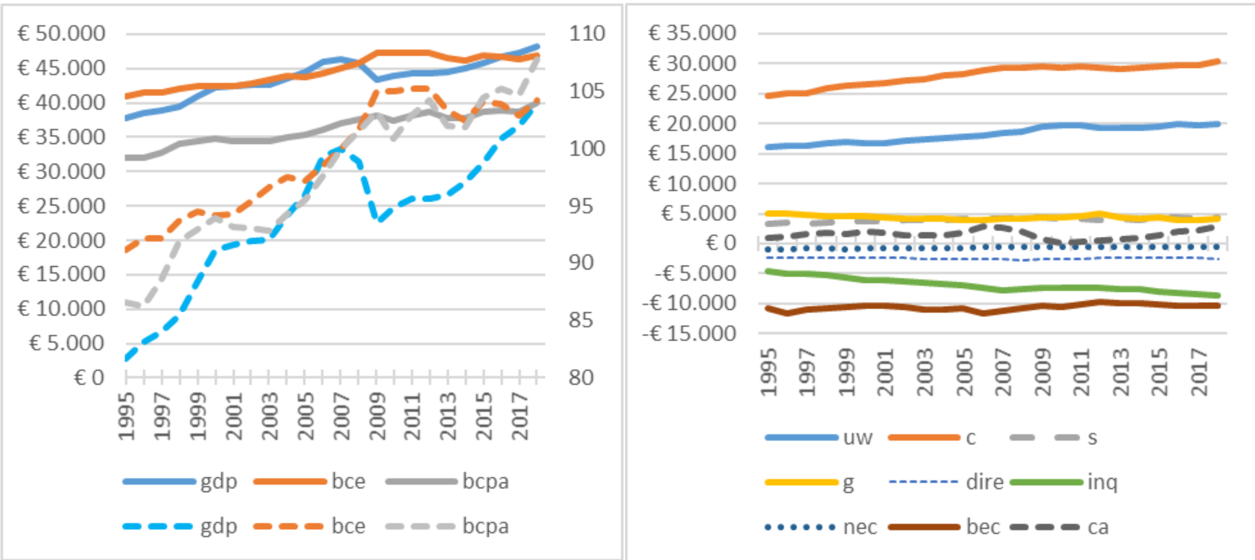
Belgium's gdp increased by 30.1%, while its bce and bcpa improved by about half of that rate: bce increased by 14.9% and bcpa by 17.9%. The financial crisis made Belgium's gdp decrease in 2008 (-0.3%) and 2009 (-3%). The crisis did not negatively impact bce and bcpa as both measures grew by 2.4% and 5.1% in 2009, as illustrated in Fig. 22. The sharp rise in bcpa was mainly caused by decreasing broader ecological costs (-7.4%). However, there was a delayed crisis effect for Belgium too as bce and bcpa decreased by respectively 0.3% and 4.3% while gdp grew by 2% in 2010. The largest contributor to the deterioration in bcpa is an increase in the broader ecological costs by 5.8%. After the polluting recovery in 2010, gdp stagnated from 2010 and 2013, while bcpa and bce declined between 2014 and 2017. In 2018, all three indicators increased so that gdp and bcpa reached their period maximum in 2018. Bce, in contrast, already peaked in 2009.

Figure 22: Belgium's GDP, BCE and BCPA per capita in absolute values (left axis) and index values with 2007 = 100 (right axis) on the left panel and the evolution of the welfare categories in per capita values on the right panel. All values are in 2010 prices.



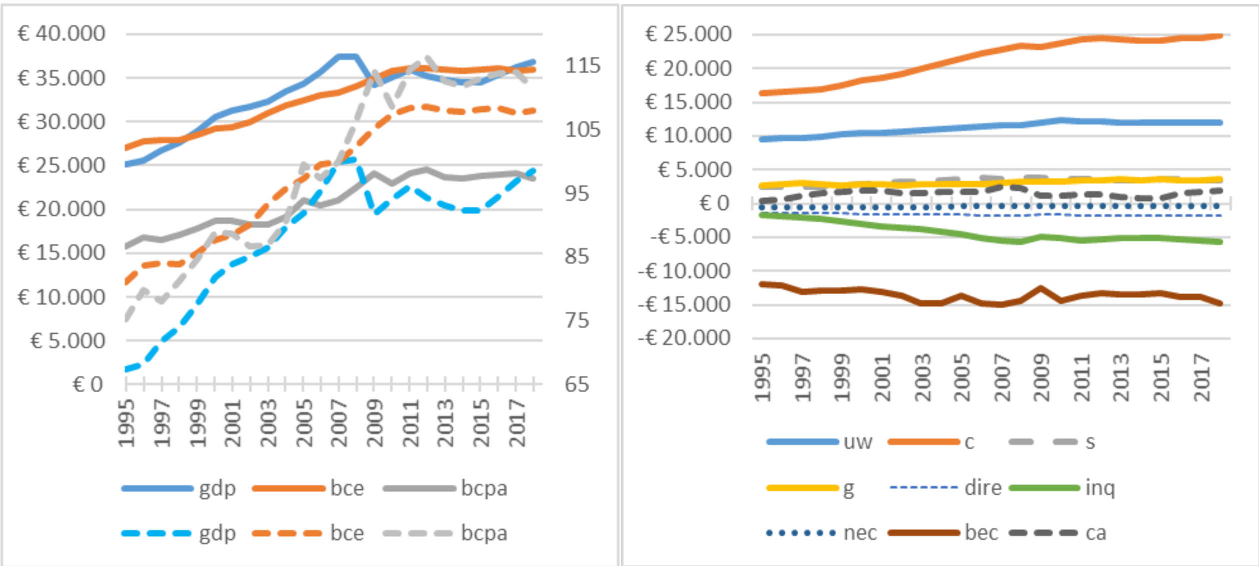
Denmark's bcpa and gdp followed a comparable trend over the entire period (see Fig. 23), the former improved by 24.4% and the latter by 27.4%. Bce only enhanced by 14.3% over the study period. Denmark was strongly impacted by the financial crisis in 2009 seen from a gdp-view but not from a welfare perspective: gdp fell by 5.4%, while bce and bcpa increased by 3.3% and 1.7% because the welfare losses from income inequality dropped by 5.3%. The evolution of bcpa was also driven by decreases in the broader ecological costs (-4.6%) and capital adjustment (-29.1%). The response in welfare was lagged. In 2010, bce stagnated, whereas bcpa diminished by 2.2% mainly due to rising broader ecological costs (+4.9%). By the end of the study period, gdp grew, bcpa fluctuated and increased too so that bcpa and gdp reached their maximum level in 2018, while bce slightly oscillated but decreased compared to its 2012 peak.

Figure 23: Denmark's GDP, BCE and BCPA per capita in absolute values (left axis) and index values with 2007 = 100 (right axis) on the left panel and the evolution of the welfare categories in per capita values on the right panel. All values are in 2010 prices.



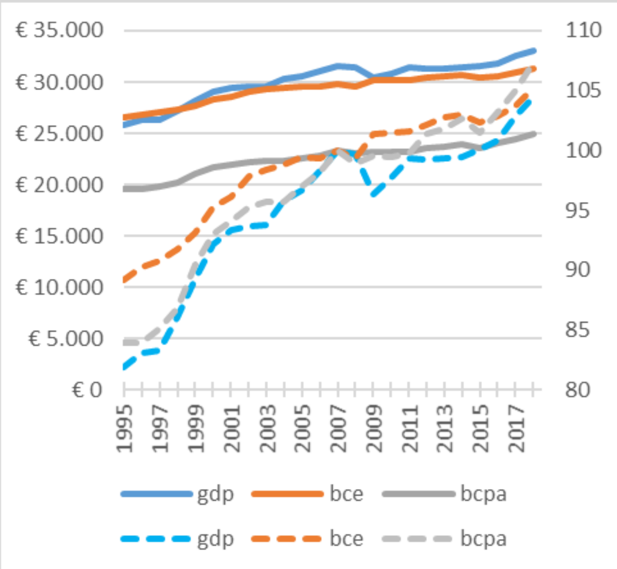
Finland performed better than the EU-15 on average over the entire period: its gdp grew by 46.2%, its bcpa improved by 48.1% and its bce bettered by 33.1%. Notwithstanding these remarkable evolutions, its gdp level was 1.7% lower in 2018 compared to its peak in 2008, while its bce and bcpa were in 2018 respectively 0.5% and 4.3% lower than their peak value in 2012. As shown in Fig. 24, The financial crisis impacted Finland strongly from a gdp-perspective, but not from a welfare view. In 2009, Finland's gdp dropped by 8.6%, however, its bcpa improved by 7.3% due do sharply falling broader ecological costs (-13.4%). The subsequent gdp recovery by 2.7% in 2010 was polluting and detrimental to bcpa, which fell by 4.9% as the broader ecological costs rose by 16.5%.

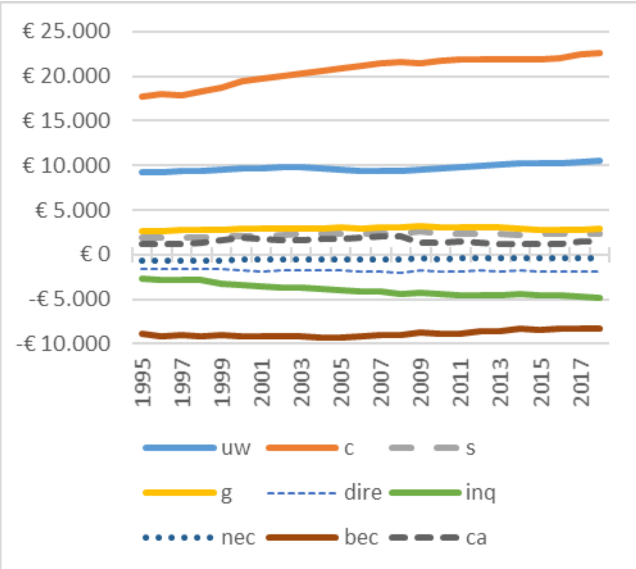
Figure 24: Finland's GDP, BCE and BCPA per capita in absolute values (left axis) and index values with 2007 = 100 (right axis) on the left panel and the evolution of the welfare categories in per capita values on the right panel. All values are in 2010 prices.



From 1995 to 2018, *France*'s bcpa and gdp both improved by about 28%, while the increase in bce was 10 percentage points lower. The financial crisis resulted in gdp decreases of 0.3 and 3.4% in 2008 and 2009, whereas bce and bcpa by 0.7% and 1.1% in 2008. Bce and bcpa increased by 2% and 0.7% in 2009, whereas there was no delayed response in ewm as both welfare indicators remained constant in 2011. The biggest explanatory factor for the welfare drop in 2008, is a rise by 7.7% in the welfare losses from income inequality. All three indicators gradually improved after the financial crisis, so that they reached their maximum level in 2018, as illustrated in Fig. 25.

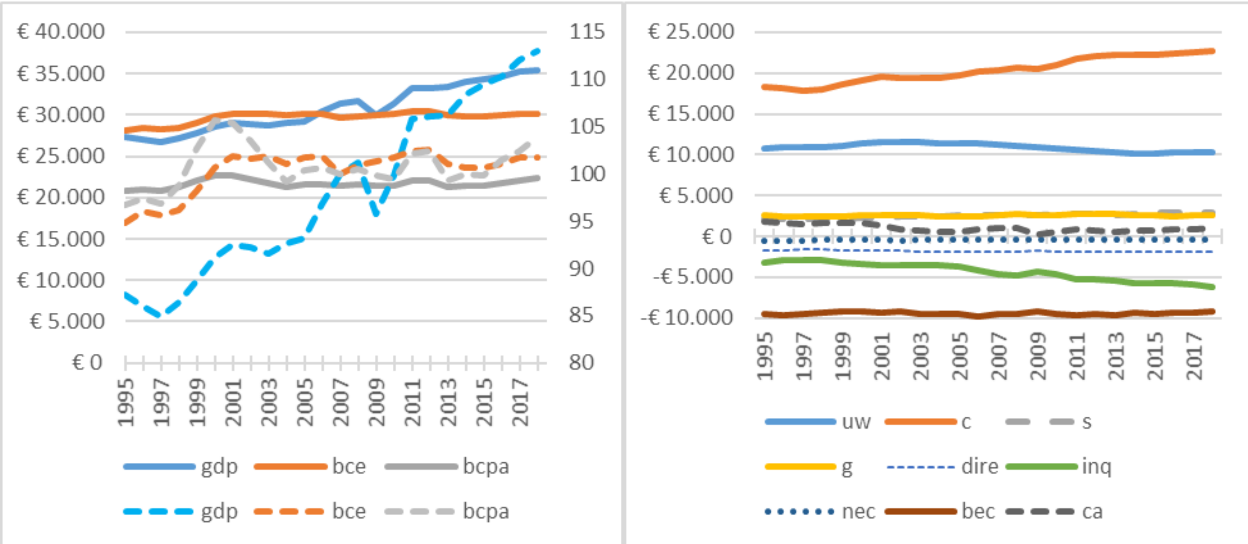
Figure 25: France's GDP, BCE and BCPA per capita in absolute values (left axis) and index values with 2007 = 100 (right axis) on the left panel and the evolution of the welfare categories in per capita values on the right panel. All values are in 2010 prices.





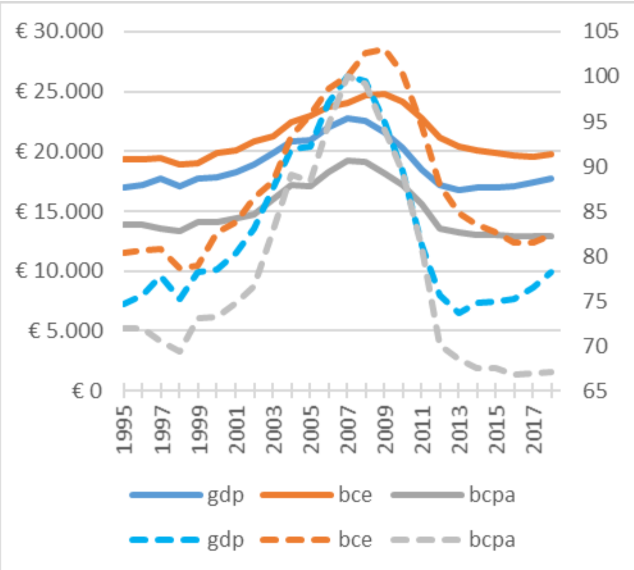
Germany's improvement in bce and bcpa was only about a quarter of its gdp growth: gdp increased by 29.5% versus an increase by 7.3% in bce and by 7.5% in bcpa. Bcpa peaked in 2000 and decreased the next four consecutive years because there was strong decrease in net capital growth (see Fig. 26). Germany's bce fluctuated around its 2001-level and peaked in 2012. The financial crisis had almost no effect on Germany's ewm, yet, bce and bcpa were more heavily impacted in 2013 when the former decreased by 1.5% and the latter by 3.1%.

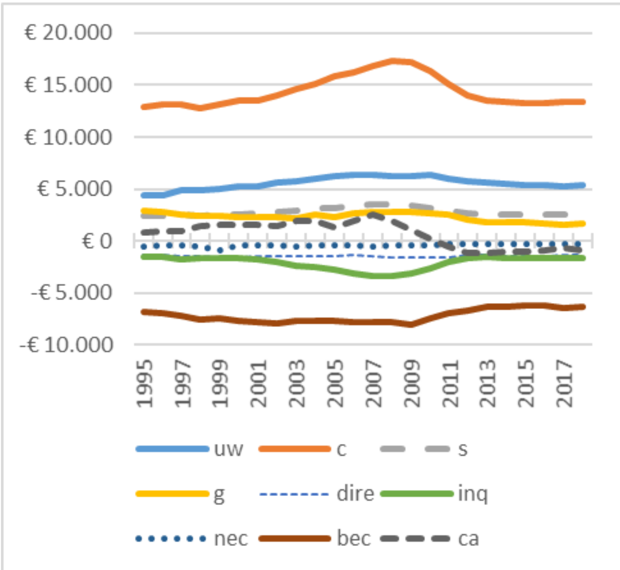
Figure 26: Germany's GDP, BCE and BCPA per capita in absolute values (left axis) and index values with 2007 = 100 (right axis) on the left panel and the evolution of the welfare categories in per capita values on the right panel. All values are in 2010 prices.



Greece's economic experience from 1995 to 2018 is bell-shaped: its gdp and bcpa increased from the beginning of the studied period and reached a peak in 2007 (see Fig. 27). The evolution of bce is similar, yet, bce reached its maximum in 2009. Gdp increased in 2007 by 34% compared to 1995, whereas its bce was 24.4% higher and its bcpa was even 39% higher in 2007 than it was in 1995 – yet, afterwards all measures decreased substantially. The financial crisis and the subsequent eurocrisis had dramatic effects on Greece's economy. Greece lost 25.9% of its gdp in the five years from 2008 to 2013 – its gdp level in 2013 was even 1.2% lower than it was in 1995 – whereas Greece's bce and bcpa decreased by 17.4% and 31% between 2008 and 2013. Contrarily to gdp, which started increasing from 2013, bce and bcpa continuously declined until 2016. During this welfare crash, net consumption plummeted, the value of unpaid work dropped as wages started falling, the shadow economy shrunk and government expenditures were reduced.[34] More strikingly, Greece's capital adjustments dropped dramatically too, which explains why bcpa fell more than bce. From 2011 onwards, Greece even had negative net capital growth, which indicates a declining capital stock. During the last two years of the study period Greece's bce and bcpa stabilized at a much lower level. In 2018, bce, bcpa and gdp were respectively 20.1%, 32.9% and 21.8% below their peak value – bcpa was even still below its starting value in 1995.

Figure 27: Greece's GDP, BCE and BCPA per capita in absolute values (left axis) and index values with 2007 = 100 (right axis) on the left panel and the evolution of the welfare categories in per capita values on the right panel. All values are in 2010 prices.

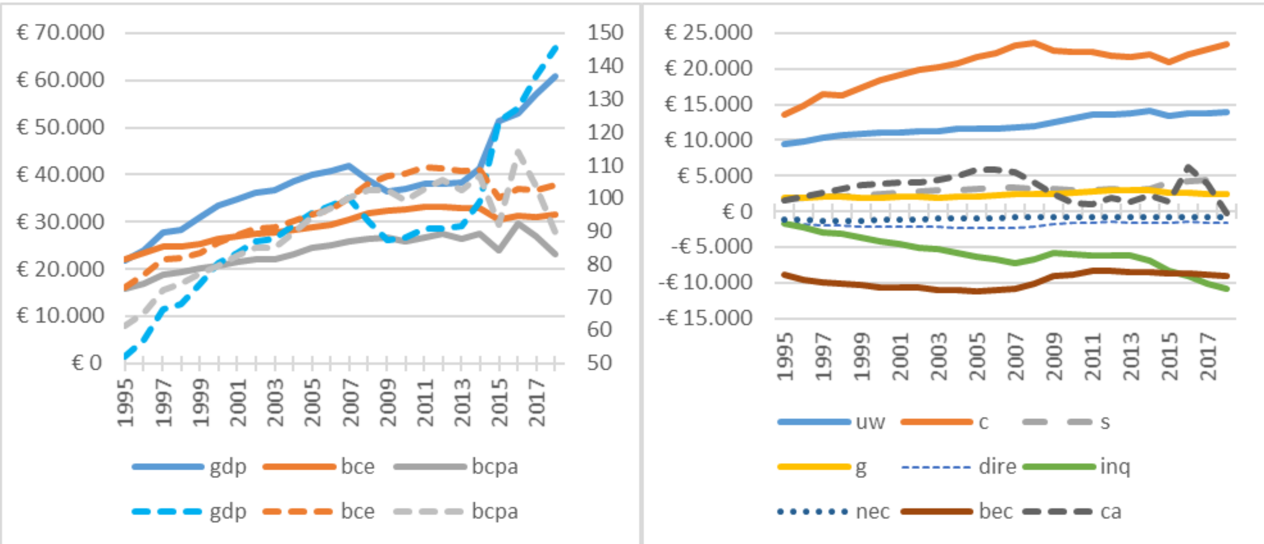




[34] The variability in the value of unpaid work depends entirely on changes in the wage rate. As I only have one datapoint, the number of unpaid hours worked is kept constant. Other countries have two datapoints, which allows me to interpolate the time use between both datapoints, which introduces time use variability too.

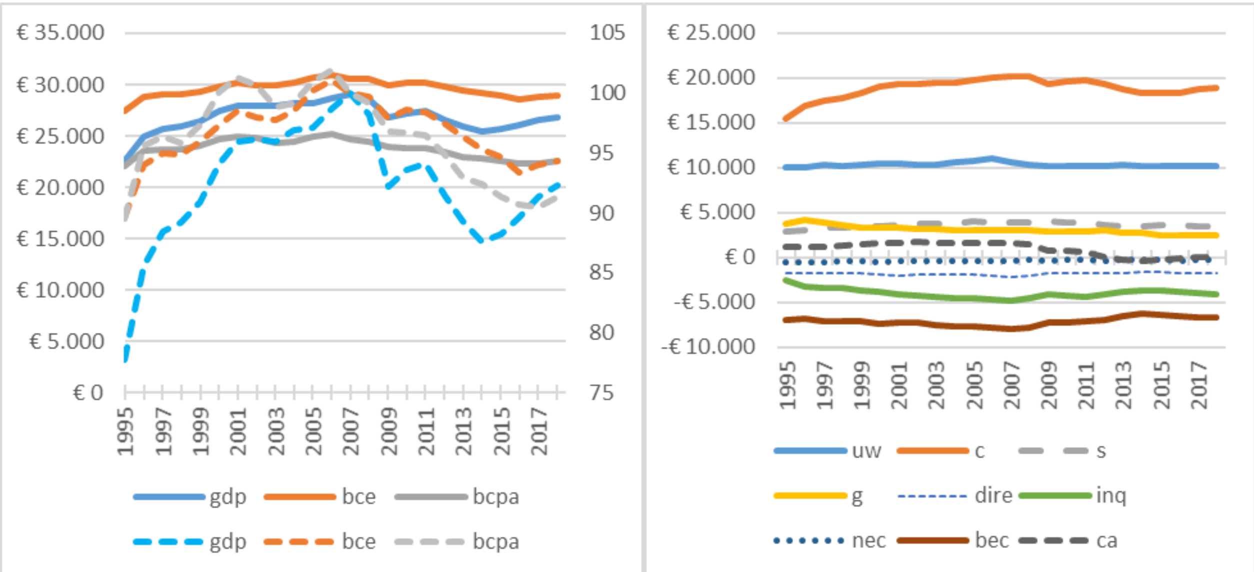
Ireland's economy grew remarkably during the mid-1990s to the late-2000s, the period when Ireland's economy was known as the 'Celtic Tiger'. Ireland's gdp almost doubled (+92.8%) between 1995 and 2007, as can be seen in Fig. 28. After a recession and stagnation from 2008 to 2013, gdp had grown by 180.7% over the entire study period. In 2018, Ireland's gdp reached its maximum with a value of more than €60,000. Ireland's improvement in bce and bcpa was about a quarter of its gdp growth: bce increased by 42.4% and bcpa by 45.7%. Its bce peaked in 2011, while its bcpa surged by 23.7% and peaked in 2016 after a strong increase in net capital growth by 376%. Bcpa by 9% and 13.6% in 2017 and 2018 because its capital adjustment plunged after its earlier spike and became negative in 2018. In contrast to the other countries, net capital growth is a quantitatively important welfare component that also introduces more variability in the Irish bcpa. Given the evolution of Irelands investments (in capital), the results of both bcpa and gdp – the Irish gdp grew by 24.5% in 2015 – are to be used and interpreted with caution.

Figure 28: Ireland's GDP, BCE and BCPA per capita in absolute values (left axis) and index values with 2007 = 100 (right axis) on the left panel and the evolution of the welfare categories in per capita values on the right panel. All values are in 2010 prices.



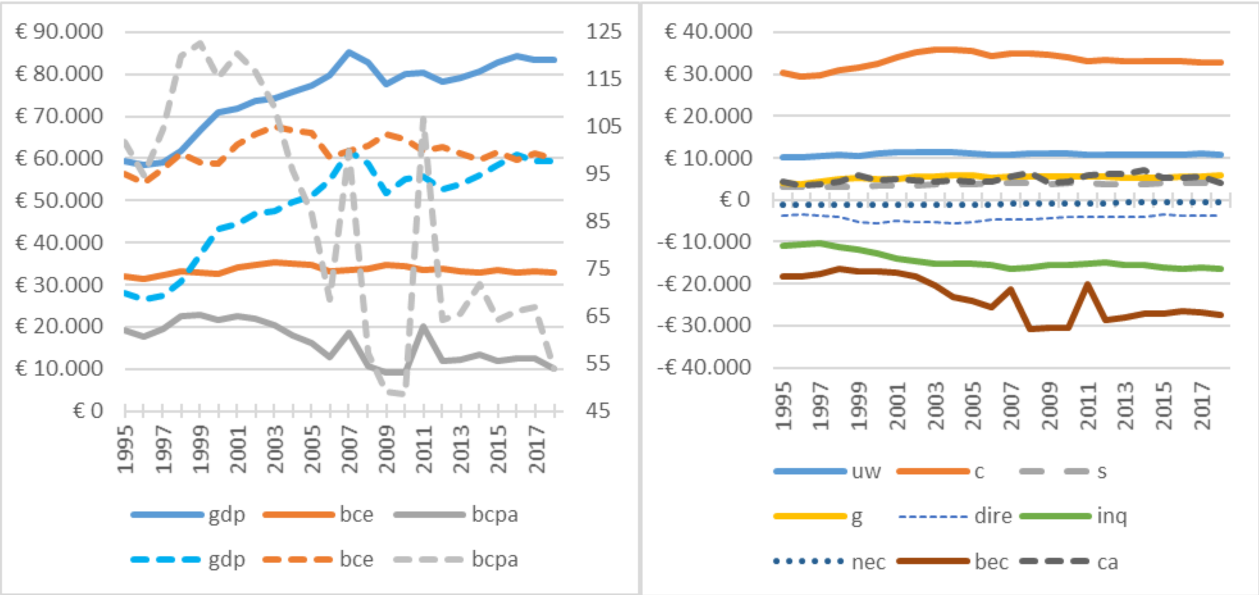
Italy is an outlier compared to the other countries as its bce is higher than its gdp during the entire period (see Fig. 29). Italy had a double recession as it first suffered from the financial crisis and later from the eurocrisis. In 2009, its gdp fell by 6.1% while the negative effect of the crisis was less severe for its bce and bcpa as the former decreased by 1.9% and the latter by 2.3%. During the eurocrisis, gdp, bce and bcpa dwindled between 2012 and 2014. Yet, bce and bcpa continued decreasing until 2016. Similar to Greece, Italy also capital adjustment decreased substantially after the financial crisis and Italy also had negative net capital growth between 20113 and 2017. Italy's gdp peaked right before the financial crisis in 2007 – it had grown by 28.6% compared to 1995 – and after the double recession, the Italian gdp was in 2018 18.7% higher than in 1995. Italy's bce and bcpa peaked in 2006 and were in 2018, respectively 5.2% and 2% higher than their starting value.

Figure 29: Italy's GDP, BCE and BCPA per capita in absolute values (left axis) and index values with 2007 = 100 (right axis) on the left panel and the evolution of the welfare categories in per capita values on the right panel. All values are in 2010 prices.



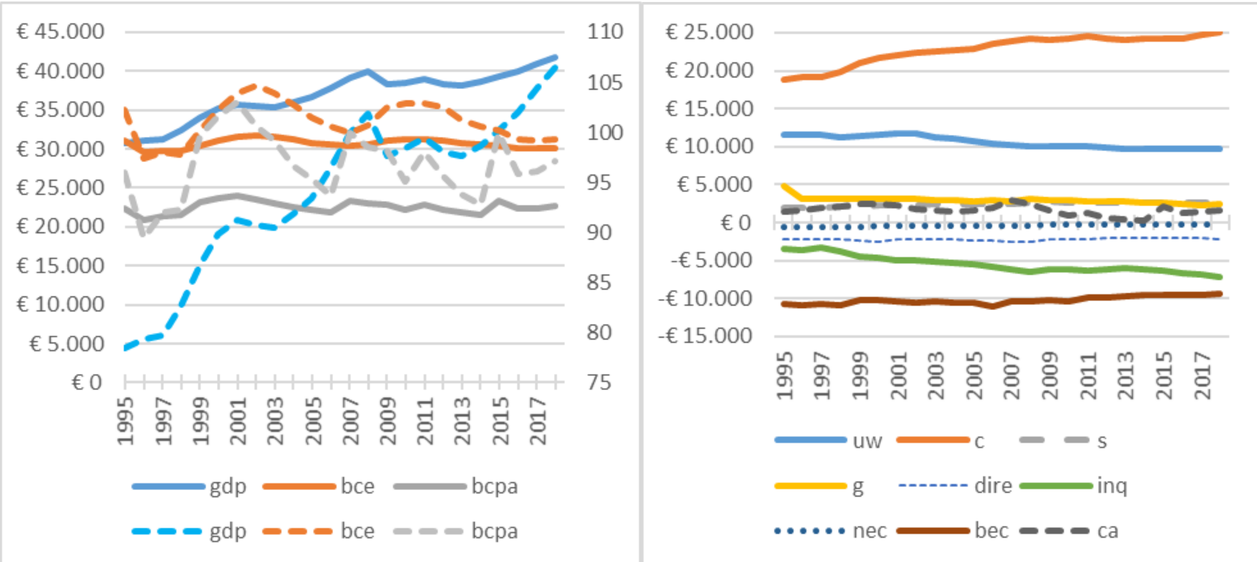
Similar to Ireland, *Luxembourg*'s gdp is extremely high too: its 2018-level of €83,000 was 40.1% higher compared to the initial year when it was almost at €60,000, as illustrated by Fig. 30. Luxembourg's bcpa was very volatile, with remarkable upturns and downturns between 2006 and 2008 and in 2011 and 2012 because its broader ecological costs – and in particular the cost of climate disruption – fluctuated heavily during these years. Bce was more constant throughout the entire period. Over the entire period, gdp and bce improved by respectively 40.1% and 3.5% whereas bcpa decreased by 47.1%. Luxembourg did not cross its 2007-peak value again by the end of the period and neither did it transgress its maxima in bce and bcpa that peaked in respectively 2003 and 1999.

Figure 30: Luxembourg's GDP, BCE and BCPA per capita in absolute values (left axis) and index values with 2007 = 100 (right axis) on the left panel and the evolution of the welfare categories in per capita values on the right panel. All values are in 2010 prices.



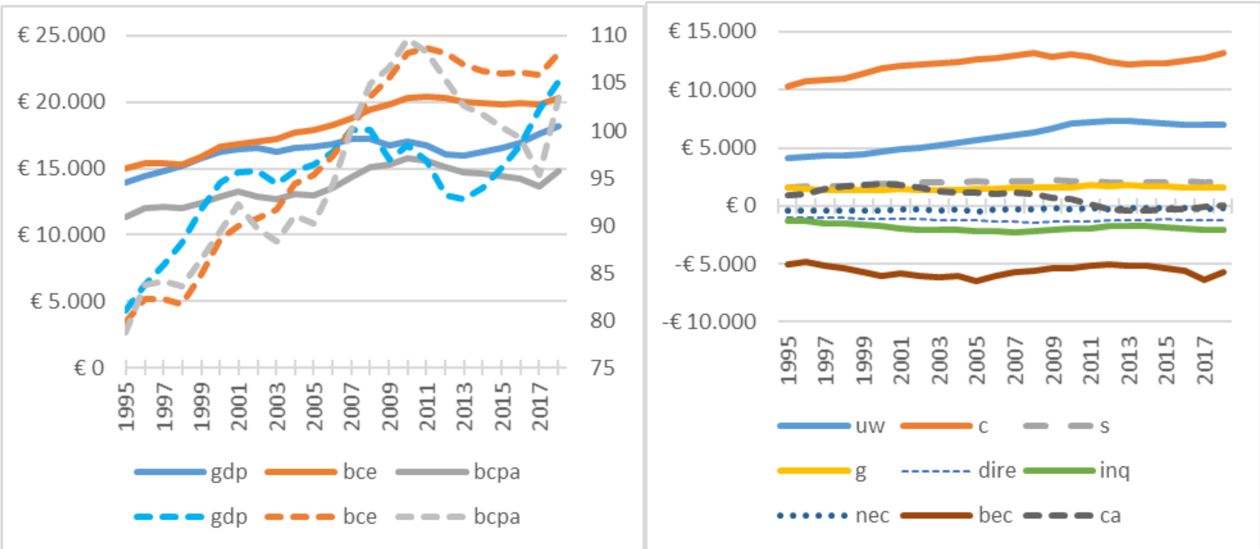
Netherlands' gdp reached its maximum in 2018 when it had increased by 35.7% since 1995 (see Fig. 31). Its bcpa, in contrast, only increased by 1.2% over time, while bce even decreased by 3%. Both ewm peaked early: bcpa peaked in 2001 and bce one year later. After their peak, both ewm decreased gradually in the early 2000s. During the financial crisis in 2009, both gdp and bcpa decreased by respectively 4.1% and 0.4%, yet bce improved by 1.8%. Also the Netherlands' bcpa has a stronger lagged effect of this crisis in 2010 mainly because the capital adjustment increased and to a lesser extent due to rising broader ecological costs. The crisis had a minor impact on the Dutch bce and bcpa, while Netherlands' gdp only fully recovered from the financial crisis by 2016.

