INCORPORATING SOCIAL JUSTICE IN CLIMATE POLICY ASSESSMENT

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Supervisor:

Dr. Rolf Groeneveld

A thesis submitted in partial fulfilment of the degree of Master of Science
at Wageningen University and Research Centre,
The Netherlands.

December 16, 2019

Wageningen, The Netherlands

Course Code: ENR-80436
Wageningen University and Research Centre
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WAGENINGEN
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ABSTRACT

National, regional and international governments around the world are in the process of adopting concrete long-term mitigation policies that must lead to large scale emission reductions. These, climate policy not only with large cost, they also change the distribution of wealth within society, which raises questions of distributional justice. There is a growing need for considering distributional issues in policy assessment. Therefore, this thesis aims to critically explore the ways in which different definitions of social justice can be explicitly incorporated in cost-benefit analysis of climate and environmental policy. This is done by assessing four different perspectives on justice, utilitarianism, Rawlsianism, Libertarianism and the capabilities approach, and attempting to translate them into quantifiable assessment criteria. For as far as the theories allow it, these assessment criteria have then been applied to a cost-benefit analysis (CBA) of the Dutch climate policy with the use of distributional weights. The theoretical analysis showed that there are different degrees of transformability of these theories into quantitative assessment criteria for the desirability of environmental policies, because of differences in level of abstraction, the ability to operationalize the conception of justice and level of possible aggregation. Libertarianism and Capabilities Approach could not be quantified within the context of a CBA and rather can provide supplementary assessment methods. The use of distributional weights on the Dutch climate policy case study showed the chosen parameter values for taking into account distributional effects, as well as the choice of reference group in the calculation of weights, might impact which decision is made on the desirability of the assessed policy. Furthermore a major difficulty for the application of these assessment criteria was identified in the inclusion or exclusion of public benefits into the distributional weighing process. As such, there is a need for new methods on operationalization of those justice criteria into measurable elements.

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LIST OF ABBREVIATIONS

APP	Ability-to-pay principle
BPP	Beneficiary-pays principle
CA	Capabilities Approach
CBA	Cost-benefit analysis
CPB	Centraal Planbureau (Netherlands Bureau for Economic Policy Analysis)
ECN	Energy research Centre of the Netherlands
EPA	Environmental policy appraisal
GDP	Gross Domestic Product
GHG	Greenhouse gas
IPCC	Intergovernmental Panel on Climate Change
NPV	Net present value
PBL	Planbureau voor de Leefomgeving (Netherlands Environmental Assessment Agency)
PPP	Polluter-pays principle
PV	Present value
SCBA	Social cost-benefit analysis
SCC	Social Cost of Carbon
SWF	Social Welfare Function
WTP	Willingness-to-pay

1. INTRODUCTION

1.1. PROBLEM DESCRIPTION

In the Paris Climate Agreement (UNFCCC, 2016) national, international governments and institutions have set ambitious targets on the reduction of CO_2 and other Green House Gas (GHG) emissions, in order to prevent the global temperature from increasing above 2 degrees Celsius above pre-industrial levels. National, regional and international governments now have the responsibility to set out concrete long-term mitigation policies that lead to those emission reductions.

Our economies have a rigid path dependency revolving around fossil fuels. Decarbonizing the economy has wide-ranging effects across economic sectors and groups of people (see for example(Flavin, 2012; Rockström et al., 2017; Unruh, 2002). Over the years, many emission reduction policies have been developed and implemented, such as cap-and-trade schemes, pollution taxes, pollution standards (mandates), bound abatement targets, environmental protection designations or simply the relocating of pollution-intensive industries (Aldy, Krupnick, Newell, Parry, & Pizer, 2009). These policies intend to mitigate climate change in order to minimize associated damages and therefore environmental costs. However, multiple studies suggest policies striving for substantial carbon reduction can generate enormous economic costs (see: Jaccard, Nyboer, Bataille, & Sadownik, 2003; Paltsev, Reilly, Jacoby, & Morris, 2009). For example Paltsev et al., (2009) calculate that if the U.S. reduces 80% of its carbon emissions in comparison to 2008 levels by 2050, it would cost 3% of the national GDP.

Climate policy not only comes with large costs. It also changes the distribution of wealth within society, as it inevitably shifts the burden of costs and benefits over individuals and groups (Ostro, 1981; Bento, 2013). The welfare effects of climate policy are potentially not evenly or proportionally spread out over different groups and individuals. These distributional effects are relevant for policy evaluation, as they relate to issues and principles of fairness, equity and political feasibility (Buchs, Bardsley, & Duwe, 2011). This is portrayed by the public debate in many societies concerning the burden placed on citizens by climate change policy. Also, there are concerns on the unequal share of that burden placed on low-income and other marginalized groups (see for example: De Cian, Hof, Marangoni, Tavoni, & Van Vuuren, 2016). There is a growing body of literature that tries to identify the winners and losers of environmental policies across different dimensions by assessing the distributional effects (see: Bento, 2013; Kerkhof, 2009).

The most used and developed method of economic policy assessment is cost-benefit analysis (CBA). CBA focuses on efficiency gains: maximizing aggregate welfare effects. Usually, it does not consider to whom those costs and benefits befall. To come to informed decision-making on environmental policies that take equity into account, it is necessary to construct assessment criteria on the distribution of effects of a policy, and not only on its aggregated effects (Atkinson, 2009). Although these can partly be derived from economic theory, they also always involve making moral judgements on the concept of justice. Research on methods to operationalise distributional effects into policy assessment can be called a form of 'moral economics' as it involves both economic and moral-philosophic reasoning and analysis. This academic discussion is very prominent within the domain of environmental policy.

Over the years, many attempts have been made to differentiate in the impacts of climate and other environmental policies on different groups, regions, and individuals within society. However, there is no standardized measurement and methodology (Bento, 2013; Bull, Hassett, & Metcalf, 1994). Some academics have conducted ex-post evaluations of the distribution of costs and benefits of environmental policies, but outside the framework of a formal cost-benefit analysis (Grover & Daniels, 2017; Håkansson, Östberg, & Bostedt, 2016). Others have developed partial and general equilibrium models to investigate the mechanisms behind certain distributional effects of environmental policies such as tax schemes (Casler & Rafiqui, 1993; I. Parry, Sigman, Walls, & Williams III, 2006), emission permit trading schemes (Parry, 2004) and emission restrictions (Fullerton & Heutel, 2010; Rausch &

Mowers, 2014). This gives us insight into how distributional effects work, but not how they should be judged in decision-making in terms of justness.

In addition, there is extensive critical academic work on the use of CBAs, its disregard of distributional effects and the implicit ethical premises therein (Adler, 2016;; Turner, 2007; Farrow, 1998). Many authors have tried to define judgement principles on what can be considered just given the equity effects of environmental policies (see for example: Atkinson, Machado, & Mourato, 2000).

There have been some attempts at defining methodology and practical application of assessment criteria based on equity effects, in order to incorporate justification of equity choices in standard practice. For example Anthoff, Hepburn, & Tol (2009) and Anthoff & Tol (2010) applied equity weights to determine the optimal reduction path taking into account inter-generational and international justice regarding the distribution of effects of climate mitigation policies. Adler (2016), Stanton (2011) and Nyborg (2014) have provided several methodological guiding principles for making moral decisions on justice within a policy evaluation framework for environmental policies.

However, most of these developed methods are based on a single perception of justice and do not explicitly elaborate on the ethical choices to be made between different theories of social justice. There is a need to test the suitability of different principles of justice to be translated to policy assessment criteria, the data requirements this brings along and the interpretability of the results it produces.

1.2. RESEARCH OBJECTIVE

This thesis aims:

To critically explore the ways in which different definitions of social justice can be explicitly incorporated in cost-benefit analysis of climate and environmental policy.

1.3. RESEARCH QUESTIONS

Three research questions are formulated that need answering in order to accomplish the research objective. The first is concerned with the theoretical and moral aspect of the construction of assessment criteria. The last two questions are concerned with the practical application of these assessment criteria:

Question 1: How and to what extent can the different economic justice approaches be translated into quantifiable assessment criteria?

This first question bridges the gap between theories of justice and policy assessment criteria, in order to make ethical choices of different distributional assessment methods explicit. It will conceptually link the argumentation, assumptions and ethical choices of different perceptions of justice to the practice of climate policy assessment.

Question 2: How and to what extent can these approaches identified in RQ1 be applied in practice in social CBA?

By answering this question, this thesis dives deeper into the possibilities and constraints for the practical application of the assessment criteria into policy assessment practices such as CBA.. This requires an analysis on the data requirements on the costs and benefits of a programme and the distribution. In Addition, it entails translating these assessment criteria into models that are compatible with current CBA practices.

Question 3: What is the effect of applying these distributional methods to the results of a practical climate mitigation policy CBA?

This last question explores the interpretability, workability and appropriateness in decision-making of the different assessment criteria when applied to real-world data on a policy case. This case is the Dutch climate change mitigation policy. The application of assessment criteria will be done in two

possible forms. The first is within a CBA through equity weights and thus a recalculation of net present value (net societal benefits). The second form is in combination with or as a substitute of CBA.

1.4. METHODOLOGY

The research conducted consisted of two methods: (1) an intensive literature and document review to answer the first research question and, (2) a case study into a cost-benefit analysis of the Dutch climate change mitigation policy to answer the latter two questions.

Question 1: How can the different economic justice approaches be translated into quantifiable assessment criteria?

This first question was addressed by an explorative and extensive literature research into peer-reviewed articles, economic textbooks and policy reports. The literature collected can be distinguished in three parts. Firstly, sources concerning different theories of justice were gathered and analysed. This included original sources as well as articles that give an overview of the theories. The second part involved analysing sources that give an economic interpretation of these philosophic conceptions of justice. Both parts combined gave the theoretical foundation to construct the distributional assessment criteria. A third part focused on analysing sources that established or tested methods of policy assessment regarding equity issues. This search was not narrowed down to the environmental domain, but also extended to other areas of policy assessment such as health and education.

Question 2: How and to what extent can these approaches identified in RQ1 be applied in practice in social CBA?

In order to answer this question, a case study approach is used. To test how assessment criteria can be applied in practice and in combination with CBA it was necessary to create a dataset on a specific policy case. It was beyond the scope of this thesis to generate data on the effects of a policy within this study. This means it was necessary to find a set of data that allowed easy use into both a standard CBA and a distributional assessment.

Dutch climate change mitigation efforts serve as an exemplary case study on the importance of distributional effects in policy assessments in the Netherlands. The national government has put forward ambitious plans to comply with the Paris Agreement and reduce CO_2-emissions to 49% by 2030 and 95% by 2050 (compared to 1990 levels) (Koot, Schulenberg, & Bollen, 2018). The package of measures to reach these targets is further defined in the so-called Climate Accord ('Klimaat-akkoord') (PBL, 2019). This is a proposal of a combination of policy tools agreed upon by politicians, sectoral industry members and environmental organizations. It remains unsure and subject to the political process to which extent these measures will be implemented. The Dutch climate mitigation plans have sparked a divisive political debate on the costs of the necessary policies, not only on their affordability, but also on the inequality of the allocation of their costs over different income groups and between citizens and industries or companies. First analyses show that lower-income households will bear relatively higher shares of the total costs than other income groups (Koot et al., 2018). Questions arise on the fairness, feasibility and effectiveness of these policies due to their distributional impacts. The Dutch government has not yet implemented a methodology to include these distributional concerns into its research on the impact of these climate change policies. This leaves a gap both in the knowledge on how to treat distributional effects and in the political process of informed decision-making on these policies.

For this case, a wide range of data and calculations is available on the effects, costs and income effects of these policies (PBL, 2019; Vergeer, Rooijers, & Marc Davidson Advies, 2017). These calculations made it possible to translate the policy effects into a simplified Cost-Benefit Analysis. In addition, a distributional effects analysis conducted by the Dutch Central Planning Agency (CPB) was used to disaggregate net income effects over different income groups. This data was then used to apply the different appraisal decision rules obtained from research question 1.

Question 3: What is the effect of applying these distributional methods to the results of a practical climate mitigation policy CBA?

This last question was assessed by calculating the outcomes of the different decision rules defined in answer to question 1 when applied to the dataset generated in answer to question 2. In this way the modelled decision rules are tested on a practical and quantifiable policy case. When the assessment criterium applied is fully incorporated within the CBA it requires parameterization of elements in the calculation. A literature study was conducted to determine acceptable parameter value ranges. Next, the influence of these parameter choices was tested by varying their values. For assessment criteria that could not be translated into a recalculated NPV, results were presented separately and their interpretability was discussed.

1.5. THESIS OUTLINE

Chapter 2 presents the theoretical framework of this thesis, in which the relevant concepts from economic, environmental and justice theories are defined, explained and connected with each other. Chapter 3 defines and operationalizes different assessment criteria for the justness and desirability of environmental policies, based on the four theories of justice. Chapter 4 elaborates on the data and calculations used for the exemplary case of the Dutch national climate change policy to which these justice principles and assessment criteria are applied. Chapter 5 gives the results of this exercise, presenting the outcomes of the application of different distributional assessment criteria and reflecting on their interpretability. Chapter 6 provides a discussion of the results, links them to the existing body of literature, reflects on the challenges encountered in the process and discusses the implications for policy building and further research. Chapter 7 gives a general conclusion in which an answer is given to the four research questions.

2. THEORETICAL FRAMEWORK

2.1. CBA AS AN ECONOMIC POLICY APPRAISAL TOOL

2.1.1. Social cost-benefit analysis

Social cost-benefit analysis (SCBA) is an appraisal tool to test the social impacts of a policy, project, or programme. The basic premise of SCBA is to compare the aggregated social costs and benefits of such an intervention, resulting in a total effect on society expressed in a single unit of measurement in the form of net-benefits. This requires both interpersonal and intertemporal comparison.

Interpersonal comparison is achieved by expressing all costs and benefits in monetary terms. Where possible, these monetary costs and benefits are derived from market prices. However, for many costs and benefits, no market exists or markets fail to provide adequate prices reflecting their actual value. These costs and benefits are still included using non-market valuation. This encompasses two main valuation methods: revealed preference and stated preference. Revealed preference infers the value of non-market costs and benefits through individuals' observed choices (Caplin & Dean, 2014). Stated preference methods values costs and benefits by asking individuals to state their willingness-to-pay for these goods. This can be used to value almost all types of costs and benefits, but their validity is more contentious (Baker & Ruting, 2014). Costs and benefits over time are made comparable through the process of discounting. This generates a present value (PV) of each of the costs and benefits of every year within the time horizon.

In an unweighted SCBA, the present value of all costs and all benefits of each individual can be aggregated through simple summation. The discounted net-benefits, or net-present value (NPV), is then calculated by subtracting the sum of discounted costs (PV(C)) from the sum of discounted benefits (PV(B)) or: NPV = PV(B) – PV(C). The correct rule for the application of CBA is to "adopt any project with a positive NPV and [when there are multiple options] rank projects by their NPVs" (Pearce, Atkinson, & Mourato, 2017, p.67). The alternative with the highest NPV is therefore the most desirable. Thus, CBA serves as a policy appraisal instrument by providing a strict and clear decision rule on the desirability of a policy or project (Turner, 2007).

2.1.2. Rationales for the use of CBA

Pearce et al. (2017) provide several central rationales for the use of CBA as a policy appraisal instrument. First, it offers a method for rational decision-making in which all effects on all people are included in terms of utility or well-being. This includes all gains and losses. It offers a way of decision-making without having to focus on the impacts on a single goal or group of people. Second, CBA requires assessing a policy as one of a series of alternatives for achieving a chosen goal. Third, CBA can determine the optimal scale of the policy – where net benefits are maximised – because all the outcomes are expressed in the same units. Fourth, CBA requires to explicitly account for time through the process of discounting. Fifth, CBA is a democratic assessment method, as it takes into account each individuals' preferences. Sixth, CBA measures explicit individual preferences instead of implicit ones. These take the form of revealed preferences in the marketplace, constructed markets or through the effect of preferences on complementary markets. All these preferences imply monetary values through which costs and benefits can be measured. The seventh and last rationale for the use of CBA is that it can account for concerns on differential impacts through the use of distributional weights. This requires that the analysis also shows the costs and benefits befalling on different groups of beneficiaries and losers. In practice, this differentiation is rarely established. The role of distributional effects on CBA is further discussed in section 2.1.4.

Not all these rationales are uniformly accepted. There is widespread discussion on the validity of using individual preferences and the use of discounting. Critics argue that individual preferences can be ill-informed instead of fully rational, meaning the monetary values deduced from those preferences

might not represent the actual value it has for people's well-being (D. W. Pearce et al., 2017). Additionally, there might be a difference between the preferences comprising of a person's self-interest and the preferences that person expresses as a citizen. The legitimacy of the use of discount rates is under scrutiny (see for example: Stern, 2007). The principle of discounting makes costs and benefits far in the future marginal or negligible. For policies which have high impacts but typically take a long to very long time to materialize, this can intuitively be deemed unsuitable. However, these criticisms and discussions around CBA are not the focus of this thesis.

2.1.3. CBA and environmental policy appraisal

The methods of standard unweighted CBA have taken a central role in environmental policy appraisal (EPA) across the world. It helps in the decision-making on environmental and climate change policies. In the US, the application of CBA techniques for EPA is mandatory (Turner, 2007). In the UK and the rest of the EU, it has been a formal part of the assessment of environmental policies since the 2004 Impact Assessment Regime (D. Pearce, 2004). In the Netherlands, CBA also is an integral part of policy appraisal and is the preferred method of ex-ante assessment of the impacts and desirability of environmental and climate mitigation policies (Van der Pol, Bos, & Romijn, 2017).

The role of CBA in the assessment of environmental and climate policy is a point of widespread discussion. The critiques on CBA mentioned above on the value of individual preferences and the role of the discount rate apply specifically to environmental policy. First, environmental policy benefits must be largely expressed in non-market values. This is because they encompass common goods, which link to the validity of individual preferences. Second, the impacts of environmental policy and particularly climate policy usually have long time horizons (> 50 years. This is linked to the discussion around discount rates. Thirdly, both within the academic and in the wider societal discussion there is a large array of critique on the neglect of distributional concerns of environmental policies world (see Farrow, 1998; Bento, 2015 for an overview). The current practical applications of CBA ignoring these distributional effects are therefore deemed insufficient (Adler, 2016). The following paragraph investigates the link between CBA, environmental policy and distributional effects, by elaborating on the conceptual basis for ignoring distributional effects in CBA. Next, it provides an overview of the academic discussion on whether to account for distributional effects in policy appraisal, specifically when environmental policy is under consideration.

2.2. CBA AND DISTRIBUTIONAL EFFECTS OF ENVIRONMENTAL POLICY

2.2.1. CBA and distributional effects

In general, distributional effects are disregarded in CBA, as the present value of costs and benefits over all individuals are aggregated through unweighted summation. The justification for this practice lies in the Potential Pareto or compensation principle of Kaldor and Hicks (Krutilla, 2005). This principle dictates a policy should provide enough benefits so that winners could hypothetically compensate all losers and still be better-off, regardless whether compensation actually takes place. By doing so, a Potential Pareto improvement is achieved and therefore an efficiency gain. When there are multiple policy alternatives, the option with the highest left-over gains after hypothetical compensation is the most desirable.

This means unweighted CBA does not consider who the winners and losers of a policy are, as all costs and benefits in monetary terms are counted equally. However, there is a strong case to differentiate in importance given to the losses and gains of different groups which better reflect their actual increase or decrease in well-being. This is because it is widely assumed that income losses or gains for rich individuals have less impact on their levels of well-being than when poor individuals experience the same losses or gains (Adler, 2016). This differentiation could be avoided by demanding actual compensation of all losses to be incorporated into the design (Farrow, 1998). However, Dreze & Stern (1987) show this redistribution incurs social costs that cannot be ignored in the policy appraisal. The

method of differentiation in considering the gains and losses of different groups, depends on which perspective on social justice is accepted.

2.2.2. Distributional assessments of environmental policy

Fankhauser, Tol, & Pearce (1997)sum up the three most established arguments against the use of distributional equity considerations in the aggregation of climate change damages. They can be extended to the appraisal of environmental policies. The first argument is that the current income distribution could be considered just if it is the result of a democratic process. This means appraisals should not necessarily favor policies that reduce the inequality of the income distribution. The counterargument is that it is unlikely that all distributive effects of all policies are considered in the democratic process of decision-making (Fankhauser et al., 1997).

A second argument is that distributional issues should be dealt with separately, outside of the sphere of specific policies. Most prominently Harberger (1978)argues that it is more efficient to compensate incurred losses caused by different policies through the income tax, instead of having to compromise on efficiency in each policy design to give room for equity. However, in the practice of tax scheme design this separation of the distributional effects of all (environmental) policies might not be so straightforwardly made (Pearce et al., 2017).

A third and final argument for not using distributional equity considerations is the acceptation of the inherent assumptions to unweighted CBA in the form of the linearity of the welfare function. This means assuming a constant marginal utility of income (Fankhauser et al., 2017). They however also mention that there is very limited empirical evidence for such an assumption. Therefore, it is in fact a main argument in favor of incorporating distributional effects. Nyborg (2014) argues that this inherent assumption of CBA should be made explicit. So, for all arguments against distributional analysis there are also counterarguments.

A more practical rationale in favor of combining distributional or equity concerns in policy appraisal is political feasibility. Distributional impacts may also have important influence on the political acceptability of the intervention (Aldy et al., 2009). Additionally, there is a lack of data to construct proper distributional analysis. However, this is partly because in CBA you are not compelled to do so rather than that it is unfeasible.

Turner (2007) concludes that due to the (increasingly) contested nature of environmental and climate mitigation policies and their outcomes – especially regarding the sharing of burdens of the policies – environmental policy appraisal should be more restrained by social justice and ethical considerations. He pleads for standard, unweighted CBA to serve more as a component of a wider policy analysis in which judgements on the distribution of outcomes of a policy are explicitly incorporated. Incorporating social justice constraints to policy appraisal requires first to define the different theories and perspectives on social justice and the economic principles that follow from it.

2.3. PERSPECTIVES ON JUSTICE

2.3.1. Theories of social justice

Atkinson (2009) pleads for economics as a moral science. He argues that many ambiguities in economics do not come from disagreements on how economic processes work, but on which criteria to apply when judgements are made. He stresses the importance of making explicit choices on the definition of justice when making value judgements because “there are several welfare criteria that could be applied in evaluating a change or policy proposal. People can legitimately reach different conclusions because they apply different theories of justice.” (Atkinson, 2009, p.803).

Sen (2000)gives a comprehensive overview of the most prominent social justice theories and discusses their bearing “on the analysis and evaluation of income distribution and related features of economic inequality” (p.60). To achieve a systematic understanding of the conceptualization of justice by the different theories and their relevance for economic evaluation, the first step is to define the

informational basis on which these are built. Sen (2000) distinguishes three aspects of this informational basis related to economic inequality. The first is the **basal space**, "the general class of variables to which assessment of justice is sensitive under that theory" of justice (p.62). This means it also excludes other variables in having a direct impact on how justice is assessed. The second is the **focal combination**, the way in which these variables are used or treated, in order to make judgements on the justice of a certain inequality or distribution. Third is the **reference group**, identifying if and how the assessment of justice is dependent on the states of other people outside the group under consideration.

Sen (2000) distinguishes four main social justice theories. The first is **utilitarianism**. Being the standard perspective in economics, it has only one variable it is concerned with: individual utility. To assess the justness of a situation it focusses on a simple aggregation of those individual utilities, independent of the utility levels of anyone outside of the group under assessment. The second theory is **Rawlsianism**, in which justice is defined as fairness and is measured in primary goods. Under Rawlsianism, full priority is given to the worst-off individual or subgroup within the population under consideration. Third is **libertarianism**, which gives full priority in its assessment of justice to the fulfilment of basic rights of the impacted group. The fourth and newest approach to justice is the **capability approach (CA).** In its conception of justice, it is concerned with the opportunities that people have to achieve certain levels of human flourishing and their ability to achieve their own ambitions. It is both less straightforward and more holistic than the other social justice theories when it comes to the establishment of variables that serve as the basis for the evaluation of justice.

In this thesis, these four social justice theory classes are taken as the starting point for the different ways of incorporating equity or the distribution of effects into environmental policy. Chapter 3 defines these four perspectives on justice in more detail and interprets them to come to testable decision rules for the assessment of environmental and climate mitigation policies.

2.3.2. Principles of environmental equity

The definitions of these theories of justice are all on a high level of abstraction, even when applied to the evaluation of the distributional effects of policies. Interpretations of these theories into practical guidelines for environmental policies can be a tedious undertaking. Different ethical and practical positions on the fairness of the impacts of environmental policies have led to several concrete burden-sharing principles that have made their way into policy design and evaluation. Atkinson et al. (2000) analyse three competing burden-sharing principles.

The first and most commonly used is the polluter-pays principle (PPP), which suggests that the burden of environmental damage should be worn by the actor or persons who are responsible for producing pollution (Tobey & Smets, 1996). It is a fundamental principle of environmental laws and policies worldwide and is referred to in legislation on national, EU, and international levels (idem). In most cases environmental policy is evaluated in terms of efficiency. PPP is often implicitly suggested as the most efficient abatement method as it internalises the externality of the pollution (Pearce et al., 2017).

A second principle is the ability-to-pay principle (APP), which prescribes that the burden of environmental damage, or the burden of policies counteracting that damage, should be shared according to the extent people can afford to contribute. This principle is often argued to be more equitable as the wealthier people are, the more they should contribute (Atkinson et al., 2000).

Third is the beneficiary-pays principle (BPP), which dictates that the burden of a policy should be placed on the individuals or parties who benefit resulting from an increase in environmental quality or foregone environmental losses (idem). This principle is used in international environmental agreements, but less so on the national and sub-national policy level. There is support for this principle as a tool of rectification for the involuntary receipt of gains through unjust processes (see: Butt, 2014; Page, 2012). However, because those benefits are involuntarily gained, enforceability of payments is limited.

These principles conflict which each other both on the ethical stances they stem from as well as in the application into policy. Which one is focused on in policy design depends on preference. Atkinson et al. (2000) used contingency ranking to find these preferences. They find that a balance of these competing principles more accurately reflects people their preferences for fair burden-sharing than either one theory individually. They also find that there is a willingness to trade-off between the PPP principle guiding property right allocation of pollution based on responsibility and the APP principle more guided by equity concerns regarding the income distribution.

Vergeer et al. (2017) attempt to link these principles to the more abstract theories of justice. They suggest the polluter-pays principle is closest to libertarianism, as people should only be forced to contribute if and to the extent they inflict on the rights of others, in this case by polluting and creating climate damages to others. However, Duff (2005) links libertarianism to the beneficiary-pays principle. He argues that in a libertarian world, taxes and other costs that an individual should bear as a result of government policy should depend on the benefits that the individual receives from the state, as it otherwise inflicts on their property rights. On the other hand, the polluter-pays principle is mostly linked to utilitarianism, because of its efficiency in terms of welfare (Pearce et al., 2017). Rawlsianism is most often linked to the ability-to-pay principle, because of its inherent solidarity with the worst-off in society (Vergeer et al., 2017). However, what is clear is that these theories of justice are not one-on-one directly translatable into clear-cut burden-sharing principles that can be readily implemented into policy design.

2.3.3. Equity-Efficiency trade-offs

The work of Atkinson et al. (2000) shows that balancing different ethical perspectives in the form of adopting different burden-sharing principles involves a possible trade-off between efficiency concerns and equity concerns. Incorporating equity considerations in policy evaluation methods such as CBA means that the appraisal of benefits and costs are no longer solely made based on WTP (Pearce et al., 2017). These possible trade-offs should be shown explicitly in order to make appropriate choices on altering the decision criterion of net present value to incorporate the distributional effects.