Figure 31: Netherland's GDP, BCE and BCPA per capita in absolute values (left axis) and index values with 2007 = 100 (right axis) on the left panel and the evolution of the welfare categories in per capita values on the right panel. All values are in 2010 prices.



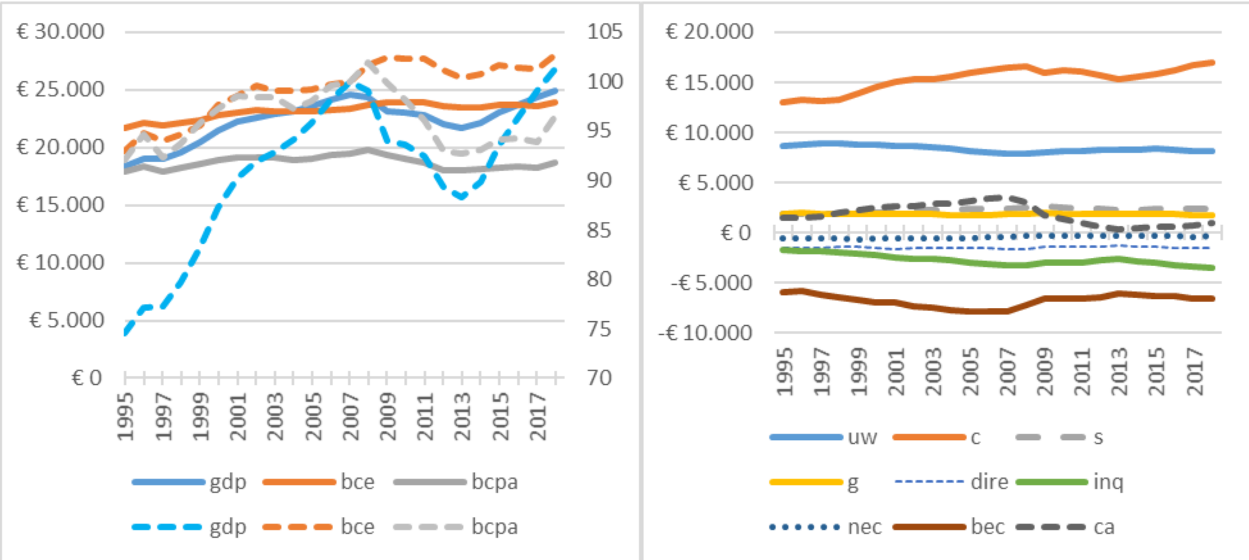
Similar to the Netherlands, *Portugal*'s bce was higher than its gdp throughout the entire period, as depicted in Fig. 32. Gdp grew by 29.8%, which is less than its welfare performance as bce and bcpa improved by respectively 35.5% and 31.5% over the study period. Portugal's ewm were not negatively affected by the financial crisis between 2009 and 2010, however, the eurocrisis caused a decrease in bce and bcpa between 2012 and 2017. Bcpa diminished more sharply than bce because the capital adjustment became negative. Parallel to Italy and Greece, Portugal also had negative net capital growth between 2012 and 2017.

Figure 32: Portugal's GDP, BCE and BCPA per capita in absolute values (left axis) and index values with 2007 = 100 (right axis) on the left panel and the evolution of the welfare categories in per capita values on the right panel. All values are in 2010 prices.



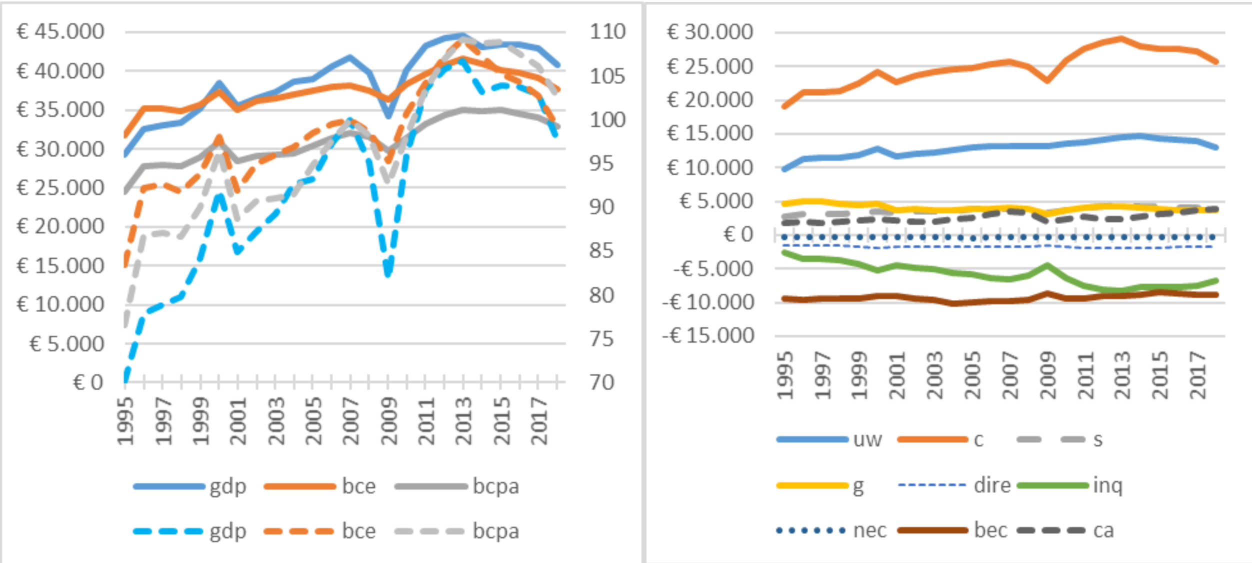
Spain is one of the few countries whose bce is higher than gdp during the largest part of the study period, as shown in Fig. 33. Spain's gdp and bce peaked in 2018 at a level that was respectively 35.9% and 10.4% higher than in 1995. The Spanish bcpa only improved by 4.7% and reached its peak in 2008. The financial crisis had a stronger impact on gdp and bcpa than on bce. Its gdp fell from 2007 to 2013, but recovered afterwards and surpassed its pre-crisis maximum value in 2018. Bcpa by 8.7% between 2008 and 2012, primarily because net capital growth fell sharply.

Figure 33: Spain's GDP, BCE and BCPA per capita in absolute values (left axis) and index values with 2007 = 100 (right axis) on the left panel and the evolution of the welfare categories in per capita values on the right panel. All values are in 2010 prices.



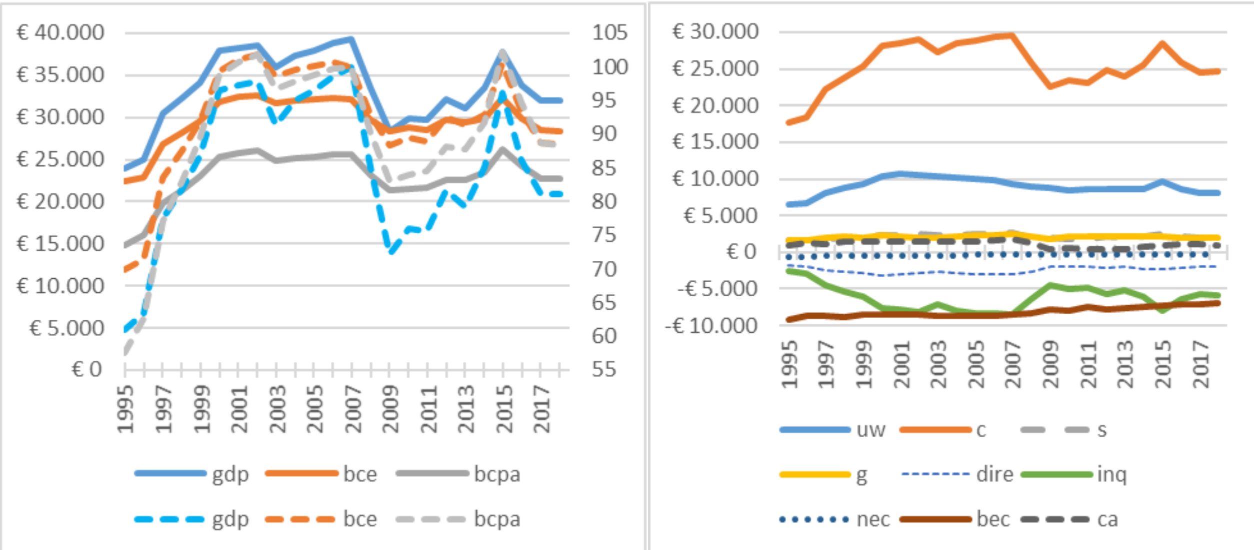
Sweden's gdp, bce and bcpa follow a very similar path as indicated by Fig. 34 . All indicators dropped markedly after the financial crisis, but recovered quickly. The financial crisis and its recovery resulted in a V-shape for the Swedish bce, bcpa and gdp: these measures fell between 2007 and 2009 by respectively 4.8%, 7.4% and 18.1% whereas they improved by respectively 14.6%, 17.9% and 30.3% between 2009 and 2013. All measures peaked in 2013 and fell subsequently. In 2018, the Swedish gdp is 39.4% higher than it was in 1995, however, the end value was 8.4% lower than its peak. The Swedish bce and bcpa rose by 18.7% and 34.1%, which is respectively 9.3% and 6% than their peak in 2013.

Figure 34: Sweden's GDP, BCE and BCPA per capita in absolute values (left axis) and index values with 2007 = 100 (right axis) on the left panel and the evolution of the welfare categories in per capita values on the right panel. All values are in 2010 prices.



The *UK*'s gdp and ewm follow very parallel trajectories (see Fig. 35). The UK's ewm and gdp improved immensely between 1995 and 2000. The UK's gdp peaked in 2007 when it had increased by 64.2% compared to 1995. The financial crisis impacted the UK heavily: in just two years, gdp fell by 27.8%, while bce decreased by 11.6% and bcpa by 17%. Bce and gdp partially recovered towards 2015, while bcpa peaked in 2015. From 2015 onwards, all indicators started dwindling after the UK decided to leave the European Union – gdp fell by 15.5%, bce by 11.7% and bcpa by 13.2% in just two years. Despite this economic setback at the end, gdp, bce and bcpa still had improved over the study period by respectively 33.3%, 26.7% and 53.5%.

Figure 35: The United Kingdom's GDP, BCE and BCPA per capita in absolute values (left axis) and index values with 2007 = 100 (right axis) on the left panel and the evolution of the welfare categories in per capita values on the right panel. All values are in 2010 prices.



3.3 Comparing peak values in the EU-15

In the previous section, some country's bce, bcpa and gdp reached a maximum value during and not at the end of the study period. We called this period maximum a *peak*. However, some peaks were only slightly higher than the value of these indicators in 2018, while other peaks were absolutely peaks in the sense that the peak value was much higher than the indicators' level at the end of the study period. Here we will compare which countries end values are only slightly below their peak values and which countries are well below their peak values. Table 10 gives an overview of the years in which gdp, bce and bcpa peaked and the relative difference of these indicator's value compared to the peak value.

The EU-15's bce and bcpa peaked in 2006 and 2007, however, their level in 2018 was only 1.5% and 1.8% lower than their peak value. Yet, the bce value in 2018 was at least 5 percent lower than its maximum value for Ireland, Italy, Luxembourg and Netherlands. The 2018-bce was much lower than peak-bce in Greece (-20.1%), Sweden (-9.3%) and the UK (-13%). When we compare bcpa-values, then we observe that more countries are well below their peak-value. Netherlands, Portugal, Spain and Sweden are more than 5 percent below their maximum bcpa-value in 2018, while the 2018 bcpa-value of Italy and the UK is respectively 10.4% and 13.7% lower than at the maximum value. The reduction in bcpa was worst in Ireland Greece and Luxembourg, where the 2018 bcpa-values were respectively 21.4%, 32.9% and 56% lower than their maximum bcpa-value. Finally, gdp reached a maximum for the EU-15 and most of its countries in 2018. Yet, gdp had decreased in Italy by 7.7%, in Sweden by 8.4%, in the UK by 18.8% and in Greece by 21.8% in 2018 compared to their period maximum-gdp.

Table 10: Year in which the EU-15-countries reached their peak or maximum GDP, BCE and BCPA (in per capita values, 2010 prices) and the relative difference between the value in the peak year and in 2018.

	gdp		bce		bcpa	
	max year	%Δ(2018-max year)	max year	%Δ(2018-max year)	max year	%Δ(2018-max year)
EU-15	2018	0	2006	-1,5	2007	-1,8
Austria	2018	0	2013	-1,2	2000	-3,1
Belgium	2018	0	2009	-0,3	2018	0
Denmark	2018	0	2012	-0,9	2018	0
Finland	2008	-1,7	2012	-0,5	2012	-4,3
France	2018	0	2018	0	2018	0
Germany	2018	0	2012	-0,9	2000	-1,7
Greece	2007	-21,8	2009	-20,1	2007	-32,9
Ireland	2018	0	2011	-5,2	2016	-21,4
Italy	2007	-7,7	2006	-6,7	2006	-10,4
Luxembourg	2007	-2,1	2003	-6,4	1999	-56
Netherlands	2018	0	2002	-5,2	2001	-5,6
Portugal	2018	0	2001	-0,6	2010	-5,7
Spain	2018	0	2018	0	2008	-5,3
Sweden	2013	-8,4	2013	-9,3	2013	-6
UK	2007	-18,8	2002	-13	2015	-13,7

Note: The color scale for the peak values indicates the most recent peak years in shades of green and the oldest peak years in shades of red.

4. Revisiting the threshold hypothesis

Our welfare results for the EU-15 as a whole do not indicate a strong decline compared to its peak value. Yet, our results clearly indicate that: (a) welfare has been stagnating after the financial crisis of 2008 and 2009, (b) our welfare measures have not recovered from the financial crisis, while gdp has and (c) the economic welfare measures in majority of the EU-15 countries (i.e. Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain, Sweden and the UK) were more than 5% lower by the end of the study period in 2018 compared to their earlier welfare peak.

Our results for the countries just mentioned gives evidence regarding Max-Neef's (1995) threshold hypothesis, stating 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 being to deteriorate". Yet, our findings for the EU-15 as a whole give no conclusive evidence regarding the threshold hypothesis, since the economic welfare per capita in the EU-15 as a whole is less than two percent below its period maximum. The reason that the threshold hypothesis fails to materialize for the EU-15 as a whole could, however, be methodological as the EWM only include a limited amount of ecological items. The methodology that is currently used, for instance, does not include the losses in agricultural land, forests, grasslands and wetlands, because of a lack of available data. Chapter 4 will look into this in greater detail.

Max-Neef (1995) thought of the threshold as indicating the point "in a country's economic evolution where quantitative growth must be metamorphosed into qualitative development", yet, he acknowledged that welfare could still increase. If we acknowledge that (a) ever increasing incomes will lead to increasingly smaller additions to welfare due to the correction for the diminishing marginal utility of income, (b) economic growth is ecologically costly and (c) many economists argue that we are in a situation of *Secular Stagnation*, in which economic growth rates have declined and are not likely to return to their earlier higher growth rates (Summers, 2016; Jackson, 2018), then policies that empower economies and societies to fare well without growth will become increasingly important in the future. With effective social and environmental welfare policies in place, EWM could increase beyond their earlier welfare peak or threshold point. Examples of these policies, could be a Green New Deal without growth (Mastini et al., 2021), measures that make social security and welfare systems less dependent on growth (Bohnenberger and Fritz, 2020), or a post-COVID economic agenda that takes into account inequality (Ashford et al., 2020) and biodiversity (McElwee et al., 2020) to build back better. More concretely, Büscher et al. (2021) outline five priorities for a post-COVID development pathway: (1) a move away from development focused on aggregate economic growth, (2) an economic framework focused on redistribution and care, (3) a transformation towards regenerative agriculture and convivial conservation, (4) reduction of consumption and travel, and (5) debt cancellation.

5. Conclusion

This paper is the first to calculate welfare for the EU-15 as a whole and for its 15 original members using a comparable methodology. Two economic welfare measures were calculated, the benefits and costs experienced (BCE) and the benefits and costs of present economic activities (BCPA). The former only looks at what is experienced here and now: it only includes present ecological costs within borders and excludes capital adjustments. The broad measure looks at the impacts of present activities and, as a consequence, it includes capital adjustments and also contains the ecological costs that are shifted in time and space. Since there are substantial costs shifted in time and space, we argued that the broad welfare measure is to be preferred to inform policy-makers about the (need to tackle the) climate and ecological crisis.

For the EU-15, GDP per capita increased by 30.8% between 1995 and 2018, while its BCE and BCPA improved by respectively 12.9% and 17%. These trends in per capita BCE and BCPA were driven by individual consumption growth (+29.3%) and the welfare losses from income inequality (+97.5%), yet, since the welfare losses from income inequality increased, part of the growth in consumption is not translated into welfare because of the diminishing marginal utility of income. Despite these overall improvements over the entire period, GDP per capita barely improved after 2007: it only fully recovered from the financial crisis in 2018, when the EU-15's GDP per capita reached its maximum value that was slightly higher than its pre-crisis level. The EU-15's economic welfare per capita already peaked right before the financial crisis in 2006 for BCE and in 2007 for BCPA. In 2018, BCE per capita and BCPA per capita were respectively 1.5% and 1.8% below their maximum values. As a consequence, we found no conclusive evidence regarding the threshold hypothesis for the EU-15 as a whole. However, we found evidence of threshold points in Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain, Sweden and the UK, where the welfare levels were at least 5% lower by the end of the study period in 2018 compared to their maximum welfare value.

Finally, the financial crisis and its recovery had a different impact on GDP and economic welfare measures. In contrast to GDP, the response in economic welfare measures to the financial crisis of 2009 was delayed in some countries: their per capita BCPA only fell during the economic GDP-recovery in 2010 as the broader ecological costs increased. At the level of the EU-15, the broader ecological costs decreased in 2009 but increased again in 2010 during an environmentally more polluting recovery in GDP per capita. Our results thus indicate in a post-COVID agenda it is needed to aim for a green and just economic recovery that is centered around welfare and a move beyond GDP that prioritizes human well-being within planetary boundaries without growth.

Chapter 4 : Are the ISEW and GPI able to reveal social and biophysical limits to growth? An in-depth analysis of the threshold hypothesis for the EU-15.[35]

1. Introduction

Over the last decade, calls have been made to urgently move beyond GDP as it is a bad indicator for social welfare, societal well-being or economic progress (Stiglitz et al., 2009, 2018; Costanza et al., 2014, Kubiszewski et al., 2013; Hoekstra, 2019). As a way to guide the transition away from GDP toward sustainable well-being, countries should adopt new metrics (Costanza et al., 2014). The Index of Sustainable Economic Welfare (ISEW) or its variant, the Genuine Progress Indicator (GPI), are potential candidates to do so, because they account for many of GDP's deficiencies when used as a welfare indicator. These economic welfare measures (EWM) register the monetary benefits and costs of economic activities and make adjustments for the value of unpaid work, the diminishing marginal utility of income, the consumption of physical and natural capital and the externalities or costs shifted to society and the ecosystem. Other attempts to guide the transition beyond GDP toward well-being and sustainability also favor a move beyond a single indicator by focusing on a set or dashboard of indicators – see, for instance, Meadows (1998), Stiglitz et al. (2009), O'Neill (2012), Raworth (2017) and O'Neill et al. (2018). The key advantage of EWM is that they provide a direct alternative to GDP to evaluate economic performance in a broader way. In order to overcome the criticisms regarding the one-dimensionality of and monetary valuation in EWM, Berik (2018) suggested to complement the welfare measurement approach with a narrative approach in a plural policy-input process.

Despite the fact that GDP is widely criticized, it is still influential in politics, economics, policy-making and society (van den Bergh, 2009). According to van den Bergh, this "GDP paradox" can be explained by recognizing that many economists accept the GDP-criticism but refute its relevance. Daly and Cobb (2007) thought that a conservatively estimated ISEW that is no longer correlated with GDP would help to persuade economists to no longer deny the relevance of the GDP-criticism, and consequently facilitate the move

[35] This paper is co-authored with Brent Bleys (Ghent University).

beyond GDP. Therefore, several authors claim that the ISEW can best be seen as an indicator to ‘debunk’ GDP as a policy guide and objective (Ziegler, 2007; Daly and Cobb, 2007).

The first welfare studies in the early 1990s confirmed this divergence between GDP and the ISEW, which led Max-Neef (1995, p. 117) to formulate the 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.” Nonetheless, authors such as Neumayer (1999, 2000), for instance, were critical of the materialization of the original threshold hypothesis as the results were highly dependent upon methodological choices for the valuation of non-renewable resource depletion and long-term environmental damage such as accumulating environmental costs over time. Max-Neef (1995) alluded the threshold point may be the vindication of John Stuart Mill’s (1848) stationary state or Herman Daly’s (1974) steady-state economy. A study estimating the global GPI based on the welfare results from 17 countries (containing 53% of global population and 57% of global GDP) for the period 1950-2003 found that global GPI per capita peaked in 1978 (Kubiszewski et al., 2013). Kubiszewski and co-authors argued that the focus in development policies needed to shift “away from maximizing production and consumption (GDP) and towards improving genuine human well-being (GPI or something similar). This is a shift that will require far more attention to be paid to environmental protection, full employment, social equity, better product quality and durability, and greater resource use efficiency (i.e., reducing the resource intensity per dollar of GDP).” Also Max-Neef (1995) thought of the threshold as indicating the point “in a country’s economic evolution where quantitative growth must be metamorphosed into qualitative development”, yet, he acknowledged that welfare could still increase.

The threshold hypothesis is based on the common economic principles of decreasing marginal benefits and increasing marginal costs. Based on these principles one would expect as production and consumption grow over time that the additional benefits of growth would be decreasing due to the diminishing marginal utility of income and that the additional costs caused to the ecosystem would be increasing because infinite growth on a limited planet is ecologically destructive. Or in other words: there are social and biophysical limits to growth. Since, few studies have investigated the empirics behind the threshold hypothesis, this study explores whether the recent welfare study for the EU-15 from 1995 to 2018 in Chapter 3 gives evidence in favor of decreasing marginal benefits and increasing marginal costs.

This paper is structured as follows. Section 2 explains the welfare methodology used for the EU-15, while Section 3 articulates the rationale and expectations behind the threshold hypothesis. Section 4 examines the existence of social and biophysical limits to growth in the EU-15's welfare and while we find no clear threshold point for the period from 1995 to 2018, we do observe that welfare per capita has been stagnating after the financial crisis. Section 5 outlines that we have to interpret the aggregate welfare trend with caution as the current EWM methodology only is able to capture the effect of social limits to growth but less so when it comes to capturing the unprecedented scale and urgency of the ecological challenges (i.e. biophysical limits to growth). This section also proposes different ways in which EWM could be used to increase their transformative potential. Finally, we will also suggest a "living well within limits" narrative to accompany EWM as a concrete alternative to move beyond GDP.

2. Two economic welfare measures with two distinct interpretations

EWM were historically developed as a response to account for GDP's deficiencies as a welfare measure by tracking both the monetized benefits and the costs of economic activities. Yet, as argued by Van der Slycken and Bleys (2020a) there are two different ways to look at these benefits and costs. One perspective sees welfare as the benefits and costs *experienced* today (BCE), while the other views welfare as accounting for the current and future benefits and costs of present economic activities (BCPA). The corresponding welfare measures both include welfare categories that account for unpaid work, individual consumption, non-defensive government expenditures and the shadow economy as benefits, while defensive, intermediate and rehabilitative expenditures, ecological costs and the welfare losses from income inequality are deducted. However, the ecological costs of economic activities are included differently in both measures. BCE only includes the *narrow* ecological costs experienced here and now, i.e. present ecological costs within domestic borders, while BCPA incorporates *broader* ecological costs that additionally include those costs that are shifted in time and space. Finally, BCPA also includes net capital growth as it can be regarded as a benefit from present activities. BCE does not include this capital adjustment since it does not yield present experiences. As explained in Chapter 2, both EWM can be mathematically represented as:

$$BCE = UW + C_i + S + G_c - DIRE_p - INQ - NEC \qquad (3)$$

$$BCPA = UW + C_i + S + G_c - DIRE_p - INQ - BEC + \Delta K \qquad (4)$$

In Eqs. 3 and 4: UW = unpaid work, C_i = individual consumption, S = shadow economy, G_c = non-defensive collective government consumption, $DIRE_p$ = defensive, intermediate and rehabilitative private expenditures, INQ = welfare losses from income inequality, NEC = narrow ecological costs that are experienced in the present and within domestic borders, BEC = broad ecological costs, including current costs within domestic and the costs shifted in time and space, ΔK = capital adjustment. UW, C_i, S, G_c are valued positively; INQ, $DIRE_p$, NEC and BEC are deducted, whereas ΔK can be either positive or negative. BCE only includes NEC, while BCPA incorporates BEC. NEC includes the current cost of air pollution, the cost of extreme weather events and the cost of nitrogen pollution. BEC additionally incorporates the future cost of air pollution and the cost of air pollution embodied in trade, the cost of climate disruption, the cost of use of nuclear power and the depletion of non-renewable energy resources, while it excludes the cost of extreme weather events in order to avoid double counting with the cost climate disruption.

For the remainder of this paper, we will reorganize the categories in Eqs. (3) and (4) into a benefit and cost account. The costs of economic activity mainly relate to the *ecological costs*, i.e. the costs related to environmental pollution, environmental degradation and natural capital depletion. The costs caused to the ecosystem are taken into account in EWM because nature is the ultimate means or the ultimate source of wealth that provides the economy with low entropy materials and energy as inputs, assimilates high entropy waste outputs and provides the necessary conditions for a life-sustaining planet such as a benign climate. Since human-made capital depreciates, a continuous flow of matter and energy ('throughput') from nature to the economy is needed to fuel economic activity and maintain human-made capital. In this process, part of nature's source, sink and life-support services are lost or sacrificed. That is why, the ISEW registers these losses as the ultimate costs of economic activities. Lawn (2008) explains that these ecosystem costs or these natural capital services lost in the economic process go back to Daly (1979). The benefits of economic activity is the sum of all the other categories. Although defensive, intermediate and rehabilitative expenditures are deducted, we do not classify them as a cost because they merely serve to know what part of consumption expenditures should count as a net benefit. In conclusion, the benefits and cost account for BCE and BCPA are thus equal to:

$$B_{BCE} = UW + C_i + S + G_c - DIRE_p - INQ \quad (11)$$

$$C_{BCE} = NEC \quad (12)$$

$$B_{BCPA} = UW + C_i + S + G_c - DIRE_p - INQ + \Delta K \quad (13)$$

$$C_{BCPA} = BEC \quad (14)$$

where B_{BCE} = the benefits of the BCE-interpretation, C_{BCE} = the costs of the BCE-interpretation, B_{BCPA} = the benefits of the BCPA-interpretation and C_{BCPA} = the costs of the BCPA-interpretation.

3. The rationale behind the threshold hypothesis

The main reason why welfare practitioners expect a threshold and why GDP would at some point no longer be correlated with welfare can be linked to the principle of the decreasing marginal utility of income and the principle of increasing marginal cost. These principles make it for an enterprise only optimal to expand its scale or to grow up to the point where the additional benefits are equal to the extra costs. If it expands its scale any further, then it becomes suboptimal. While these are a common microeconomic principles, Daly and Farley (2004) argue that in ecological economics, the logic of the optimal scale also applies to the entire macroeconomy and its parts. At the macroeconomic level, it is only desirable to expand the physical scale of the economy (i.e. to grow or to increase production and consumption), if the additional benefits are larger than the additional costs. In this case growth is economic because it brings more benefits than costs. If the additional costs outweigh the benefits, than growth is 'uneconomic' (Daly, 1996) or 'anti-economic' (Lawn and Sanders, 1999). At the macroeconomic level, the principles of diminishing marginal benefits and increasing marginal costs are known as, respectively, social limits to growth (Hirsch, 1976; Kallis, 2015) and biophysical limits to growth (Meadows et al., 1972).

Since EWM measure the difference between the benefits and costs of economic activities, it is expected that economic welfare will start to decrease once marginal costs exceed marginal benefits (Lawn and Sanders, 1995) and, as a consequence, the threshold hypothesis will be confirmed. For Lawn (2008, p. 71) the switch from economic to uneconomic growth is "an inevitable outcome given the applicability of the principles of diminishing marginal benefits and increasing marginal costs in a finite world subject to the first and second laws of thermodynamics and where human beings possess a limited physiological capacity to experience well-being". According to Lawn (2008) EWM are capable to signal whether growth is economic or uneconomic and whether an economy has exceeded its optimal macroeconomic scale. Yet, although the issue of scale is a central element in Daly and Cobb's (1989) book For the Common Good, in which the ISEW was introduced in the appendix, they did not explicitly connect the ISEW to the optimal scale. This was only done later on by Lawn and Sanders (1999) and Brennan (2008). Nonetheless, the elaboration of the ISEW was motivated by the problem of scale between the economy and the ecosystem (Daly and Cobb, 1989; Brennan, 2008; Ziegler, 2007).

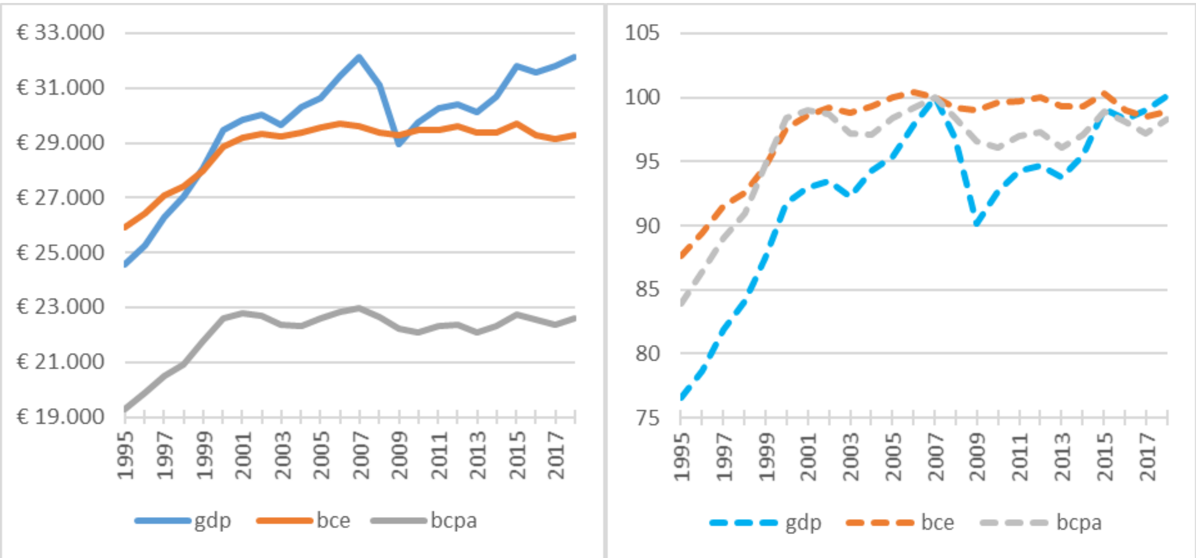
The principles of diminishing marginal benefits and increasing marginal costs enter EWM via adjustment for the welfare losses from income inequality and via the ecological costs. Income growth is subject to diminishing marginal utility. The extra benefit of an extra dollar for wealthy people is much lower than giving an extra dollar to people in need. Furthermore, there is also a diminishing marginal utility of total income growth over time. Because of the existence of status or positional goods and phenomena such as "keeping up with the Joneses" (e.g. larger houses and expensive cars), the gains from possessing these goods disappear as incomes grow and give more people access to them, which illustrates that there are certain social limits to what growth can deliver in terms of social welfare or well-being (Hirsch, 1976; Kallis, 2015). Or to put it in other words: when a rising tide lifts all boats, no one notices that the tide is rising. Since EWM deduct the welfare losses from income inequality as a way to account for the diminishing marginal utility of income, it is expected that net consumption after the inequality correction is subject to diminishing marginal benefits. As a consequence, the benefits of economic activity (i.e. B_{BCE} and B_{BCPA}) should also be subject to diminishing marginal returns.

The costs of economic activity (i.e. C_{BCE} and C_{BCPA}) mainly relate to the ecological costs, as already explained in Section 2. After the Limits to Growth report in 1972, an increasing number of studies indicates that economic growth comes at an enormous 'ecological cost'. The life-supporting Earth System has already been severely impacted by human activities. In a recent paper titled 'Scientists' warning on affluence', Wiedmann et al. (2020) illustrate that environmental impacts are mainly driven by affluence: "for over half a century, worldwide growth in affluence has continuously increased resource use and pollutant emissions far more rapidly than these have been reduced through better technology". Steffen et al. (2015) found that several planetary boundaries have already been crossed, which means that humanity may push itself out of a 'safe operating space' (Rockström et al., 2009). Climate change, for instance, poses an increasing threat of unexpected and irreversible changes in the climate system (Lenton et al., 2019). If climate tipping points are crossed, the Earth System would be on a "Hothouse Earth" trajectory that is likely to lead to severe disruptions ecosystems, societies and economies (Steffen et al., 2018). Since economic activities and economic growth are closely linked to an acceleration in climate change, environmental degradation and the loss of biodiversity and natural capital (EEA, 2020), there are increasing ecological costs associated to growth and economic activities. Incessantly pursuing infinite growth on a finite planet will eventually make the ecological costs rise exponentially and go to infinity as the ecological catastrophe limit is being approached (Daly and Farley, 2004; Daly, 2005). That is why, one would expect increasing ecological costs in EWM.

4. A threshold point for the EU-15?

In order to verify the existence of a threshold point for the EU-15, we will investigate whether an expansion of the scale of the macroeconomy measured by GDP is coupled with welfare or not by using the data from Chapter 3. We will focus on per capita data of GDP, BCE and BCPA (in lower case) to filter out the population trend. Over the entire period from 1995 to 2018, gdp grew by 30.8%, while bcpa and bce improved by respectively 17% and 12.9%. During this period, the correlation between gdp and bce and gdp and bcpa was high with respectively R^2 = 0.858 and R^2 = 0.865. Fig. 36 illustrates that growth in gdp is coupled to welfare improvements in bce and bcpa during the first period right before the global financial crisis. Yet, during after the crisis in 2008/2009 and its aftermath, welfare and gdp seem to have decoupled. From 2008 to 2018 the correlation between gdp and bce dropped to 0.018 versus 0.623 between gdp and bcpa. Bce and bcpa are stagnating after a gdp per capita level of € 29,000 has been reached. Since the results do not give evidence of a clear deterioration of welfare, we conclude that there is not enough evidence in the EU-15 data to support the threshold hypothesis.

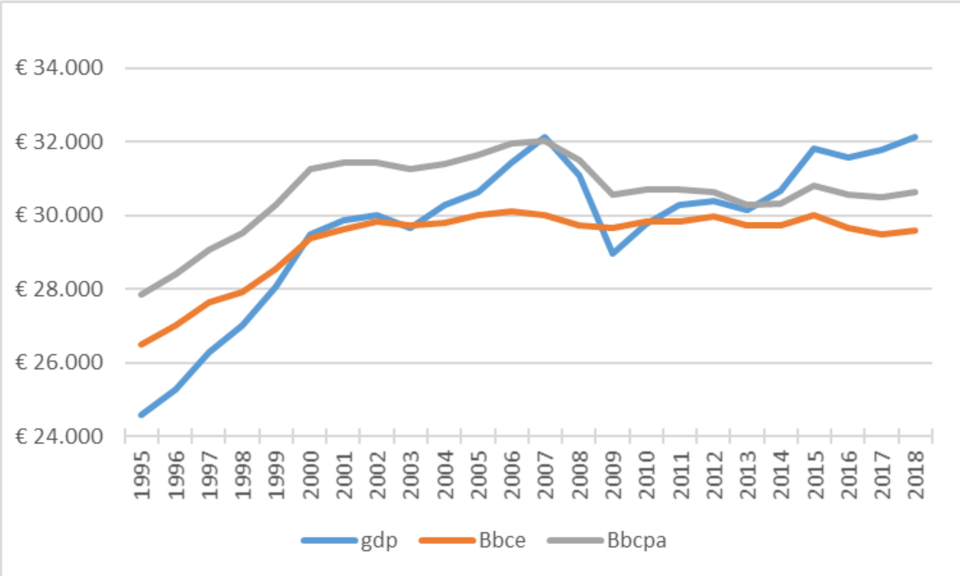
Figure 36: Welfare and GDP per capita for the EU-15 in prices of 2010 (left panel) and as index values with 2007 = 100 (right panel).



Nonetheless, since bce and bcpa have reached a plateau, we will scrutinize the benefits (B) and costs (C) accounts of bce and bcpa to investigate what is driving this stagnation. Over the period 1995-2018, both the B_{bce} and B_{bcpa} increased – respectively by 11.7% and 10%. Yet, this aggregate trend hides that already before the financial crisis in 2008 and 2009, B_{bce} and B_{bcpa} reached a period peak in respectively 2006 and

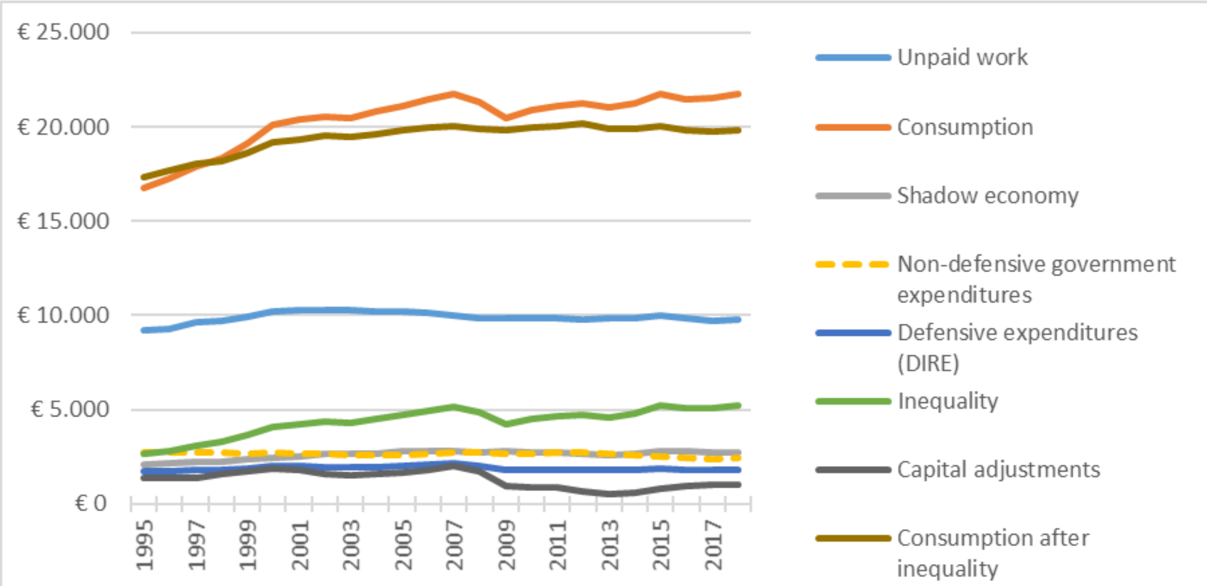
2007, as shown in Fig. 37. While gdp is 0.08% higher in 2018 than in 2007, B_{bce} and B_{bcpa} have not recovered from the financial crisis: in 2018 B_{bce} and B_{bcpa} are respectively 1.35% and 4.32% lower than their 2007 peak.

Figure 37: GDP per capita and the per capita benefit accounts of BCE and BCPA (in prices of 2010).



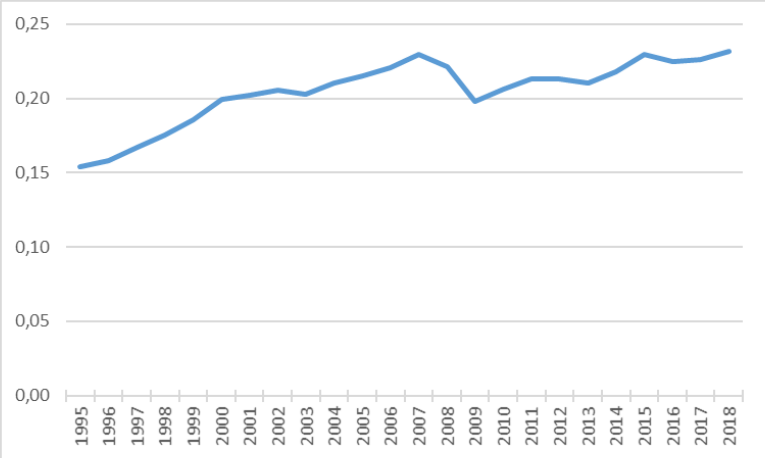
A detailed breakdown of the benefit accounts in Fig. 38 illustrates that individual consumption expenditures have steadily increased from 2009 onwards, offering no explanation for the stagnation of B_{bce} and B_{bcpa}. Yet, the welfare losses from income inequality have increased toward the end of the study period. As a consequence, the 'consumption after adjustments for inequality' (i.e. individual consumption expenditures, the shadow economy and the non-defensive government expenditures minus defensive expenditures and the welfare losses from income inequality) remains almost constant at €20,000 from 2006 onwards. In the case of the B_{bce}, there is a clear decrease between 2007 and 2009, which is caused by a fall in net capital growth.

Figure 38: Components of the benefit account of BCE and BCPA (per capita values, in prices of 2010).



In 2018, B_{bce} and B_{bcpa} were respectively €405 and €1,382 lower than they were in 2007. These decreasing benefits were caused by a decreases in non-defensive government expenditures (-€277), the value of unpaid work (-€218), the shadow economy (-€89) and individual consumption expenditures (-€47). These decreases in positive welfare contributions more than compensated a decrease in the defensive, intermediate en rehabilitative expenditures by €301. The downward trend can additionally be explained by a slight increase in the welfare losses from income inequality by €75. The stronger decrease of B_{bcpa} is caused by a decline in the capital adjustment by €977, which almost halved net capital growth. The increase in the welfare losses from income inequality is noteworthy. Based on the methodology of this component, one would expect the welfare losses to decrease as individual consumption, the shadow economy and also the defensive expenditures dropped. Yet, the welfare losses increased because the inequality adjustment factor increased over time, as shown in Fig. 39. The inequality adjustment factor is calculated based on the principle of diminishing marginal utility of income, and adjusts the incomes higher than a certain sufficiency level downward. The increasing inequality adjustment, thus indicates that incomes are more unevenly distributed. As a consequence, a higher portion of incomes is subject to the diminishing marginal utility of income such that the growth in individual consumption is not translated into welfare. Our methodology that makes use of a sufficiency threshold is thus capable of signaling the fact that there are social limits to growth or that aggregate consumption growth yields little welfare gains beyond a certain point, especially if incomes are distributed unevenly.

Figure 39: Evolution of the inequality adjustment factor for the EU-15 from 1995 to 2018.



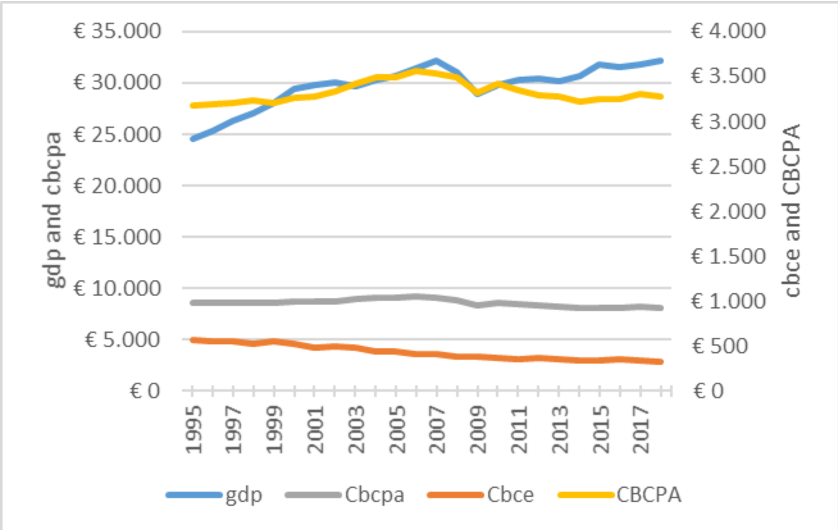
The benefit accounts of bce and bcpa already give evidence on why welfare has stagnated after the financial crisis. Yet, now we will turn to the question whether the ecological costs in the cost account of bce and bcpa also help to explain this plateauing. C_{bce} and C_{bcpa} both decreased over time, the former dropped by 42.7%, while the latter decreased by 5.9% (see Fig. 40). Note that, on the aggregate level the evolution of ecological costs was different: C_{BCE} still decreased by 37.2%, however, C_{BCPA} actually increased by 3.1%. These aggregate numbers might give a better indication on the EU15's total ecosystem impacts compared to per capita numbers as it is the total environmental impact that counts to evaluate the impact on the ecosystem.

Since the amount of ecological items is only limited in the narrow ecological costs of C_{BCE} and thus will be less appropriate to evaluate whether the ecological costs increase as the economy grows, it is better to investigate the broader ecological costs of C_{BCPA}, which are substantial. C_{BCPA} was positively coupled to gdp before the financial crisis, which may point us in the direction of increasing ecological costs of growth. Nevertheless, the costs fell together with GDP during the crisis. In the economic recovery in 2010s, gdp and C_{BCPA} increased simultaneously. Yet, from 2011 onwards there was some *decoupling* (i.e. divergence) between GDP and C_{BCPA}, which illustrates that continued gdp growth was not associated with increasing broader ecological costs.

The overall increase in the broader ecological costs (that are included in our methodology) by 3.6% is mainly driven by a rise in the costs of climate disruption by 24.7%, which outweighed the reduction by 16% in the other ecological costs (i.e. the cost of air pollution, the cost of nitrogen pollution, the depletion of non-renewable resources and the cost of using nuclear energy) – see Fig. 41 for an evolution of the broader ecological cost items. Although the total amount of greenhouse gas emissions decreased by 10.6% from

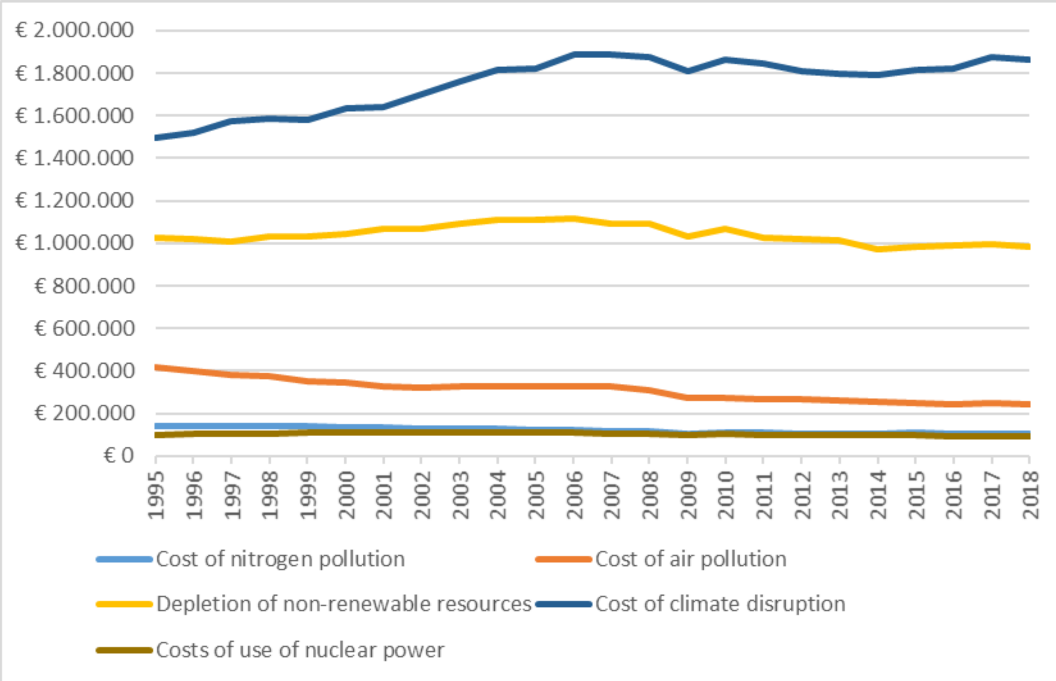
1995 to 2018, the costs of climate disruption did actually rise because the social cost of carbon increased by 39.5% over time as the social cost of carbon grew annually by 1.457%. To conclude, the slight increase in C_{BCPA} indicates that ecological costs have increased over time. Yet, from 2006 onwards the broader ecological costs have decreased. That is why, the reduction in the broader ecological costs offers no explanation for the decrease and stagnation of bcpa during and after the financial crisis. The fact that the cost accounts are not increasing goes against what could have been expected based on the principle of increasing ecological costs if environmental conditions worsen. In the next section, we will discuss the reasons why this is the case.

Figure 40: Gdp per capita and the cost account of bce and bcpa for the EU-15 from 1995 to 2018.



Note: Gdp, C_{bce} and C_{bcpa} are per capita values in 2010 prices, whereas the aggregate C_{BCPA} are in billion euros in 2010 prices. C_{bcpa} and gdp are shown on the left axis, while the right axis depicts C_{bce} and C_{BCPA}.

Figure 41: The items of the broader ecological costs for the EU15 from 1995 to 2018 (million euros, in prices of 2010).



5. Discussion

5.1 Caveats of the current methodology

We observe no clear threshold point, which may be a peculiar finding after decades of economic growth and overshooting the Earth's biocapacity. Against the background of decades of growth and the current ecological crisis in Europe, welfare practitioners would expect that Europe would have crossed the threshold. Are our EWM poorly reflecting there are social and biophysical limits to growth or is the way we are interpreting the data flawed or is it a combination of both? To answer this question, we will scrutinize the methodology used for the ecological costs and inequality adjustment and the state of the environment in Europe.

5.1.1 Social limits to growth

In Section 4, we found evidence that there are social limits to growth, which is related to our methodology in which a sufficiency threshold is introduced as a way to capture the diminishing marginal utility of income (see Chapter 2). We assumed a threshold of $20,000 (in 2011 prices) so that beyond this point, increases in incomes – average income measured by GDP per capita in the EU-15 increased from €24,583 in 1995 to €32,147 in 2018 – and consumption contribute less than proportional to welfare. This adjustment helps to explain why the benefit accounts of bce and bcpa were stagnating after the financial crisis. Yet, the methodology that we used in Chapter 2 assumes an elasticity of the marginal utility to income equal to one, which is rather conservative. If we would have used an elasticity equal to 1.26, which is consistent within the well-being literature as shown in Chapter 2, then we would have found more profound evidence in favor of the threshold hypothesis.

5.1.2 Biophysical limits to growth

As highlighted in the previous section, BCPA's broader ecological costs did not increase substantially. Given the current state of the environment in Europe one would expect that the broader ecological costs would have increased more than they actually did. Europe consumes more resources and contributes more to environmental degradation than other regions in the world (EEA, 2019). Next, Dorninger et al. (2020) report evidence of ecologically unequal trade during the period 1990 to 2015: the world's high-income countries are net-appropriators of materials, energy, land (and labor).[36] In addition, the planetary boundary framework reveals that Europe's environmental footprints transgressed several safe planetary boundaries (O'Neill et al., 2018; EEA and FOEN, 2020; Sala et al., 2020). Similar conclusions can be drawn by comparing ecological footprints with the biocapacity available. Rees (2013, p. 58) notes that "[h]igh-income nations and people are able to 'appropriate' vastly more than their equitable share of global biocapacity through trade and by exploiting the global commons." A comparison of the EU-15's fair earth share, i.e. "the amount of ecologically productive land "available" *per capita* on Earth" (Rees, 1996), with their ecological footprints illustrates that between 1995 and 2016 the EU-15 countries have overshot their fair share by a factor of 3.06.[37] Despite these environmental challenges of unprecedented urgency and scale, the broader ecological costs only increased by 3.6% between 1995 and 2018.

The moderate increase in the broader ecological costs may indicate three things: (1) the ecological catastrophe limit has not been crossed since ecological costs do not rise exponentially, (2) that the current methodology is limited, or (3) that ecological issues have not deteriorated that much over time but that the environmental state was already very problematic in 1995, which goes unnoticed in aggregate EWM because we are not looking careful enough at the data to see that the broader ecological costs were already substantial in 1995. Later in this section, we will come back to the third point by suggest a "user guide" for

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[36] In this literature the exact term that is used by Dorninger et al. (2020) is "ecologically unequal exchange".

[37] The data on the world's biocapacity and the EU-15's footprints come are obtained from the Global Footprint Network (2019), while fair earth shares of the world's biocapacity are calculated using global population data from the World Bank (2020) and country level population numbers from Eurostat (2019).

EWM, in which we confirm the calls to complement EWM with a comparison of a country's ecological footprint and its biocapacity in order to evaluate whether a country is living within the means of the planet (Lawn, 2003, 2008, 2013; Kubiszewksi et al., 2013). Yet, in the remainder of this subsection, we will look into the former two methodological issues.

The modest increase in the broader ecological costs could be a shortcoming of our current methodology since BCPA's cost account may be underestimating them due to: (a) a limited number of items included, or (b) fixed cost estimates that do not properly reflect the current state of the environment. First, the number of ecological items included in Chapters 2 and 3 is limited because of data availability issues. The following ecological costs are not computed in this study: farmlands and soil lost, wetlands lost, forest lost, noise pollution, light pollution, ozone layer depletion, costs of alien-invasive species, mineral resource depletion, plastic pollution, fresh water depletion, depletion of fisheries, biodiversity losses etc. Whilst it is an almost impossible task to properly monetize all these ecological impacts, we believe that the items included capture an important part of the economy's impact on the ecosystem. The methodology developed in Chapter 2 focused on resolving time and boundary issues within EWM, while at the same time updating several of the valuation methods used such as including the emissions embodied in trade for air pollution and climate change and updating (increasing) the cost estimates for climate disruption and nonrenewable energy resources depletion compared to earlier studies. Second, an important methodological shortcoming that remains, however, is the fact that many of the cost estimates used in the EWM do not vary over time. Yet, varying cost estimates are needed that (a) decrease to indicate improvements in environmental issues, or (b) increase to signal that many environmental issues are worsening and are no longer marginal when tipping points are being crossed. Due to these methodological limitations, it is definitely possible to pursue efforts in future research to improve the methodology, especially with regards to the ecological costs.

5.2 Compensability and incommensurability

A characteristic of EWM and of all aggregate indicators, is that they are *compensability* indicators in which the evolutions of certain items can be traded-off with other components. The aspect of compensability is an artefact of EWM's monetary measurement. Compensability is the "possibility of offsetting a disadvantage on some attribute by a sufficiently advantage on another attribute, whereas smaller advantages would not do the same" (Martinez-Alier et al., 1998). Furthermore, by expressing every variable in a common monetary unit, EWM also assumes commensurability of different values. Commensuration is defined as "the expression or measurement of characteristics normally represented by different units according to a common metric" (Espeland and Stevens, 1998).

It is worthwhile to point to the existence of two sorts of comparability: "From a philosophical perspective, it is possible to distinguish between the concepts of strong comparability (there exists a single comparative term by which all different actions can be ranked) implying strong commensurability (common measure of the different consequences of an action based on a cardinal scale of measurement) or weak commensurability (common measure based on an ordinal scale of measurement), and weak comparability (irreducible value conflict is unavoidable but compatible with rational choice employing practical judgement)" (O'Neill, 1993 in Martinez-Alier et al., 1998, 277-286).

EWM are based on strong commensurability since all items are expressed in a common monetary measure. This commensurability is problematic because "aggregating different dimensions into a single-value metric entails loss of complexity, obscures the sources of change in well-being, and therefore provides incomplete information for decision making" (Berik, 2018). Further on in this section, we will therefore suggest a disaggregated approach to look at EWM, which is a complementary way to use these one-dimensional monetary aggregate indicators. Yet, it should be noted that there also exist other approaches with a multi-dimensional framework that operationalize weak comparability by making use of multi-criteria evaluation – see, for instance, Munda (2015, 2016).

5.3 Methodological trade-offs

In order to illustrate the trade-offs and compensability in our current methodology, we will investigate in a simulation for the EU-15 what would have happen if the broader ecological costs were reduced in 2018, the final year of the study period. More specifically, we will compute the trade-offs in a case where Paris-compliant emissions reduction pathways are pursued from 2017 to 2018.

Anderson et al. (2020) showed that Paris-compliant pathways to limit global heating to well below 2°C imply much deeper and faster emission cuts than those commonly acknowledged: developed countries should increase their mitigation rate to at least 10% per annum and achieve a fully decarbonized energy system by 2035-40. Anderson and co-authors come to these findings when determining the mitigating agenda for developing countries by taking into account the Paris principles of equity and of 'common but differentiated responsibilities and respective capabilities' and by not relying on planetary scale negative emission technologies. Negative emission technologies are a problematic 'high-stakes gamble' because "[t]here is a real risk they will be unable to deliver on the scale of their promise" (Anderson and Peters, 2016, p. 183). Double digit emission reductions would mean for the EU to step up its ambition to become the first climate neutral continent much earlier than 2050. For our trade-off analysis, we will apply an emission reduction rate of 10% to a country's production-based total GHG emissions without LULUCF and indirect emissions.[38] The 10% emission reduction is much higher compared to the actual emission reduction rate between 2017 and 2018 of 2.77% in the EU-15's production-based total GHG emissions without LULUCF and indirect emissions. In our compilation for the EU-15, BCPA per capita increased by 1.06% between 2017 and 2018, everything else being equal. Yet, if the EU-15 would have achieved double digit emission reductions, then welfare would have, *ceteris paribus,* increased between these two years with 2.08%. Instead of translating these emission reductions in welfare improvements, we could also illustrate the trade-off with individual consumption by maintaining the same 2017-level. If emissions are reduced by 10%, it is – ceteris paribus – possible to achieve the same welfare level as in 2017 while per capita individual consumption expenditures are 1.87% lower than they actually were in 2017. Or in other words, a reduction of greenhouse gas emissions by 10% can reduce per capita individual consumption expenditures up to 1.87% without that per capita welfare declines.

Future scenarios could explore how the welfare losses from income inequality could be reduced, for instance, by redistributing the incomes so that also the people in the lowest income deciles earn an income equal to the sufficiency threshold of $20,000 in 2011 prices. Similarly, scenarios can look into the welfare effects of meeting the climate goals from the Paris Agreement. Such future research could predict future welfare levels under various sustainability (see, for instance, Rugani et al., 2018), equity, or just and sustainable scenarios. These forecasts will help to determine what would happen in a dynamic situation in which all else is not assumed to remain constant – besides looking at actual welfare levels in future computations. Recent developments in ecological macroeconomics illustrated the possibility of improving social and environmental conditions by introducing specific targeted policy measures, even when the growth rate decreases to zero (Jackson and Victor, 2020) or in a degrowth scenario (D'Alessandro et al., 2020). Yet, other important impacts of such policies should also be investigated, as D'Alessandro et al. found that the improved social and ecological outcomes from the degrowth scenario resulted in an increase in public debt in the long run.

[38] The total amount of emissions included in the cost of climate disruption in Chapter 3 contains a broader basket of emissions as it also includes the emissions embodied in trade, the emissions from aviation and navigation, the emissions from biomass and from land use, land-use change and forestry) and the emissions related to global land use changes which are allocated to countries based on a consumption footprint approach.

5.4 Articulating a "living well within limits" narrative for economic welfare measures

Most welfare studies suggest to (1) move beyond GDP because GDP cannot serve as a welfare indicator and (2) move beyond economic growth since there are social and biophysical limits to growth. Yet, what alternatives are available beyond growth? In this subsection, we will first look into the dominant narrative of economic growth in which green growth takes a pivotal role before suggesting an alternative narrative that may accompany EWM in order to fare well within planetary boundaries.

Currently, a dominant approach for "sustainable prosperity" relies on green growth and decoupling – this approach that still prioritizes economic growth, is put forward by institutions and actors such as governments, financial institutions, voters and scientists, is implemented in EU and OECD policies and aligns closely with dominant interests, systems and cultures (Wiedmann et al., 2020). The European Commission, for instance, frames its European Green Deal as a new growth strategy in which economic growth is decoupled from resource use, but also focuses on a just transition (European Commission, 2019). Green growth and decoupling are appealing strategies for European policy-makers because they hold the promise of decoupling greenhouse gas emissions, environmental impacts and resource use from GDP growth. As such, economic growth does not need to be questioned. While the European Green Deal is a clear critical juncture that transformed the EU's climate policy path (Dupont et al., 2020), it may be needed to move beyond (green) growth and beyond decoupling in the European Green Deal and other political initiatives for a sustainable future.

The decoupling approach is misleading from both a social welfare and sustainability view. First, it is misleading from a social welfare view – what is the point in trying to decouple environmental impacts from GDP, when the indicator you are decoupling from is a bad proxy for social welfare after all. Second, scientific review studies have debunked the myth that ecological sustainability can be achieved with green growth and decoupling (Parrique et al., 2019; Hickel and Kallis, 2019; Haberl et al., 2020; EEA, 2020). For these reasons, it is needed to move beyond green growth and target sustainability (and equity) directly (O'Neill, 2020). For an effective sustainability transition technological advancements need to be complemented with stringent absolute reduction targets and 'sufficiency' or degrowth strategies that reduce production and (over)consumption (Parrique et al. 2019; Wiedmann et al., 2020; Haberl. et al., 2020). In order to achieve the goals of the European Green Deal, for instance, changes in consumption and social practices are required besides technological change (EEA, 2020). Today, there are many alternatives ready and available that offer valuable insights to mainstream conceptions of economic growth such as post-growth, degrowth, doughnut economics (EEA, 2020) or a-growth, i.e. being agnostic or indifferent about what happens to GDP (van den Bergh, 2011). These approaches differ, some are reformist (e.g. post-growth, a-growth, steady state economy, prosperity and managing without growth), while other approaches such as eco-socialism, degrowth and eco-anarchism are more radical (Wiedmann et al., 2020).

Yet, it is not easy to overcome growth because economies are structurally dependent on it. In this regard, calls have been made redesign economies so they become less dependent on growth and can manage without growth (Raworth, 2017; Jackson, 2017; Victor, 2019). As growth is deep-rooted in cultures, politics and institutions, change demands democratic ways to overcome these built-in cultural, political and institutional barriers (EEA, 2020). EWM could be of use to overcome these barriers by making visible there are social and biophysical limits to growth – in this regard, EWM can be seen as pragmatic tools for political and democratic accountability. This is important, because changing “the goals in the system” and “the mindset or paradigm out of which the system arises” are key leverage points to intervene in a system (Meadows, 1999). Nonetheless, to date, EWM have had little impact on policy-making (Corlet Walker and Jackson, 2019; Bleys and Whitby, 2015). Hayden and Wilson (2016) suggest that alternative indicators are by themselves not transformative forces, since “the widespread use of new indicators is more accurately seen a product of political and social movement efforts to expand the role of non-economic values in policy-making and in society more generally”. Bleys and Whitby (2015) identified that improving the communication around alternative welfare measures poses an opportunity to increase their policy value, while Berik (2018) suggested to complement the welfare measurement approach with a narrative approach in a plural policy-input process to overcome the criticisms regarding EWM being one-dimensional monetary indicators. Therefore, we propose to embed EWM in a post-growth, degrowth, a-growth, or doughnut narrative of safely living well (with less) within planetary boundaries as a starting point to make the transition beyond GDP toward well-being and ecological sustainability. Based on one’s preferences one could take either a reformist or more radical narrative.

Finally, this narrative can be linked to some concrete proposals for policy-makers. Based on the design of our EWM, some conclusions can be drawn for economic policy-making at the international level (e.g. EU institutions, IMF, OECD, etc.), national and regional level. Given the diminishing marginal utility of income and the sufficiency threshold that is introduced in EWM, it is becoming increasingly inefficient to stimulate welfare by increasing or growing aggregate incomes. Instead it would be more effective to improve welfare with redistributive policies that target people with incomes below the threshold. Furthermore, given the quantitative importance of the broader ecological costs and the urgency and scale of the ecological challenges, alternative policies should be explored to effectively reduce these ecological costs. There are various potential policies to address inequality, see, for instance, Ashford et al. (2020) for an overview, while Hartley et al. (2020) specifically propose strategies for equality when there is low or no growth. Ecological costs and the cost of climate disruption could be reduced by policies to reduce greenhouse gas emissions such as non-tradable caps or carbon pricing via taxation or via emission trading systems (Daly and Cobb, 1994; Alcott, 2010; Kallis and Martinez-Alier, 2010; Baranzini et al., 2017; Edwards and Cox, 2020; van den Bergh et al., 2020). In a global context, carbon pricing can alleviate all pressures on (other) planetary boundaries if it is allied with a biofuel policy (Engström et al., 2020).

5.5 Developing a user guide for economic welfare measures

Given EWM's inherent compensability, the aggregate welfare trend should be interpreted carefully. Here we will put forward a user guide on how to interpret EWM. But first, a careful reflection is needed on the direction of the aggregate EWM.