Cookson (2016) provides a framework for thinking about the relationship between equity and efficiency in economic policy evaluation. It portrays the striving for equity or fairness on the one hand and efficiency on the other hand in the form of the equity-efficiency impact plane (see Figure 1). On the vertical access is the efficiency impact showing an either positive or negative balance of costs and benefits and can be analysed through traditional CBA appraisal methods. The horizontal axis shows the distributional equity impact as either increasing or decreasing social inequality, which should be provided by alternative evaluation methods separate of CBA. This results in a win-win, loose-loose, win-lose and lose-win quadrant. If the combination of evaluation methods puts a policy in either of the latter quadrants, a decision-maker faces a trade-off between equity and efficiency. The decision-maker should decide whether the gain in efficiency is worth the increased inequality or weather the more even spread of resources is worth the loss of efficiency in comparison to other policy options (Cookson, 2016). He also provides three aspects that need to be defined when distributional objectives or criteria are incorporated in policy assessment and design. The first aspect is the ‘distribuendum’, or the thing being distributed. The second is the appropriate unit of analysis between whom the distribution is measured. Lastly, it should define how the distribution of effects is measured, thus with which kind of equality it is defined. The definition of these aspects depend on moral choices to be made based on the perspective of justice that is accepted. Those perspectives, and their translation into distributional assessment criteria, will be the focus of chapter 3.

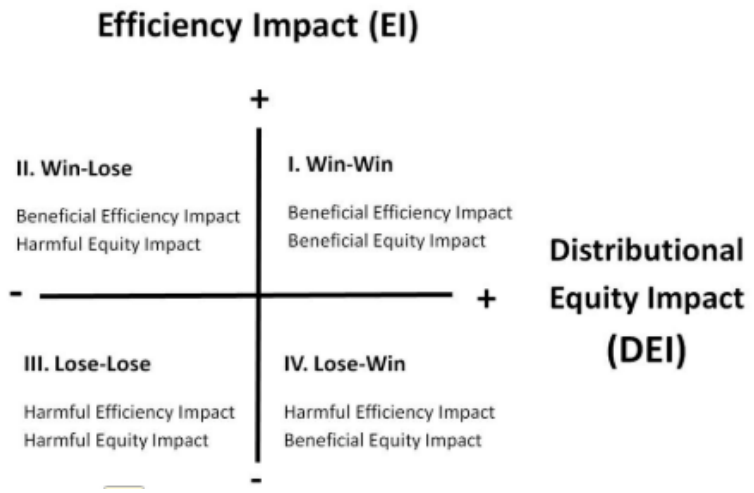

Figure 1. Equity-Efficiency Impact Plane, by Cookson (2016).

3. CONSTRUCTING ALTERNATIVE ASSESSMENT CRITERIA

This chapter will discuss the four perspectives (theories) of social justice as defined by Sen (2000) in more detail and from these perspectives operationalize different distributional justice criteria. Close attention is paid to how those interpretations of distributional justice can be linked to the practice of Cost-Benefit Analysis. Based on the essential literature, this chapter gives a short summary of how each of the perspectives assesses a certain distribution on its justness, in line with the earlier work of Sen (2000; 2017) and constructs explicit assessment criteria based on these theories that provide an alternative or complementation to the regular CBA Kaldor-Hicks criterion that could be applied in practice to policy assessments.

3.1. UTILITARIANISM

Utilitarianism can be seen as the standard, most adopted theory within traditional welfare economics. In most literature, when no theoretical perspective is explicitly presented, utilitarianism is the implicit perspective from which a problem is approached (Sen, 2000).

3.1.1. Definition

The most prominent classical utilitarians are Jeremy Bentham and John Stuart Mill. Utilitarianism is a form of consequentialism in that actions are morally judged based on their effects. The variable that constitutes as the basal space of utilitarianism is, as the name suggests, individual utility. The definition of utility is tied to the concept of hedonism. From a hedonistic perspective, the only thing that has intrinsic value in a person's life is happiness or pleasure. All other things, such as goods, freedom and social interactions, only have instrumental value in that they produce or contribute to this happiness or pleasure and this instrumental value is called utility. Bentham (1996, p.2) defines utility as the "property in any object, whereby it tends to produce benefit, advantage, pleasure, good, or happiness, (…) or (…) to prevent the happening of mischief, pain, evil, or unhappiness to the party whose interest is considered". Any judgement on the goodness of an action should be in terms of utility, e.g. the contribution towards happiness. The transformability of goods, services or any object into utility can be expressed through a utility function which is a representation of the individual preference orderings for those goods and services.

The focal combination - the way in which utility is used in assessment - is very simple, namely through summation or "sum-ranking" (Sen, 2000). The reference group is the group under consideration itself in the sense that only utilities of individuals in that group are focused on and utilities of other non-group members are ignored (Sen, 2000).

3.1.2. Conceptualization of justice

Utilitarianism uses a one-dimensional aggregational approach to justice in that it is only concerned with the level of happiness over the whole of society. Utilitarianism defines all actions as just that "contribute to achieving general happiness" (Askari & Mirakhor, 2020, p.131). This general happiness can be defined as the social welfare. The assessment of justice with regard to policies thus consists of establishing whether that policy has a positive effect on the aggregate social welfare, in which the utility function of each individual in society is taken into account. As utilitarianism is only concerned with the aggregated happiness, it does not give intrinsic value to how that welfare is distributed over society. However utilitarianism still could prefer the redistribution of welfare and thus take the justness of a certain state or alternatives of states into account. To which extent this should be done, depends on the assumptions made regarding the dependency of utility (Fankhauser et al., 1997).

In a traditional CBA, the assessment variable of utility is always proxied by income or another equivalent monetary outcome variable such as total consumption. However, utilitarian theory suggest simple summation of monetary values cannot give a correct welfare outcomes. This relates to the diminishing marginal utility of income, meaning that utility increases as income increases, but at a declining rate, which is a widely accepted assumption (Oswald, 2005). The concept entails that a 100 dollar gain for a low-income individual is worth more than the same gain for a high-income individual. This means there is room for efficiency gain if income is better distributed. Thus, for the assessment of the justness of an action in terms of overall utility, it does matter who experiences the monetizable effects (in terms of income, goods and services) of that action. This diminishing marginal utility should therefore be taken into account when transforming monetary effects into utility effects. In this strict utilitarian approach the overall welfare exists of the total sum of individual utilities, regardless of the distribution of these utility levels over the population. This total sum is also referred to as the Benthamite Social Welfare Function (Turner, 2007).

This strict utilitarian framework could also be extended, taking the incorporation of distributional concerns one step further by making the total welfare also dependent on the distribution of utility itself. The moral theoretical argument for this social altruïsm is that one's utility level or 'happiness' is not only determined by one's situation in isolation, but also how this compares to others within the same group or society. This concept of "relative deprivation" suggests people in different societies with objectively the same living standards have different levels of happiness because of their difference in relative position in different societies (see e.g. Walker & Smith, 2002). Applying this reasoning implies that there is an aversion towards societal inequality that reduces the societal sum of utilities when inequality increases (Fankhauser et al., 1997) . From this perspective, the total welfare outcomes are not only sensitive to the distribution of income through the diminishing marginal utility of income, but also sensitive to the distribution of utility itself. Incorporating social aversion to inequality into the total welfare is also referred to as the isoelastic Social Welfare Function (Adler, 2016).

3.1.3. Utilitarian decision rule for justice: the Social Welfare Function (SWF) and distributional weights

The general utilitarian decision rule for justice in the assessment of a policy is thus that the net benefits to the overall societal welfare should be larger than zero. Applying this decision rule quantitatively requires the adoption of a certain Social Welfare Function (SWF), which incorporates the diminishing marginal utility and/or society's aversion to inequality into the formula to aggregate individual utility levels (indirectly measured by monetary units in the form of income or consumption) into societal welfare. This assessment criterium can be incorporated into CBA through the use of distributional weights, by which the monetary impacts of a policy are weighed to reflect their actual impact on the total welfare (Adler, 2016).

Both the use of the utilitarian and the isoelastic SWFs are compatible with the theoretical underpinnings on which the CBA methodology is built. Firstly, both satisfy the strict Pareto principle allowing for sum-ranking that if the utility of at least one person increases and there are no persons with utility loss, the total welfare increases (Adler, 2016, p.266). Secondly, they satisfy the requirement of impartiality, which means the only focus on levels and changes in well-being as such, not the identities of the persons who have particular well-being outcomes. Thirdly, both SWFs are separable which means that in calculating the outcomes based on these SWFs, the ranking of those outcomes is fully independent of the utility levels of unaffected people (those who do not have standing).

In section 4.5 the SWFs described here are formalized and parameters for the diminishing marginal utility and inequality aversion are introduced, which are then used to construct a distributional weights model, which is applied to an existing policy case.

3.2. RAWLSIANISM

Rawls's theory of justice, in which the concept of justice is defined as fairness, in many ways clashes with the utilitarian perspective presented above. Where utilitarianism is primarily concerned with the fulfilment of needs which contribute to utility levels, Rawls gives full priority of rights over needs (Rawls, 1971). These rights are rather narrowly defined in the form of "basic personal and political liberties" (Sen, 2000, p.70). Rawls strongly criticizes utilitarianism for its aggregational approach regarding that only the effect on total welfare is considered and thereby applies a choice principle that is only suitable for an individual to society as a whole. Rawls critiques utilitarianism for failing to "take seriously the distinction between persons" (Rawls, 1971, p.24)

3.2.1. Definition

For Rawls' theory, the basal space, focal combination and reference group which are necessary to translate this perspective to usable assessment criteria in policy evaluation are not as straightforward to define as for utilitarianism. The definition of Rawlsianism is based on the Original Position, a hypothetical thought device Rawls uses to establish how participants in a society would define social justice if they had full information on the structure of human society in general, but lacked any form of information on the position they have, or the person they are within that society, the so-called "veil of ignorance" (Rawls, 1971). In the original position it is assured that each participant has equal power in the choice to adopt a certain principle of justice. The basal space consists of the things that the participants in the Original Position pursue. These are called primary goods, which are defined as "things that citizens need as free and equal persons, and claims to these goods are counted as appropriate claims" (Rawls, 1988, p.257). Primary goods can be seen as the resources people use in the pursuit of different objectives and are divided by Rawls (1988) into five main categories: 1) basic rights and liberties 2) freedom of movement and choice of occupation 3) powers and prerogatives of offices and positions in institutions (democratic form) 4) income and wealth, and 5) social bases of self-respect.

In pursuing these primary goods, participants are "mutually disinterested" (Rawls, 1971, p.12), meaning they want to obtain as many primary goods as possible for themselves and do not take into account to what extent others obtain these goods. The way in which these primary goods are used in the assessment of justice, i.e. the focal combination, is by giving full priority to the worst-off group. The rational choice for people without any information on their position in society is to protect their liberties, widen their opportunities and enlarge their means for promoting their aims whatever these are, even in the worst-off situation. Narrowing down to distributional justice this concretely means that inequalities are only just if they result in compensating benefits for everyone, and in particular to the most disadvantaged members of society (Rawls, 1971, p.13).

3.2.2. Conceptualization of justice: fairness and the difference principle

Rawls defines two main principles based on the Original Position and calls this "Justice as Fairness". The first principle is that society has to assure that all citizens have an equal claim to equal basic rights and liberties (Rawls, 2005). The second principle is concerned with the distribution of opportunities and primary goods and consists of two separate parts. The first is concerned with opportunities and states that society must assure the equality of opportunities. The second part, which is concerned with the distribution of income and wealth is defined as the "Difference Principle", which states that any inequality should be "to the greatest benefit of the least advantaged members of society" (Rawls, 2005, p.6). The principle allows only a divergence from full equality, if it makes no one worse off and at least some better off. Rawls focuses thereby on the least-well of group in society.

This perspective on justice has a clear translation into an assessment criteria: a policy is only desirable if the effect on the worst-off is positive. When a policy has negative effects on the worst-off, it should be rejected, no matter how large the positive outcome on overall (aggregated) well-being (Sen, 2000). Despite the strictness of this definition, it is questionable whether from a Rawlsian perspective, this

assessment criterium can be formally integrated within a CBA calculation or whether it should be a completely separate substitutional criterium.

Rawlsian theory is essentially non-welfarist as the basal space is not that of utilities but that of primary goods. Therefore any attempt to translate Rawls' concept of fariness into a social welfare function is not compatible with Rawls' theory of justice as a whole (Fankhauser et al., 1997). To fully implement a Rawlsian assessment criterion, one would have to stay within the basal space of primary goods, of which the confinements are not measurably defined. In policy assessment practice the only available outcome variables are (spendable) income or consumption, which is translatable into utility outcomes (see the previous paragraph) but not into a 'primary goods' measure. Therefore, attempts to develop CBA policy assessments methods from a Rawlsian perspective must be seen as a rather narrow economist interpretation of Rawls' difference principle, than of Rawls' theory of justice as a whole.

3.2.3. Rawlsian decision rule for justice: leximin principle

The method to implement the Rawlsian perspective on justice of giving full priority to the worst-off group within a CBA framework is by using a the maximin decision rule. Maximin gives full priority to the welfare change of the worst-off group, disregarding any costs borne or benefits obtained by the other groups. An extension of this is the leximin decision rule: It gives full priority to the worst-off group, but if there is no change, it considers the second-worst-off group, and so forth (Adler, 2016). The formal elaboration of these principles is explained in section 4.6, where they are applied to the policy case study

3.3. LIBERTARIANISM: RIGHTS AND LIBERTIES CRITERION

3.3.1. Definition

Libertarian critiques on the dominant economic strain of utilitarianism have been made for a very long time. However, it has fully been developed into a social and political theory mostly by the work of Nozick (2003). In libertarianism the principle of freedom from limitations and forced action are paramount. As in Rawlsianism, priority is given to rights and liberties, but in a stricter sense. The basal space of their theoretical conception of justice therefore consists of the fulfilment or violation of different rights (Sen, 2000). It is in particular concerned with negative rights, meaning the restrictions of other people not to do something that impact someone. The core right within libertarianism in measurable economic terms is the right to own property. The strictness of upholding these rights is reflected in the focal combination of their definition of justice, which is the fulfilment of all the specified rights. This means if any right is violated, there is a failure of justice (Sen, 2000). The reference group in assessment is only the directly impacted group, without outside comparison.