It is – often implicitly – assumed a good thing if the ISEW goes up, and a bad thing when it goes down (Costanza, 2000). Yet, similar to GDP we could wonder whether EWM have to increase or be maximized. Given the simulations that were made in Section 5.3, we believe that EWM could also be used with a focus on keeping welfare constant. For instance, it would be possible to reduce the welfare losses from income inequality and the ecological costs and keep welfare constant, while simultaneously consume less, which may be beneficial to well-being. Consuming less may be beneficial to well-being because it would halt phenomena such as "keeping up with the Joneses". More income and thus more consumption fail to deliver their promise of increased well-being as individuals adapt to their new living conditions and as the living standards of others improve. Since individuals fail to properly anticipate the well-being effects of adaptation and social comparison, their well-being is reduced (Easterlin 2003) as they spend too much time on monetary goals and work and too little time on health, family life and friends (Frank 2000; Easterlin 2003). Escaping this process thus may not be detrimental to well-being. In a comparative study between Germany and the United States, Hüttel et al. (2020) found that voluntary simplicity and collaborative consumption do not reduce individual's well-being but even enhances it in some cases. Moreover, these two types of "anti-consumption" are thus not only good for societal welfare but also for protecting environmental resources since voluntary simplicity involves less material consumption and as collaborative consumption involves the shared use of products. For these reasons, Kasser (2009) suggested that higher personal well-being and ecological sustainability can be jointly promoted by shifting people's values from materialistic, extrinsic aims to intrinsic aims and helping people to live lifestyles that are voluntarily simple and time rich. In order to capture these potential well-being effects, it is suggested to complement EWM with life satisfaction data.

All of the above lead us to the formulation of the following user guide:

1. *Be cautious about the aggregate welfare trend* because the overall trend might hide important imbalances between different components, such as rising welfare losses from income inequality or ecological costs. This means that EWM should not be maximized or seen as a target. Why wouldn't we try to keep welfare constant?
2. *Adopt a disaggregated approach to reduce ecological costs and welfare losses from income inequality. An economy is not performing well if aggregate welfare increases, while any of these categories are increasing or remaining constant.*
3. *Embed EWM in a broader set of Well-being and Sustainability Accounts* by complementing it with a dashboard of social and biophysical indicators such as well-being, life expectancy, ecological footprint.
4. *Complement EWM with its underlying physical, non-monetized data,* as argued by Berik (2020) and *connect these physical data to absolute reduction targets,* to reduce emissions by ten percent per year in rich countries, for instance. This dashboard would provide meaningful insights for a detailed policy analysis, whereas calculating the aggregate number is useful to communicate the overall welfare trend to the media and the broader public (Patterson et al. 2019).
5. *Move beyond seeing more consumption as something that stimulates well-being, highlight the need of sufficiency and decommodify welfare measures* because reducing overconsumption is not only needed for sustainability, but living well with less may also be desirable from a well-being perspective. Gerber and Gerber (2017), for instance, argued that decommodification may be the best option toward a post-growth future.
6. *Take social and ecological costs shifted in time and space into account.*
7. *Ignore GDP information.* A-growth or being indifferent about growth is a logical option because GDP is a flawed indicator for social welfare (van den Bergh, 2011).
8. *Where possible, substitute GDP with EWM such as the ISEW or GPI to evaluate economic performance and make progress toward social welfare.* It is not needed to wait to replace GDP until a perfect alternative welfare indicator is available (van den Bergh and Antal, 2014). For instance, replace GDP as indicator for Sustainable Development Goal 8 in Europe with the ISEW or GPI to

measure progress to sustainable development in a more coherent way (Coscieme et al., 2020). This would be compatible with Target 19 of Sustainable Development Goal 17 that wants to "develop measurements on progress on sustainable development that complement gross domestic product".

9. *Accompany the welfare measurement approach with a post-growth, degrowth or doughnut narrative of living well within planetary limits.*
10. *Articulate concrete policy proposals that focus on social equity, social welfare and social security systems without growth, full employment via a job guarantee – for instance, see Mitchell and Muyskens (2008), Lawn (2010) and Alcott (2013), environmental protection, Paris-compliant emission reduction pathways, and standards for better product quality and durability and greater resource use efficiency.*

6. Conclusion

Economic welfare measures (EWM) measure the benefits and costs of economic activity. Concerns over social limits and biophysical limits to growth have led scholars to belief that the social benefits indicated by GDP growth would evaporate when a more comprehensive measure of economic welfare is used to evaluate economic performance. By applying the principles of diminishing marginal benefits and increasing marginal cost at the macroeconomic level, EWM can be used to indicate the point beyond which economic growth becomes uneconomic growth, i.e. further growth brings more costs than benefits. Pursuing growth beyond this point is suboptimal. Due to the limits to growth, economic welfare measures are expected to indicate a threshold point in a time series of welfare results beyond which continued GDP growth reduces welfare.

The welfare results for the EU-15 from 1995 to 2018 in Chapter 3 do not provide evidence for the threshold hypothesis as formulated by Max-Neef (1995). Yet, our results indicate that welfare has been stagnating after the financial crisis of 2008 and 2009. After the financial crisis, as incomes grow, the growth in individual consumption is not translated into welfare. Our methodology that makes use of a sufficiency threshold thus signals there are social limits to growth, or that "keeping up with the Joneses" or aggregate consumption growth yields little welfare gains beyond a certain point.

This stagnation in welfare is not caused by the existence of biophysical limits to growth, since the broader ecological costs have not substantially increased. Yet, as the EU-15 has transgressed planetary boundaries, one would expect that the broader ecological costs would have increased substantially. We believe the absence of clear biophysical limits is is potentially a shortcoming of the current methodology since: (a) the number of ecological items is limited and does not account for the ecosystem losses related to land-use changes, for instance and (b) the cost estimates of most ecological items do not change over time, which makes it difficult to capture deteriorating or improving environmental conditions. At this point the methodology could definitely be improved in future research. Yet, the observation that there are no clear biophysical limits to growth is only partly a methodological shortcoming because the methodological advances made in the welfare study for the EU-15 tried to account for the biophysical limits to growth by improving the valuation of the ecological costs as follows: (1) the emissions embodied in trade were included for air pollution and climate change, (2) greenhouse gas emissions from aviation, shipping and land-use changes are counted in, (3) the costs for the use of nuclear energy were included and (4) the cost estimates for climate change and nonrenewable energy resources depletion were updated and revised upwards compared to earlier studies.

Besides a potential shortcoming of the current methodology, the failure to detect clear biophysical limits to growth could also be related to the way of looking at and using EWM. Since evaluating economic performance should not be reduced to merely balancing the monetized benefits and costs, we suggested to be cautious about the aggregate welfare trend and to de-emphasize the aggregate welfare trend. Instead, EWM should adopt a disaggregate approach to verify whether issues such as the welfare losses from income inequality and ecological costs are reduced. We proposed a user guide to facilitate the use and transformative potential of EWM and articulated a narrative of living well within planetary limits, so that EWM may be a starting point to move beyond GDP and its growth.

Conclusion

A. Beyond GDP growth

Small steps are being taking to gradually abandon GDP, as illustrated by the following examples. The Wellbeing Economy Alliance, a collaboration of organizations and individuals, wants to facilitate economic system change so that the economic system will bring human and ecological well-being. Certain policy entrepreneurs such as the New Zealand Government led by Jacinda Ardern are introducing well-being budgets to spend the government budget on those areas that would stimulate New Zealanders' well-being instead of allocating the budget as a way to accelerate economic growth. Together with Scotland, Wales and Iceland, New Zealand is part of the Wellbeing Economy Governments network – established in 2018 and supported by the Wellbeing Economy Alliance – recognizing "that 'development' in the 21st century entails delivering human and ecological wellbeing" (Wellbeing Economy Alliance, 2020). Also at the local level, cities such as Amsterdam and Brussels are adopting the doughnut model developed by Kate Raworth (2017) that prioritizes human and planetary health as a way for societies to flourish within planetary boundaries.

These small steps for mankind are encouraged by repeated calls to move beyond GDP. Stiglitz et al. (2009, 2018) urge us to measure what counts for social and economic performance and to focus on designing policies that stimulate well-being and economic welfare in a sustainable way, while Hoekstra (2019) proposed to come up with a common well-being and sustainability language in order to "replace GDP by 2030". Moreover, Coscieme et al. (2020) suggested to replace GDP as indicator for the United Nation's Sustainable Development Goal (SDG) 8 "Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all" in Europe with the Index of Sustainable Economic Welfare (ISEW) or Genuine Progress Indicator (GPI) to measure progress to sustainable development in a more coherent way. Cook and Davidsdottir (2021) compared several macro-economic indicators (i.e. Environmentally Adjusted Net Domestic Product, Measure of Economic Welfare, Genuine Savings, Genuine Progress Indicator and Inclusive Wealth Index) and found that the GPI was the most comprehensive one as it made direct links to targets in fourteen of the seventeen SDGs.

Besides these calls to move beyond GDP, there also have been repeated calls to move beyond growth. This is needed because "[f]or over seventy years, economic growth has been the dominant goal of economic policy, and the principal measure of an economy's success … [e]quity and environmental considerations have largely been dealt with 'after the event' rather than as integral to economic policy" (OECD, 2020). In 2018, a landmark Post-Growth conference was held in Brussels to discuss that the European Union should plan for a post-growth future where human and planetary well-being are prioritized over growth and where alternative indicators are incorporated into the macroeconomic framework. An open letter signed by 238 scientists and more than 91.000 citizens urged the EU to transform its Stability and Growth Pact into a Stability and Wellbeing Pact (The Guardian, 2018). This petition together with a poll indicating that a majority of Europeans believe that the environment should be a priority even if it comes at the expense of growth (The Guardian, 2019), illustrate that there is bottom-up support for prioritizing other goals than economic growth. Recent initiatives indicate that post-growth is gaining momentum. More than 11.000 scientists have warned humanity that to adequately respond to the climate emergency "our goals need to shift from GDP growth and the pursuit of affluence toward sustaining ecosystems and improving human well-being by prioritizing basic needs and reducing inequality" (Ripple et al., 2019). Also the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES, 2019) stressed the necessity of "steering away from the current, limited paradigm of economic growth". The OECD's (2020) New Approaches To Economic Challenges initiative of the OECD (2020) pleads for moving "Beyond Growth" in a new economic approach the need to focus on the goals well-being, reducing inequality, environmental sustainability and resilience although the OECD states that this "means neither abandoning growth as an objective nor relying upon it". The degrowth movement, in contrast, contests the growth paradigm in an attempt to prioritize well-being, social justice and ecological sustainability by contesting the growth paradigm (Demaria e al., 2013). Finally, the European Environmental Agency's (2020) rapport *Growth without economic growth*, urges societies to rethink growth since economic growth and economic activities are closely linked to biodiversity losses, climate change, pollution and environmental degradation since fully decoupling economic growth from resource consumption may be impossible.

Questions on the necessity or desirability of economic growth date back to the 1960s and 1970s. Scholars argued it is needed to move beyond growth because there are social limits to growth (Hirsch, 1976) and biophysical limits to growth (Meadows et al., 1972). First, there are social limits to growth, which means that growth fails to deliver its promise that growth improves the human condition. Due to the existence of status or positional goods and phenomena such as "keeping up with the Joneses" (e.g. larger houses and expensive cars), the gains from possessing these goods disappear as incomes grow and give more people access to them, which illustrates that there are certain social limits to what growth can deliver in terms of social welfare or well-being (Hirsch, 1976; Kallis, 2015). Or to put it in other words: when a rising tide lifts all boats, no one notices that the tide is rising. As a consequence, aggregate growth is socially pointless in affluent societies. Second, there are biophysical limits to growth. Ecological economists have been questioning the goal of economic growth ever since Kenneth Boulding (1966) and Nicholas Georgescu-Roegen (1971) introduced the laws of thermodynamics to economic theory. Key message of their research is that continuous economic growth on a finite planet is not possible. Recent research by Steffen et al. (2015) has shown that several planetary boundaries such as climate change and biodiversity have already been crossed, which means that humanity may push itself out of a "safe operating space" as argued by Rockström et al. (2009). Ecological economists have questioned the goal of continued growth as early as 1970 because the scale of the economy relative to the Earth System was already too large ever since, when the global Ecological Footprint first exceeded global biocapacity. Therefore, ecological economists would aim to bring the economy back within safe planetary boundaries and envisage an economy that operates within ecological limits.

Green growth and decoupling are appealing strategies for European policy-makers because they hold the promise of decoupling greenhouse gas emissions, environmental impacts and resource use from GDP growth. As such, economic growth does not need to be questioned. Yet, one could wonder what the point is in trying to decouple environmental impacts from GDP, when the indicator you are decoupling from is a bad proxy for social welfare after all. Green growth holds the promise to keep expanding economies while mitigating climate change by absolutely decoupling carbon emissions from economic growth. Yet, is a high-risk strategy because it is incompatible with remaining within safe planetary boundaries. Hickel and Kallis (2019) argued that while it is technically possible to absolutely decouple carbon emissions from economic growth, it is highly unlikely that this decoupling will be achieved rapidly enough to limit global warming to 2°C and this also holds true for optimistic policy scenario's. Recent opinion surveys indicate that Europeans are supportive of more radical and rapid measures than those proposed by the European Commission, since (1) a majority of Europeans believe that the environment should be a priority even if it comes at the expense of growth (The Guardian, 2019), (2) 70% of Europeans think the EU is not doing enough to tackle climate change (Garton Ash et al., 2020) and (3) a majority of Europeans wants the EU to be climate neutral by 2030 already (Garton Ash and Zimmermann, 2020).

Since global growth in affluence has, for more than five decades, "continuously increased resource use and pollutant emissions far more rapidly than these have been reduced through better technology" (Wiedmann et al., 2020), a sustainability transition does not only require technological advances, but also sufficiency strategies that reduce consumption and production (Parrique et al., 2019; Wiedmann et al., 2020; Haberl et al., 2020; Büscher et al., 2021). Today, there are many alternatives ready and available that offer valuable insights to mainstream conceptions of economic growth such as post-growth, degrowth, doughnut economics (EEA, 2020) or a-growth, i.e. being agnostic or indifferent about what happens to GDP (van den Bergh, 2011). These approaches differ, some are reformist (e.g. post-growth, a-growth, steady state economy, prosperity and managing without growth), while other approaches such as eco-socialism, degrowth and eco-anarchism are more radical (Wiedmann et al., 2020).

Degrowth is often wrongly interpreted as a reduction in consumption and production, yet, degrowth is more nuanced than that. As noted by Demaria et al. (2013) “degrowth challenges the hegemony of growth and calls for a democratically led downscaling of production and consumption in industrialised countries as a means to achieve environmental sustainability, social justice and well-being”. Degrowth in the global North would be a potential pathway toward an equitable steady-state global economy that remains within planetary boundaries by freeing up some ecological space for the global South to have some economic growth (Kerschner, 2010). In the coming years, degrowth may be a crucial strategy to avert climate breakdown. While, the European Commission recognizes the need to tackle the climate crisis and proposed the European Green deal to become the first climate neutral continent by 2050, further steps are needed. High-income countries should step up their climate ambitions and actions in order to comply with the Paris Agreement. Paris-compliant pathways to limit global heating to well below 2°C imply much deeper and faster emission cuts than those commonly acknowledged: developed countries should increase their mitigation rates to minimum 10% per annum and achieve a fully decarbonized energy system by 2035 to 2040 (Anderson et al., 2020). Since such sharp emission reductions are not deemed compatible with economic growth, high-income countries would temporarily need to adopt degrowth strategies in order to avoid “beyond dangerous climate change” of more than 2°C as articulated by Anderson and Bows (2011) and Anderson and Bows-Larkin (2013).

Notwithstanding the popular support, frontrunners and steps taken, economic growth still remains a dominant goal in economic policy-making and narrative at the international and national level because economies are structurally dependent on growth – see, for instance, Schmelzer (2016). The United Nation’s Sustainable Development Goal 8 is to “Promote sustained, inclusive and sustainable economic growth”, while the OECD still believes in green growth as going *Beyond Growth* in the OECD’s (2020) New Economic Approach “means neither abandoning growth as an objective nor relying upon it” (OECD, 2020). Furthermore, the European Green Deal is also framed as a new “growth story” by the European Commission (2019). These examples illustrate that it is difficult to say farewell to growth. Because of the growth dependency, calls have been made redesign economies so they become less dependent on growth and can manage without growth (Raworth, 2017; Jackson, 2017; Victor, 2019; Bohnenberger and Fritz, 2020).

B. Main contributions

This thesis contributes to the field of economic welfare measures (EWM) with a focus on the ISEW and GPI by elaborating on the theoretical and conceptual welfare framework of these measures, by standardizing and improving their methodologies, and by estimating welfare levels for the EU-15 based on a comparable methodology while at the same time investigating whether the ISEW and GPI are able to reveal a threshold point and social and biophysical limits to growth.

The ISEW and GPI are often argued to lack a sound theoretical foundation. However, we observe that the initial ISEW by Daly and Cobb (1989) was jointly inspired by Hicksian and Fisherian income. Welfare's experiential nature is Fisher-inspired, whereas seeing the consumption of community capital (e.g. the ecosystem) as a cost is Hicks-inspired. As most scholars do not recognize this double theoretical foundation, they have found it difficult to deal with welfare's time and boundary issues. Elaborating on this double theoretical foundation, we have put forward two welfare interpretations with distinct time and boundary dimensions to address time and boundary complexities. EWM can be seen as either capturing the benefits and costs experienced (BCE), or as reflecting the benefits and costs of present economic activities (BCPA). The former interpretation only takes into account what is currently experienced within domestic borders: it excludes future costs, costs shifted abroad and capital changes. BCPA makes use of broader time and boundary dimensions, and includes the benefits and costs of present activities. Consequently, costs shifted in time and space and capital changes are included in BCPA as they all are benefits and costs arising from current economic activities. Recent developments reveal that EWM are converging toward the ex post established experiential Fisherian foundation and the BCE-interpretation. Yet, we argue that this is not the only way forward as the BCPA-perspective offers an alternative viewpoint to account for the costs of present activities shifted abroad or to the future such as those involved in climate change, irrespective of whether they are currently "experienced" or not.

Based on these different welfare interpretations, two EWM with distinct time and boundary effects are calculated for Belgium in this dissertation: the benefits and costs experienced and the benefits and costs of present activities. This welfare compilation for Belgium is the first of its kind to include the welfare benefits of the shadow economy and to make use of a sufficiency threshold to calculate the diminishing marginal utility of income for the item welfare losses from income inequality. Other methodological novelties for the broader BCPA include a consumption footprint view for greenhouse gas emissions and air pollution by accounting for the emissions embodied in trade, and the registration of the climate impacts of aviation and shipping. Belgium's welfare measured by both indicators improved from 1995 to 2018: BCE per capita improved by 15% and BCPA per capita enhanced by 18%, which is about half of the growth in GDP per capita by 30%. These trends indicate a growing divergence between both welfare measures and GDP. Furthermore, the aggregate trend over time masks that the per capita welfare losses from income inequality and the per capita broader ecological costs in BCPA have increased by, respectively, 89.9% and 6.8%. Yet, these trends are outweighed or compensated by increasing benefits from consumption. As there are substantial ecological costs shifted in time and space, we suggest to account for ecological cost-shifting by using the BCPA-view when calculating EWM because it is more informative for policy-makers. A careful reflection on EWM's design and use is needed in future studies in order to stimulate their policy-guiding and transformative potential.

Next, we estimate both EWM for the EU-15 as a whole and all individual countries from 1995 to 2018. For the EU-15, GDP per capita improved by about 31% during the studied period. Also at the level of the EU-15 GDP and EWM diverged as BCE and BCPA per capita (only) improved by 13% and 17%. The EU-15's GDP per capita reached its maximum in 2018, while its welfare per capita already peaked right before the financial crisis. By 2018, the EU-15 had entirely recovered from the financial crisis from a GDP-perspective but not from a welfare view. The financial crisis and its recovery had a different impact on GDP and economic welfare measures. In contrast to GDP, the response in economic welfare measures to the financial crisis of 2009 was delayed in some countries: their per capita BCPA only fell during the economic GDP-recovery in 2010 as the broader ecological costs increased. At the level of the EU-15, the broader ecological costs decreased in 2009 but increased again in 2010 during an environmentally more polluting recovery in GDP per capita. Our results thus indicate that a post-COVID agenda needs to aim for a green and just economic recovery that is centered around welfare and a move beyond GDP that prioritizes human well-being within planetary boundaries without growth. The overall trends in per capita BCE and BCPA were driven by individual consumption growth (+29.3%) and the welfare losses from income inequality (+97.5%), yet, since the welfare losses from income inequality increased, part of the growth in consumption is not translated into welfare because of the diminishing marginal utility of income. Despite the overall improvements over the entire period, GDP per capita barely improved after 2007: it only fully recovered from the financial crisis in 2018, when the EU-15's GDP per capita reached its maximum value that was slightly higher than its pre-crisis level. The EU-15's economic welfare per capita already peaked right before the financial crisis in 2006 for BCE and in 2007 for BCPA. In 2018, BCE per capita and BCPA per capita were respectively 1.5% and 1.8% below their maximum values. As a consequence, we found no conclusive evidence for the EU-15 as a whole regarding the threshold hypothesis (i.e. the existence of a threshold beyond which continued GDP growth reduces welfare). However, we found evidence of threshold points in Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain, Sweden and the UK, where the per capita welfare levels were at least 5% lower by the end of the study period in 2018 compared to their maximum welfare value.

Finally, concerns over social limits and biophysical limits to growth have led scholars to belief that the social benefits indicated by GDP growth would evaporate when a more comprehensive measure of economic welfare is used to evaluate economic performance. By applying the principles of diminishing marginal benefits and increasing marginal cost at the macroeconomic level, economic welfare measures can be used to indicate the point beyond which economic growth becomes uneconomic growth, i.e. further growth brings more costs than benefits. Pursuing growth beyond this point is suboptimal. Due to the limits to growth, economic welfare measures are expected to indicate a threshold point in a time series of welfare results beyond which continued GDP growth reduces welfare. The welfare results for the EU-15 from 1995 to 2018 do not provide evidence for the threshold hypothesis as formulated by Max-Neef (1995). Yet, our results indicate that welfare has been stagnating after the financial crisis of 2008 and 2009. After the financial crisis, as incomes grow, the growth in individual consumption is not translated into welfare. Our methodology that makes use of a sufficiency threshold thus signals there are social limits to growth, or that “keeping up with the Joneses” or aggregate consumption growth yields little welfare gains beyond a certain point. This stagnation in welfare is not caused by the existence of biophysical limits to growth, since the broader ecological costs have not substantially increased. Yet, as the EU-15 has transgressed planetary boundaries, one would expect that the broader ecological costs would have increased substantially. We believe the absence of clear biophysical limits is potentially a shortcoming of the current methodology since the number of ecological items is limited and the cost estimates of most ecological items do not change over time, which makes it difficult to capture deteriorating or improving environmental conditions. Yet, the observation that there are no clear biophysical limits to growth is only partly a methodological shortcoming because the methodological advances made for welfare study for the EU-15 tried to account for the biophysical limits to growth by improving the valuation of the ecological costs, for instance, by updating and revising upwardly the cost estimates for climate change and nonrenewable energy resources depletion. Besides a potential shortcoming of the current methodology, the failure to detect clear biophysical limits to growth could also be related to the way of looking at and using EWM. Since evaluating economic performance should not be reduced to merely balancing the monetized benefits and costs, we suggested to be cautious about the aggregate welfare trend and to de-emphasize the aggregate welfare trend. Instead, EWM should adopt a disaggregate approach to verify whether issues such as the welfare losses from income inequality and ecological costs are reduced. We proposed a user guide to facilitate the use and transformative potential of EWM and articulated a narrative of living well within planetary limits, so that EWM may be a starting point to move beyond GDP and its growth.

C. Some insights for policy-making

Now that the COVID-19 pandemic is bringing the world to a standstill and economies are contracting due to mitigation measures, lockdowns and a vicious cycle of falling consumer demand and deepening recessions, economies are at a crossroad. The policy decisions made today will have an impact for decades to come. On the one hand, some policy makers and economists are proposing to kickstart economic growth. On the other hand, others are putting addressing inequality, sustainability and biodiversity losses high on the policy agenda (Ashford et al., 2020; McElwee et al., 2020; Büscher et al., 2021).

Based on the design of our EWM, some conclusions can be drawn for economic policy-making at the international level (e.g. EU institutions, IMF, OECD, etc.), national and regional level. If we acknowledge that (a) ever increasing incomes will lead to increasingly smaller additions to welfare due to the correction for the diminishing marginal utility of income, (b) economic growth is ecologically cataclysmic and (c) many economists argue that we are in a situation of Secular Stagnation, in which economic growth rates have declined and are not likely to return to their earlier higher growth rates (Summers, 2016; Jackson, 2018), then policies that empower economies and societies to fare well without growth will become increasingly important in the future. Given the diminishing marginal utility of income and the sufficiency threshold that is introduced in EWM, it is becoming increasingly inefficient to stimulate welfare by increasing or growing aggregate incomes. Instead it would be more effective to improve welfare with redistributive policies that target people with incomes below the threshold. Furthermore, given the quantitative importance of the broader ecological costs and the urgency and scale of the ecological challenges, alternative policies should be explored to effectively reduce these ecological costs.

With effective social and environmental welfare policies in place, EWM could continue to increase beyond their earlier welfare peak or threshold point. There are various potential policies to address inequality, see, for instance, Ashford et al. (2020) for an overview, while Hartley et al. (2020) specifically propose strategies for equality when there is low or no growth. Ecological costs and the cost of climate disruption could be reduced by policies to reduce greenhouse gas emissions such as non-tradable caps or carbon pricing via taxation or via emission trading systems (Daly and Cobb, 1994; Alcott, 2010; Kallis and Martinez-Alier, 2010; Baranzini et al., 2017; Edwards and Cox, 2020; van den Bergh et al., 2020). In a global context, carbon pricing can alleviate all pressures on (other) planetary boundaries if it is allied with a biofuel policy (Engström et al., 2020). Examples of policies that could reinforce existing initiatives such as the European Green Deal, could be a Green New Deal without growth (Mastini et al., 2021), measures that make social security and welfare systems less dependent on growth (Bohnenberger and Fritz, 2020), or a post-COVID economic agenda that takes into account inequality (Ashford et al., 2020) and biodiversity (McElwee et al., 2020) to build back better. More concretely, Büscher et al. (2021) outline five priorities for a post-COVID development pathway: (1) a move away from development focused on aggregate economic growth, (2) an economic framework focused on redistribution and care, (3) a transformation towards regenerative agriculture and convivial conservation, (4) reduction of consumption and travel, and (5) debt cancellation. A good starting point here, would be to evaluate economic performance differently by using alternative measures of economic welfare, for instance – with the wrong goals in place it will prove extremely difficult to start making effective progress toward living well within ecological limits.

D. Areas of future research

Future research on EWM would benefit from updated methods and better data availability. Future studies could explore how to account for the costs related to land use changes and the social costs shifted in time and abroad. Moreover, valuation methods such as the transition cost due to the use of non-renewable energy resources could be updated making use of estimates from cost effectiveness studies to achieve the Paris goals of limiting global warming to 1.5°C or 2°C. Furthermore, more frequent and timely time-use and environmental data would be helpful to compile more up-to-date and real-time welfare measures, which would increase their use for policy-making and policy analysis. Besides these data and methodological improvements, the EWM literature would also benefit from continued theoretical and conceptual refinements, for instance, by investigating if and how leisure time should be registered.

A second future research area for EWM could look into estimating future welfare levels under specific policy interventions – e.g. the European Green Deal, emission pathways consistent with the Paris Agreement or the introduction of a shorter workweek. Rugani et al. (2018), for instance, forecasted Luxembourg's future welfare levels based on different energy policy scenarios. These predictions could together with future welfare levels be used to verify whether the aggregate welfare trend would decline or has declined in a just ecological and climate transition with reduced consumption and production. In addition, EWM could also be integrated in (ecological) macroeconomic models – e.g. the state-of-the-art models by D'Alessandro et al. (2020) and by Jackson and Victor (2020) – and in economic research more generally as a different dependent variable.

A third research agenda for EWM could compare the determinants of GDP growth versus the determinants of EWM by investigating historical GDP and EWM data. This research would highlight which traditional pro-economic growth policies are most (or least) effective in also stimulating economic welfare. To date, only three studies (Talberth and Bohara, 2006; Feeny et al., 2013; Hashim et al., 2019) have investigated in what ways the determinants of economic growth are different from or comparable to the determinants of economic welfare. All these studies only focus on one or two countries and none of these studies focused on Europe. In order to overcome model uncertainty, robust determinants can be obtained from panel data approaches as those by Moral-Benito (2012, 2016). These traditional determinants of economic growth could be extended by including inequality and useful work. Recent research has indicated that inequality negatively affects growth (Berg et al., 2018) and that 'raw' energy (exergy) converted to useful work explains output and drives long-run growth in the US, together with labor and capital (Ayres and Warr, 2005).

Finally, the 'Beyond GDP' movement would greatly benefit from harmonizing the multitude of existing initiatives and from developing policy tools to inform policy-makers on how to stimulate well-being, ecological sustainability and social justice (Hoekstra, 2020). Future research could investigate how rapid and drastic emission reductions can effectively be achieved in a socially sustainable way and how ecological debts owed to the global South and future generations can be somewhat "addressed". These research avenues could explore paths of debt cancellation, making social security and welfare systems less dependent on growth (see, for instance, Bohnenberger and Fritz, 2020), full employment via job guarantees – for instance, see Mitchell and Muyskens (2008), Lawn (2010) and Alcott (2013) and, last but not least, making money public by seeing money as a public resource (Mellor, 2010, 2015).

E. Reflections on economic welfare measures

Despite the fact that GDP is widely criticized, it is still influential in politics, economics, policy-making and society (van den Bergh, 2009). According to van den Bergh, this "GDP paradox" can be explained by recognizing that many economists accept the GDP-criticism but refute its importance. Daly and Cobb (2007) thought that a conservatively estimated ISEW that is no longer correlated with GDP would help to persuade economists to no longer deny the relevance of the GDP-criticism, and consequently facilitate the move beyond GDP. Therefore, several authors claim that the ISEW can best be seen as an indicator to 'debunk' GDP as a policy guide and objective (Ziegler, 2007; Daly and Cobb, 2007). As Daly and Cobb (2007) stated: "[i]f the world is perversely addicted to a one-dimensional monetary index of welfare, then at least try the ISEW – if you insist on smoking, at least try our charcoal filter!" Although the ISEW and GPI still have imperfections, they are clear improvements over GDP – operationalizing the idea that it is better to be approximately right than precisely wrong.

As growth is deep-rooted in cultures, politics and institutions, change demands democratic ways to overcome these built-in cultural, political and institutional barriers (EEA, 2020). Economic welfare measures (EWM) such as the ISEW and GPI could be of use to overcome these barriers for two reasons. First, EWM help to move beyond GDP by providing an alternative indicator of economic welfare. Second, EWM also help to move beyond growth by making visible there are social and biophysical limits to growth – in this regard, EWM can be seen as pragmatic tools for political and democratic accountability. This is important, because changing "the goals in the system" and "the mindset or paradigm out of which the system arises" are key leverage points to intervene in a system (Meadows, 1999). Nonetheless, to date, EWM have had little impact on policy-making (Corlet Walker and Jackson, 2019; Bleys and Whitby, 2015). Providing alternative indicators alone is not enough. Hayden and Wilson (2016) suggest that alternative indicators are by themselves not transformative forces, since "the widespread use of new indicators is more accurately seen a product of political and social movement efforts to expand the role of non-economic values in policy-making and in society more generally".

A benefit of the ISEW and related one-dimensional indicators is that they are a simple communication tool to give policy-makers, media, economists and the broader public an overall idea about how the economy has been doing. On the downside, a lot of information and complexity is lost. Caution is warranted against focusing exclusively on the aggregate trend of EWM, especially since this dissertation has demonstrated that rising welfare losses from income inequality and ecological costs can be easily compensated by consumption growth. On the downside, the empirical welfare compilation is reducing many welfare aspects to balancing the benefits and costs of economic activities. This is problematic for two reasons. First, balancing benefits and costs is not a neutral criterion upon which one can safely base value judgements. Second, balancing benefits and costs is a recipe for disaster if you overestimate the benefits and underestimate the costs. A textbook example of both reasons is William Nordhaus who was awarded the *Sveriges Riksbank Prize in Economic Sciences in Memory of Alfred Nobel*, but has seriously underestimated the damages of climate change by at least an order of magnitude (Keen, 2020). By taking growth as a starting point and by balancing the overestimated benefits (i.e. by assuming continued growth), and the underestimated costs of climate change, Nordhaus (2018) comes to an "optimal" warming of 3.5°C by 2100. Whilst Earth and climate scientists would undoubtedly call this far beyond dangerous climate change – in fact they would label any temperature increase above 2°C already as beyond dangerous. Instead of abandoning outdated growth models as part of a precautionary approach to reduce the risk of climate breakdown, Nordhaus is optimally adjusting the climate system to fit obsolete growth models. Given the welfare measures' cost-benefit rationale, it should be avoided to optimize them and caution is warranted against the aggregate welfare trend since economic welfare measures could also easily be misused.

One could try to improve and further refine the methodology, yet, given the methodological difficulties and data availability issues inherent in measuring welfare, we may never arrive at a "perfect" welfare indicator whose aggregate trend can be safely trusted to get the trade-offs right so that can be safely considered it is beneficial to welfare if the indicator goes up, but detrimental to welfare if the indicator goes down. Therefore, this dissertation proposes to adopt a disaggregate approach and to complement welfare measurement with a dashboard of social and biophysical indicators to illustrate the degree of abstraction involved in measuring welfare and to partly overcome the loss of complexity when calculating aggregate measures. Given the difficulties and abstractions involved when measuring welfare, it may still be useful for economic welfare measures to be calculated because the world is still addicted to one-dimensional indicators. It is still needed to continue debunking, for instance, to replace economic growth in Sustainable Development Goal 8. Furthermore, economic welfare measures' broader perspective could be used for educational purposes, as it helped university students to easily understand world problems regardless of their prior knowledge (Yoshida et al., 2020). In addition, it is crucial to complement EWM with a degrowth, sufficiency or post-growth narrative of living well within planetary limits. As such, the ISEW and GPI can be a bridge to the future by moving beyond GDP. Nonetheless, economic welfare measures could also be a bridge to nowhere if (1) too much importance is given to the aggregate welfare trend, (2) welfare measures are optimized or become a goal in itself, and (3) economic welfare measures fail in their purpose to properly debunk, abandon and overcome growth.

Bell and Morse (2011) wondered why we would try to go beyond GDP because GDP in itself is not the problem as it only fulfills a certain demand: "GDP is a cultural artifact and a symptom of our mindset, not its creator." Perhaps the difficulty does not lie in merely moving "Beyond GDP", but in moving beyond the cultural mindset that demands one-dimensional indicators. And similarly, we could wonder whether EWM have to increase or be maximized parallel to GDP. It may be a cultural thing that indicators have to increase, but why shouldn't welfare be kept constant or remain in a steady-state? Consuming less, reducing the welfare losses from inequality, meeting basic needs and reducing ecological costs may all be part of *living well within limits* or *faring well without welfare growth.* Fortunately, we do not need to wait to replace GDP by 2030 as Simon Kuznets already warned us nine decades ago that social welfare can barely be deduced from a measuring gross domestic product. Therefore, it is time to move beyond GDP and beyond welfare growth – the sooner, the better. Since GDP can be seen as an indicator of biodiversity loss (Czech et al., 2005), continued exponential economic growth on a finite planet would be cataclysmic. So, in order to have "a prosperous way down" (Odum and Odum, 2001) and live well within planetary boundaries, let's flatten the GDP-curve too.

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Appendix A: Detailed methods

This appendix discusses in detail the methods used to compute the items for the welfare study for the EU15-countries.

All estimates cover the time period 1995-2018 and are in million euros in 2010 prices. The deflators used are GDP deflators from the World Bank (2019). Population data to calculate per capita values was taken from Eurostat (2019a), while the Gross Domestic Product at market prices was also extracted from Eurostat (2020b).

1. Unpaid work

The time use data comes from the OECD's (2019) Time Use Database – the data for Ireland were updated in 2020 (OECD, 2020a). This database lists the results from the Harmonized European Time Use Survey (HETUS) for European countries. In the HETUS-survey, unpaid work covers routine housework, shopping, care for household members, care for non-household members, volunteering, travel related to household activities and other unpaid work. Compared to other studies that have separate items for household work and volunteer work – see for instance Held et al. (2018) and Kenny et al. (2019) – the item *unpaid work* is in this study thus broader as it contains both household work and volunteer work. The availability is limited: only six countries have more than one data-point. Both data-points were used to interpolate the values between these data-points. Memory items are used for the values before and after these two datapoints. In the case of only one data-point, the time-use allocated to unpaid work is assumed constant throughout the entire period.

Unpaid work is valued by multiplying the total hours of unpaid work by the population from 15 to 74 years, taken from Eurostat (2019b) by market wages. The replacement wages come from the mean earnings of service and sales workers in the business economy, which are collected from the Structure of earnings survey on Eurostat (2019h). This Survey was collected in 2002, 2006, 2010 and 2014. The values between these datapoints were interpolated. Values before 2002 and after 2014 were extrapolated using average annual wages from OECD.Stat (2019a).

The average wages used for the opportunity cost method in the sensitivity analysis are calculated by dividing average annual wages (OECD.Stat, 2019a) by the average annual hours actually worked per worker (OECD.Stat, 2020).

2. Individual consumption expenditures

2.1 Actual individual consumption

Data on actual individual consumption is accessible via Eurostat (2019d).

2.2 Costs of consumer durables

This item deducts the expenditures on consumer durables, which are included in households' final consumption expenditures and thus in actual individual consumption. In order to subtract these expenses, I make use of the availability category 'durable goods' in the System of National Accounts. Eurostat (2019f) provides data on Final consumption aggregates by durability from 1995-2018. This item only incorporates durable goods, goods classified as semi-durables are treated as normal consumer goods and thus not deducted from the index.[39] In line with previous studies, consumer durables are expected to last for eight years.

2.3 Services of consumer durables

The services of consumer durables are the benefits experienced from using consumer durables. As the stock of consumer durables lasts for 8 years, this means a linear depreciation of 12.5%. However, all studies value the services of consumer durables by taking 20% of the stock of consumer durables, which is equal to 12.5% depreciation and an interest rate of 7.5% on the stock of capital. Present studies continue to use this interest rate, after Daly and Cobb (1994). Yet, this approach may be outdated. In this study I follow this common approach and calculate the services by multiplying the existing stock of consumer durables by 0.2.

Future studies may look into this valuation method to increase the relevance and information-yielding capacity of this component by incorporating recent trends. First, using an interest rate of 7.5% may be outdated now there is a low interest environment in the aftermath of the great recession. With a 0% interest rate, a service of 20% would be similar to the linear depreciation of a stock of consumer durables with a life span of 5 years. Second, the durability of consumer durables may change over time because of planned obsolescence or perceived obsolescence or because of the introduction of product standards and regulation that increase the lifetime of consumer durables. Moreover, a transformation toward a sharing

[39] Semi-durables also have an expected life time over one year. However, their life span and purchase price is lower compared to durable goods.

economy in which consumer durables are shared instead of owned may also impact the durability of and services from consumer durables.

In order to construct the services from consumer durables, expenditures are needed as early as 1988 to build up the stock of consumer durables in 1995. As Eurostat only provides data from 1995 onwards, expenditures prior to 1995 are extrapolated using GDP data taken from AMECO (2019a), which is the annual macro-economic database of the European Commission's Directorate General for Economic and Financial Affairs. For the UK, data prior to 1995 is extrapolated using GDP figures. The 1988-deflator is also imputed using AMECO (2019b).

3. Defensive, rehabilitative and intermediate expenditures

Not all consumption expenditures incorporated in AIC are taken into account in economic welfare measures (EWM). Certain parts of consumption categories in the Classification of Individual Consumption According to Purpose (COICOP) are deducted as defensive expenditures. These expenditures are not counted as contributing to welfare as they are compensating for the unwanted effects of other activities. Moreover, not all expenditures are to be seen as welfare enhancing or as final consumption since some expenses are of intermediate nature.

In this paper, defensive, intermediate and rehabilitative expenditures involve the subtracting of the following: 25% of food and alcohol expenditures, 100% of tobacco and narcotics expenditures, 100% of insurance and financial services expenditures and the cost of road accidents. The food deduction is supported by estimates for the EU-28 that 20% of the total amount of food produced was wasted in 2011 (Stenmarck et al., 2016). 25% of alcohol expenses and 100% of tobacco expenditures and insurance are deducted, which is in line with Talberth and Weisdorf (2017). Narcotics are not counted, since these expenditures cover both legal and illegal purchases by households, whereas the narcotics for medical purposes and the instant consumption of narcotics in coffee shops are classified elsewhere in the COICOP (UNSD, 2018).

Insurance and financial services expenditures are unusual categories in the COICOP. Both are imputed as their expenditures are not directly observable from expenditure surveys and household income (UNSD, 2018). Similar to Talberth and Weisdorf (2017), insurance expenditures (life and non-life insurance) are entirely excluded as they are defensive by nature. The imputation of non-life insurance, for instance, is equal to the total amount of premiums earned plus investment income earned from investing the premiums less adjusted claims incurred (UNSD, 2018). This category is not pure final consumption compared to true final consumption categories, as it is defensive and includes investment income. Yet, the effect of insurance is not entirely removed from the index, as insured losses help to reduce the economic losses related to extreme weather events (see Section 7.4).

Financial services are entirely subtracted for two reasons. First, financial services include the following activities: monitoring services, convenience services, liquidity provision, risk assumption, underwriting and trading services (European Commission et al., 2009). This financial intermediation services are intermediate, i.e. they support other types of final consumption that are elsewhere included in the index. Second, over time GDP's production boundary has expanded to include financial services (Derock, 2019). Yet, EWM do not have to follow this GDP bias. Including financial services in EWM would reflect tendencies of increasing financialization in the economy. As argued by Van der Slycken and Bleys (2020b), this intermediate consumption is not the final consumption that contributes to welfare.

In contrast to Lawn (2008, 2013) who deducts certain fractions of all consumption categories, the defensive consumption categories in this paper are rather limited. Nonetheless, in Section 5 of this appendix we will discount overall consumption to account for the diminishing marginal utility of income.

Defensive expenditures involve the subtracting of the following: 25% of food and alcohol expenditures, 100% of tobacco and narcotics expenditures, 100% of insurance and financial services expenditures. 25% of food expenditures are subtracted. Detailed data on Final consumption expenditure of households by consumption purpose was extracted from Eurostat (2019e). The detailed data for Greece in 2018 was extrapolated using previous' years trend.

Finally, the costs of car accidents are deducted too because this are rehabilitative expenditures that are undertaken to restore to previous, more healthy conditions and are deducted because they are to be seen as costs, not benefits. The cost of road accidents is calculated by coupling costs estimates for deaths and injuries with the number of deaths and injured. The number of fatalities and injured is obtained from OECD.Stat (2019c) – memory items were used is data were missing toward the end of the time period. The country-specific cost estimates come from HEATCO, which is a EU-project dedicated to developing harmonized European approaches for transport costing and project assessment, by Bickel et al. (2006). As suggested by Bickel et al. the number of deaths and the number of injured are multiplied with respectively factors 1.02 and 2.25 to account for unreported road accidents. By using the factor 2.25 for average accidents, we assume that the accidents listed on OECD.Stat are 'average' accidents as the OECD-database does not distinguish between severe of slight accidents, for which Bickel et al. provide other adjustment factors.

The cost estimates used only captures the direct and indirect economic costs related to fatalities and injuries. Since the data from OECD.Stat gives no indication on the type of injury, the cost estimates for slight injuries are chosen instead of the higher estimates of severe injuries. Direct costs included are medical and rehabilitation costs, legal court and emergency service costs and material damages, while the indirect costs consist of the lost production that could have been produced if there was no accident (Bickel et al. 2006). For future years, the 2002-point estimate was converted using the trend in GDP, as recommended by Bickel et al. The cost estimates for the years before 2002 were obtained using the same scaling technique.

This item is calculated in a similar fashion for both welfare interpretations because of a lack of estimates that allow to separate current from future costs. The indirect costs and the medical and rehabilitation costs include future costs, which makes this valuation method less appropriate for the experiential welfare interpretation. Nonetheless, we believe the used valuation method, also for the experiential interpretation, is rather conservative because the estimates for the value of safety or the value of a statistical life that cover the largest share of the total accident costs are not included. The value of safety is "the value of a very small change in the change of risk of dying or getting injured in an accident" (Bickel et al., 2006). In this study the value of a statistical life is not considered here, nor in other items, as it gives no indication about how many life years are lost. For this reason, the valuation of the items air pollution and the costs of extreme weather events, discussed in Sections 7.1 and 7.4, is based on estimates that account for the life years lost. Future research could, look into finding different valuation methods for each welfare interpretation, distinguishing the number of injuries by type and the number of life years lost.

4. Shadow economy

The new item shadow economy is introduced in the category net consumption to account for the welfare contributions of informal market activities. This item is estimated based on a study by Kelmanson et al. (2019), in which the size of the Europe's shadow economy is estimated as a percentage of GDP from 2000 to 2016. The percentages before 2000 and for 2017 are extrapolated from Medina and Schneider's (2019) global study with country estimates from 1991 to 2017. The value for 2018 is a memory item.

In order to conservatively approximate the welfare contribution of the shadow economy, the size of the shadow economy was halved. This can be thought of as a conservative estimate to exclude illegal activities, avoid double counting with actual individual consumption and unpaid work and exclude defensive expenditures. As the shadow economy is also treated as consumption and included in net consumption, the value of the shadow economy is also corrected for income inequality using the adjusted Atkinson Index.

Future research could investigate ways of refining this item's valuation methods, for instance distinguishing between consumption and investment. Part of the shadow economy that is included as consumption here, but that is in fact an investment should be factored back in as capital adjustments in the broad welfare interpretation in a similar was as was done with the benefits of consumer durables.

5. Welfare losses from income inequality

The welfare losses from income inequality are calculated by multiplying an inequality adjustment factor with the sum of individual consumption expenditures and the shadow economy minus defensive, intermediate en rehabilitative expenditures.

The adjustment for the diminishing marginal utility of income makes use of decile data obtained from Eurostat (2019g) to have an indication about the distribution of incomes in percentages. The income deciles are calculated based on disposable income. The total disposable household income is equivalized to account for the differences in household size and composition. Actual (average) incomes per decile and the median income are obtained by matching the decile data with GDP-data from Eurostat (2020b). The datagaps on income deciles are extrapolated for values in between two income decile datapoints. Income decile data gaps at the beginning of the time period for Denmark (1995-2002), Finland (1995) and Sweden (1995-2003) were filled via memory items.

The sufficiency threshold of $20,000 in 2011 prices was converted to 2010 prices using World Bank (2019) deflators. This sufficiency threshold in 2010 dollars was converted to a country-specific sufficiency threshold in euro by using data on purchasing power parities from the OECD (2020b).

Part of the sensitivity analysis is based on the Adjusted Atkinson Index. Compared to previous studies a higher income inequality aversion is chosen: in the final measure ε is put to 1.5 based on Latty (2011) instead of 0.8. Moreover, parameter α is put to 0.35 after Howarth and Kennedy (2016) to account for relative income effects, in contrast to earlier studies in which this is not the case (i.e. $\alpha = 0$). The Atkinson index is calculated based on the decile data obtained from Eurostat (2019g). The Gini coefficient of equivalized disposable from Eurostat (2019c) was used to extrapolate the adjusted Atkinson Index when income deciles were missing. Missing Gini coefficients were interpolated, while memory items were used if it was not possible to extrapolate the adjusted Atkinson Index based on the Gini coefficients.

6. Non-defensive government expenditures

This category measures the non-defensive goods and services produced by the general government, but consumed by households collectively such as housing, cultural and artistic activities. In contrast to the individual consumption expenditures by the government on health and education that is incorporated in actual individual consumption, this adjustment factors in the non-defensive part of the general government's collective consumption expenditures. The categories *general public services, housing and community amenities* and *recreation, culture and religion* are entirely seen as non-defensive and thus seen as beneficial to welfare. *Defense, public order and safety, economic affairs, environmental protection, health, education, and social protection* are categories that treated as defensive and are not counted in EWM, except for the part of health and education expenditures which are reallocated as actual individual consumption. Data are obtained from Eurostat (2020c).

The categories included here and labelled as 'non-defensive' are rather broad. General public services includes the following subcategories: 'general public services' and 'general public services not elsewhere classified', but also 'executive and legislative organs, financial and fiscal affairs, external affairs', 'foreign economic aid', 'basic research', 'R&D General public services', 'public debt transactions' and ' transfers of a general character between different levels of government'. Therefore, future research should scrutinize these categories in greater detail to verify which expenditures are defensive, which expenditures are on durable goods, which expenditures are investments, which expenditures should be included in the different welfare interpretations and which expenses are potentially double counted. Data availability could, however, limit a proper translation of these subcategories from theory to practice. Government expenditures are exactly the same for both welfare interpretations because subcategories in general public services are only available from 2001 onwards. If data would have been available from 1995 on, BCE and BCPA could be calculated differently, for instance, by excluding foreign economic aid for BCE and including it in BCPA.

At this point, I believe the approach of including or excluding entire categories of government expenditures and the reallocation of health and education to actual individual consumption is less arbitrary compared to previous welfare studies, in which certain fractions were deducted.

7. Ecological costs

7.1 Cost of air pollution

The cost of air pollution is calculated differently for BCE's narrow ecological costs (NEW) and BCPA's broad ecological costs (BEC). The starting point to estimate this item are within border (i.e. production-based) emissions for the following air pollutants: PM 2,5, NOx, NH3, SO_x and NMVOC. Emission data for these pollutants from 1995-2017 are available on Eurostat (2019i). The cost estimate for each pollutant (€/ton) is taken from a study by the European Environmental Agency (EEA, 2014). This report specifically estimates air pollution's health-related costs as the valuation methods consist of two complementary approaches: the value of a statistical life (VSL), "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"; and the value of a life year (VOLY), "an estimate of damage costs based upon the loss of life expectancy (expressed as potential years of life lost, or YOLLs). This measure takes into account the age at which deaths occur by giving greater weight to deaths at younger age and lower weight to deaths at older age". The low VOLY (and not high VSL) is taken to obtain cost estimates, as it provides more information by accounting for the years of life lost. Because the EEA-study only provides a cost estimate for SO_2 and not SO_x the emissions of SO_x are valued using the cost SO_x-estimate. This can be considered as a decent approximation as all the sulphur emitted from other points sources than SO_2 accounts for less than 5% of the total amount of sulphur emitted (Green et al., 2016).

The EEA-study quantifies both chronic and acute effects of air pollution's health impacts. This is not problematic for BEC as it also incorporates future costs. However, in order to approximate the presents costs of air pollution for NEC, an adjustment is needed. For this reason, only 20% of the production-based cost of air pollution is treated as a cost in the present. Lawn (2008) executed a similar adjustment to capture the direct disamenity cost as opposed to the long-term health impacts.

The broad ecological costs, in contrast, include the entire cost from domestic emissions and adds the costs of the air pollution embodied in trade to account for costs shifted elsewhere. Data on the effect of air pollution on human health (for pollutants PM 2.5 from fossil and biogenic sources, NH_3, NO_x, SO_2) from a domestic production and consumption footprint are obtained from the SCP Hotspots Analysis Tool (UN

Environment, 2020)[40]. The amount of air pollution embodied in trade is obtained by taking the difference between the consumption and production perspectives. However, as these data are expressed in disability-adjusted life years (DALYs) instead of raw emissions, they are valued using a cost estimate of €41,000 per life year related to air pollution mortality taken from Desaigues et al.'s (2011) contingent valuation survey on the value of a life year related to air pollution mortality in the EU-15.

Data from SCP-HAT only covers the years up until 2015, of which the values for 2013 until 2015 also have been extrapolated (Piñero et al., 2019). These authors used CO_2-emissions to project PM 2.5 fossil, NO_x and SO_2. In order to project the emissions embodied in trade until 2018, production and consumption based CO_2-emissions from the global carbon project 2019 were taken (see Section 7.3). The same production-based emissions were used to extrapolate domestic emissions for PM 2.5, NO_x and SO_x to 2018 as Eurostat only records emissions up until 2017. Emission data for NH_3 and NMVOC in 2018 are memory items of the values in 2017.

7.2 Ecosystem costs of nitrogen pollution

In Van der Slycken and Bleys (2020b), a new item was introduced: the costs of nitrogen pollution. The rationale for including this item stems from recent scientific evidence, showing that the nitrogen cycle is a planetary boundary that is being transgressed (Steffen et al., 2015).[41] This item is included in the NEC and BEC since it is assumed to reflect the current ecosystem costs within domestic borders.

The cost of nitrogen pollution is calculated by matching emissions data on NO_x and NH_3 from Eurostat (2019i) and a study for Europe by Van Grinsven et al. (2013). These authors provide detailed costs for nitrogen pollution's impact on health, the climate and ecosystems. In order to avoid double counting with the items air pollution and climate disruption, the valuation method of this item does not incorporate the health and climate impacts of nitrogen pollution, instead it only registers the ecosystem costs from the emissions of NO_x and NH_3. This study provides a range for the costs from NO_x and NH_3 emissions (to air) for the entire EU27. Marginal cost estimates per ton for both types of emissions were obtained by dividing the average of this cost range by the total amount of emissions for the EU27. Similarly, the total ecosystem cost

[40] The use of this information is with permission from UN Environment, subject to the Terms and Conditions in www.scp-hat.lifecycleinitiative.org.

[41] Steffen et al. (2015) identified that the threshold for biochemical flows has been crossed. The planetary boundary biochemical flows consists of two subcomponents, the nitrogen and phosphorus cycle, which have both transgressed planetary boundaries. This study only includes the ecosystem costs of nitrogen pollution. Calculating the costs related to the phosphorus cycle is left for future research, because of a lack of available data.

from reactive nitrogen losses to rivers and seas from agricultural sources was converted in an estimate per ton using data on the consumption of inorganic nitrogen fertilizer from Eurostat's (2020d) – memory items were used to fill data gaps at the beginning and end of the period. The consumption of inorganic nitrogen fertilizer was used as a quantity to capture the nitrogen run-off to rivers and seas from agricultural sources. In a next step, the cost per ton in € 2008 was converted to € 2010 using a country-specific deflator. For Belgium, for instance, NO_x is valued in 2010 prices at € 3,842.71 per ton, NH_3 at € 11,675.02 per ton and reactive nitrogen at € 5,697.82 per ton.

Van der Slycken and Bleys (2020b) proposed not to include a separate "cost of water pollution" item as most other studies do, yet to instead approximate these costs by including in this item the ecosystem costs from reactive nitrogen losses from agricultural sources to rivers and seas.

7.3 Cost of climate breakdown

This item, previously referred to as the costs of 'climate change', has changed significantly over the years – see e.g. O'Mahony et al. (2018) for an overview.[42] Most studies valued this item by coupling the emissions related to the domestic consumption of fossil fuels with a social cost of carbon. Nevertheless, scholars are still discussing how to properly account for 'climate change'. Bagstad et al. (2014) suggested to substitute this common valuation method with components such as the cost of natural disasters and water scarcity, whereas O'Mahony et al. (2018) stipulated the need for a separate approach to distinguish between future global impact costs related to current domestic emitting activities and the current national welfare costs of climate change stemming from past global emissions.

The appropriate approach to account for climate disruption depends on the welfare interpretation used. Van der Slycken and Bleys's (2020a) conceptual exploration on welfare costs here and now and the costs shifted abroad and to the future, helps to distinguish between BCPA and BCE. BCPA can include future and distant costs and thus can make use of a social cost of carbon to capture damages caused. However, BCE can't and should focus on the local and current costs arising from climate change, i.e. the damages suffered. That is why, the item *costs of climate breakdown* is only included in BCPA. Yet, the new item *costs of extreme weather events,* which approximates the damages suffered 'here and now', is to be included in BCE (see Section 7.4) but not in BCPA to avoid double counting with the cost of climate breakdown.

[42] I prefer to use the term climate breakdown instead of a mere change in climate as recent evidence on climate tipping points indicates the threat of rapid and irreversible changes in the climate system that would severely disrupt ecosystems, societies and economies.

Other methodological novelties regarding the calculation of the *costs of climate breakdown* are a broader set of emissions beyond territorial GHG-emissions. The quantity of emissions is based on the data countries send to UNFCCC and includes: territorial GHG emissions (without Land Use, Land-Use Change and Forestry (LULUCF), without indirect CO_2), the emissions from international bunkers (aviation and navigation), CO_2 emissions from biomass and LULUCF. This data is taken from a data viewer by the EEA (2019a).[43] The values for 2018 are taken from a greenhouse gas inventory report (EEA, 2019b), which are sometimes memo items if the data are missing from the inventory report.

The emissions of navigation were slightly changed to account for the bunkering of fuels – the navigation emissions send to the UNFCCC are based on marine fuel sales in each European country, which does not reflect each countries' activity-based emissions (Transport and Environment, 2019). Based on this study from Transport and Environment, navigation emissions are allocated to countries' activities and not sales for the year 2018. This estimate was compared to the country-estimate reported to the UNFCCC in 2018 that was taken from EEA (2019b). The ratio between both 2018 values for the emission from navigation was used to extrapolate a time series based on Transport and Environment's methodology until the beginning of the time period. This ratio is assumed to stay constant over this time period and is applied to the navigation emission data reported to the UNFCCC. The final emissions for international navigation is calculated by taking the average of the UNFCCC-series and the series based on Transport and Environment's methodology.

Furthermore, two types of footprint emissions are added to register the emissions beyond domestic borders that can be related to national consumption. The first type involves the carbon dioxide emissions embodied in goods and services. These emissions are updated from Peters et al. (2011) in the Global Carbon Project by Friedlingstein et al. (2019). Consumption based emissions for 2018 were extrapolated using last year's trend. It should be noted, however, that the Global Carbon Atlas defines 'transfer emissions', as the difference between production and consumption carbon dioxide emissions. Because this procedure gives negative quantities for countries that import emissions, I have taken the opposite numbers, i.e. the difference between consumption and production emissions, in this paper to obtain positive quantities if countries are net importers of emissions, i.e. the emission from the production of imports are larger than the emissions from the production of exports.

[43] Data is taken for the following categories on the EEA-viewer: Total (without LULUCF, without indirect CO2), 1.D.1.a – International Aviation, 1.D.1.b – International Navigation, 1.D.3 – CO2 emissions from biomass, 4 – Land Use, Land-Use Change and Forestry.

The second type of footprint emissions relates the land-use change emissions from the Global Carbon Project 2019 (Friedlingstein et al., 2019) a EU15-country's share in the global land-use consumption footprint using SCP-HAT. The global carbon project emission data is based on the average of two bookkeeping models from Houghton and Nassikas (2017) and Hansis et al. (2015). These global emissions are allocated to EU15-countries according to their land-use consumption footprint as a share of the global land-use consumption footprint. Both consumption footprints are taken from UN Environment (2019). As these footprints only cover the years up until 2015, 2016 values are projected using data on the global and country's Ecological Footprint provided by the Global Footprint Network (2019) – more specifically by assuming the land-use footprint follows the same trend from 2015 to 2016 as the combined ecological footprint of built-up land, cropland, forest products and grazing land, however, since some countries do not have such a detailed breakdown of their footprint, I used their total footprint. The values for 2017 and 2018 are memory items.

To calculate the damage caused by climate disruption, these emissions are coupled with a social cost of carbon (SCC). The SCC differs significantly depending on the specific parameters (i.e. damage functions, discount rate, climate sensitivity). Ackerman and Stanton's (2012) estimates of the SCC in 2010 vary between \$28 and \$892 in 2007\$. O'Mahony et al. (2018) use in the Spanish ISEW-study an estimate of \$232 in 2010\$ or €175.37 in 2010€ per tonne of CO_2 (equivalent), which is based on a 3% discount rate, 95th percentile climate sensitivity and Hanemann Weitzman damage functions. Stern (2006), however, argued in favor of a lower discount rate based on the aspect of intergenerational equity. In order to suitably measure the future costs in BCPA and thus discount future costs less, we would suggest to use a lower discount rate compared to O'Mahony et al. (2018). Using the same damage functions, a 1.5% discount rate would lead to SCC-estimates of \$445 and \$892 in 2007\$ (or €340.23 and €681.98 in 2010€ for Belgium), for respectively average and 95th percentile climate sensitivity (Ackerman and Stanton, 2012). As the lowest of these SCC's is almost the double of O'Mahony et al.'s estimate, I use the estimate based on average climate sensitivity and apply an annual growth rate of 1.4452407% to extrapolate and interpolate the estimates in the years before and after 2010. The annual growth rate is obtained by extrapolation Ackerman and Stanton's (2012) 2010 values to 2050. Using discount rate of 1.5%, is similar the 1.4% discount rate proposed by Stern (2006) in the Stern Review. The 2007 values are first converted to euros in 2007 prices. Afterwards, national deflators from the World Bank (2019) were used to obtain a SCC-estimate in 2010 prices for each country.

7.4 Cost of extreme weather events

Van der Slycken and Bleys (2020b) introduced with the *costs of extreme weather events* a new item to capture the present damages suffered from geophysical, hydrological, meteorological and climatological extreme weather events. This item measures what is experienced 'here and now' from these events for BCE's NEC. This item is excluded from BCPA's BEC to avoid double counting. The calculation method, however, does not cover all the costs of extreme weather events, but only focuses on the uninsured costs. This way, the insurance expenditures made in previous years help to reduce the damages suffered from these events. This approach thus accounts for the positive contribution of insurance when they are of use or consumed, instead of when expenditures are made.

Data on the uninsured losses is taken from Munich Reinsurance Company's NatCatService (2019). This global database of natural catastrophes lists the economic losses from the following types of extreme events: hydrological (i.e. flood, mass movement wet), climatological (i.e. extreme temperature, drought, wildfire), geophysical (i.e. earthquake, volcanic eruption, mass movement dry) and meteorological (i.e. tropical storm, extra-tropical storm, convective storm, local windstorm). The cost is calculated by taking the difference between direct economic loss estimates (all physical/tangible losses) and insured losses (i.e. all paid-out insured losses through all affected lines of business – "market loss") from NatCatService (2018). Exchange rate data is taken from OECD.Stat (2019b) to convert US dollars to euros.

7.5 Depletion of non-renewable energy resources

The valuation of this item is based on the total energy investments expenditures needed in the European Union under the requirement of meeting certain climate goals agreed upon by the European Council as an approximation to value the depletion of non-renewable resources. These targets include an overall GHG emission reduction of at least 40% compared to 1990 and a share of renewable energy in final energy consumption of at least 27%. Moreover, the European Council agreed on the following minimum ambition level for the energy efficiency target: a 27% reduction of primary energy consumption compared to 2007. The investments needed are calculated, given the various policy options for 2030 energy efficiency targets: 27%, 30%, 33%, 35% and 40%. Policy options with a level of energy efficiency higher than 30% in 2030 also have higher share of renewable energy sources of 28% (European Commission, 2016). A mid-value of 33% target was chosen, which leads to a total energy related investment expenditure of 1115 billion euros (in 2010 prices) in the EU-28. This amount is an annual average investment that needs to be made every year from 2010 to 2030 to meet the 2030 targets. A marginal cost estimate of € 797,45 (in 2010 prices) per ton of oil equivalent is obtained by dividing the total investment by the primary energy consumption in 2016 for the EU-28, which was taken from Eurostat (2020a). A 27% and 40% energy efficiency target would result respectively in a marginal cost of € 670,58 and € 1.012,99. This marginal cost was than coupled with EU15-countries' primary energy consumption taken from Eurostat (2020a) to approximate the transition investments needed.

7.6 Costs of use of nuclear power

Using nuclear energy involves significant costs and these costs should be accounted for. So far, the German welfare study by Held et al. (2018) is the only one that accounts for this item. This item couples data from the IEA (2020) on nuclear electricity generation with a cost estimate (€0,124 per kWh in 2010 prices) from Held et al. (2018). The cost of use of nuclear power is only included in BCPA's broad ecological costs, as the estimate used includes the costs of dismantlement, search of a disposal site and final storage of radioactive waste and the costs of insurance against a worst case event. Future research may look into finding a way to calculate the costs that are experienced in the present.

8. Capital adjustment

This item net capital growth is included in BCPA. In contrast to previous studies, this study only traces mere capital adjustments. It breaks with taking 5-year rolling averages and by including the growth requirement in this item. Following Hicks' income concept, capital changes should be counted as income. However, by taking 5-year rolling averages to smooth out fluctuations, one is actually treating this item as the services flowing from a stock that would last five years. Furthermore, the net capital growth required to keep the capital stock per worker intact is removed as this procedure is motivated by a sustainability rationale. As Lawn (2013) articulated welfare measures only capture economic welfare and not sustainability. Including this net investment has a clear welfare interpretation. Weitzman (1976), for instance, has shown that adding net investments to a country's consumption (i.e. the net national product) is (in theory) a proxy for the present discounted value of future consumption – as such the future consumption possibilities locked up in current wealth are registered.

Net capital growth is calculated by taking the difference between the capital stock in the present and previous year. The data on the net capital stock comes from the AMECO (2019c). In the Ameco-database this year's net capital stock is obtained by adding the difference between gross fixed capital formation and the consumption of fixed capital to the previous year's net capital stock.

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Appendix B: Data

The data presented here are per capita data in 2010 prices, except the population data.