Within a strict libertarian framework, a judgement on justice is therefore always binary. Either a program is just by protecting all rights and liberties or one or more rights are violated and thus the outcome is unjust. Only when all rights are protected, utilitarian considerations might be added on a lower decisional level (Sen, 2000). This binary definition of justice makes a strict libertarian perspective incompatible with economic policy assessment, as this always requires an ordering of outcomes on a metric scale. What can be done is work from the libertarian notion of justice as starting point and then deduce which economic assessment principle gives largest respect to this definition of justice.

3.3.2. Conceptualization of justice: entitlement principle

In libertarianism, the sole legitimate purpose of government intervention is the protection of personal liberty and private property to which each individual is entitled to as a matter of natural right (Duff, 2005). According to Nozick (2003) a just society is formed through a system of private ownership and trade in the form of the just acquisition of "unheld" things, the transfer between individuals of justly acquired holdings and a rectification (possibly by a government) of past injustices. The appropriation

of “unheld” things is always just as long as it does not worsen the situation of others (Duff, 2005), which is also called the ‘entitlement principle’. Nozick defines the right to hold property as being able to select the alternative to be realized with the good owned within a constrained set of alternatives that does not interfere with other people's rights (Nozick, 2003).

Nozick (2003) himself addressed the issue of distributive justice from a libertarian perspective elaborately. He is strongly against any patterned principle of distributive justice that is strived for in other social theories, such as egalitarianism (striving towards equal distribution) and Rawlsianism (full priority to worst-off in any instance). These principles of distributive justice always require deliberate redistribution activities by a government. According to Nozick, deliberate redistribution violates the people's rights to exchange, give and own (2003).In a fully voluntary society they would not cooperate to this redistribution, otherwise the distribution would be different in the first place. Thus any patterned distribution definition of justice requires appropriating the actions of other persons. The only exception is when intervention takes place to rectify earlier injustices (redistributions). Libertarians argue that proponents of patterned conceptions of justice such as Rawls inevitably create direct clashes between moral constrains on rights infringement and the patterned distribution that must be realized according to their justice principle.

3.3.3. Libertarianism and (environmental) government policy

This rejection of redistribution as unjust has clear consequences for how libertarianism judges intervention through government policy, especially taxation. Nozick (2003) describes direct taxation on earnings as being equal to forced labour. The argument is that taking income from people through taxes is taking away leisure possibilities of those who are willing to pay for them. As a result, redistribution through taxation makes government part-owner of you. It gives a state property right on individual persons which strongly conflicts on the defined people’s rights and liberties.

Libertarianism however gives room for government policy and even taxation, as long as this is directed at the protection of people’s rights and possessions. It is argued this also holds for climate policy (Duff, 2005). Climate policy aims to protect people’s lives and properties from damages inflicted by GHG-emissions, for example by increasing sea levels and damages done by extreme weather. Climate change policy can thus be a legitimate government intervention under libertarianism, as it rectifies the injustice of climate change damage on peoples properties (and lives) inflicted by the emission of others. If government intervention is not by definition rejected by libertarianism, it begs the question of how the justness of policies can be evaluated within its framework. The extrapolation of a justice principle from the libertarian theory is not clear-cut and the existing literature gives different interpretations.

3.3.4. Libertarian decision rule for justice: the benefit principle

The first interpretation can be derived from the benefit principle of taxation. This benefit principle of taxation is already advocated by Adam Smith in his first maxim of taxation that taxes should be based on the benefits that people receive from governmental services (Wagner, 1991). According to Wagner (1991, p.2) this benefit principle “follows directly from (…) theories of the state, where the purpose of government is seen as being to protect people’s rights and to advance their interests through collective projects that they could not advance (…) through market processes”, thus including libertarianism. This means taxes collected by a libertarian state cannot exceed the benefits that it provides through security and protection (Duff, 2005). The entitlement principle dictates that this is not only maintained on an aggregate societal level, but also for each individual. Thus taxes levied by a state to an individual should correspond with the benefits that individual receives, otherwise impermissible redistribution of people’s property takes place inflicting on the right of individual choice and protection of property (idem). Also all net benefits resulting from government actions payed for by these taxes, should be reimbursed in proportion to taxes paid, thus leaving the distribution of wealth before government intervention intact. Different types of taxes could therefore be preferred by a libertarian society. One argument is that taxes based on personal wealth – and not income – might proxy the benefits received

through the protection of that property (Musgrave, Musgrave, & Bird, 1987). The benefit principle also supports taxation of personal consumption, in this case this could be the personal consumption of CO_2. A consumption tax is neutral between saving and spending – where an income tax is not – and therefore affects individual choices to a lesser extent. Whatever the government intervention and the tax scheme introduced to pay for it, taxes should always be levied on a flat rate so that it does not alter the relative distribution of income and thus does not inflict a patterned redistribution. In sum, Libertarianism is able to accept government intervention, but has some clear preferences in the design of that intervention.

The next step is to translate this libertarian benefit principle to the cost-benefit framework of policy evaluation. Of course, the policy under evaluation here entails more than only taxes, but also subsidies, investment strategies and quota's. However, the same principles hold for those interventions: they interfere with peoples initial choices which is only allowed if it is beneficial to those people, because only then would they choose to opt-in. Especially important here is that from a libertarian perspective the null of the CBA should always be a scenario without any government interference.

The benefit principle dictates that every individual should be better-off with the policy than without, otherwise they would prefer to opt-out which is impossible with government policy and thus inflicts on their rights and liberties. This bears a lot of resemblance to the strict pareto principle that at least one person should be better off, without anyone else being worse-off. Since full compensation is unconditional, this can be translated into a decision rule that for every individual net benefits should be higher than or equal to zero. However, libertarianism has one additional demand that any net benefit should be redistributed among all individual proportionate to their wealth, so that the initial distribution of wealth is not altered. In a CBA this means every individual should have a positive NPV that is proportionate to their income, or other measure of wealth used. If net benefits are not proportionally distributed, this is an injustice that must be rectified by the state. Because this principle is so strict, it is unrealistic to expect that any far-reaching and multi-layered policy – such as regarding climate – has proportionate net benefits for every individual and thus will always be unjust. However what it is possible is to apply the strict pareto decision rule and then calculate based on all the individual NPVs how the state should redistribute the net benefits – for example through tax cuts or subsidies – so that the initial distribution of income is unaltered. Any policy assessment from the perspective of Libertarianism should not necessarily present a decision rule for whether a policy is just or unjust. Rather it must assess what rectification of unjust redistributions as a result of the policy should be made for the policy to be justified.

Unlike Utilitarianism and Rawlsianism, Libertarianism lacks the possibility to give a clear-cut decision rule of justice over society as a whole, because of the one-dimensionality of its basal space and following from this the inability to aggregate over individuals and over elements that constitute an individual's liberty. A policy either infringes on at least one individual's liberty and thus is unjust or does not infringe on anyone's liberty and is just. The latter only occurs if for each individual the costs made for the intervention to take place are lower than their personal benefit in the form of the protection of property and rights the policy establishes. This requires a completely different approach to how benefits and costs are measured, because current methods that establish values for society as a whole do not suffice (Butt, 2014; Duff, 2005)Furthermore in a strict Libertarian framework this assessment of justice should be made for every individual in society, which poses an insurmountable data problem in practice. Current levels of disaggregation of effects would most likely be deemed highly insufficient by any libertarian to make judgements on the justness of a policy intervention. An illustration of this data and aggregation problem of Libertarianism is elaborated upon by the attempt to apply its principles to the case study in section 4.7

3.4. CAPABILITIES APPROACH

3.4.1. Definition

The Capabilities Approach (CA) draws on the work of Aristotle and "is concerned with the opportunities that people enjoy to achieve what Aristotle called human flourishing" (Sen, 2000, p.73). Rather than focusing on the means people possess, it is focused on the elements that constitute the broader concept of 'quality of life'. In some respects it links to Rawlsianism and libertarianism in that it pays close attention to individual circumstances as opposed to the aggregational approach of utilitarianism. However, CA uses a fundamentally different basal space to define and measure human wellbeing, which impacts directly the evaluation of justice. Instead of looking at primary goods (Rawls), or at liberties (Nozick), or the fulfilment of needs (Utilitarianism), it looks at what people are able to be or do (Sen, 2000, p.74). It is concerned with the ability to pursue the life they desire by choosing to do and be different things (Nussbaum, 2000).

Central to this approach are the two concepts of functionings and capabilities. Functionings can be defined as actual achievements based on the choices people make. They are the doings and beings on which human and personal development depend and include elementary life conditions as being well nourished, good health, freedom of movement, etcetera. Other more complex functionings can be defined such as self-respect, having a community to take part and be accepted in. One's Capability can be defined as the set of valuable functionings that an individual has access to. It is sometimes also referred to as the capability set. Sen (1985) also defines capability as the effective freedom one has to pursue a desired life by achieving certain functionings. In terms of the informational basis of this approach to justice, functionings can be defined as the basal space, while the focal combination is an individual's capability. Thus, evaluation of how well people are doing should be in terms of their capabilities. In general, CA can be divided in two strains. The first is the initial approach developed by Sen and elaborated by others that limits itself to being a framework for evaluating the well-being of society and the quality of life of individuals within that society. The second strain is is largely developed by Martha Nussbaum, who adapted the approach into a partial theory of justice with a more philosophical and normative character regarding the justness of society. The differences in definition and interpretation between Sen, an economist, and Nussbaum, a philosopher and sociologist, reflect their backgrounds. The fundamental difference lies in how the endpoint or goal of evaluation is defined (Robeyns, 2005). Sen emphasizes freedom of choice, specifically the ability to choose between different functionings, regardless of the actual choices made. Nussbaum emphasizes human dignity. She formulates that for any individual to have a dignified life, a number of universal capabilities are required to some extent. As a result, Nussbaum proposes a list of essential human capabilities that are identified as the central elements of human dignity and for which a certain threshold can be defined below which a dignified life is impossible. Sen rejects this idea that there can be an objectively identified list of essential capabilities, because it undermines the relevance of changes in values that people might have and the role of democracy should have in determining these values (Sen, 2004). Another difference is that Sen takes a more economic approach where capabilities can be seen as real or effective opportunities which should be analysed to more quantitative empirical measurement. Nussbaum is closer to the subject of humanities and defines capabilities more as skills and personal traits that requires a more narrative approach (Robeyns, 2005). Here I have taken Sen's broader evaluative framework as a starting point for application in environmental policy appraisal. I treat Nussbaum's capabilities thresholds for justice as one of more possibilities to transform Sen's Capability Approach into a normative framework for justice.

3.4.2. Conceptualization of justice

The other approaches discussed evaluate people's means and their distribution over society, while CA focuses directly on the ends. Its aim is to determine the functionings that matter for the quality of life through which a valuation framework of justice in society can be devised. The fundamental difference with other theories in the evaluation of justice is that CA rejects interpersonal comparability in terms

of means, be it resources, needs or liberties. CA's objection is that there is heterogeneity in the extent to which people are able to convert these means into achieved beings and doings and thus how they should be valued. Sen defines three conversion factors that result in this heterogeneity (Robeyns, 2005). The first are personal or physiological characteristics, such as disabilities which make that goods or commodities cannot be converted into functionings. The second are social factors or norms that limit how people are able to use resources, commodities or liberties. The third are physical environmental factors that enable or limit how means can be converted to functionings.

Sen therefore rejects conceptualizations of justice which are limited to resources and primary goods, such as Rawls, because it gives not enough information on the quality of life that people are able to achieve. This does not mean that resources are of no concern in the evaluation of procedural fairness, as they are still an important input to what the abilities people have. For the same reason CA criticizes utilitarian approaches to justice. Specifically the sum-ranking that is central to utilitarianism is rejected, even when distributional weights are applied, because it does not make a distinction between individuals for having different conversion factors. Additionally Sen rejects the psychological measure of satisfaction in the form of utility because in situations of social injustice and deprivation people can still be satisfied in terms of utility as a coping mechanism with their deprivation. Figure 2 gives a schematic overview of the core relationships between resources, utility, capabilities and functionings within CA.

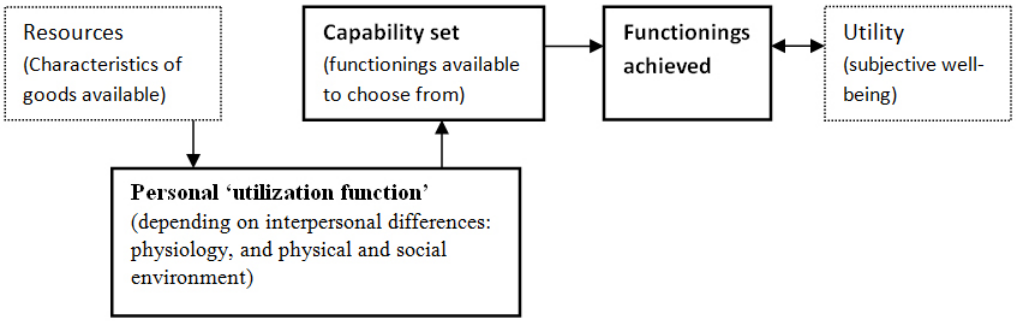

Figure 2. Scheme of core relationships between concepts in the Capability Approach. Source: (Wells, n.d.).

The heterogenic relationship between means and ends on individual level makes the reality of society complex. According to CA the evaluation of justice should reflect this complexity. The conceptualization of justice in terms of individual capability therefore leads to under-theorisation. CA, at least form Sen's perspective, dictates that which capabilities are important and how they should be distributed is a political, democratic decision for society to make. Critics argue that this makes it unsuitable for a complete theory of justice (Robeyns, 2006). Although the definition of capability itself is abstracted from particular circumstances and thus equal for all, the realization of capability depends on context-specific elements which makes it difficult to abstract the requirements for justice from it.

3.4.3. Capability and policy evaluation

Despite this under-theorisation, proponents of the Capability Approach argue that it can provide sensible alternatives to the standard utilitarian evaluation methodologies such as cost-benefit analysis in the assessment of policies and other practices or changes to society (Robeyns, 2005; 2006; Sen, 2000). CA is more limited in giving strict normative outcomes than assessment methods coming from other approaches to justice. It is an open, diagnostic approach that first needs to determine what capabilities can or could be impacted by the policy that is assessed. It is not able to aggregate those effects on capabilities into a single number or metric. Rather, a range of dimensions needs to be

identified that can be smaller or larger depending on the purpose of evaluation (Sen, 1985). Regarding the assessment of justness, society in a local context and through a democratic process should decide which capabilities are important enough to be guaranteed as a matter of justice. The CA in Sen's initial definition is only able to identify capability failures and diagnose their causes. If there is clear consensus on which capabilities should equally be guaranteed, policies that fail to guarantee these capabilities can be deemed unjust.

This requirement of high level of agreement on what constitutes as the quality of life in the form of central capabilities has drawn criticism, especially from Libertarian theorists (Sugden, 1993),because it limits people's freedoms to decide for themselves what they deem as important for their own life. The argument is that approaches focused on resources or liberties better ensure objectively identifiable fairness of conditions of participation in society. However, Sen (1985) argues that because there is variation between individuals in to which extent these resources or liberties can be used ensuring fairness in the provision of these objectively identifiable means is not sufficient to ensure justice.

Evaluation of policies or societal changes are always multi-dimensional and cannot be aggregated into one dimension. Shortfalls in one capability cannot be compensated by improvements in another capability. This bears resemblance to the absolutist approach of libertarianism where the failure of one liberty cannot be compensated by another. The difference is that in libertarianism liberties are either guaranteed or not, while the Capability Approach acknowledges that there is a degree to which capabilities can be fulfilled. Because capabilities are never exchangeable, evaluation of policy that inflicts on multiple capabilities both positively and negatively is difficult. Therefore the Capabilities Approach is unable to rank alternatives for ways of improving or achieving capabilities.

The assessment of policy from CA is informationally demanding and dependent on the level of agreement on the value of different capabilities. A main critique on the approach is that it leaves large information gaps. For the assessment of a policy or societal change in general, there are specific information requirements on the central aspects of the quality of life that are affected by such a policy. First, information is necessary on the level of many different functionings of people that together form these capability sets. Second, information is required on the inter-personal variations in the ability to convert measurable commodities or other means variables into functionings. It is not clear how such degree of informational ambition could ever be realized. Multiple attempts have been undertaken to extent Sen's approach with operationalizations through which justice can be assessed in terms of capabilities.

Robeyns (2005) developed a procedural approach for the selection and operationalization of capabilities into distinguishable 'elements' applicable to the policy or situation to be assessed. She formulates a list of five criteria for this selection: First, they need to be explicitly formulated. It should be possible to discuss and debate all elements that need to be assessed. Second, there needs to be a methodological justification, which entails compiling a list of operationalized elements which should be made transparent for scrutinization by all those impacted. Third, there should be sensitivity to context. For different purposes, for example philosophical or economic assessments, the capabilities should be operationalized on different levels of abstractions. Fourth, the list of operationalized elements should be made on different levels of generality. In first instance as elements that ideally reflect the capability, in second instance as pragmatic translation of that ideal. Fifth, the selection should be exhaustive in that all relevant elements are included and that no elements can be reduced into others. This operationalization process leads to a list of measurable elements that fully encompass the central capabilities and based on which criteria can be set to which a policy can be tested. In sum, this is a proposal for policy assessment through extensive multi-criteria analysis where the criteria are formed from the concept of human capabilities. Such a process cannot be generalized for multiple purposes and should be drawn differently for every assessment.

(Alkire, 2002) proposes a participatory approach to evaluation, which is specifically developed as an alternative to financial CBA for development projects. The assessment of a situation or policy takes place in two stages. The first takes place on a philosophical, theoretical level where different

operationalizable elements are identified based on which capabilities that constitute the quality of life are affected in theory. In the second participatory phase, the people subject to the change or policy are asked to define their core needs to determine the capabilities they have reason to value.

Nussbaum's partial theory of justice can also be used to operationalize capabilities in assessments of justice. Nussbaum comprises a list of ten central capabilities that are presented as the "bare minimum of what respect for human dignity requires" (Nussbaum, 2000, p222). For each of these capabilities a theoretical threshold exists which needs to be fulfilled for every individual. They are the minimum requirements of justice. All policies should be assessed on their effect on these central capabilities and whether these thresholds are reached. The central capabilities are deliberately left vague, as the actual level of the thresholds and how they are operationalized can be different for each context. Application into policy evaluation thus first requires these thresholds. Because each capability on the list is equally, centrally important, the possibility of making trade-offs between capabilities is very limited, meaning incorporation in quantitative cost-benefit analysis is close to impossible.

3.4.4. Capability Approach and the Environment

The capability approach literature has given special attention to the valuation and role of nature and the environment in the evaluation of human wellbeing. Holland (2008)describes how the capability approach can be used as a tool for improving the normative thinking about the environment in relation to social justice. From a capability perspective, the environment with all its ecosystems provides all goods and resources required to achieve the minimum thresholds for human capabilities. Active protection of the environment from over-extraction and pollution is necessary as it protects human capabilities that heavily rely on them from falling below that threshold. Holland (2008) proposes therefore to treat the total of environmental functions as a meta-capability. In line with the interpretation of Nussbaum, Holland also defines a threshold above which all other capabilities can be achieved, which she calls the "Environmental Justice Threshold" (p.328). This conceptual threshold defines that "as long as ecological systems have the functional capacity to sustain the conditions enabling the minimum threshold level of each essential human capabilities for each person, the ecological conditions of justice are met" (p.328). As any failure of maintaining this environmental justice threshold will result in the failure of other capability thresholds, protecting these ecological conditions is justified at any cost. In fact Holland (2008) argues that the capability approach would reject a monetized approach to nature for its value to society. It is simply society's responsibility to protect the environmental functional capacity to carry out activities required for human capabilities.

3.4.5. Decision rule of justice

In sum, a number of reasons can be given why it is difficult if not impossible to incorporate the justice principles of the Capability Approach into quantitative policy assessments such as CBA. First, the relevant capabilities under assessment need to be selected through a democratic, participatory and context-specific process, which makes it impossible to devise universally applicable measures that are necessary for CBA. Second, even when there is agreement on the relevant capabilities, there is an information gap on the relationship between measurable elements such as resources and commodities and the actual functionings that can be achieved. This makes operationalization very difficult. Thirdly, the approach is largely unable to aggregate over individuals, because the link between objectively measurable elements and the actual capability assessed is different per individual. CA is a conceptually dense approach in which the conditions for justice have not been operationalized in a quantitative way, which is necessary for the application into policy assessment in combination with CBA in any sensible way. The Capability Approach can be used in complementary more qualitative multi-criteria analysis, if the criteria decided upon come from the idea of enabling human capabilities. Setting these criteria should be a policy-specific process and data collection should be adapted to these decisions. Because here I try to apply different perspectives of justice on an existing policy case, this process lies outside of the scope of this thesis. The Capabilities Approach could therefore not be incorporated in the quantitative assessment of the existing case of the Dutch climate policy. However, it can give

another perspective on environmental justice for policy assessment that is more grounded in what constitutes to people's quality of life and is focused on the links between human well-being and ecosystem use. Treating environment as a meta-capability would shift environmental policy assessment away from efficiency and would be focused on ensuring everyone has the access to environmental commodities or has freedom from environmental risks they need to pursue a certain quality of life.

3.5. SYNTHESIS

In the ideal case, each social justice theory could be translated into a concrete distributional criterium that allows for policy alternatives to be ranked on their justness in a way that could be incorporated in the traditional CBA framework. However as Sen (2000) already pointed out, some theories of justice yield a clash of commitments and concerns on which the assessment of justice is based, making ranking very hard or even impossible. In other cases ranking of the distributive outcomes is possible, but incorporating it explicitly into the CBA framework is not. This arises if the perspective on what is assessed as just and unjust, is not translatable into a welfare outcome. In this last case, an assessment criterium for distributional justice is constructed that is complementary instead of substitutionary to traditional CBA assessment criteria.

4. MATERIALS AND METHODS

This section will describe the case study, discuss the available data on the distribution of costs and benefits of the policy and presents the methodology for using this data in the application of the justice assessment criteria in a CBA. Section 4.1 gives an overview of the case of the Dutch climate policy, while the goal of the case for this wider study is explained in 4.2. Section 4.3 presents the different available datasets on the costs and benefits of the Dutch climate policy and their distribution over different groups. There are a number of limitations to the applicability of the data in a weighed CBA, which require certain assumptions and alterations to the data as well as careful interpretation of the results. These will be discussed in section 4.4. The specifications for the distributional weights model according to the Utilitarian assessment criteria will be discussed in section 4.5. In section 4.6, the method for using the same distributional weights model for the application of the Rawlsian assessment criterium of the leximin principle. In section 3 it was established that the other distributional justice principles, Libertarianism and CA, cannot be expressed through distributional weights and no other standardized methodology for incorporation into CBA or other evaluation methods exists to apply them. However for Libertarianism, a quantifiable assessment criterium was established in the form of the benefits principle. For this principle, section 4.7 assesses whether with the available data of both aggregated costs and benefits and distributional effects it was possible to make value judgements on the justness of the policy case and if not, which data would be required to be gathered or constructed to be able to make those evaluations.

4.1. CASE DESCRIPTION

After the Dutch parliamentary elections of 2017 the new government administration committed itself firmly to the 2015 Paris Climate Agreement. In the coalition agreement (2017) national targets were set of 55% CO_2 reduction by 2030 and 95% reduction by 2050 compared to 1990 levels. A range of policy measures to achieve this were agreed upon on the areas of transport and mobility, gas extraction, agriculture, renewable energy, built environment and carbon capture (Koot et al., 2018) and most measures already partially implemented by the previous administration were continued. However, many policy details and exact measures were left open for further elaboration. This was done in so-called 'climate tables' creating a coalition of different stakeholders and experts, extending beyond decision-makers, on different sub-themes related to climate policy. The results of these negotiations were presented in 2019 as the so-called 'Climate Agreement' with the support of the coalition government, industry and agriculture representatives and labour unions. This agreement consisted of 153 additional policy proposals across all economic sectors and different areas of intervention (energy production, built environment, transport, etcetera) on top of the concrete policy measures of the 2017 coalition agreement.

In order to make an informed decision on the actual implementation of the agreement, an ex-ante analysis was commissioned on the effects of the proposed policy package of the climate agreement, as well as the overall effects of the total combination of the Dutch climate policies planned and already in place. The assessment of effects was not done in the form of an explicit CBA, however analyses on the CO_2 effects, total costs and income effect analyses were available. Special concerns were raised on the distribution of the overall costs over different income groups and between the industry, government and the public, which was therefore also a part of the analyses.

4.2. GOAL OF THE CASE

The goal of the case is to test the applicability and interpretability of incorporating defined decision rules on distributional outcomes into CBA. The case serves as a calculation example to practically apply the often abstract theories of justice and place them in the context of an environmental or climate policy assessment. This is an experiment in applying different justice theories in cost-benefit analysis, instead of applying already well-established assessment methodologies. Therefore the case of the Dutch climate mitigation policy is explicitly not meant to give normative results on the desirability of the specific policies used in the calculations. I use the best existing available datasets on costs and benefits and distributional effects of the described case to test their compatibility with the proposed decision rules. The next step, producing normative results on the desirability of the particular policies in this case would require new cost-benefit and distributional data collection and production with these specific normative assessment goals defined from the beginning and therefore lies beyond the scope of this thesis.

4.3. AVAILABLE DATASETS

In order to apply different justice principles to a CBA of the Dutch climate mitigation policy, a detailed dataset of cost and benefits – and their distribution over different groups – is required. In the ideal situation, data on the discounted monetized value of costs and benefits of the policy package described above would be available, including a compatible disaggregation of those costs and benefits over different wealth or income groups. Unfortunately, no such dataset exists as it is not (yet) common practice to combine standardized CBA analysis with distributional analysis. For the described case, a number of datasets were available that quantify and valuate the effects of Dutch climate policies that had the potential of being transformed into a CBA. Additionally a number of datasets provide information on the distributional effects of these policies on people's incomes. However, none of the datasets covers the exact same policy set or time frame and methodologies are not equal across the different datasets. I will discuss here the differences and similarities of the four available datasets on the subject and provide a justification for the chosen datasets to use for this analysis.

Daniels et al. (2012)provided an elaborated CBA of three hypothetical climate mitigation policy packages which included the most cost-effective policies reaching a set reduction target with a focus either on taxation, subsidizing or regulation respectively. It is the only source of data on Dutch climate mitigation that actually performs a CBA, but it thus does not assess on actual proposed policy. Neither does it give distributional data of those costs and benefits over any defined groups.

Vergeer et al., (2017) provides a dataset with information on the distributional impacts of climate change policy. It performs an analysis of the effects of taxes and subsidies of the climate mitigation policies agreed upon in the current coalition agreement on the total household costs for energy (and as a share of their total income). However it only looks at the effects of climate policy on households' energy bill and thus does not take into account other societal costs or benefits in their distributional analysis, making the data incomplete.

PBL (2019) offers the most comprehensive dataset on the costs and benefits of the climate policy package proposed by the climate agreement of 2019, although not directly structured into a CBA. It does analyse the direct, indirect and wider economic costs and the direct economic benefits of the proposed policy as well as the environmental benefits of the policy in the form of emission and pollution reduction. The report does not monetize these environmental benefits. This requires an additional step of data adaptation through common practice CBA methodology, by valuating these benefits through the use of the social cost of carbon. Furthermore, it does not give any calculations on or suggestions for the distribution of both the costs and benefits over different groups of people.

CPB (2019) conducted a distributional effect analysis by calculating the impact of both the climate agreement of 2019 and the climate policies of the coalition agreement of 2017/2018 on the disposable

income of household quintile income groups. The analysis was commissioned with the specific goal to provide information on the inequalities incurred by the policy package and provide insight for decision makers into possible injustices as a result of distributional mechanisms of the policy. As in the PBL analysis, the CPB analysis does not monetize environmental effects, which are thus not reflected in the welfare change of different income groups. Because of lack of detail in some of the individual proposed policy measures, these could not be taken into account in the distributional analysis. The CPB distributional and PBL cost and benefit analysis are therefore not completely overlapping in policy package assessed, which means any application of decision rules cannot use a combination of both datasets. However the combination of the PBL and CPB analyses may provide the most detailed, albeit still incomplete, information needed for a CBA with distributional weights.