Austria

	gdp	bce	bcpa	population
1995	28.814,64 €	27.415,72 €	22.673,17 €	7943489
1996	28.903,41 €	27.668,91 €	22.522,01 €	7953067
1997	28.634,14 €	27.229,18 €	22.428,31 €	7964966
1998	29.571,64 €	27.809,82 €	22.871,18 €	7971116
1999	30.789,08 €	28.138,29 €	23.367,34 €	7982461
2000	31.749,98 €	28.772,82 €	24.075,72 €	8002186
2001	32.077,10 €	29.016,43 €	23.833,97 €	8020946
2002	32.434,23 €	28.723,93 €	23.156,78 €	8063640
2003	32.591,53 €	29.115,61 €	22.599,51 €	8100273
2004	33.309,01 €	29.366,99 €	22.768,04 €	8142573
2005	33.812,36 €	29.466,59 €	22.576,94 €	8201359
2006	34.755,92 €	29.755,58 €	22.436,09 €	8254298
2007	35.926,56 €	29.692,70 €	22.836,85 €	8282984
2008	36.341,53 €	29.753,23 €	22.833,95 €	8307989
2009	34.860,07 €	30.275,16 €	23.073,90 €	8335003
2010	35.429,75 €	30.442,68 €	22.497,93 €	8351643
2011	36.362,89 €	30.544,67 €	22.991,76 €	8375164
2012	36.466,81 €	30.643,28 €	23.155,26 €	8408121
2013	36.287,35 €	30.662,59 €	23.145,84 €	8451860
2014	36.287,19 €	30.475,36 €	22.992,37 €	8507786
2015	36.373,29 €	30.287,52 €	22.746,56 €	8584926
2016	36.730,30 €	30.229,18 €	22.877,44 €	8700471
2017	37.285,30 €	30.078,48 €	22.742,90 €	8772865
2018	38.009,93 €	30.283,16 €	23.324,32 €	8822267

	uw	c	s	g	dire	inq	nec	bec	ca
1995	9.058,68 €	18.737,79 €	1.324,65 €	3.494,73 €	1.679,72 €	3.093,36 €	427,06 €	7.785,59 €	2.615,98 €
1996	9.023,44 €	18.924,93 €	1.344,01 €	3.523,28 €	1.618,18 €	3.091,43 €	437,13 €	8.377,97 €	2.793,94 €
1997	8.958,86 €	18.831,00 €	1.346,62 €	3.082,15 €	1.617,81 €	2.924,21 €	447,43 €	7.959,38 €	2.711,08 €
1998	9.228,70 €	19.367,19 €	1.375,08 €	3.135,66 €	1.686,13 €	3.180,29 €	430,39 €	8.169,39 €	2.800,36 €
1999	9.419,25 €	19.919,35 €	1.464,23 €	3.223,38 €	1.699,81 €	3.735,69 €	452,42 €	7.935,44 €	2.712,07 €
2000	9.509,55 €	20.555,82 €	1.476,37 €	3.262,84 €	1.775,10 €	3.808,48 €	448,18 €	8.108,53 €	2.963,25 €
2001	9.523,55 €	20.859,75 €	1.411,39 €	3.382,71 €	1.823,33 €	3.907,64 €	429,99 €	8.277,93 €	2.665,47 €
2002	9.667,62 €	20.992,31 €	1.491,97 €	3.260,66 €	1.777,23 €	4.131,25 €	780,15 €	8.589,55 €	2.242,25 €
2003	9.702,38 €	21.297,93 €	1.548,10 €	3.149,49 €	1.792,55 €	4.346,48 €	443,26 €	9.339,72 €	2.380,37 €
2004	9.697,48 €	21.602,37 €	1.565,52 €	3.125,19 €	1.825,31 €	4.414,73 €	383,55 €	9.293,69 €	2.311,19 €
2005	9.612,66 €	21.883,61 €	1.690,62 €	3.222,62 €	1.878,86 €	4.617,66 €	446,39 €	9.512,22 €	2.176,18 €
2006	9.589,53 €	22.295,76 €	1.720,42 €	3.284,81 €	1.889,22 €	4.834,86 €	410,87 €	9.888,08 €	2.157,71 €
2007	9.615,50 €	22.588,42 €	1.688,55 €	3.366,63 €	1.981,00 €	5.186,85 €	398,56 €	9.671,18 €	2.416,78 €
2008	9.663,60 €	22.891,24 €	1.708,05 €	3.243,90 €	1.902,39 €	5.469,66 €	381,51 €	9.725,68 €	2.424,90 €
2009	9.715,12 €	22.745,50 €	1.812,72 €	3.353,84 €	1.815,15 €	5.182,20 €	354,68 €	9.274,68 €	1.718,73 €
2010	9.860,31 €	23.104,06 €	1.736,06 €	3.315,04 €	1.806,48 €	5.423,99 €	342,32 €	9.730,97 €	1.443,90 €
2011	9.851,97 €	23.528,90 €	1.672,69 €	3.271,48 €	1.829,09 €	5.623,53 €	327,75 €	9.738,76 €	1.858,10 €
2012	9.820,62 €	23.699,65 €	1.695,71 €	3.239,80 €	1.767,42 €	5.714,53 €	330,55 €	9.631,63 €	1.813,06 €
2013	9.825,84 €	23.796,41 €	1.705,51 €	3.197,48 €	1.773,95 €	5.659,85 €	428,84 €	9.769,55 €	1.823,96 €
2014	9.764,63 €	23.725,35 €	1.741,79 €	3.044,67 €	1.793,90 €	5.676,02 €	331,17 €	9.491,05 €	1.676,89 €
2015	9.720,67 €	23.521,04 €	1.764,10 €	3.041,23 €	1.779,65 €	5.625,96 €	353,91 €	9.641,64 €	1.746,77 €
2016	9.770,41 €	23.581,47 €	1.763,05 €	2.946,72 €	1.757,68 €	5.726,74 €	348,06 €	9.626,87 €	1.927,07 €
2017	9.756,33 €	23.845,36 €	1.717,14 €	2.797,60 €	1.736,46 €	5.971,06 €	330,43 €	9.754,39 €	2.088,38 €
2018	9.779,24 €	24.111,83 €	1.750,51 €	2.816,81 €	1.748,41 €	6.104,18 €	322,64 €	9.540,76 €	2.259,28 €

Belgium

	gdp	bce	bcpa	population
1995	27.701,49 €	29.417,93 €	19.919,19 €	10130574
1996	27.509,31 €	29.787,39 €	19.819,74 €	10143047
1997	27.570,46 €	29.572,78 €	19.538,90 €	10170226
1998	28.002,48 €	29.696,22 €	19.297,70 €	10192264
1999	29.143,72 €	30.524,35 €	20.215,81 €	10213752
2000	30.149,47 €	30.874,88 €	20.242,29 €	10239085
2001	30.373,36 €	31.124,87 €	20.571,17 €	10263414
2002	30.740,99 €	31.519,40 €	20.060,98 €	10309725
2003	30.887,51 €	31.858,13 €	20.069,53 €	10355844
2004	31.845,26 €	32.088,39 €	19.956,56 €	10396421
2005	32.413,62 €	32.251,51 €	20.492,56 €	10445852
2006	33.019,11 €	32.029,56 €	19.857,75 €	10511382
2007	33.971,33 €	32.441,68 €	20.499,71 €	10584534
2008	33.857,66 €	33.096,66 €	21.533,93 €	10666866
2009	32.827,54 €	33.890,78 €	22.632,54 €	10753080
2010	33.500,30 €	33.775,33 €	21.666,43 €	10839905
2011	33.506,17 €	33.889,49 €	22.254,24 €	11000638
2012	33.520,06 €	33.819,85 €	22.950,28 €	11075889
2013	33.560,88 €	33.885,01 €	22.622,67 €	11137974
2014	34.051,58 €	33.823,31 €	23.379,16 €	11180840
2015	34.686,52 €	33.520,98 €	23.191,72 €	11237274
2016	34.959,39 €	33.530,85 €	23.005,68 €	11311117
2017	35.536,02 €	33.409,50 €	22.753,37 €	11351727
2018	36.050,73 €	33.794,19 €	23.478,20 €	11398589

	uw	c	s	g	dire	inq	nec	bec	ca
1995	10.291,33 €	18.019,01 €	2.837,52 €	4.087,24 €	2.053,50 €	3.138,83 €	624,85 €	11.608,41 €	1.484,83 €
1996	10.404,61 €	18.169,12 €	2.860,97 €	4.004,01 €	1.934,46 €	3.099,47 €	617,38 €	11.947,59 €	1.362,56 €
1997	10.599,36 €	17.916,39 €	2.867,33 €	3.805,49 €	1.901,05 €	3.121,01 €	593,72 €	12.204,50 €	1.576,90 €
1998	10.506,23 €	18.258,45 €	2.970,80 €	3.726,90 €	2.032,16 €	3.146,03 €	587,96 €	12.531,98 €	1.545,50 €
1999	11.051,00 €	18.759,92 €	3.030,95 €	3.781,13 €	1.949,13 €	3.580,14 €	569,37 €	12.478,69 €	1.600,77 €
2000	11.083,86 €	19.431,44 €	3.135,54 €	3.866,26 €	2.149,13 €	3.959,12 €	533,98 €	12.898,03 €	1.731,46 €
2001	11.117,62 €	19.686,04 €	3.249,95 €	3.751,41 €	2.149,75 €	4.020,83 €	509,58 €	12.694,94 €	1.631,66 €
2002	11.262,26 €	19.817,95 €	3.350,77 €	3.747,90 €	2.030,10 €	4.134,86 €	494,52 €	13.096,68 €	1.143,74 €
2003	11.411,02 €	19.964,48 €	3.413,07 €	3.680,87 €	1.924,37 €	4.208,86 €	478,07 €	13.203,36 €	936,68 €
2004	11.550,67 €	20.245,82 €	3.439,29 €	3.583,44 €	1.992,94 €	4.263,44 €	474,44 €	13.934,73 €	1.328,45 €
2005	11.656,23 €	20.565,78 €	3.597,91 €	3.559,50 €	2.051,32 €	4.618,33 €	458,27 €	13.735,41 €	1.518,19 €
2006	11.667,64 €	20.803,02 €	3.582,57 €	3.391,48 €	2.230,89 €	4.743,85 €	440,42 €	14.075,30 €	1.463,07 €
2007	11.757,61 €	21.192,76 €	3.685,89 €	3.520,29 €	2.391,55 €	4.891,03 €	432,30 €	14.176,48 €	1.802,21 €
2008	11.848,06 €	21.759,14 €	3.792,06 €	3.507,70 €	2.286,12 €	5.135,86 €	388,31 €	13.716,81 €	1.765,77 €
2009	12.057,44 €	21.663,61 €	3.972,13 €	3.561,70 €	2.134,00 €	4.861,83 €	368,27 €	12.693,95 €	1.067,44 €
2010	12.120,77 €	22.016,53 €	3.802,28 €	3.473,61 €	2.207,76 €	5.043,00 €	387,11 €	13.434,19 €	938,17 €
2011	11.888,08 €	22.188,15 €	3.819,70 €	3.483,84 €	2.049,68 €	5.100,96 €	339,64 €	13.164,64 €	1.189,76 €
2012	11.660,79 €	22.476,79 €	3.620,17 €	3.533,65 €	1.981,04 €	5.163,94 €	326,56 €	12.316,06 €	1.119,94 €
2013	11.546,03 €	22.719,18 €	3.658,14 €	3.457,69 €	1.991,85 €	5.178,93 €	325,24 €	12.470,67 €	883,08 €
2014	11.523,05 €	22.807,63 €	3.745,67 €	3.421,18 €	2.054,64 €	5.301,87 €	317,71 €	11.952,51 €	1.190,66 €
2015	11.384,57 €	22.972,20 €	3.867,55 €	3.300,99 €	2.190,81 €	5.504,47 €	309,04 €	12.023,51 €	1.385,21 €
2016	11.349,17 €	23.087,80 €	3.863,01 €	3.325,60 €	2.180,94 €	5.607,60 €	306,18 €	12.403,18 €	1.571,83 €
2017	11.332,01 €	23.466,15 €	3.833,79 €	3.075,73 €	2.220,91 €	5.779,42 €	297,85 €	12.540,04 €	1.586,06 €
2018	11.484,38 €	23.840,90 €	3.889,32 €	3.132,81 €	2.294,76 €	5.960,97 €	297,49 €	12.395,64 €	1.782,15 €

Denmark

	gdp	bce	bcpa	population
1995	37.828,31 €	41.007,04 €	32.090,94 €	5215718
1996	38.499,18 €	41.460,51 €	31.942,12 €	5251027
1997	38.915,73 €	41.450,28 €	32.823,56 €	5275121
1998	39.547,65 €	42.136,25 €	34.063,36 €	5294860
1999	40.918,24 €	42.516,56 €	34.442,94 €	5313577
2000	42.216,52 €	42.355,70 €	34.804,39 €	5330020
2001	42.421,02 €	42.392,61 €	34.510,29 €	5349212
2002	42.590,32 €	42.898,48 €	34.469,45 €	5368354
2003	42.634,97 €	43.426,24 €	34.396,60 €	5383507
2004	43.603,94 €	43.851,90 €	34.926,09 €	5397640
2005	44.438,25 €	43.696,88 €	35.397,11 €	5411405
2006	45.995,47 €	44.311,97 €	36.190,05 €	5427459
2007	46.299,22 €	44.963,98 €	37.048,29 €	5447084
2008	45.787,48 €	45.707,45 €	37.609,59 €	5475791
2009	43.316,10 €	47.214,94 €	38.247,93 €	5511451
2010	43.934,40 €	47.204,62 €	37.387,60 €	5534738
2011	44.294,79 €	47.307,32 €	38.116,31 €	5560628
2012	44.277,90 €	47.337,56 €	38.635,12 €	5580516
2013	44.430,03 €	46.468,18 €	37.794,25 €	5602628
2014	44.970,78 €	46.076,83 €	37.751,14 €	5627235
2015	45.736,23 €	46.827,55 €	38.713,12 €	5659715
2016	46.696,07 €	46.733,68 €	38.972,15 €	5707251
2017	47.214,52 €	46.265,61 €	38.770,24 €	5748769
2018	48.181,10 €	46.890,05 €	39.933,58 €	5781190

	uw	c	s	g	dire	inq	nec	bec	ca
1995	16.047,79 €	24.704,67 €	3.279,01 €	4.979,47 €	2.404,02 €	4.701,73 €	898,15 €	10.797,49 €	983,24 €
1996	16.229,38 €	25.019,80 €	3.407,18 €	4.978,97 €	2.308,95 €	4.937,84 €	928,04 €	11.590,17 €	1.143,74 €
1997	16.403,76 €	25.118,02 €	3.373,27 €	4.733,50 €	2.294,45 €	5.037,42 €	846,42 €	11.004,05 €	1.530,93 €
1998	16.689,79 €	25.809,82 €	3.499,97 €	4.619,32 €	2.355,44 €	5.314,13 €	813,08 €	10.699,41 €	1.813,44 €
1999	16.853,21 €	26.361,00 €	3.621,26 €	4.649,29 €	2.362,63 €	5.731,63 €	873,94 €	10.553,35 €	1.605,80 €
2000	16.759,51 €	26.594,37 €	3.736,16 €	4.562,19 €	2.458,50 €	6.092,03 €	746,01 €	10.354,45 €	2.057,13 €
2001	16.800,61 €	26.809,30 €	3.690,63 €	4.436,21 €	2.460,25 €	6.172,00 €	711,88 €	10.390,32 €	1.796,11 €
2002	17.076,38 €	27.102,38 €	3.939,60 €	4.239,40 €	2.452,81 €	6.329,42 €	677,05 €	10.521,84 €	1.415,75 €
2003	17.427,13 €	27.437,28 €	4.007,69 €	4.147,70 €	2.502,79 €	6.417,29 €	673,47 €	11.004,82 €	1.301,71 €
2004	17.663,79 €	27.943,47 €	4.011,56 €	4.062,43 €	2.505,21 €	6.665,15 €	659,00 €	10.968,10 €	1.383,28 €
2005	17.759,09 €	28.173,13 €	4.110,54 €	3.850,63 €	2.558,59 €	6.936,69 €	701,23 €	10.800,50 €	1.799,49 €
2006	17.992,90 €	28.842,65 €	4.185,59 €	3.895,75 €	2.576,17 €	7.412,11 €	616,64 €	11.631,18 €	2.892,62 €
2007	18.472,27 €	29.230,44 €	4.190,08 €	4.052,94 €	2.607,67 €	7.750,55 €	623,53 €	11.299,92 €	2.760,70 €
2008	18.632,33 €	29.424,35 €	4.372,70 €	4.219,24 €	2.682,47 €	7.652,30 €	606,39 €	10.750,73 €	2.046,47 €
2009	19.420,55 €	29.530,25 €	4.353,27 €	4.439,43 €	2.610,61 €	7.366,15 €	551,79 €	10.349,10 €	830,29 €
2010	19.679,54 €	29.433,86 €	4.217,70 €	4.387,60 €	2.494,78 €	7.473,17 €	546,13 €	10.541,64 €	178,50 €
2011	19.691,68 €	29.510,06 €	4.141,56 €	4.547,65 €	2.533,29 €	7.453,03 €	597,32 €	10.055,38 €	267,05 €
2012	19.361,34 €	29.412,62 €	3.940,73 €	4.996,48 €	2.458,12 €	7.413,77 €	501,72 €	9.745,12 €	540,96 €
2013	19.312,40 €	29.201,28 €	4.087,56 €	4.272,63 €	2.334,54 €	7.512,33 €	558,82 €	10.008,07 €	775,32 €
2014	19.233,32 €	29.243,32 €	3.957,43 €	4.174,35 €	2.382,63 €	7.665,76 €	483,20 €	9.845,28 €	1.036,39 €
2015	19.577,64 €	29.483,09 €	4.367,81 €	4.281,81 €	2.431,33 €	7.955,48 €	495,99 €	10.088,41 €	1.477,99 €
2016	19.841,77 €	29.703,02 €	4.296,04 €	4.005,83 €	2.408,67 €	8.220,56 €	483,74 €	10.261,98 €	2.016,70 €
2017	19.676,23 €	29.856,56 €	4.200,14 €	3.849,02 €	2.444,74 €	8.336,44 €	535,17 €	10.329,43 €	2.298,90 €
2018	19.919,99 €	30.419,93 €	4.286,13 €	4.077,51 €	2.470,73 €	8.746,93 €	595,84 €	10.368,94 €	2.816,62 €

Finland

	gdp	bce	bcpa	population
1995	25.205,77 €	26.996,01 €	15.838,64 €	5098754
1996	25.508,92 €	27.827,59 €	16.825,71 €	5116826
1997	26.791,37 €	27.946,08 €	16.455,72 €	5132320
1998	27.687,65 €	27.929,62 €	17.141,34 €	5147349
1999	29.003,88 €	28.505,38 €	17.864,87 €	5159646
2000	30.611,44 €	29.167,68 €	18.751,43 €	5171302
2001	31.341,80 €	29.450,22 €	18.699,34 €	5181115
2002	31.784,06 €	30.007,97 €	18.287,76 €	5194901
2003	32.342,33 €	31.044,63 €	18.320,78 €	5206295
2004	33.545,19 €	31.837,82 €	19.091,21 €	5219732
2005	34.368,38 €	32.398,16 €	20.998,13 €	5236611
2006	35.626,41 €	33.100,34 €	20.523,20 €	5255580
2007	37.358,15 €	33.274,22 €	21.072,65 €	5276955
2008	37.469,48 €	34.075,37 €	22.442,40 €	5300484
2009	34.242,16 €	35.013,82 €	24.079,11 €	5326314
2010	35.157,54 €	35.765,36 €	22.887,70 €	5351427
2011	35.907,10 €	36.074,86 €	24.134,94 €	5375276
2012	35.241,89 €	36.124,43 €	24.522,94 €	5401267
2013	34.762,84 €	35.917,99 €	23.725,21 €	5426674
2014	34.458,94 €	35.842,15 €	23.555,37 €	5451270
2015	34.498,39 €	36.024,28 €	23.826,83 €	5471753
2016	35.349,32 €	36.087,07 €	23.989,74 €	5487308
2017	36.253,25 €	35.778,98 €	24.050,68 €	5503297
2018	36.840,83 €	35.932,79 €	23.462,03 €	5513130

	uw	c	s	g	dire	inq	nec	bec	ca
1995	9.443,84 €	16.280,78 €	2.408,86 €	2.617,02 €	1.497,23 €	1.737,48 €	519,78 €	11.983,87 €	306,72 €
1996	9.763,67 €	16.492,37 €	2.493,24 €	2.812,95 €	1.381,93 €	1.829,00 €	523,71 €	12.189,53 €	663,93 €
1997	9.757,25 €	16.701,94 €	2.541,00 €	2.966,21 €	1.358,96 €	2.142,06 €	519,31 €	13.125,19 €	1.115,52 €
1998	9.883,17 €	16.856,25 €	2.545,82 €	2.785,91 €	1.401,43 €	2.237,48 €	502,63 €	12.869,14 €	1.578,23 €
1999	10.175,12 €	17.564,18 €	2.666,85 €	2.740,51 €	1.466,18 €	2.671,62 €	503,48 €	12.828,75 €	1.684,75 €
2000	10.509,16 €	18.206,38 €	2.770,34 €	2.772,80 €	1.545,25 €	3.062,43 €	483,32 €	12.800,90 €	1.901,33 €
2001	10.495,00 €	18.594,34 €	3.071,50 €	2.784,46 €	1.595,25 €	3.410,38 €	489,45 €	13.093,64 €	1.853,32 €
2002	10.621,80 €	19.181,80 €	3.146,62 €	2.692,16 €	1.557,06 €	3.598,99 €	478,36 €	13.661,47 €	1.462,90 €
2003	10.859,79 €	20.025,10 €	3.298,92 €	2.766,43 €	1.553,14 €	3.867,27 €	485,21 €	14.717,30 €	1.508,24 €
2004	11.055,35 €	20.773,56 €	3.488,70 €	2.824,20 €	1.577,51 €	4.255,37 €	471,11 €	14.902,59 €	1.684,86 €
2005	11.205,96 €	21.420,19 €	3.557,13 €	2.879,70 €	1.639,23 €	4.587,62 €	437,98 €	13.633,91 €	1.795,90 €
2006	11.360,48 €	22.241,22 €	3.776,40 €	2.919,40 €	1.715,37 €	5.036,59 €	445,20 €	14.799,20 €	1.776,86 €
2007	11.538,03 €	22.795,83 €	3.698,46 €	2.997,89 €	1.800,80 €	5.523,39 €	431,81 €	15.066,53 €	2.433,15 €
2008	11.671,91 €	23.398,50 €	3.821,89 €	3.163,01 €	1.838,10 €	5.714,91 €	426,92 €	14.370,61 €	2.310,72 €
2009	11.926,04 €	23.150,93 €	3.715,27 €	3.219,66 €	1.699,24 €	4.916,98 €	381,87 €	12.442,85 €	1.126,28 €
2010	12.346,47 €	23.741,07 €	3.656,38 €	3.292,21 €	1.659,86 €	5.187,57 €	423,35 €	14.491,58 €	1.190,58 €
2011	12.247,61 €	24.356,08 €	3.626,62 €	3.473,96 €	1.750,16 €	5.486,67 €	392,57 €	13.760,75 €	1.428,26 €
2012	12.098,76 €	24.490,76 €	3.559,43 €	3.447,64 €	1.754,94 €	5.354,16 €	363,07 €	13.305,17 €	1.340,62 €
2013	11.988,51 €	24.292,85 €	3.354,61 €	3.526,29 €	1.762,84 €	5.120,20 €	361,22 €	13.493,57 €	939,57 €
2014	11.965,01 €	24.180,19 €	3.445,89 €	3.475,92 €	1.801,78 €	5.063,48 €	359,61 €	13.438,89 €	792,50 €
2015	11.905,44 €	24.171,02 €	3.587,83 €	3.528,09 €	1.760,37 €	5.068,51 €	339,22 €	13.329,84 €	793,16 €
2016	12.032,33 €	24.587,03 €	3.534,93 €	3.420,88 €	1.812,76 €	5.346,88 €	328,45 €	13.861,45 €	1.435,67 €
2017	11.909,75 €	24.602,41 €	3.434,52 €	3.464,70 €	1.784,15 €	5.525,81 €	322,44 €	13.787,72 €	1.736,98 €
2018	11.932,14 €	24.859,85 €	3.490,18 €	3.579,08 €	1.826,85 €	5.779,43 €	322,18 €	14.750,37 €	1.957,43 €

France

	gdp	bce	bcpa	population
1995	25.843,45 €	26.540,64 €	19.511,80 €	59315139
1996	26.246,34 €	26.860,61 €	19.524,08 €	59522297
1997	26.283,61 €	27.018,80 €	19.794,12 €	59726386
1998	27.178,11 €	27.308,22 €	20.183,11 €	59934884
1999	28.182,10 €	27.700,35 €	21.053,12 €	60158533
2000	29.100,91 €	28.334,69 €	21.627,17 €	60545022
2001	29.466,83 €	28.617,87 €	21.898,17 €	60979315
2002	29.585,66 €	29.109,31 €	22.155,60 €	61424036
2003	29.617,02 €	29.268,54 €	22.253,52 €	61864088
2004	30.245,78 €	29.391,74 €	22.260,42 €	62292241
2005	30.513,40 €	29.593,97 €	22.572,79 €	62772870
2006	31.034,95 €	29.565,91 €	22.829,84 €	63229635
2007	31.579,98 €	29.756,83 €	23.262,58 €	63645065
2008	31.481,37 €	29.548,54 €	22.998,95 €	64007193
2009	30.413,81 €	30.153,42 €	23.151,23 €	64350226
2010	30.858,71 €	30.191,09 €	23.138,59 €	64658856
2011	31.380,11 €	30.230,96 €	23.219,69 €	64978721
2012	31.334,55 €	30.399,96 €	23.592,35 €	65276983
2013	31.359,79 €	30.581,51 €	23.671,88 €	65600350
2014	31.389,00 €	30.635,63 €	23.877,60 €	66165980
2015	31.598,80 €	30.445,69 €	23.595,65 €	66458153
2016	31.858,55 €	30.610,33 €	24.007,10 €	66638391
2017	32.497,79 €	30.878,85 €	24.419,09 €	66804121
2018	32.998,06 €	31.315,68 €	24.974,69 €	66926166

	uw	c	s	g	dire	inq	nec	bec	ca
1995	9.254,46 €	17.666,13 €	1.901,37 €	2.626,42 €	1.604,39 €	2.649,13 €	654,21 €	8.903,11 €	1.220,06 €
1996	9.294,50 €	18.008,70 €	1.944,61 €	2.677,40 €	1.649,65 €	2.771,54 €	643,40 €	9.168,27 €	1.188,34 €
1997	9.388,62 €	17.851,33 €	1.988,22 €	2.796,06 €	1.620,24 €	2.765,40 €	619,79 €	8.996,31 €	1.151,84 €
1998	9.462,15 €	18.248,66 €	1.971,40 €	2.748,18 €	1.624,64 €	2.876,82 €	620,71 €	9.119,05 €	1.373,24 €
1999	9.591,30 €	18.749,83 €	2.044,22 €	2.809,62 €	1.583,15 €	3.214,42 €	697,05 €	9.002,58 €	1.658,30 €
2000	9.691,75 €	19.408,47 €	2.080,72 €	2.886,50 €	1.763,24 €	3.379,04 €	590,48 €	9.165,66 €	1.867,66 €
2001	9.732,56 €	19.761,11 €	2.121,61 €	2.954,81 €	1.848,46 €	3.536,71 €	567,05 €	9.117,98 €	1.831,24 €
2002	9.863,58 €	20.018,88 €	2.189,34 €	2.987,51 €	1.762,93 €	3.632,41 €	554,66 €	9.127,21 €	1.618,83 €
2003	9.765,86 €	20.291,74 €	2.280,51 €	2.945,96 €	1.718,87 €	3.714,21 €	582,46 €	9.203,61 €	1.606,14 €
2004	9.694,67 €	20.605,93 €	2.298,68 €	2.983,15 €	1.769,35 €	3.896,01 €	525,32 €	9.363,81 €	1.707,17 €
2005	9.588,70 €	20.908,63 €	2.334,28 €	3.005,23 €	1.768,06 €	3.964,99 €	509,83 €	9.294,77 €	1.763,76 €
2006	9.459,88 €	21.180,13 €	2.389,69 €	2.933,20 €	1.847,39 €	4.073,15 €	476,46 €	9.089,82 €	1.877,29 €
2007	9.422,32 €	21.448,49 €	2.384,29 €	3.078,91 €	1.959,55 €	4.148,01 €	469,61 €	9.068,00 €	2.104,13 €
2008	9.398,19 €	21.613,28 €	2.408,32 €	3.105,55 €	2.028,09 €	4.467,67 €	481,03 €	9.050,09 €	2.019,46 €
2009	9.580,85 €	21.421,96 €	2.569,97 €	3.138,44 €	1.814,50 €	4.297,31 €	445,99 €	8.725,17 €	1.276,98 €
2010	9.665,96 €	21.741,95 €	2.406,98 €	3.052,61 €	1.834,48 €	4.386,50 €	455,43 €	8.850,46 €	1.342,52 €
2011	9.794,07 €	21.923,48 €	2.337,82 €	3.098,57 €	1.857,15 €	4.619,27 €	446,55 €	8.873,16 €	1.415,33 €
2012	9.898,64 €	21.905,14 €	2.303,09 €	3.088,49 €	1.819,82 €	4.570,29 €	405,28 €	8.574,94 €	1.362,05 €
2013	10.041,53 €	21.963,02 €	2.336,30 €	3.053,70 €	1.845,36 €	4.550,44 €	417,24 €	8.569,78 €	1.242,91 €
2014	10.199,03 €	21.905,61 €	2.275,70 €	2.925,34 €	1.811,58 €	4.448,20 €	410,27 €	8.341,46 €	1.173,16 €
2015	10.208,17 €	21.882,51 €	2.322,51 €	2.792,48 €	1.863,68 €	4.492,54 €	403,75 €	8.414,40 €	1.160,60 €
2016	10.274,21 €	22.071,77 €	2.389,39 €	2.744,95 €	1.863,08 €	4.595,76 €	411,15 €	8.255,69 €	1.241,31 €
2017	10.442,38 €	22.401,79 €	2.337,44 €	2.738,14 €	1.897,16 €	4.736,60 €	407,15 €	8.312,44 €	1.445,53 €
2018	10.558,46 €	22.654,30 €	2.373,43 €	2.871,06 €	1.893,26 €	4.857,25 €	391,06 €	8.238,99 €	1.506,95 €