In sum, the perfect dataset required for this thesis in the form of a complete CBA and corresponding distributional analysis does not exist. However, within certain assumptions and further specifications the available data could be used to apply the distributional justice principles to CBA for this policy case. The Utilitarian and Rawlsian decision rules described in chapter 3 can be applied to CBA in the form of distributional weights. Here, I used the CPB data on the income effects for the construction and application of distributional weights. It is the only dataset that calculates the effects of the whole policy package over income groups and thereby comes closest to an explicit disaggregation of the costs and benefits over different groups. However the CPB data on income effects does not include the public benefit of CO_2 abatement, therefore the PBL data on the effects of the policies on CO_2-emissions is used to calculate the value of CO_2 emission reduction according to the prescribed CO_2 valuation methodology for Dutch governmental SCBAs by Aalbers, Renes, & Romijn (2016).

4.4. DATA SPECIFICATIONS AND ASSUMPTIONS

4.4.1. Net financial costs: data on income effects

The CPB data provides the average disposable income change of households in the five income groups as a result of the Dutch climate mitigation policy package, ceteris paribus. The data is presented as a % change with respect to January 2018 income levels. The data provide only partial income effects: it assumes static behaviour, thus there is no consumption change. The % income changes are abstracted from economic development and thus calculated with respect to January 2018 income levels. The data reflects both direct and indirect effects of the policies on income. Indirect effects occur as a result of higher prices for products because of the extra costs companies have to make. CPB (2019) assumed that 80% of the costs for companies are passed on to consumers and thus lower disposable income through higher prices. Effects on employment were calculated/projected to be marginal and thus disregarded. Behavioural changes as a result of price changes were not taken into account. The table below provides the average per household disposable income by income quintile (Q1-5) in January 2018 and the provided data by CPB on the % income changes. Q1 represents the lowest income quintile, while Q5 represents the highest.

Table 1. Average disposable income per household and % income change in 2030 by income quintile. (CPB, 2019).

Income Quintile	Q1	Q2	Q3	Q4	Q5
Average disposable income per household (January 2018)	€13,200	€24,100	€34,250	€48,400	€84,850
% change in 2030	-1.80%	-1.6%	-1.4%	-1.1%	-0.8%

This data on income effects captures both public and private costs. Public costs are borne by the government and paid for by taxes, private costs are borne by households or by companies, who charge

households extra. However on the benefits side, the data only captures private benefits and those public benefits that lead to increased government income, lowering taxes and thus increasing disposable income (CPB, 2019). Private benefits include structural economic growth, employment growth, and lower prices for certain products all leading to higher disposable income. Other public benefits that do increase people's well-being – in this case the reduction in CO_2-emissions – do increase people's well-being, but does not alter their disposable income and are thus not taken into account. Therefore, the data on income effects should be interpreted as the net financial costs of the policy, not the net overall benefits.

4.4.2. Data on CO_2-effects

I use the PBL (2019) data on the effects of the Dutch climate policy on the CO_2-emissions to calculate the value of the public benefits. The assessed CO_2 reductions consist of two components. The first is the CO_2 reductions established through the coalition agreement (2017) which amount to 36 Mton yearly relative to 2015 levels by 2030 (Schoots, Hekkenberg, & Hammingh, 2017). The second component consists of the estimated emission reductions as a result of the Dutch Climate Agreement of 2019, which results in an additional yearly reduction of 31.4 to 51.6 Mton CO_2 by 2030. The reduction could only be established as a range, because there are still a lot of uncertainties around the details of the proposed policies. For simplicity the CO_2 reduction by the Climate Agreement taken into account in this CBA is the average between this upper and lower bound, so 41.5 Mton. Thus the total yearly CO_2 emission reduction in 2030 that is valued as the public benefits in this CBA is 77.5 Mton. The assumed implementation path of these CO_2 reductions is described in section 4.4.4.

In the valuation of CO_2 emission reduction, I follow the guidelines set by Aalbers et al. (2016) on accounting for CO_2 in SCBA on Dutch climate-related policies and projects. The guidelines prescribe that the value of CO_2 in SCBA should be based on the "climate scenarios of the Future Exploration of Welfare, Prosperity and the Human Environment" (p.4). These are two reference scenarios that describe the development of GHG emissions in the Netherlands based on an emission budget for the 21st century and an associated CO_2 emission reduction target (p.2). In the high scenario, there is high international collaboration reaching an agreement on a low emission budget achieving large reductions in CO_2. In the low scenario, there is less international agreement leading to a higher CO_2 budget and thus lower emission reductions (CPB & PBL, 2015).

These two scenarios lead to a two efficient CO_2 price paths until 2050, which "represents the CO_2 prices needed to achieve a given scenario's assumed cumulative reduction in CO_2 emissions against the lowest possible cost" and should "act as a benchmark for the inspection of new climate-related energy measures and projects in a CBA" (Aalbers et al., 2016, p.6). These efficient prices thus reflect the minimum marginal abatement cost under a certain scenario. These prices can be used to value the benefits of CO_2 emission reduction as the benefits of "an invested euro are to be compared with the most profitable alternative use" (p.6). I use the two price paths (figure 3) to create an upper and lower bound value for each CO_2 emission reduction relative to the null in a given year.

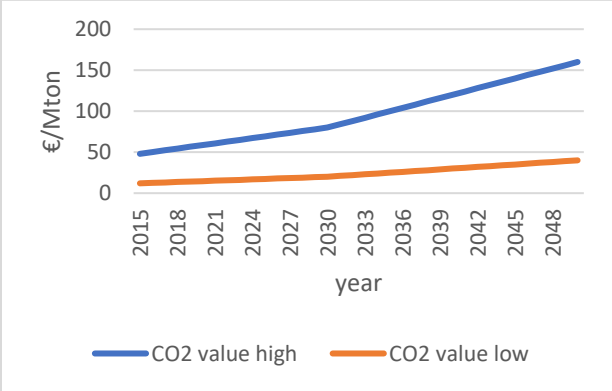

Figure 3. High and low CO_2 price paths from 2015-2050. Based on Aalbers et al. (2016).

4.4.3. Baseline, null and policy alternative

The policy alternative of which the income effects are analysed includes both the policy package proposed in the climate agreement of 2019 (with the exception of proposed measures with lack of detail) as well as already implemented or planned policy measures agreed upon in the coalition agreement of 2018. The null scenario with respect to which the income effects are calculated is a situation in which there are no additional climate mitigation policy measures since the beginning of 2018. The policy alternative consists of a total of 153 policy measures. For a full overview of all measures included in the policy alternative, see annex D of the CPB (2019) report.

Table 2. Null vs policy scenario description.

Null-scenario	Policy scenario
• No governmental climate policies after 2017. • No reduction GHG-emissions by 2030 and 2050 (baseline 2015).	• All climate and energy policies agreed upon in coalition agreement 2018, that have been in place since 2018 or are in process of becoming legislation. • 153 extra policy instruments in built environment, mobility, agriculture, industry and electricity that were concrete enough to be taken into account in CPB income effect calculations. • Reduction of 67.4 to 87.6 Mton in CO_2-emissions yearly by 2030 (baseline 2015). Constant reduction from 2030 to 2050.

4.4.4. Implementation path and time horizon

The CPB (2019) data on the effects on disposable income are given as a % change in 2021 and 2030 with respect to January 2018 levels. However for cost-benefit analysis it is necessary to compare the income levels in a given year with the policy to the income level in that given year without the policy and not the income levels in 2018. The given % income change is then taken as the change between that given year with and without policy, as there is no reason to assume economic growth will alter the relative income effects of the policy.

It is assumed that the implementation path of the proposed policies is linear between the years for which the income change is calculated, so from 2018 to 2021 and from 2021 to 2030. Thus, the income effects increase linearly from zero in 2018 to the amounts estimated for 2021 in the existing data. The income changes from 2021 also increase linearly to the income changes calculated for 2030. By 2030 all policies under assessment here are fully implemented. Also for the CO_2-emission abatement, a linear implementation path is assumed from 0 emission reduction in 2018 to 77.5 Mton yearly emission reduction in 2030. The time horizon of this CBA continues until 2050 to create a 32-year time horizon. It is assumed that all yearly effects after 2030 remain at 2030 levels.

4.4.5. Discount rates

To calculate the present value (PV) of the income changes until 2050, the difference between the null and alternative income levels for each year are discounted. Therefore the income changes are discounted at three different discount rates reflecting different perspectives on the discounting of climate policy measures. 1.4% is used as the lower-bound discount rate, in accordance with the average discount rate for climate policies used by Stern (2007) reflecting a close to zero pure rate of time preference. The upper-bound discount rate was set at 5.5%, in line with (Nordhaus, 2007), more

reflecting market's real interest rates. The standard discount rate used in the calculations was 3%, in accordance with the Dutch governmental standard for environmental SCBA (Ministerie van Financiën, 2015). The sensitivity of the results to the discount rates will be tested.

4.5. DISTRIBUTIONAL WEIGHTS MODEL

This section establishes the different social welfare functions based on the different theoretical perspectives discussed in section 3 and construct a model of distributional welfare weights based on these functions.

4.5.1. The Social Welfare Function

The first step in the calculation of distributional welfare weights is to define the social welfare function (SWF) on which these weights are based. In chapter 3 was discussed that the justice perspectives that can be applied through distributional weights, utilitarianism and rawlsianism, use different definitions of the SWF based on how they define individual welfare and how they aggregate them over the whole society. Based on earlier work on distributional weights methodology (by for example, Adler, 2016), I will build a SWF that is able to reflect those different perspectives on justice depending on the chosen parameter values.

First, we have to define individual welfare levels with the available data. In this case we measure individual household welfare based on the yearly disposable income (after tax) of an individual household i (Y_i). The measure of individual welfare in welfare economics is utility U_i, which is a function of disposable income. In some cases, other welfare indicators instead of disposable income are used, such as yearly consumption, value of non-consumptive (welfare) goods, lifetime income or a combination of those. These indicators are often chosen as they better reflect a household's level of well-being because they better measure actual ability to acquire both public and private goods and services and are less sensitive to the influence of outliers[1] (Kriström, 2005). However in this case, only disposable income data was available.

The relation between utility and income has to be theoretically defined. As discussed in paragraph 3.2, the calculation of utility based on disposable income should account for the decreasing marginal utility of income. Let this be reflected by a parameter λ, which stands for the degree of concavity of this utility function, thus the rate at which marginal utility declines when income increases. It also describes an individual household's level of risk aversion. Therefore, λ can also be referred to the coefficient for Constant Relative Risk Aversion (CRRA) (Kolstad et al., 2014). The former definition of λ is relevant for the calculation of utilitarian weights. Through this definition, the income elasticity of utility is equal to 1- λ. The role of λ is to take the overall distribution of income into account in calculating individual utility levels. Individual household utility is thus defined as:

$$U(Y_i) = \frac{Y_i^{1-\lambda}}{1-\lambda} \quad (1)$$

The next step is to define how to aggregate over individual household utilities to calculate an overall social welfare measure. From a strict utilitarian perspective (see section 3.2) a simple summation of household utilities suffices, as utility is the ultimate measure of someone's well-being. However from another perspective supported by Atkinson (2011)and Kroll & Davidovitz (2003), overall social welfare should not only account for the distribution of income, but also for the distribution of utility itself, because society has a general aversion to inequality. This inequality aversion is depicted schematically in figure 4.

[1] Such as for example students who are likely to have very low or no income, but only temporary, while their consumption levels are relatively higher (because of support). In the CPB (2019) household income data used here, students are discarded because of this reason.

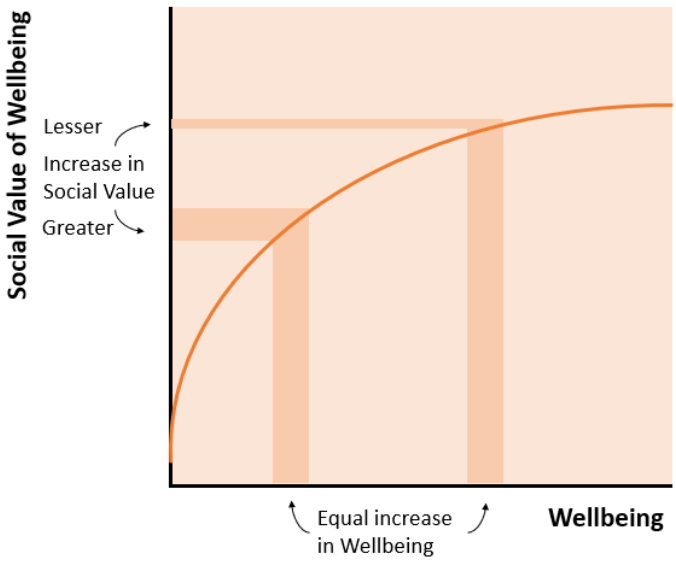

Figure 4. Inequality inversion. Adapted from: Kolstad et al. (2014, p.189).

To take this into account I introduce a parameter γ, representing society's aversion to inequality with respect to individual household utility levels. For the calculation of welfare weights we have to assume this parameter is a constant and thus equal for all households in society. If $\gamma = 0$, society has no care for the distribution of utilities, i.e. it does not matter if utility is added to poor or rich households. The higher γ, the more important utility levels (and changes) for lower income groups become. Again this aversion follows the CRRA form and we get the following isoelastic SWF:

$$W = \frac{1}{1-\gamma}\sum_{i=1}^{N}\big(U(Y_i)\big)^{1-\gamma} \tag{2}$$

Since we do not measure individual utilities, only disposable income, we can use equation (1) to substitute into equation (2). If we define a new parameter ρ that covers both risk aversion and inequality aversion, such that: $(1-\rho) = (1-\gamma)(1-\lambda)$ we get the following social welfare equation (3):

$$W = \frac{1}{1-\rho}\sum_{i=1}^{N} Y_i^{1-\rho} \tag{3}$$

Using this SWF, it is possible to apply the utilitarian perspectives on distributional justice discussed in section 3.1 to the measurement of welfare. From the perspective of Atkinson (year), supported by Adler (2016), both the decreasing marginal utility of income for all individuals and society's general aversion to inequality should be taken into account, so $\gamma > 0$ and $\lambda > 0$ and total welfare is described by eqn. x, which is therefore also called the Atkinson or Isoelastic SWF.

When measuring welfare from a strict utilitarian definition individual utility is the only element determining well-being regardless of other people's utility levels. Thus from this perspective inequality aversion does not exist, but the decreasing marginal utility of income does, meaning $\gamma = 0$ and $\lambda > 0$. Equation (3) then collapses into the simple summation of individual utilities, called a Benthamite SWF:

$$W = \sum_{i=1}^{N} U(Y_i) \tag{4}$$

When we substitute $U(Y_i)$ with equation (1), we get:

$$W = \frac{1}{1-\lambda} \sum_{i=1}^{N} Y_i^{1-\lambda} \tag{5}$$

In Unweighted CBA the Kaldor-Hicks criterium is applied, which disregards any distributional concerns and only measures effects in monetary terms. In terms of the SWF, Unweighted CBA shows whether the policy is welfare increasing according to an individualistic Benthamite definition for welfare, where individual well-being is measured by the income measure, instead of utility itself (Turner, 2007), meaning $\gamma = 0$ and $\lambda = 0$. Equation (3) then collapses into the simple summation of all individual incomes, or:

$$W = \sum_{i=1}^{N} Y_i \tag{6}$$

4.5.2. Distributional welfare weights

Next, we use the defined SWFs based on the different perspectives to assess the impact of changes to individual household's disposable income on the total societal welfare, while taking into account the distributional income effects. Distributional welfare weights are calculated to evaluate the effects of policy measures on total social welfare. These serve to differentiate between individual changes by weighing the monetized effects on disposable income of the individual households – or in this case income groups – and add them together. By differencing the SWF (equation (3)) on disposable income, we get an equation that describes the effects of a change in income (through a policy measure) on a change in overall social welfare:

$$dW = \sum_{i=1}^{N} \frac{\partial W}{\partial Y_i} dY_i \quad = \sum_{i=1}^{N} Y_i^{-\rho} dY_i \tag{7}$$

We can define a weight ω_i with which every individual change in income is weighed to calculate the change in the overall sum of welfare. Thus:

$$\omega_i = \frac{\partial W}{\partial Y_i} = Y_i^{-\rho} \tag{8}$$

The standardized CBA calculation for a welfare change due to the income effect of a policy thus becomes:

$$dW = \sum_{i=1}^{N} \omega_i dY_i \tag{9}$$

This welfare change thus reflects the net benefits of the policy assessed and can be used as the decision rule for the different interpretations of a utilitarian definition of justice. If $dW > 0$, the policy is desirable, if $dW < 0$, it is not. Note that in this case, this weighed change in welfare does not include the public benefits of CO_2 abatement, as it has no effect on income. Therefore the result of equation (9) should be interpreted as the weighed net financial costs that need to be compared to the value of the unweighted public benefit of CO_2 abatement.

When $\gamma > 0$ and $\lambda > 0$, the weights both distributional issues of decreasing marginal utility of income and society's inequality aversion, and thus are compatible with the isoelastic SWF. If the strict utilitarian SWF is used where inequality aversion is disregarded, but decreasing marginal utility is taken into account, we have: $\gamma = 0$ and $\lambda > 0$, then $\omega_i = Y_i^{-\rho} = Y_i^{-\lambda}$. In traditional unweighted CBA the Kaldor-Hicks criterion is used as a decision rule, meaning $\gamma = 0$ and $\lambda = 0, \text{thus } \rho = 0$. Then $\omega_i = 1$ for all individual households.

4.5.3. Normalization of weights

The weights as defined by equation (8) are relative to the total welfare as defined by equation (3), which means applying the weights to an income change loses any monetizable meaning. Therefore they cannot be directly implemented in practice in a CBA. It is necessary to use a reference income, for which the weight is set equal to one. Following this, Florio (2014) generally defines normalized weights as:

$$\omega_i^n = \left(\frac{Y_i}{Y_n}\right)^{-\rho} \tag{10}$$

with Y_n being the reference income. This reference income can be for example the average, median, modal or lowest income. If the average income is chosen, as is done by for example Kind, Botzen, & Aerts (2017), the weight for the changes on all average incomes are set equal to one. Every individual with a below average income will get a weight larger than one, every individual above it will get a weight smaller than one if $\rho >= 0$. The problem with the use of a reference income is that the average normalized weight over all observations can be higher or lower than one. This results in an altered scaling of the monetary values attached to the costs and benefits than in the standard unweighted CBA case. Thus even when all net benefits are distributed perfectly equally across all individuals/households in the population, the results of a weighed CBA are still different from an unweighted CBA.

For this particular case we do not have information on the income levels and changes of all households, but only on the average level and change of different equal-sized income classes. For data with discrete income classes, another normalization process can be used that ensures that the weighed average of the normalized weights equals one. To eliminate both the general problem of altered scaling and the problem of incomplete data due to the income classes, Lockwood and Weinzierl 2016) and Hendren (2014) provide another normalization process for the construction of welfare weights with discrete income classes. Say we have k income groups of equal size in number of households (10 with deciles, 5 with quintiles or 4 with quartiles), of which we only know the average income and the average change in income per household. We have ω_k as the non-normalized welfare weight of income group k. We then introduce a constant $\theta(\rho)$ for a given value of ρ as a combination of decreasing marg. Utility of income and inequality aversion. To ensure the average normalized weight is exactly one we define:

$$\theta(\rho)\sum_{k=1}^{K} P_k\omega_k = 1 \leftrightarrow\ \theta(\rho) = \frac{1}{\sum_{k=1}^{K} P_k\omega_k} \tag{11}$$

where P_k is the share of the total population in income group k. The normalized discrete weights can then be defined as:

$$\omega_i^n = \theta(\rho) Y_i^{-\rho} \quad (12)$$

For the results presented in 5.3 and 5.5, I will use this normalization for calculating the weights. In the sensitivity analysis of 5.4, the sensitivity of the results to using different types of reference income for normalization will be presented.

4.5.4. The value of ρ

In order to analyze the application of weights for each income group for the weighed cost-benefit analysis, it is necessary to define a reasonable range for the values of ρ, which itself is a combination of risk aversion and inequality aversion. A decision on the value of ρ is often considered a political or moral choice (Adler, 2016; Van der Pol, Bos, & Romijn, 2017), rather than an actual reflection of reality in the form of a social-welfare function. From this perspective, if the underlying political motives of a policy are more directed towards equality, the value of ρ is high, while when the goal is pure efficiency the value of ρ is 0 or close to 0. In theory the value of ρ can range from 0 till infinity.

However, the range for the value of ρ can also be established from an empirical perspective. There is considerable empirical work that tries to identify the values for the different parameters of the SWF, based on stated-preference and revealed-preference methods. These studies enable a much narrower range of values for ρ. Table 3 gives an overview of the studies empirically identifying realistic parameter values for risk aversion/income elasticity, inequality aversion or a combination of the two by estimating ρ directly.

Table 3. SWF parameter value ranges. Overview partly based on Pearce et al. (2017) and Kind et al. (2017)

Study/Source	Parameter estimated	Parameter value range	Method
Pearce (2003)	ρ (risk + ineq. Aversion)	0.5 – 1.2	Meta-analysis
(Cowell & Gardiner, 20Cowell & Gardiner (2000)	ρ (risk + ineq. Aversion)	0.5 – 4	Meta-analysis (0.5, revealed preference; 4 stated preference)
Cowell & Gardiner (2000)	ρ (risk + ineq. Aversion)	1.2-1.4	Revealed-preference (tax rates data)
Pearce and Ulph (1999)	λ (risk aversion)	0.8	Revealed-preference
Layard, Mayraz, & Nickell (2016)	λ (Utility elasticity of income / risk aversion)	1.16 – 1.37	Stated-preference
Squire & Van der Tak (1992)	ρ	0.5 – 1.5	Revealed-preference
Bombardini and Trebbi (2012)	λ (risk aversion)	1	Stated-preference (choice experiments)
Harrison and Ruström (2009)	λ (risk aversion)	0.89	Stated-preference (choice experiments)
Kolstad et al. (	γ (ineq. Aversion)	1 – 3	Meta-analysis
Fankhauser et al. (1997)	ρ (risk + ineq. Aversion)	0.5 – 1.5	Meta-analysis
HM Treasury (2011)	ρ (risk + ineq. Aversion)	0.7 – 1.5	Meta-analysis
Evans (2005)	Labda (utility of income)	1.4	Revealed-preference (Income tax rates data)

This empirical evidence suggests that within a social welfare framework, the combined parameter value of ρ can range somewhere between 0.5 and 4, with most estimates ranging between 0.5 and 1.5. According to Pearce (2003) values as high as 4 cannot be taken serious for policy purposes as they diminish any gain to richer-than-average groups to almost 0 in value. In section 5the results of the weighed CBA are shown for values of ρ ranging from 0 (the unweighted CBA) to 3. This gives insight in the sensitivity of weighed cost-benefit estimates to the extent of taking into account risk and inequality aversion represented by parameter ρ from complete disregard (0), to a reasonable and observed range (0.5-1.5) to an extreme form of aversion (3). See annex A for a matrix of values for ρ under different values for λ and γ.

4.6. CASE STUDY WITH MAXIMIN/LEXIMIN

As discussed in section 3.2 a quantifiable economic interpretation of the Rawlsian perspective on justice can be applied to a SWF evaluation framework as described above through the maximin or leximin rule. The problem is that the calculation of weights according to leximin or maximin cannot be represented by a mathematical formula as such (Adler, 2016), which makes it difficult to apply it to CBA in the form of distributional weights using the SWF (equation (3)) as specified in section 4.5.

However, a leximin decision rule can be approximated with the use of the isoelastic SWF with a very large value of the inequality aversion parameter γ (Adler, 2016). It can be shown that, when $\gamma \rightarrow \infty$, the weight for all income quintiles except the worst-off group $\omega_{others} \rightarrow 0$ (Fankhauser et al., 1997). The weight for the worst-off group (Q1) depends on the reference method. The weight for the worst-off group ω_{Q1} approaches 1 if the lowest income group Q1 also serves as the reference. With discrete groups the weight $\omega_{Q1} \rightarrow k$, where k is the number of discrete groups. If the median or average income is used as a reference, $\omega_{Q1} \rightarrow \infty$. This means no sensible monetary interpretation can be given to the NPV outcome – which consists of only the NPV of the worst-off group - when these weights are applied. It is only possible to interpret the sign of the NPV outcome, which indicates whether the welfare of the worst-off group increases or decreases.

The problem here is that until now, I have avoided to determine a distribution of the benefits of CO_2 emission reduction over the income groups. If these weights are applied to only the income effect to give full priority to the worst-off group, it does not take into account the public benefits. Therefore, applying the leximin decision rule requires a decision on how to assign a certain portion of those benefits to the worst-off income group Q1. I use two alternatives for this distribution. The first is to distribute the benefits evenly over the five income groups, based on the perspective that every person has equal benefit from the prevention of climate change from happening. The second is to distribute the benefits proportional to the income level of each group, based on the perspective that people with higher wealth benefit relatively more in monetary terms from the prevention of damage through climate change.

4.7. CASE STUDY WITH LIBERTARIANISM

As discussed in chapter 3, one way to evaluate government intervention through a libertarian framework of justice is through the application of the benefits (or benefactor-pays) principle. This was defined as a strict pareto criterion where for every individual NPV > 0, with the additional demand that the distribution of wealth before intervention should remain intact. If this is not fulfilled, individuals would prefer to opt-out of the intervention and since this is impossible, it would inflict on their liberty.

Because this principle is so strict, it is hard to translate it in a realistic decision rule as it is very unlikely that any far-reaching and multi-layered policy – such as regarding climate change – has proportionate net benefits for every individual and thus will always be unjust. However it is possible to apply the strict pareto decision rule and then calculate based on all the individual NPVs how the state should

redistribute the net benefits (through tax cuts or subsidies) so that the initial distribution of income is unaltered. Given the data available, it is impossible to calculate an NPV for every individual for this case. This forces us to apply the benefits principle over the smallest identifiable group that the data provides, which is the income quintiles. Again for these NPVs to be calculated, a decision has to be made on how the total CO_2 benefits are distributed over the income groups.

The libertarian justice criterion cannot be applied through the use of distributional weights. For proper application of a Libertarian approach to justice in this case study, there are a number of data deficiencies and problems with specification: Firstly, further data is required on wealth indicators such as income, capital, and consumption on the lowest-possible level of aggregation, preferably on the individual level. For large-scale policies, such as regarding climate, this is an impossible task.

Secondly, information is necessary on actual monetarized benefits received through the protection of personal property as a result of government intervention. Thus a disaggregation of benefits is required. In the case of climate policy it requires to establish who actually benefits how much from the reduction of CO_2 emissions and thus the foregone damages of climate change to possessions. These values could be measured using existing valuation techniques such as choice experiments or stated preference surveys, acquiring the willingness-to-pay to avoid those damages. As opposed to within a utilitarian framework where the overall societal benefits are defined – for example in the form of social cost of carbon – the goal here is to define the benefits to individuals or individual groups (at the lowest level of aggregation possible). People living and/or owning property near coasts, regions prone to extreme weather disasters or drought, experience larger benefits and thus should also cover more costs.

In a libertarian framework assessment of policy intervention should always be compared to a situation where there is no intervention whatsoever. This makes it very hard to actually create a baseline scenario. There are often already interventions (policies) in place, also in this case, that could have and probably do have led to injustices. Therefore the baseline and thus the initial distribution of wealth already contain injustices and it is difficult to disentangle whether the intervention creates injustices or corrects past injustices.

5. CASE STUDY RESULTS

This chapter presents the results of the cost-benefit analysis with distributional weights for the Dutch national climate policy. This application of distributional weights analysis is only able to reflect different utilitarian and, to some extent, Rawlsian, perspectives on justice. As discussed, justice perspectives based on libertarianism or the capabilities approach require other additional types of data that are not available for this case, both regarding assessment variables and the level of aggregation. Therefore this cannot present results on justice criteria from libertarianism and the capabilities approach for this case. Chapter 6 reflects on the data and analysis requirements for both theories to be applied to this case.