Germany

	gdp	bce	bcpa	population
1995	27.397,97 €	28.089,00 €	20.799,72 €	81538603
1996	27.003,39 €	28.448,90 €	20.949,07 €	81817499
1997	26.659,37 €	28.340,37 €	20.844,47 €	82012162
1998	27.137,34 €	28.505,08 €	21.254,23 €	82057379
1999	27.851,38 €	29.100,53 €	22.108,82 €	82037011
2000	28.607,06 €	29.820,55 €	22.739,94 €	82163475
2001	29.062,14 €	30.187,28 €	22.682,11 €	82259540
2002	28.948,88 €	30.124,69 €	22.269,31 €	82440309
2003	28.745,09 €	30.197,42 €	21.785,40 €	82536680
2004	29.090,92 €	29.937,17 €	21.336,94 €	82531671
2005	29.251,95 €	30.161,55 €	21.608,69 €	82500849
2006	30.419,74 €	30.199,78 €	21.646,20 €	82437995
2007	31.394,50 €	29.632,20 €	21.515,79 €	82314906
2008	31.755,46 €	29.900,11 €	21.638,09 €	82217837
2009	30.051,10 €	30.050,70 €	21.471,70 €	82002356
2010	31.348,77 €	30.144,32 €	21.405,49 €	81802257
2011	33.220,68 €	30.369,51 €	21.989,63 €	80222065
2012	33.301,38 €	30.395,86 €	22.047,84 €	80327900
2013	33.363,79 €	29.931,16 €	21.361,89 €	80523746
2014	34.037,86 €	29.833,10 €	21.500,97 €	80767463
2015	34.364,56 €	29.833,32 €	21.498,03 €	81197537
2016	34.648,60 €	29.967,64 €	21.826,62 €	82175684
2017	35.185,31 €	30.155,42 €	22.030,45 €	82521653
2018	35.483,05 €	30.131,66 €	22.364,60 €	82792351

	uw	c	s	g	dire	inq	nec	bec	ca
1995	10.721,26 €	18.233,24 €	2.084,05 €	2.513,28 €	1.777,08 €	3.164,05 €	521,69 €	9.557,66 €	1.746,69 €
1996	10.843,65 €	18.149,66 €	2.136,20 €	2.458,93 €	1.690,47 €	2.946,97 €	502,10 €	9.603,78 €	1.601,85 €
1997	10.879,31 €	17.888,08 €	2.092,76 €	2.436,64 €	1.613,45 €	2.856,23 €	486,72 €	9.501,29 €	1.518,66 €
1998	10.968,00 €	18.001,24 €	2.097,25 €	2.473,78 €	1.595,11 €	2.970,78 €	469,29 €	9.339,20 €	1.619,05 €
1999	11.151,16 €	18.610,49 €	2.169,39 €	2.489,68 €	1.686,38 €	3.163,73 €	470,07 €	9.183,27 €	1.721,49 €
2000	11.346,76 €	19.144,79 €	2.245,65 €	2.574,74 €	1.686,91 €	3.357,85 €	446,64 €	9.215,82 €	1.688,57 €
2001	11.511,46 €	19.496,82 €	2.281,38 €	2.563,12 €	1.730,23 €	3.508,22 €	427,04 €	9.291,03 €	1.358,82 €
2002	11.572,77 €	19.331,56 €	2.460,65 €	2.577,65 €	1.747,50 €	3.514,77 €	555,67 €	9.271,49 €	860,44 €
2003	11.483,48 €	19.463,98 €	2.500,82 €	2.543,47 €	1.856,74 €	3.515,50 €	422,09 €	9.511,57 €	677,46 €
2004	11.405,87 €	19.481,88 €	2.414,55 €	2.487,35 €	1.845,97 €	3.606,36 €	400,14 €	9.585,93 €	585,56 €
2005	11.373,92 €	19.741,12 €	2.603,42 €	2.485,31 €	1.911,45 €	3.740,79 €	389,98 €	9.503,85 €	561,00 €
2006	11.382,47 €	20.127,16 €	2.600,89 €	2.494,03 €	1.900,18 €	4.109,11 €	395,48 €	9.840,24 €	891,18 €
2007	11.178,72 €	20.308,94 €	2.574,35 €	2.511,31 €	1.916,62 €	4.636,00 €	388,49 €	9.485,91 €	981,01 €
2008	11.067,81 €	20.630,99 €	2.524,56 €	2.671,11 €	1.847,16 €	4.765,78 €	381,43 €	9.586,41 €	942,96 €
2009	10.854,42 €	20.459,78 €	2.599,42 €	2.601,92 €	1.797,91 €	4.314,30 €	352,63 €	9.169,14 €	237,51 €
2010	10.723,40 €	20.987,43 €	2.711,67 €	2.658,17 €	1.868,70 €	4.702,45 €	365,20 €	9.583,25 €	479,22 €
2011	10.576,51 €	21.832,53 €	2.707,49 €	2.814,99 €	1.924,35 €	5.253,88 €	383,78 €	9.628,15 €	864,49 €
2012	10.410,22 €	22.083,20 €	2.697,41 €	2.751,23 €	1.917,14 €	5.267,87 €	361,20 €	9.460,34 €	751,12 €
2013	10.285,99 €	22.160,05 €	2.552,33 €	2.668,56 €	1.900,91 €	5.391,13 €	443,73 €	9.598,42 €	585,41 €
2014	10.171,26 €	22.254,79 €	2.740,05 €	2.638,15 €	1.892,62 €	5.713,41 €	365,11 €	9.412,57 €	715,33 €
2015	10.199,14 €	22.263,57 €	2.903,81 €	2.528,22 €	1.925,43 €	5.760,76 €	375,24 €	9.445,10 €	734,57 €
2016	10.220,55 €	22.401,91 €	2.893,16 €	2.486,02 €	1.869,14 €	5.799,20 €	365,67 €	9.383,12 €	876,44 €
2017	10.259,54 €	22.614,23 €	2.855,60 €	2.532,56 €	1.837,95 €	5.914,69 €	353,88 €	9.402,50 €	923,65 €
2018	10.342,41 €	22.776,94 €	2.879,76 €	2.528,16 €	1.821,47 €	6.226,81 €	347,33 €	9.151,37 €	1.036,97 €

Greece

	gdp	bce	bcpa	population
1995	16.948,11 €	19.329,40 €	13.868,84 €	10535973
1996	17.201,79 €	19.390,71 €	13.868,33 €	10588332
1997	17.683,48 €	19.412,51 €	13.588,87 €	10629267
1998	17.081,98 €	18.893,55 €	13.384,44 €	10693250
1999	17.784,83 €	18.971,56 €	14.099,06 €	10747768
2000	17.838,92 €	19.856,75 €	14.129,48 €	10775627
2001	18.249,12 €	20.132,33 €	14.421,24 €	10835989
2002	18.873,95 €	20.786,07 €	14.764,45 €	10888274
2003	19.917,31 €	21.249,97 €	15.992,67 €	10915770
2004	20.878,27 €	22.459,34 €	17.180,91 €	10940369
2005	20.946,80 €	23.018,91 €	17.040,54 €	10969912
2006	22.060,81 €	23.700,37 €	18.249,13 €	11004716
2007	22.718,42 €	24.041,55 €	19.278,25 €	11036008
2008	22.591,25 €	24.667,25 €	19.136,34 €	11060937
2009	21.553,78 €	24.766,00 €	18.136,41 €	11094745
2010	20.327,86 €	24.109,14 €	17.221,73 €	11119289
2011	18.464,62 €	22.722,16 €	15.593,03 €	11123392
2012	17.173,71 €	21.125,84 €	13.514,36 €	11086406
2013	16.742,07 €	20.385,60 €	13.200,31 €	11003615
2014	16.984,47 €	20.072,61 €	13.012,39 €	10926807
2015	17.017,24 €	19.866,84 €	13.022,86 €	10858018
2016	17.101,72 €	19.607,49 €	12.873,52 €	10783748
2017	17.384,20 €	19.601,23 €	12.911,07 €	10768193
2018	17.765,06 €	19.784,75 €	12.932,56 €	10741165

	uw	c	s	g	dire	inq	nec	bec	ca
1995	4.415,95 €	12.910,90 €	2.481,57 €	2.969,34 €	1.338,88 €	1.557,03 €	552,44 €	6.807,19 €	794,18 €
1996	4.459,61 €	13.094,60 €	2.435,37 €	2.754,81 €	1.376,73 €	1.546,54 €	430,42 €	6.896,48 €	943,68 €
1997	4.838,86 €	13.205,44 €	2.560,68 €	2.520,61 €	1.462,56 €	1.796,61 €	453,92 €	7.224,38 €	946,82 €
1998	4.909,90 €	12.814,81 €	2.427,60 €	2.372,69 €	1.481,42 €	1.624,44 €	525,59 €	7.500,08 €	1.465,37 €
1999	5.044,88 €	13.151,42 €	2.546,64 €	2.409,66 €	1.573,87 €	1.689,62 €	917,55 €	7.378,46 €	1.588,42 €
2000	5.249,67 €	13.479,74 €	2.506,37 €	2.298,33 €	1.600,54 €	1.640,30 €	436,51 €	7.729,01 €	1.565,23 €
2001	5.322,04 €	13.575,64 €	2.637,00 €	2.280,75 €	1.494,91 €	1.751,36 €	436,84 €	7.766,37 €	1.618,45 €
2002	5.630,25 €	14.045,94 €	2.774,47 €	2.260,57 €	1.491,98 €	2.005,46 €	427,71 €	7.921,14 €	1.471,81 €
2003	5.820,02 €	14.629,65 €	2.957,72 €	2.188,73 €	1.474,56 €	2.386,27 €	485,32 €	7.682,58 €	1.939,96 €
2004	6.016,85 €	15.102,14 €	3.183,94 €	2.603,80 €	1.470,40 €	2.520,14 €	456,86 €	7.681,66 €	1.946,38 €
2005	6.242,39 €	15.909,15 €	3.142,02 €	2.294,93 €	1.450,40 €	2.696,41 €	422,75 €	7.674,41 €	1.273,28 €
2006	6.374,03 €	16.188,11 €	3.430,46 €	2.630,95 €	1.369,36 €	3.137,12 €	416,71 €	7.793,87 €	1.925,93 €
2007	6.342,87 €	16.822,92 €	3.487,28 €	2.832,89 €	1.488,27 €	3.383,65 €	572,49 €	7.838,60 €	2.502,80 €
2008	6.249,05 €	17.380,03 €	3.501,64 €	2.797,04 €	1.524,69 €	3.351,02 €	384,80 €	7.835,08 €	1.919,36 €
2009	6.247,83 €	17.190,73 €	3.470,16 €	2.827,45 €	1.547,01 €	3.052,30 €	370,86 €	8.058,32 €	1.057,87 €
2010	6.357,98 €	16.377,13 €	3.232,13 €	2.650,89 €	1.549,94 €	2.615,92 €	343,14 €	7.392,06 €	161,52 €
2011	6.046,72 €	15.138,77 €	2.889,71 €	2.521,36 €	1.515,71 €	2.048,93 €	309,76 €	6.957,53 €	-481,36 €
2012	5.804,56 €	13.999,49 €	2.627,58 €	2.032,51 €	1.381,31 €	1.672,75 €	284,24 €	6.725,35 €	-1.170,37 €
2013	5.677,47 €	13.572,70 €	2.544,79 €	1.801,59 €	1.370,43 €	1.554,00 €	286,52 €	6.273,64 €	-1.198,18 €
2014	5.515,95 €	13.457,53 €	2.530,69 €	1.853,06 €	1.395,64 €	1.602,96 €	286,01 €	6.272,55 €	-1.073,68 €
2015	5.388,08 €	13.300,37 €	2.586,62 €	1.865,81 €	1.391,25 €	1.575,26 €	307,52 €	6.154,55 €	-996,97 €
2016	5.340,34 €	13.268,09 €	2.582,36 €	1.677,92 €	1.398,60 €	1.579,34 €	283,29 €	6.167,23 €	-850,02 €
2017	5.324,82 €	13.346,13 €	2.563,01 €	1.630,21 €	1.372,81 €	1.593,46 €	296,68 €	6.380,56 €	-606,28 €
2018	5.350,67 €	13.425,74 €	2.619,16 €	1.652,12 €	1.351,52 €	1.617,05 €	294,37 €	6.297,67 €	-848,89 €

Ireland

	gdp	bce	bcpa	population
1995	21.657,28 €	22.155,31 €	15.939,43 €	3597617
1996	23.823,38 €	23.297,04 €	16.936,48 €	3620065
1997	27.775,30 €	24.719,28 €	18.699,58 €	3654955
1998	28.397,81 €	24.888,34 €	19.207,21 €	3693386
1999	31.009,69 €	25.414,25 €	20.061,22 €	3732006
2000	33.532,66 €	26.283,28 €	20.612,02 €	3777565
2001	34.807,51 €	27.038,26 €	21.416,59 €	3832783
2002	36.238,12 €	27.578,21 €	22.032,83 €	3899702
2003	36.701,82 €	27.667,50 €	22.068,39 €	3964191
2004	38.485,88 €	28.327,10 €	23.198,04 €	4028851
2005	39.848,01 €	28.905,89 €	24.478,36 €	4111672
2006	40.898,42 €	29.392,61 €	25.111,30 €	4208156
2007	41.760,22 €	30.389,48 €	25.926,57 €	4340118
2008	38.866,98 €	31.707,65 €	26.519,87 €	4457765
2009	36.396,05 €	32.397,33 €	26.606,31 €	4521322
2010	36.868,88 €	32.641,14 €	25.752,85 €	4549428
2011	37.989,12 €	33.271,71 €	26.630,62 €	4570881
2012	37.953,58 €	33.152,55 €	27.348,51 €	4589287
2013	38.256,39 €	32.866,92 €	26.525,76 €	4609779
2014	41.330,64 €	33.013,53 €	27.618,19 €	4637852
2015	51.468,88 €	30.412,55 €	23.881,71 €	4677627
2016	53.101,03 €	31.293,42 €	29.550,44 €	4726286
2017	57.147,30 €	31.086,99 €	26.883,51 €	4784383
2018	60.802,17 €	31.553,53 €	23.217,66 €	4830392

	uw	c	s	g	dire	inq	nec	bec	ca
1995	9.478,83 €	13.565,78 €	1.710,28 €	1.946,90 €	1.569,25 €	1.737,22 €	1.240,01 €	8.963,53 €	1.507,65 €
1996	9.835,53 €	14.768,84 €	1.868,62 €	1.974,99 €	1.741,46 €	2.171,53 €	1.237,95 €	9.650,76 €	2.052,26 €
1997	10.355,75 €	16.370,69 €	2.104,50 €	2.053,05 €	1.925,09 €	2.993,42 €	1.246,20 €	9.898,07 €	2.632,16 €
1998	10.768,13 €	16.269,52 €	2.091,05 €	2.056,61 €	1.914,53 €	3.130,57 €	1.251,87 €	10.111,92 €	3.178,91 €
1999	10.925,53 €	17.363,33 €	2.217,19 €	1.876,84 €	2.103,37 €	3.619,25 €	1.246,02 €	10.361,59 €	3.762,54 €
2000	11.005,86 €	18.431,35 €	2.397,59 €	1.960,22 €	2.129,37 €	4.186,23 €	1.196,14 €	10.669,53 €	3.802,13 €
2001	11.125,21 €	19.091,08 €	2.645,37 €	2.011,84 €	2.198,07 €	4.525,01 €	1.112,17 €	10.710,95 €	3.977,11 €
2002	11.228,85 €	19.776,01 €	2.826,57 €	2.050,57 €	2.187,47 €	5.039,18 €	1.077,15 €	10.704,76 €	4.082,24 €
2003	11.227,56 €	20.135,73 €	2.936,15 €	1.937,64 €	2.226,43 €	5.290,72 €	1.052,41 €	11.021,23 €	4.369,70 €
2004	11.567,69 €	20.842,93 €	3.021,14 €	2.045,49 €	2.289,56 €	5.851,49 €	1.009,09 €	11.025,08 €	4.886,93 €
2005	11.627,99 €	21.604,73 €	3.227,69 €	2.125,59 €	2.339,11 €	6.368,02 €	972,98 €	11.206,22 €	5.805,71 €
2006	11.648,57 €	22.215,73 €	3.292,32 €	2.231,78 €	2.337,52 €	6.737,62 €	920,65 €	11.096,34 €	5.894,39 €
2007	11.699,90 €	23.322,72 €	3.340,82 €	2.410,19 €	2.350,19 €	7.181,91 €	852,05 €	10.853,75 €	5.538,79 €
2008	11.885,84 €	23.680,49 €	3.225,96 €	2.443,64 €	2.097,51 €	6.634,60 €	796,19 €	10.073,38 €	4.089,41 €
2009	12.566,96 €	22.575,68 €	3.111,86 €	2.472,98 €	1.745,46 €	5.802,49 €	782,19 €	9.031,68 €	2.458,47 €
2010	13.076,15 €	22.393,10 €	3.023,25 €	2.669,21 €	1.683,60 €	6.038,97 €	798,01 €	8.880,01 €	1.193,71 €
2011	13.569,29 €	22.380,72 €	3.058,12 €	2.821,96 €	1.636,78 €	6.211,09 €	710,51 €	8.372,52 €	1.020,92 €
2012	13.560,97 €	21.865,79 €	3.074,24 €	3.011,81 €	1.485,06 €	6.169,50 €	705,69 €	8.419,92 €	1.910,18 €
2013	13.693,59 €	21.678,05 €	3.060,51 €	2.990,77 €	1.640,15 €	6.141,42 €	774,43 €	8.495,49 €	1.379,89 €
2014	14.050,46 €	22.089,05 €	3.182,46 €	3.027,25 €	1.672,53 €	6.884,59 €	778,57 €	8.483,95 €	2.310,05 €
2015	13.385,08 €	21.015,06 €	4.066,04 €	2.662,55 €	1.555,43 €	8.393,00 €	767,75 €	8.617,69 €	1.319,10 €
2016	13.789,76 €	22.052,23 €	4.194,98 €	2.573,49 €	1.511,84 €	9.055,09 €	750,12 €	8.769,15 €	6.276,04 €
2017	13.767,74 €	22.798,19 €	4.468,09 €	2.526,28 €	1.625,49 €	10.058,08 €	789,75 €	8.877,88 €	3.884,65 €
2018	14.008,26 €	23.520,23 €	4.753,85 €	2.515,71 €	1.617,93 €	10.812,45 €	814,14 €	8.981,62 €	-168,39 €

Italy

	gdp	bce	bcpa	population
1995	22.606,51 €	27.440,09 €	22.080,26 €	56844408
1996	24.882,47 €	28.757,13 €	23.582,53 €	56844197
1997	25.704,12 €	29.055,57 €	23.747,45 €	56876364
1998	25.931,42 €	29.046,84 €	23.635,98 €	56904379
1999	26.429,16 €	29.361,51 €	24.005,86 €	56909109
2000	27.376,57 €	29.796,44 €	24.669,98 €	56923524
2001	27.905,44 €	30.163,82 €	24.959,67 €	56960692
2002	27.941,53 €	29.992,82 €	24.820,09 €	56987507
2003	27.901,16 €	29.914,20 €	24.369,80 €	57130506
2004	28.158,69 €	30.152,14 €	24.457,17 €	57495900
2005	28.237,01 €	30.656,16 €	24.899,94 €	57874753
2006	28.712,39 €	30.945,32 €	25.132,48 €	58064214
2007	29.072,11 €	30.602,62 €	24.652,58 €	58223744
2008	28.559,50 €	30.522,43 €	24.431,90 €	58652875
2009	26.818,28 €	29.945,93 €	23.876,72 €	59000586
2010	27.222,09 €	30.194,69 €	23.836,13 €	59190143
2011	27.371,42 €	30.118,27 €	23.790,68 €	59364690
2012	26.586,07 €	29.835,95 €	23.377,15 €	59394207
2013	25.952,85 €	29.485,69 €	22.904,60 €	59685227
2014	25.471,58 €	29.152,13 €	22.773,25 €	60782668
2015	25.664,06 €	28.983,18 €	22.507,80 €	60795612
2016	26.047,07 €	28.582,20 €	22.349,16 €	60665551
2017	26.566,69 €	28.785,09 €	22.319,66 €	60589445
2018	26.838,65 €	28.870,43 €	22.513,01 €	60483973

	uw	c	s	g	dire	inq	nec	bec	ca
1995	10.078,65 €	15.537,86 €	2.944,62 €	3.731,42 €	1.726,00 €	2.623,07 €	503,39 €	7.003,98 €	1.140,76 €
1996	10.092,26 €	16.916,38 €	3.072,71 €	4.190,86 €	1.826,34 €	3.200,59 €	488,15 €	6.835,89 €	1.173,13 €
1997	10.267,72 €	17.477,87 €	3.348,10 €	3.815,87 €	1.829,25 €	3.410,47 €	614,28 €	7.105,46 €	1.183,06 €
1998	10.228,43 €	17.740,99 €	3.260,73 €	3.546,26 €	1.814,91 €	3.457,10 €	457,57 €	7.149,96 €	1.281,53 €
1999	10.324,92 €	18.298,93 €	3.427,64 €	3.277,16 €	1.836,65 €	3.688,78 €	441,72 €	7.192,11 €	1.394,74 €
2000	10.430,47 €	19.037,57 €	3.504,20 €	3.272,53 €	1.952,02 €	3.907,13 €	589,18 €	7.350,36 €	1.634,71 €
2001	10.417,77 €	19.307,40 €	3.599,80 €	3.363,96 €	1.986,93 €	4.123,70 €	414,48 €	7.280,16 €	1.661,53 €
2002	10.274,43 €	19.328,55 €	3.730,19 €	3.240,11 €	1.918,12 €	4.250,92 €	411,43 €	7.346,12 €	1.761,95 €
2003	10.393,05 €	19.436,18 €	3.752,71 €	3.108,92 €	1.961,45 €	4.348,51 €	466,70 €	7.628,46 €	1.617,36 €
2004	10.580,91 €	19.512,79 €	3.801,42 €	3.070,00 €	1.902,85 €	4.537,97 €	372,16 €	7.673,61 €	1.606,47 €
2005	10.804,66 €	19.766,05 €	3.981,42 €	3.033,63 €	1.960,49 €	4.612,81 €	356,31 €	7.717,47 €	1.604,95 €
2006	11.003,07 €	20.112,87 €	3.919,24 €	3.010,58 €	2.036,29 €	4.711,66 €	352,49 €	7.828,59 €	1.663,26 €
2007	10.675,21 €	20.220,18 €	3.924,74 €	3.057,20 €	2.137,15 €	4.795,93 €	341,63 €	7.955,20 €	1.663,53 €
2008	10.368,10 €	20.135,23 €	3.941,21 €	3.092,30 €	2.098,18 €	4.586,67 €	329,57 €	7.800,94 €	1.380,85 €
2009	10.114,97 €	19.391,51 €	3.969,11 €	2.879,78 €	1.809,03 €	4.157,62 €	442,78 €	7.250,77 €	738,78 €
2010	10.133,26 €	19.693,34 €	3.919,98 €	2.827,34 €	1.775,88 €	4.292,60 €	310,76 €	7.339,51 €	670,18 €
2011	10.161,98 €	19.783,25 €	3.818,31 €	2.847,07 €	1.815,50 €	4.386,32 €	290,51 €	7.166,66 €	548,55 €
2012	10.205,90 €	19.347,65 €	3.602,41 €	2.974,97 €	1.730,13 €	4.100,93 €	463,92 €	6.935,13 €	12,41 €
2013	10.257,59 €	18.803,92 €	3.490,66 €	2.811,29 €	1.715,61 €	3.876,62 €	285,54 €	6.578,83 €	-287,80 €
2014	10.240,36 €	18.315,22 €	3.515,08 €	2.701,43 €	1.681,64 €	3.650,14 €	288,18 €	6.289,88 €	-377,19 €
2015	10.227,34 €	18.344,79 €	3.580,14 €	2.511,59 €	1.688,13 €	3.716,16 €	276,38 €	6.447,09 €	-304,66 €
2016	10.191,72 €	18.352,09 €	3.555,42 €	2.459,54 €	1.714,07 €	3.856,66 €	405,85 €	6.490,58 €	-148,32 €
2017	10.148,46 €	18.703,38 €	3.485,52 €	2.451,56 €	1.742,90 €	3.980,46 €	280,47 €	6.708,32 €	-37,58 €
2018	10.193,31 €	18.920,98 €	3.521,20 €	2.435,98 €	1.760,89 €	4.151,07 €	289,08 €	6.716,63 €	70,13 €

Luxembourg

	gdp	bce	bcpa	population
1995	59.511,53 €	31.891,68 €	19.047,02 €	405650
1996	58.335,80 €	31.274,93 €	17.716,41 €	411600
1997	59.035,30 €	32.266,99 €	19.524,96 €	416850
1998	61.699,42 €	33.321,12 €	22.409,22 €	422050
1999	66.561,92 €	32.738,82 €	22.908,75 €	427350
2000	71.008,08 €	32.638,28 €	21.542,58 €	433600
2001	71.910,40 €	33.957,60 €	22.512,55 €	439000
2002	73.808,00 €	34.676,55 €	21.838,55 €	444050
2003	74.299,49 €	35.255,86 €	20.377,10 €	448300
2004	75.856,29 €	34.959,61 €	17.937,86 €	454960
2005	77.198,84 €	34.804,21 €	16.209,35 €	461230
2006	79.836,74 €	33.093,61 €	12.797,65 €	469086
2007	85.216,91 €	33.535,94 €	18.690,54 €	476187
2008	82.802,84 €	33.874,33 €	10.689,85 €	483799
2009	77.636,96 €	34.705,54 €	9.156,08 €	493500
2010	80.024,94 €	34.378,83 €	9.074,69 €	502066
2011	80.489,95 €	33.557,12 €	19.957,88 €	511840
2012	78.217,70 €	33.815,79 €	11.984,71 €	524853
2013	79.236,42 €	33.298,69 €	12.280,20 €	537039
2014	80.740,46 €	32.854,18 €	13.402,63 €	549680
2015	82.696,72 €	33.434,18 €	12.002,60 €	562958
2016	84.368,95 €	32.919,87 €	12.340,92 €	576249
2017	83.423,28 €	33.337,24 €	12.487,04 €	590667
2018	83.387,13 €	33.000,78 €	10.082,14 €	602005

	uw	c	s	g	dire	inq	nec	bec	ca
1995	10.208,55 €	30.340,51 €	2.996,83 €	4.169,48 €	3.586,12 €	10.949,13 €	1.288,45 €	18.379,81 €	4.246,70 €
1996	10.026,42 €	29.425,65 €	3.021,56 €	3.846,69 €	3.309,29 €	10.493,70 €	1.242,39 €	18.307,80 €	3.506,88 €
1997	10.393,04 €	29.623,10 €	3.057,79 €	4.484,56 €	3.730,69 €	10.404,56 €	1.156,25 €	17.760,39 €	3.862,11 €
1998	10.793,61 €	30.914,83 €	3.107,01 €	4.857,78 €	4.142,13 €	11.164,89 €	1.045,10 €	16.457,53 €	4.500,53 €
1999	10.623,81 €	31.675,17 €	3.224,18 €	5.135,04 €	5.128,85 €	11.725,02 €	1.065,50 €	16.911,83 €	6.016,26 €
2000	11.048,45 €	32.635,61 €	3.337,38 €	5.061,76 €	5.548,68 €	12.792,57 €	1.103,68 €	17.016,39 €	4.817,00 €
2001	11.354,20 €	34.053,68 €	3.343,83 €	5.050,87 €	4.813,85 €	13.957,40 €	1.073,74 €	17.469,22 €	4.950,43 €
2002	11.544,53 €	35.228,42 €	3.358,26 €	5.434,12 €	5.303,59 €	14.535,48 €	1.049,72 €	18.406,91 €	4.519,19 €
2003	11.484,62 €	35.860,77 €	3.603,53 €	5.543,00 €	5.113,35 €	15.089,47 €	1.033,24 €	20.290,62 €	4.378,62 €
2004	11.414,50 €	35.749,62 €	3.679,03 €	5.826,99 €	5.485,32 €	15.067,17 €	1.158,04 €	22.997,84 €	4.818,04 €
2005	11.187,80 €	35.438,80 €	3.744,14 €	5.965,68 €	5.167,88 €	15.248,82 €	1.115,52 €	24.010,64 €	4.300,26 €
2006	10.680,32 €	34.270,21 €	3.991,84 €	5.353,40 €	4.629,82 €	15.557,65 €	1.014,68 €	25.625,05 €	4.314,40 €
2007	10.934,43 €	34.953,50 €	4.047,80 €	5.530,09 €	4.506,71 €	16.504,03 €	919,16 €	21.374,85 €	5.610,30 €
2008	10.944,85 €	34.960,73 €	4.015,94 €	5.602,48 €	4.570,70 €	16.220,89 €	858,08 €	30.640,41 €	6.597,86 €
2009	11.213,86 €	34.600,98 €	3.881,85 €	5.679,08 €	4.343,04 €	15.553,69 €	773,50 €	30.438,60 €	4.115,64 €
2010	11.226,80 €	33.921,11 €	4.001,25 €	5.693,08 €	4.049,55 €	15.638,55 €	775,31 €	30.364,40 €	4.284,96 €
2011	10.893,02 €	33.240,44 €	4.024,50 €	5.600,13 €	4.136,59 €	15.317,53 €	746,85 €	20.228,55 €	5.882,46 €
2012	10.828,52 €	33.290,42 €	3.754,45 €	5.733,50 €	4.091,90 €	15.012,36 €	686,84 €	28.706,52 €	6.188,59 €
2013	10.823,08 €	33.211,41 €	3.842,97 €	5.430,38 €	3.998,17 €	15.377,11 €	633,87 €	27.929,46 €	6.277,10 €
2014	10.699,87 €	32.986,64 €	3.875,54 €	5.382,16 €	4.133,82 €	15.356,41 €	599,80 €	27.133,41 €	7.082,07 €
2015	10.910,35 €	33.128,07 €	4.176,18 €	5.304,80 €	3.549,05 €	15.984,64 €	551,55 €	27.233,61 €	5.250,48 €
2016	10.865,02 €	33.003,05 €	4.091,89 €	5.536,62 €	3.721,79 €	16.274,70 €	580,21 €	26.536,04 €	5.376,87 €
2017	11.087,22 €	32.855,76 €	4.092,53 €	5.524,38 €	3.601,57 €	16.124,13 €	496,96 €	26.915,07 €	5.567,91 €
2018	10.816,99 €	32.827,86 €	4.090,76 €	5.769,31 €	3.614,85 €	16.344,22 €	545,07 €	27.559,40 €	4.095,69 €

Netherlands

	gdp	bce	bcpa	population
1995	30.729,54 €	31.067,85 €	22.364,14 €	15424122
1996	31.057,48 €	29.579,19 €	20.835,12 €	15493889
1997	31.212,83 €	29.754,55 €	21.439,87 €	15567107
1998	32.357,17 €	29.691,16 €	21.489,13 €	15654192
1999	34.001,79 €	30.418,42 €	23.208,57 €	15760225
2000	35.196,73 €	31.044,72 €	23.675,37 €	15863950
2001	35.738,37 €	31.551,09 €	23.979,39 €	15987075
2002	35.553,14 €	31.804,65 €	23.430,46 €	16105285
2003	35.416,52 €	31.541,19 €	23.094,55 €	16192572
2004	35.974,09 €	31.217,59 €	22.485,96 €	16258032
2005	36.604,95 €	30.816,53 €	22.199,57 €	16305526
2006	37.805,33 €	30.561,08 €	21.812,24 €	16334210
2007	39.174,63 €	30.370,05 €	23.287,44 €	16357992
2008	39.909,19 €	30.587,51 €	22.954,34 €	16405399
2009	38.258,29 €	31.123,83 €	22.868,38 €	16485787
2010	38.563,34 €	31.263,25 €	22.131,02 €	16574989
2011	38.971,53 €	31.237,96 €	22.833,12 €	16655799
2012	38.398,12 €	31.114,94 €	22.272,28 €	16730348
2013	38.235,63 €	30.754,54 €	21.852,84 €	16779575
2014	38.665,32 €	30.563,99 €	21.595,95 €	16829289
2015	39.256,21 €	30.431,55 €	23.288,23 €	16900726
2016	39.931,37 €	30.144,09 €	22.305,64 €	16979120
2017	40.891,54 €	30.109,31 €	22.387,57 €	17081507
2018	41.715,19 €	30.140,49 €	22.626,82 €	17181084

	uw	c	s	g	dire	inq	nec	bec	ca
1995	11.568,86 €	18.887,41 €	1.991,27 €	4.864,37 €	2.117,28 €	3.469,76 €	657,02 €	10.727,95 €	1.367,22 €
1996	11.611,52 €	19.154,15 €	2.012,52 €	3.184,38 €	2.105,15 €	3.698,65 €	579,58 €	10.947,28 €	1.623,63 €
1997	11.587,99 €	19.157,58 €	1.985,14 €	3.099,83 €	2.166,39 €	3.358,81 €	550,78 €	10.737,79 €	1.872,32 €
1998	11.171,87 €	19.878,78 €	2.057,92 €	3.150,00 €	2.252,15 €	3.754,04 €	561,22 €	10.864,70 €	2.101,45 €
1999	11.412,63 €	20.989,07 €	2.121,71 €	3.178,32 €	2.373,21 €	4.399,75 €	510,36 €	10.242,76 €	2.522,56 €
2000	11.632,02 €	21.674,81 €	2.217,39 €	3.151,30 €	2.448,89 €	4.709,01 €	472,90 €	10.273,88 €	2.431,63 €
2001	11.679,01 €	22.005,87 €	2.251,52 €	3.186,02 €	2.233,28 €	4.894,18 €	443,87 €	10.299,29 €	2.283,72 €
2002	11.670,15 €	22.356,66 €	2.328,73 €	3.067,30 €	2.186,65 €	5.001,02 €	430,52 €	10.595,54 €	1.790,83 €
2003	11.299,53 €	22.540,53 €	2.390,62 €	3.024,23 €	2.242,36 €	5.055,26 €	416,09 €	10.395,87 €	1.533,14 €
2004	11.041,02 €	22.748,11 €	2.482,21 €	2.891,94 €	2.259,46 €	5.273,16 €	413,08 €	10.577,34 €	1.432,64 €
2005	10.708,55 €	22.923,13 €	2.452,53 €	2.847,42 €	2.286,42 €	5.433,00 €	395,68 €	10.556,34 €	1.543,69 €
2006	10.334,45 €	23.471,53 €	2.438,44 €	2.898,07 €	2.433,84 €	5.751,92 €	395,66 €	11.071,57 €	1.927,08 €
2007	10.192,88 €	23.941,00 €	2.526,76 €	2.863,90 €	2.547,97 €	6.225,56 €	380,97 €	10.364,89 €	2.901,32 €
2008	10.028,33 €	24.181,70 €	2.673,92 €	3.070,77 €	2.518,94 €	6.499,68 €	348,58 €	10.420,93 €	2.439,18 €
2009	10.072,39 €	24.015,35 €	2.716,34 €	3.003,58 €	2.178,47 €	6.180,79 €	324,57 €	10.145,97 €	1.565,95 €
2010	10.040,67 €	24.234,39 €	2.564,46 €	3.043,74 €	2.182,41 €	6.122,63 €	314,98 €	10.376,99 €	929,79 €
2011	10.014,67 €	24.503,94 €	2.708,52 €	2.857,37 €	2.210,62 €	6.332,86 €	303,06 €	9.921,18 €	1.213,29 €
2012	9.865,49 €	24.255,42 €	2.668,67 €	2.768,63 €	2.009,27 €	6.143,17 €	290,84 €	9.784,72 €	651,21 €
2013	9.738,42 €	24.064,13 €	2.580,91 €	2.714,74 €	2.019,15 €	6.030,69 €	293,82 €	9.657,67 €	462,15 €
2014	9.712,92 €	24.149,12 €	2.551,91 €	2.700,92 €	2.046,92 €	6.218,90 €	285,06 €	9.468,84 €	215,74 €
2015	9.735,07 €	24.170,11 €	2.590,91 €	2.616,48 €	2.016,20 €	6.367,84 €	296,98 €	9.533,43 €	2.093,13 €
2016	9.764,09 €	24.278,07 €	2.655,44 €	2.417,57 €	2.066,19 €	6.582,77 €	322,12 €	9.503,83 €	1.343,26 €
2017	9.723,34 €	24.657,37 €	2.629,64 €	2.339,17 €	2.076,65 €	6.878,91 €	284,65 €	9.525,11 €	1.518,71 €
2018	9.646,46 €	24.991,91 €	2.682,61 €	2.403,57 €	2.122,05 €	7.181,74 €	280,26 €	9.427,64 €	1.633,70 €

Portugal

	gdp	bce	bcpa	population
1995	13.979,40 €	14.959,62 €	11.301,35 €	10008659
1996	14.444,48 €	15.419,43 €	12.024,03 €	10043693
1997	14.805,58 €	15.419,01 €	12.080,25 €	10084196
1998	15.200,87 €	15.321,20 €	12.003,23 €	10133758
1999	15.804,77 €	15.907,15 €	12.416,65 €	10186634
2000	16.301,82 €	16.603,60 €	12.850,83 €	10249022
2001	16.487,39 €	16.871,26 €	13.242,67 €	10330774
2002	16.509,48 €	17.016,25 €	12.876,57 €	10394669
2003	16.275,81 €	17.208,69 €	12.693,25 €	10444592
2004	16.522,49 €	17.694,02 €	13.068,76 €	10473050
2005	16.617,85 €	17.878,61 €	12.962,01 €	10494672
2006	16.859,94 €	18.271,33 €	13.556,47 €	10511988
2007	17.246,62 €	18.755,41 €	14.366,00 €	10532588
2008	17.267,66 €	19.435,51 €	15.069,93 €	10553339
2009	16.713,52 €	19.808,27 €	15.319,00 €	10563014
2010	16.986,92 €	20.289,78 €	15.754,83 €	10573479
2011	16.700,73 €	20.395,48 €	15.553,19 €	10572721
2012	16.070,73 €	20.288,41 €	15.131,07 €	10542398
2013	16.003,25 €	20.049,62 €	14.739,71 €	10487289
2014	16.215,46 €	19.928,72 €	14.611,53 €	10427301
2015	16.588,02 €	19.875,28 €	14.409,68 €	10374822
2016	16.972,12 €	19.895,44 €	14.267,67 €	10341330
2017	17.619,28 €	19.857,53 €	13.701,79 €	10309573
2018	18.145,99 €	20.274,44 €	14.862,87 €	10291027

	uw	c	s	g	dire	inq	nec	bec	ca
1995	4.086,81 €	10.322,87 €	1.620,99 €	1.550,78 €	970,67 €	1.278,61 €	372,55 €	4.994,43 €	963,62 €
1996	4.269,27 €	10.692,93 €	1.635,60 €	1.514,07 €	1.002,81 €	1.329,39 €	360,25 €	4.819,65 €	1.064,01 €
1997	4.354,77 €	10.804,25 €	1.716,79 €	1.403,52 €	1.007,08 €	1.476,58 €	376,65 €	5.139,03 €	1.423,62 €
1998	4.358,88 €	10.908,33 €	1.712,97 €	1.308,73 €	1.035,32 €	1.559,89 €	372,51 €	5.419,09 €	1.728,61 €
1999	4.471,24 €	11.354,66 €	1.815,44 €	1.402,05 €	1.093,42 €	1.675,09 €	367,73 €	5.699,13 €	1.840,90 €
2000	4.697,55 €	11.814,11 €	1.899,16 €	1.403,41 €	1.123,99 €	1.724,65 €	361,99 €	5.991,18 €	1.876,42 €
2001	4.876,80 €	12.061,76 €	1.953,76 €	1.465,33 €	1.157,17 €	1.983,84 €	345,38 €	5.767,76 €	1.793,78 €
2002	4.988,14 €	12.178,18 €	2.005,90 €	1.372,81 €	1.164,47 €	2.028,95 €	335,37 €	6.032,86 €	1.557,81 €
2003	5.197,75 €	12.232,38 €	2.018,20 €	1.372,36 €	1.205,25 €	2.008,88 €	397,87 €	6.118,10 €	1.204,79 €
2004	5.455,16 €	12.444,79 €	2.048,79 €	1.389,24 €	1.238,40 €	2.102,73 €	302,83 €	6.083,82 €	1.155,73 €
2005	5.657,32 €	12.634,84 €	2.093,85 €	1.423,74 €	1.256,06 €	2.200,48 €	474,61 €	6.494,90 €	1.103,70 €
2006	5.860,24 €	12.736,42 €	2.065,34 €	1.433,67 €	1.341,77 €	2.215,60 €	266,98 €	6.015,50 €	1.033,66 €
2007	6.082,42 €	12.933,26 €	2.112,71 €	1.530,66 €	1.389,98 €	2.237,80 €	275,86 €	5.755,04 €	1.089,76 €
2008	6.376,63 €	13.221,22 €	2.123,92 €	1.608,82 €	1.442,12 €	2.197,73 €	255,24 €	5.648,18 €	1.027,36 €
2009	6.712,07 €	12.864,16 €	2.222,90 €	1.613,44 €	1.322,74 €	2.043,50 €	238,05 €	5.411,42 €	684,10 €
2010	7.084,06 €	13.054,37 €	2.182,82 €	1.579,34 €	1.356,28 €	1.988,69 €	265,83 €	5.388,54 €	587,76 €
2011	7.207,21 €	12.811,72 €	2.120,99 €	1.760,99 €	1.340,71 €	1.941,47 €	223,26 €	5.197,07 €	131,52 €
2012	7.337,29 €	12.444,44 €	2.065,09 €	1.736,62 €	1.259,56 €	1.782,13 €	253,33 €	5.084,48 €	-326,19 €
2013	7.274,77 €	12.188,46 €	1.968,40 €	1.753,22 €	1.226,71 €	1.683,70 €	224,82 €	5.116,12 €	-418,61 €
2014	7.156,00 €	12.258,06 €	1.970,18 €	1.717,02 €	1.186,29 €	1.753,08 €	233,17 €	5.159,80 €	-390,56 €
2015	7.061,52 €	12.310,88 €	2.032,03 €	1.672,66 €	1.171,25 €	1.801,69 €	228,88 €	5.408,42 €	-286,06 €
2016	7.028,04 €	12.514,41 €	2.079,08 €	1.610,49 €	1.201,57 €	1.899,86 €	235,16 €	5.565,65 €	-297,28 €
2017	6.990,88 €	12.780,48 €	2.032,14 €	1.565,22 €	1.237,66 €	2.019,76 €	253,76 €	6.322,55 €	-86,95 €
2018	7.033,68 €	13.190,41 €	2.092,89 €	1.562,00 €	1.283,48 €	2.095,55 €	225,51 €	5.665,02 €	27,94 €

Spain

	gdp	bce	bcpa	population
1995	18.344,81 €	21.711,14 €	17.899,79 €	39639726
1996	19.013,93 €	22.123,01 €	18.385,38 €	39808374
1997	19.024,36 €	21.950,60 €	17.947,79 €	39971329
1998	19.627,96 €	22.107,46 €	18.213,03 €	40143449
1999	20.501,15 €	22.319,51 €	18.616,26 €	40303568
2000	21.498,97 €	22.797,70 €	18.900,77 €	40470182
2001	22.243,24 €	23.010,08 €	19.164,99 €	40665545
2002	22.638,21 €	23.253,76 €	19.124,64 €	41035278
2003	22.874,73 €	23.125,82 €	19.126,95 €	41827838
2004	23.181,37 €	23.119,58 €	18.901,71 €	42547451
2005	23.601,37 €	23.165,32 €	19.047,19 €	43296338
2006	24.171,59 €	23.284,07 €	19.362,65 €	44009971
2007	24.630,02 €	23.339,37 €	19.432,76 €	44784666
2008	24.395,74 €	23.716,74 €	19.805,98 €	45668939
2009	23.162,96 €	23.903,56 €	19.415,42 €	46239273
2010	23.075,65 €	23.879,05 €	19.069,35 €	46486619
2011	22.788,07 €	23.885,26 €	18.668,38 €	46667174
2012	22.002,13 €	23.606,00 €	18.078,32 €	46818219
2013	21.737,94 €	23.432,25 €	18.007,61 €	46727890
2014	22.134,67 €	23.511,89 €	18.088,06 €	46512199
2015	23.021,99 €	23.723,92 €	18.287,79 €	46449565
2016	23.731,58 €	23.678,74 €	18.316,42 €	46440099
2017	24.406,48 €	23.634,38 €	18.251,33 €	46528024
2018	24.936,45 €	23.975,41 €	18.747,02 €	46658447

	uw	c	s	g	dire	inq	nec	bec	ca
1995	8.720,49 €	12.962,61 €	1.893,96 €	1.902,56 €	1.516,64 €	1.656,34 €	595,49 €	5.927,20 €	1.520,35 €
1996	8.840,49 €	13.262,47 €	1.875,97 €	1.983,90 €	1.465,27 €	1.777,73 €	596,82 €	5.854,97 €	1.520,51 €
1997	8.916,59 €	13.112,81 €	1.916,60 €	1.907,10 €	1.461,47 €	1.871,68 €	569,35 €	6.210,59 €	1.638,43 €
1998	8.874,88 €	13.328,78 €	1.903,87 €	1.908,14 €	1.435,86 €	1.905,90 €	566,45 €	6.415,55 €	1.954,67 €
1999	8.812,37 €	13.860,27 €	2.005,64 €	1.860,14 €	1.420,23 €	2.114,31 €	684,37 €	6.662,47 €	2.274,85 €
2000	8.736,88 €	14.591,91 €	2.031,65 €	1.871,40 €	1.583,20 €	2.275,55 €	575,40 €	6.989,54 €	2.517,21 €
2001	8.684,59 €	15.023,99 €	2.124,23 €	1.867,69 €	1.633,11 €	2.516,00 €	541,31 €	6.993,81 €	2.607,42 €
2002	8.623,98 €	15.315,34 €	2.207,23 €	1.845,24 €	1.580,61 €	2.627,60 €	529,81 €	7.345,59 €	2.686,66 €
2003	8.487,29 €	15.307,98 €	2.253,16 €	1.828,63 €	1.538,52 €	2.656,13 €	556,59 €	7.420,48 €	2.865,03 €
2004	8.340,33 €	15.618,26 €	2.283,37 €	1.695,13 €	1.568,60 €	2.738,35 €	510,56 €	7.683,72 €	2.955,30 €
2005	8.176,77 €	15.913,69 €	2.348,34 €	1.733,36 €	1.548,33 €	2.958,15 €	500,35 €	7.800,62 €	3.182,14 €
2006	8.018,73 €	16.206,40 €	2.417,16 €	1.768,28 €	1.550,85 €	3.121,09 €	454,56 €	7.819,91 €	3.443,92 €
2007	7.923,81 €	16.528,64 €	2.401,43 €	1.835,24 €	1.643,33 €	3.251,18 €	455,25 €	7.856,00 €	3.494,14 €
2008	7.920,29 €	16.580,21 €	2.537,16 €	1.916,36 €	1.602,45 €	3.281,93 €	352,91 €	7.272,87 €	3.009,21 €
2009	8.047,07 €	16.013,10 €	2.605,83 €	2.002,61 €	1.385,02 €	3.023,99 €	356,04 €	6.636,77 €	1.792,59 €
2010	8.178,44 €	16.148,47 €	2.480,63 €	1.841,07 €	1.374,31 €	3.046,32 €	348,93 €	6.582,35 €	1.423,72 €
2011	8.209,34 €	16.065,93 €	2.426,93 €	1.900,31 €	1.356,01 €	3.020,92 €	340,32 €	6.521,44 €	964,25 €
2012	8.238,67 €	15.673,89 €	2.321,22 €	1.860,98 €	1.357,73 €	2.783,11 €	347,91 €	6.415,38 €	539,78 €
2013	8.256,05 €	15.292,97 €	2.228,14 €	1.926,71 €	1.306,55 €	2.630,20 €	334,87 €	6.072,06 €	312,55 €
2014	8.326,99 €	15.538,53 €	2.279,87 €	1.923,17 €	1.387,27 €	2.813,77 €	355,63 €	6.188,97 €	409,51 €
2015	8.418,04 €	15.869,79 €	2.382,78 €	1.877,18 €	1.414,10 €	3.046,76 €	363,01 €	6.342,26 €	543,12 €
2016	8.327,09 €	16.218,39 €	2.408,75 €	1.821,82 €	1.500,93 €	3.241,42 €	354,95 €	6.298,83 €	581,55 €
2017	8.197,33 €	16.670,02 €	2.360,95 €	1.734,03 €	1.530,21 €	3.403,82 €	393,93 €	6.552,30 €	775,33 €
2018	8.190,20 €	17.027,43 €	2.412,22 €	1.793,73 €	1.566,20 €	3.519,52 €	362,44 €	6.549,09 €	958,26 €

Sweden

	gdp	bce	bcpa	population
1995	29.297,21 €	31.775,11 €	24.574,33 €	8816381
1996	32.536,49 €	35.140,45 €	27.860,10 €	8837496
1997	32.973,69 €	35.272,55 €	27.964,69 €	8844499
1998	33.355,70 €	34.943,78 €	27.840,47 €	8847625
1999	35.176,89 €	35.750,98 €	28.898,62 €	8854322
2000	38.412,06 €	37.367,59 €	30.997,02 €	8861426
2001	35.464,51 €	35.042,68 €	28.483,23 €	8882792
2002	36.488,90 €	36.197,48 €	29.145,59 €	8909128
2003	37.311,49 €	36.551,45 €	29.231,84 €	8940788
2004	38.729,91 €	36.924,83 €	29.376,04 €	8975670
2005	38.966,61 €	37.504,64 €	30.448,91 €	9011392
2006	40.697,63 €	37.922,61 €	31.369,06 €	9047752
2007	41.796,71 €	38.096,18 €	32.119,02 €	9113257
2008	39.780,80 €	37.575,63 €	31.553,17 €	9182927
2009	34.216,32 €	36.276,07 €	29.741,31 €	9256347
2010	40.075,18 €	38.382,82 €	31.479,02 €	9340682
2011	43.232,42 €	39.701,48 €	33.226,31 €	9415570
2012	44.222,81 €	40.856,28 €	34.351,60 €	9482855
2013	44.577,81 €	41.585,45 €	35.071,99 €	9555893
2014	43.134,35 €	40.872,25 €	34.933,79 €	9644864
2015	43.408,14 €	40.079,55 €	34.962,12 €	9747355
2016	43.385,76 €	39.732,04 €	34.564,71 €	9851017
2017	43.005,39 €	39.125,79 €	34.102,69 €	9995153
2018	40.832,66 €	37.725,87 €	32.956,16 €	10120242

	uw	c	s	g	dire	inq	nec	bec	ca
1995	9.770,24 €	19.088,56 €	2.767,77 €	4.537,98 €	1.459,80 €	2.572,07 €	357,58 €	9.404,03 €	1.845,67 €
1996	11.287,62 €	21.235,13 €	3.120,02 €	4.944,44 €	1.544,42 €	3.547,95 €	354,39 €	9.541,46 €	1.906,72 €
1997	11.522,41 €	21.237,12 €	3.068,25 €	4.937,52 €	1.509,49 €	3.634,36 €	348,91 €	9.468,97 €	1.812,20 €
1998	11.493,70 €	21.293,01 €	3.151,19 €	4.575,74 €	1.490,03 €	3.737,20 €	342,63 €	9.492,41 €	2.046,47 €
1999	11.938,57 €	22.399,06 €	3.248,28 €	4.461,54 €	1.673,87 €	4.283,07 €	339,52 €	9.348,34 €	2.156,45 €
2000	12.754,48 €	24.156,69 €	3.437,88 €	4.536,61 €	1.857,58 €	5.328,36 €	332,11 €	9.017,73 €	2.315,04 €
2001	11.723,50 €	22.697,06 €	3.227,27 €	3.763,87 €	1.640,50 €	4.398,24 €	330,26 €	9.142,98 €	2.253,26 €
2002	12.034,69 €	23.586,46 €	3.393,47 €	3.955,51 €	1.648,56 €	4.807,30 €	316,80 €	9.340,91 €	1.972,22 €
2003	12.231,95 €	24.163,37 €	3.488,62 €	3.735,26 €	1.644,86 €	5.113,32 €	309,57 €	9.688,19 €	2.059,01 €
2004	12.589,09 €	24.613,97 €	3.563,15 €	3.702,83 €	1.685,44 €	5.554,87 €	303,91 €	10.182,18 €	2.329,48 €
2005	12.903,37 €	24.841,97 €	3.877,18 €	3.786,64 €	1.688,92 €	5.733,42 €	482,17 €	10.069,98 €	2.532,07 €
2006	13.096,31 €	25.424,02 €	3.845,93 €	3.931,33 €	1.783,88 €	6.307,62 €	283,47 €	9.891,34 €	3.054,32 €
2007	13.159,42 €	25.798,19 €	3.782,60 €	3.988,23 €	1.827,88 €	6.519,42 €	284,97 €	9.827,49 €	3.565,36 €
2008	13.151,78 €	25.014,48 €	3.600,16 €	3.855,57 €	1.733,15 €	6.027,98 €	285,23 €	9.671,21 €	3.363,52 €
2009	13.243,06 €	22.815,96 €	3.301,87 €	3.199,43 €	1.557,38 €	4.480,87 €	246,01 €	8.661,20 €	1.880,43 €
2010	13.496,51 €	25.812,29 €	3.726,99 €	3.698,56 €	1.768,66 €	6.320,84 €	262,03 €	9.481,48 €	2.315,65 €
2011	13.827,45 €	27.548,31 €	3.999,00 €	4.081,09 €	1.914,21 €	7.573,87 €	266,29 €	9.426,44 €	2.684,98 €
2012	14.147,97 €	28.588,07 €	4.223,28 €	4.195,82 €	1.977,58 €	8.084,94 €	236,33 €	9.127,06 €	2.386,04 €
2013	14.446,34 €	29.041,60 €	4.368,63 €	4.307,25 €	2.016,13 €	8.312,09 €	250,14 €	9.065,12 €	2.301,51 €
2014	14.614,99 €	27.935,87 €	4.227,17 €	4.056,61 €	1.939,31 €	7.764,37 €	258,70 €	8.887,46 €	2.690,31 €
2015	14.242,06 €	27.621,88 €	4.210,59 €	3.885,85 €	1.874,73 €	7.741,35 €	264,74 €	8.440,92 €	3.058,75 €
2016	14.126,78 €	27.694,58 €	4.078,26 €	3.710,67 €	1.827,20 €	7.808,93 €	242,12 €	8.708,73 €	3.299,29 €
2017	13.845,21 €	27.203,25 €	3.968,33 €	3.712,71 €	1.748,78 €	7.611,21 €	243,71 €	8.907,38 €	3.640,56 €
2018	13.039,49 €	25.771,61 €	3.767,84 €	3.709,63 €	1.641,27 €	6.688,39 €	233,05 €	8.860,48 €	3.857,73 €

United Kingdom

	gdp	bce	bcpa	population
1995	23.969,96 €	22.427,65 €	14.762,70 €	57943472
1996	24.963,71 €	22.905,04 €	16.088,02 €	58094587
1997	30.507,07 €	26.817,46 €	19.811,40 €	58239312
1998	32.233,81 €	28.133,73 €	21.325,73 €	58394596
1999	34.166,61 €	29.502,58 €	22.957,72 €	58579685
2000	37.968,73 €	31.903,07 €	25.364,89 €	58785246
2001	38.247,47 €	32.440,49 €	25.841,29 €	58999781
2002	38.519,98 €	32.663,69 €	26.111,79 €	59239564
2003	35.943,51 €	31.626,72 €	24.815,34 €	59501394
2004	37.365,40 €	31.978,62 €	25.098,01 €	59793759
2005	38.000,69 €	32.113,50 €	25.358,58 €	60182050
2006	38.833,18 €	32.301,71 €	25.576,33 €	60620361
2007	39.347,51 €	32.089,36 €	25.655,98 €	61073279
2008	33.458,92 €	29.788,63 €	23.158,63 €	61571647
2009	28.425,84 €	28.379,39 €	21.285,61 €	62042343
2010	29.873,46 €	28.734,37 €	21.533,89 €	62510197
2011	29.774,16 €	28.558,21 €	21.678,59 €	63022532
2012	32.129,39 €	29.685,87 €	22.621,73 €	63495088
2013	31.141,37 €	29.349,20 €	22.540,28 €	63905342
2014	33.467,77 €	29.834,67 €	23.548,12 €	64351203
2015	37.805,06 €	32.261,25 €	26.251,01 €	64853393
2016	33.879,53 €	29.948,24 €	24.254,86 €	65379044
2017	31.942,25 €	28.498,06 €	22.781,37 €	65844142
2018	31.943,13 €	28.419,02 €	22.660,90 €	66273576

	uw	c	s	g	dire	inq	nec	bec	ca
1995	6.573,18 €	17.631,47 €	1.569,70 €	1.663,03 €	1.793,64 €	2.624,74 €	591,35 €	9.268,66 €	1.012,36 €
1996	6.638,86 €	18.335,07 €	1.606,35 €	1.695,59 €	1.895,55 €	2.906,40 €	568,88 €	8.680,70 €	1.294,80 €
1997	8.109,07 €	22.222,42 €	1.876,19 €	1.992,30 €	2.429,64 €	4.427,70 €	525,17 €	8.697,37 €	1.166,15 €
1998	8.708,81 €	23.756,38 €	1.945,67 €	2.191,46 €	2.648,04 €	5.300,08 €	520,48 €	8.756,20 €	1.427,72 €
1999	9.254,89 €	25.389,35 €	2.101,25 €	2.045,05 €	2.797,06 €	6.014,57 €	476,34 €	8.429,93 €	1.408,74 €
2000	10.340,51 €	28.214,39 €	2.335,08 €	2.333,05 €	3.146,57 €	7.703,74 €	469,65 €	8.517,09 €	1.509,26 €
2001	10.614,84 €	28.539,20 €	2.390,47 €	2.079,30 €	2.977,87 €	7.767,99 €	437,46 €	8.509,62 €	1.472,96 €
2002	10.528,72 €	29.006,75 €	2.484,54 €	2.032,25 €	2.830,67 €	8.133,97 €	423,92 €	8.468,67 €	1.492,86 €
2003	10.355,70 €	27.276,14 €	2.282,41 €	1.929,73 €	2.630,88 €	7.180,26 €	406,12 €	8.650,64 €	1.433,15 €
2004	10.177,48 €	28.483,90 €	2.335,34 €	2.098,37 €	2.821,91 €	7.903,50 €	391,06 €	8.710,04 €	1.438,36 €
2005	9.993,73 €	28.909,07 €	2.546,05 €	2.318,54 €	2.984,38 €	8.295,17 €	374,34 €	8.668,12 €	1.538,85 €
2006	9.744,02 €	29.319,10 €	2.543,57 €	2.407,34 €	3.009,23 €	8.351,22 €	351,87 €	8.733,80 €	1.656,54 €
2007	9.384,06 €	29.627,38 €	2.596,94 €	2.464,12 €	3.040,77 €	8.579,65 €	362,72 €	8.576,11 €	1.780,01 €
2008	9.004,26 €	25.835,91 €	2.057,72 €	2.138,33 €	2.580,94 €	6.351,60 €	315,04 €	8.256,55 €	1.311,50 €
2009	8.739,73 €	22.548,15 €	1.975,60 €	1.867,16 €	2.018,23 €	4.440,83 €	292,18 €	7.779,94 €	393,99 €
2010	8.484,83 €	23.358,53 €	1.882,03 €	2.215,53 €	1.954,62 €	4.951,06 €	300,86 €	7.996,60 €	495,26 €
2011	8.536,06 €	23.107,07 €	1.875,77 €	2.194,09 €	1.989,86 €	4.885,16 €	279,77 €	7.531,62 €	372,23 €
2012	8.605,25 €	24.826,32 €	2.072,35 €	2.178,87 €	2.090,03 €	5.627,33 €	279,56 €	7.715,27 €	371,57 €
2013	8.636,72 €	24.031,30 €	1.961,91 €	2.064,68 €	1.963,98 €	5.109,63 €	271,78 €	7.571,53 €	490,84 €
2014	8.674,67 €	25.512,05 €	2.158,67 €	2.099,54 €	2.222,86 €	6.116,92 €	270,48 €	7.373,20 €	816,16 €
2015	9.702,46 €	28.573,72 €	2.438,43 €	2.206,80 €	2.368,32 €	8.027,17 €	264,67 €	7.276,58 €	1.001,67 €
2016	8.598,28 €	25.919,55 €	2.185,23 €	1.942,27 €	2.124,50 €	6.327,43 €	245,16 €	7.053,66 €	1.115,12 €
2017	8.036,51 €	24.467,97 €	1.996,56 €	1.913,48 €	1.955,52 €	5.720,52 €	240,41 €	7.013,98 €	1.056,88 €
2018	8.003,21 €	24.577,95 €	1.996,61 €	1.932,93 €	2.003,85 €	5.848,04 €	239,80 €	6.926,50 €	928,58 €

EU-15

pc	gdp	bce	bcpa	population
1995	€ 24.583,12	€ 25.928,43	€ 19.302,43	372458285
1996	€ 25.273,94	€ 26.451,81	€ 19.870,07	373545996
1997	€ 26.290,46	€ 27.098,91	€ 20.483,47	374565060
1998	€ 27.015,44	€ 27.397,78	€ 20.908,01	375484537
1999	€ 28.074,32	€ 27.984,97	€ 21.771,65	376365647
2000	€ 29.487,99	€ 28.877,86	€ 22.622,18	377591232
2001	€ 29.858,20	€ 29.168,08	€ 22.776,62	378987973
2002	€ 30.018,37	€ 29.349,65	€ 22.704,45	380704422
2003	€ 29.647,18	€ 29.249,57	€ 22.345,59	382812638
2004	€ 30.291,87	€ 29.371,98	€ 22.328,91	384948320
2005	€ 30.623,41	€ 29.581,13	€ 22.618,87	387276491
2006	€ 31.437,24	€ 29.713,10	€ 22.813,32	389386803
2007	€ 32.121,85	€ 29.590,66	€ 22.995,38	391489367
2008	€ 31.098,19	€ 29.366,46	€ 22.637,00	394013787
2009	€ 28.963,92	€ 29.288,27	€ 22.204,70	395975347
2010	€ 29.765,76	€ 29.466,53	€ 22.102,89	397385718
2011	€ 30.281,23	€ 29.491,54	€ 22.305,62	397417091
2012	€ 30.400,75	€ 29.608,05	€ 22.367,75	398734337
2013	€ 30.135,49	€ 29.387,26	€ 22.099,60	400034881
2014	€ 30.682,08	€ 29.379,02	€ 22.332,05	402362437
2015	€ 31.825,67	€ 29.687,91	€ 22.740,11	403829434
2016	€ 31.565,10	€ 29.298,71	€ 22.553,37	405762666
2017	€ 31.789,04	€ 29.143,57	€ 22.356,57	407193519
2018	€ 32.146,83	€ 29.267,80	€ 22.592,79	408415604

	uw	c	s	g	dire	inq	nec	bec	ca
1995	€ 9.184,68	€ 16.798,15	€ 2.120,05	€ 2.748,30	€ 1.699,51	€ 2.652,15	€ 571,08	€ 8.549,17	€ 1.352,09
1996	€ 9.299,25	€ 17.288,99	€ 2.175,17	€ 2.761,56	€ 1.710,73	€ 2.809,59	€ 552,82	€ 8.529,93	€ 1.395,36
1997	€ 9.614,47	€ 17.897,15	€ 2.266,48	€ 2.728,00	€ 1.777,31	€ 3.076,54	€ 553,36	€ 8.573,87	€ 1.405,08
1998	€ 9.724,62	€ 18.341,37	€ 2.266,85	€ 2.700,31	€ 1.814,30	€ 3.295,16	€ 525,92	€ 8.623,08	€ 1.607,40
1999	€ 9.930,43	€ 19.097,89	€ 2.373,49	€ 2.648,24	€ 1.868,17	€ 3.645,45	€ 551,46	€ 8.521,26	€ 1.756,48
2000	€ 10.212,53	€ 20.096,54	€ 2.463,58	€ 2.724,58	€ 2.005,74	€ 4.093,83	€ 519,79	€ 8.654,06	€ 1.878,60
2001	€ 10.276,10	€ 20.385,11	€ 2.519,52	€ 2.689,28	€ 1.998,50	€ 4.230,52	€ 472,91	€ 8.654,32	€ 1.789,95
2002	€ 10.299,85	€ 20.574,65	€ 2.634,72	€ 2.659,21	€ 1.943,41	€ 4.375,63	€ 499,74	€ 8.750,10	€ 1.605,16
2003	€ 10.250,02	€ 20.456,76	€ 2.651,67	€ 2.591,93	€ 1.931,40	€ 4.290,66	€ 478,74	€ 8.931,55	€ 1.548,83
2004	€ 10.225,71	€ 20.816,43	€ 2.672,21	€ 2.594,55	€ 1.967,60	€ 4.531,54	€ 437,80	€ 9.058,09	€ 1.577,23
2005	€ 10.194,62	€ 21.129,04	€ 2.802,46	€ 2.622,23	€ 2.018,32	€ 4.713,92	€ 434,98	€ 9.030,47	€ 1.633,24
2006	€ 10.147,24	€ 21.490,25	€ 2.819,53	€ 2.639,32	€ 2.058,32	€ 4.916,55	€ 408,36	€ 9.149,39	€ 1.841,25
2007	€ 9.991,84	€ 21.766,09	€ 2.826,71	€ 2.707,80	€ 2.128,79	€ 5.164,20	€ 408,79	€ 9.020,62	€ 2.016,54
2008	€ 9.863,37	€ 21.310,62	€ 2.763,05	€ 2.716,86	€ 2.036,34	€ 4.872,58	€ 378,52	€ 8.866,27	€ 1.758,29
2009	€ 9.824,15	€ 20.458,86	€ 2.804,95	€ 2.634,18	€ 1.801,13	€ 4.257,73	€ 375,02	€ 8.378,54	€ 919,96
2010	€ 9.825,47	€ 20.892,83	€ 2.750,89	€ 2.666,59	€ 1.807,65	€ 4.500,75	€ 360,86	€ 8.592,77	€ 868,27
2011	€ 9.828,17	€ 21.094,44	€ 2.715,48	€ 2.720,75	€ 1.832,72	€ 4.683,65	€ 350,93	€ 8.415,92	€ 879,06
2012	€ 9.817,63	€ 21.289,53	€ 2.679,69	€ 2.712,19	€ 1.810,10	€ 4.717,87	€ 363,02	€ 8.270,13	€ 666,81
2013	€ 9.826,65	€ 21.057,39	€ 2.606,66	€ 2.637,79	€ 1.784,11	€ 4.601,55	€ 355,57	€ 8.178,35	€ 535,13
2014	€ 9.841,94	€ 21.247,27	€ 2.676,81	€ 2.589,00	€ 1.826,16	€ 4.812,00	€ 337,85	€ 8.006,53	€ 621,71
2015	€ 10.003,71	€ 21.775,44	€ 2.810,43	€ 2.515,33	€ 1.867,81	€ 5.211,13	€ 338,06	€ 8.059,05	€ 773,18
2016	€ 9.835,75	€ 21.501,18	€ 2.777,83	€ 2.416,68	€ 1.833,27	€ 5.047,40	€ 352,07	€ 8.022,62	€ 925,21
2017	€ 9.746,89	€ 21.518,68	€ 2.708,43	€ 2.391,69	€ 1.814,09	€ 5.074,37	€ 333,67	€ 8.132,61	€ 1.011,94
2018	€ 9.773,97	€ 21.719,54	€ 2.737,97	€ 2.430,72	€ 1.828,09	€ 5.239,22	€ 327,10	€ 8.041,38	€ 1.039,27