The results presented in this chapter should be interpreted with care and restraint. The applicability of the assessment criteria through a distributional weights model is tested on the best available data for this case. The results show the effect of different decisions in parameter values and model specifications on the outcome of costs and benefits. This is more important than the interpretation of the actual outcome values of the NPV, which is tricky due to the required assumptions and adaptations to the data described in the previous chapter. For a distributional weights CBA where an actual policy choice is made based on the NPV outcome, parameters should be set in advance and cost-benefit and distributional data should be collected or calculated with this goal in mind beforehand.

5.1. UNWEIGHTED CBA

Figure 5 shows the aggregated income per income quintile over all households within that quintile and over the whole time horizon (2018-2050), with a discount rate of 3%. This data is based on the average baseline household income per quintile given in table 1 (section 4.4). The PV of the aggregated average income per group is €319.8 billion. The baseline total income of the lowest-income quintile as a present value of €123.8 billion, while for the highest-income quintile this is €792.3 billion.

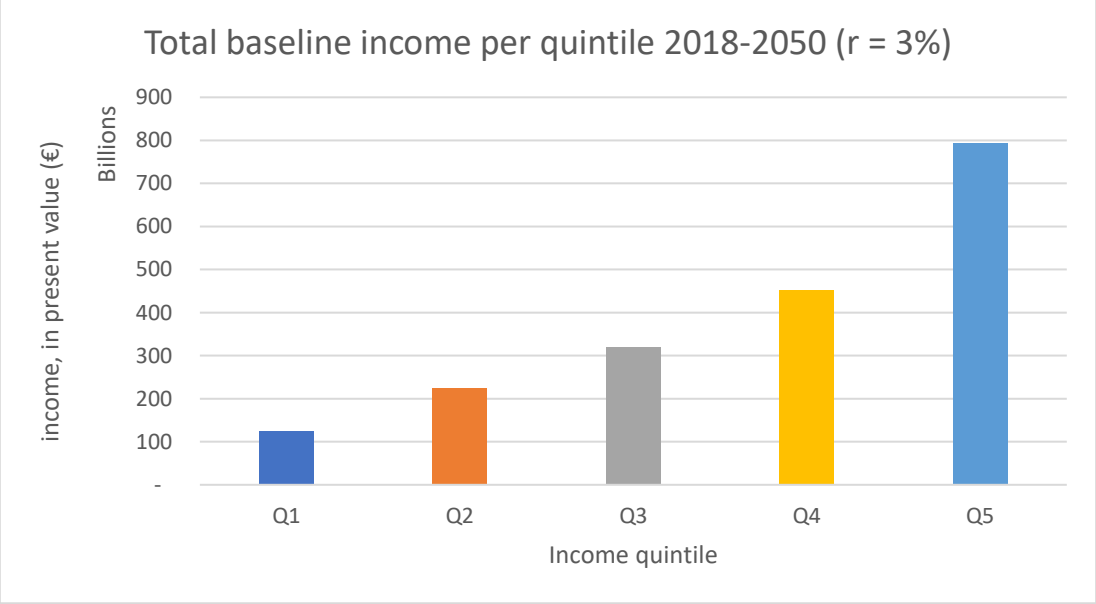

Figure 5. Total baseline income per quintile (Q) for 2018 – 2050, with a discount rate of 3%.

The implementation of the Dutch climate policy as proposed in 2019 leads to a shift in investment, taxes and subsidies. This results in a change in household income, which is taken here as the aggregated estimate of the net costs of the policy, excluding the emission benefits. These net costs are separated per income quintile. Figure 6 shows the path of % income change for each income quintile (Q1 being the lowest-income quintile) as calculated by CPB (2019).

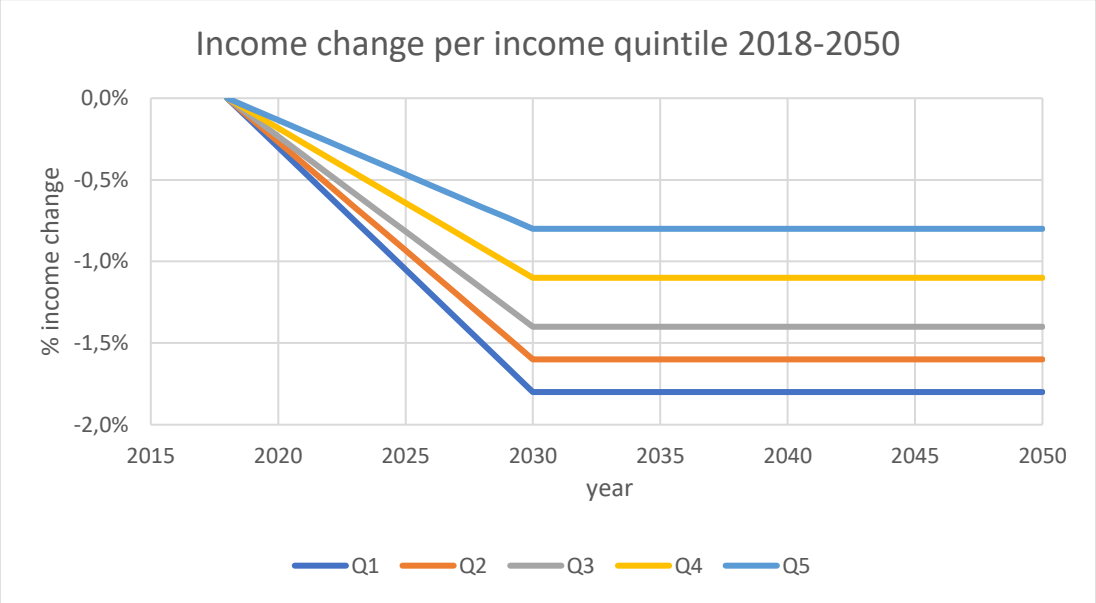

Figure 6. Graph of income loss for different income groups per year 2018-2050.

Figure 7 shows the aggregated present value of these income losses per income quintile, for three different discount rates. It shows that the income losses in absolute terms are higher for higher-income groups, but in relative terms, the income losses are higher for lower-income groups.

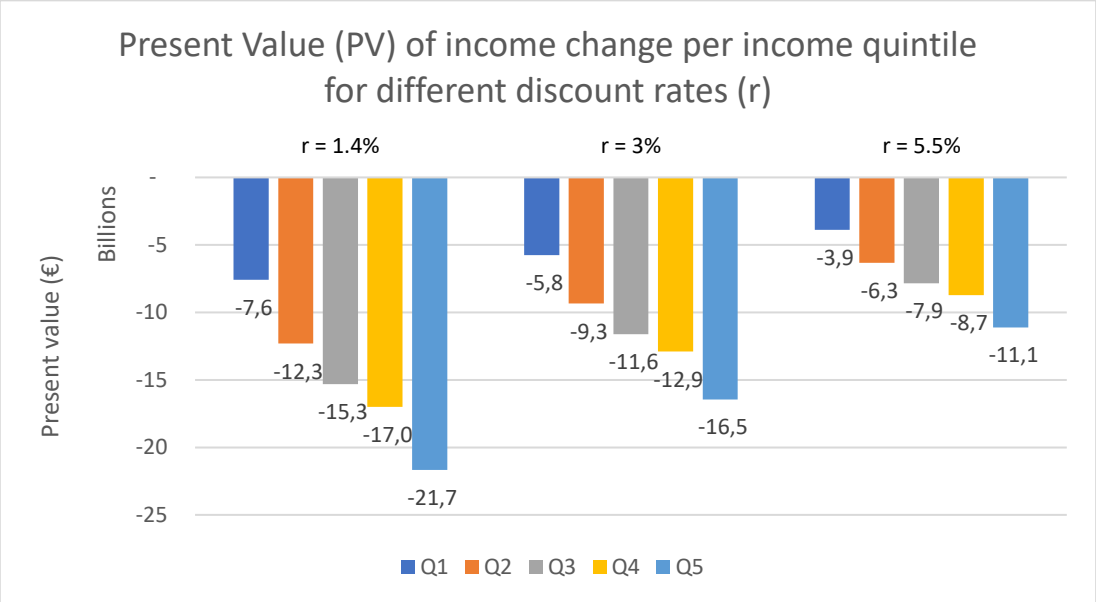

Figure 7. Present Value of income change in billion euros per quintile (Q), for different discount rates (r) 1.4%, 3% and, 5.5%.

Simple summation of these income losses in present value per quintile give the unweighted aggregated income losses for the climate policy alternative. These can be compared to the CO_2-benefits of the policy, which is shown in Figure 8, for three different discount rates (1.4%, 3% and 5.5%). The unweighted costs are in all instances above the CO_2-benefits in the low price path – with a relatively low CO_2 price - and under the CO_2 benefits in the high price path with a relatively high CO_2 price. With a discount rate of 3%, the total income loss amounts to €56.1 billion, while the value of the CO_2 benefits range between €30.4 (scenario low) and €121.6 (scenario high) billion.

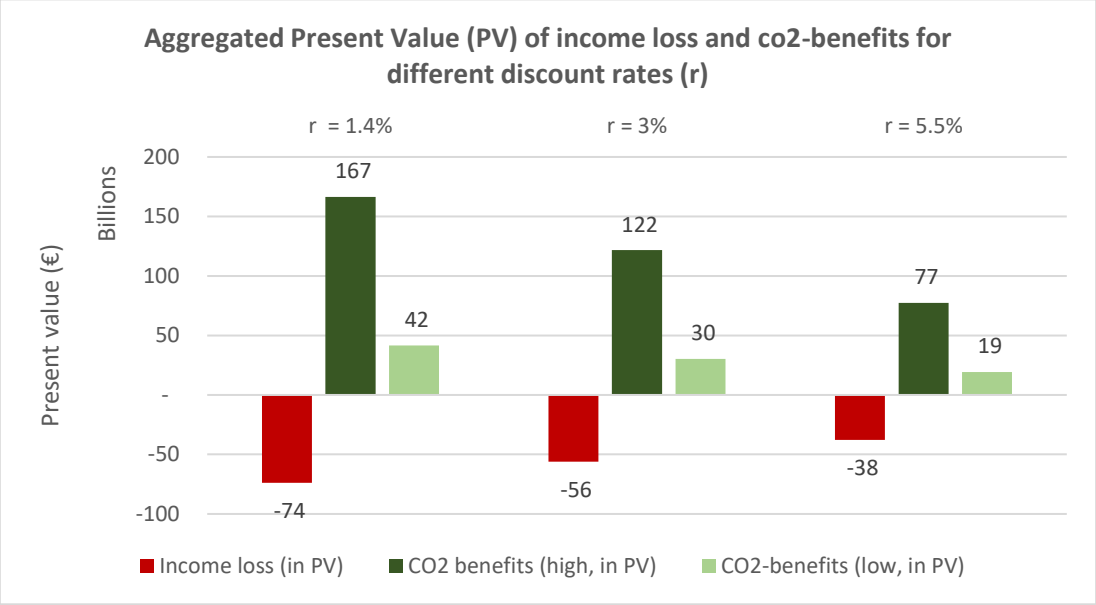

Figure 8. Aggregated Present Value (PV) of income loss and CO_2-benefits in billions, for different discount rates (r) 1.4%, 3% and, 5.5%.

5.2. DISTRIBUTIONAL WEIGHTS

The weights given to each group in the weighing of costs and benefits depends on three things: the initial or baseline distribution of wealth (see Figure 5), the chosen value of ρ (see Annex Table 5) and the reference to which the weights are constructed. As discussed in chapter 4 there are a number of candidates for the choice of reference, of which the most intuitive is the average income. Figure 8-12 give the weights given to each income quintile as a function of ρ, with the use of the average, median and lowest income as reference and with discrete group references. With both the average and median income as reference, the weights for the two highest-income groups (Q4 and Q5) approach 0 as ρ increases, while the weights for the two lowest-income groups increase exponentially with ρ (Figure 9 andFigure 10). The difference is that as the median income (€ per household) is lower than the average income (€ per household), the weights of the lower-income groups with the median income reference are generally lower than with the average income reference. With a ρ of 3, the weight for the lowest-income group (Q1) is about 17.5 with median income as reference and about 30 with average income as reference. With the lowest income as reference, the weight for the lowest-income group remains constant at 1, while the other weights approach 0 as ρ becomes larger (Figure 11). With weights for discrete income groups, the average weight given over all income groups remains 1 (Figure 12). This means weights increase or decrease much slower than with other references. The three highest-income groups eventually approach 0 as ρ becomes larger. The weights for second-lowest income group (Q2) initially increase when ρ increases when $0 < \rho < 1$ However as ρ becomes > 1, these weights decline with an increase in ρ. The weights for the lowest-income group rise as ρ becomes larger, however not exponentially as the weights approach a maximum of 5 (when all other income groups approach a weight of 0 and the average remains 1).

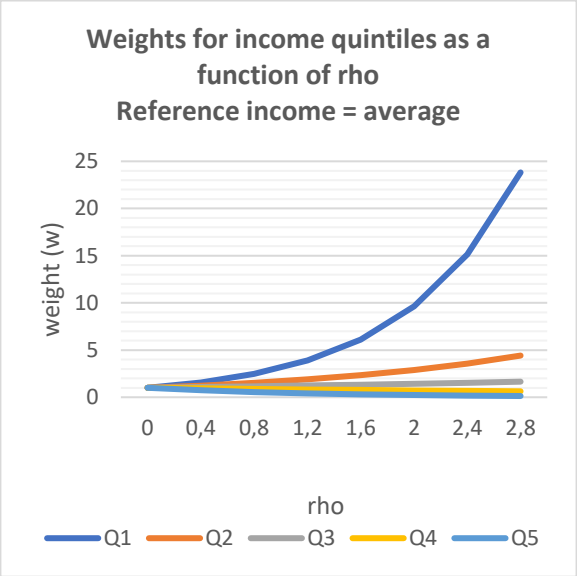

Figure 9. Weights for income quintiles as a function of rho, with as reference income the average income.

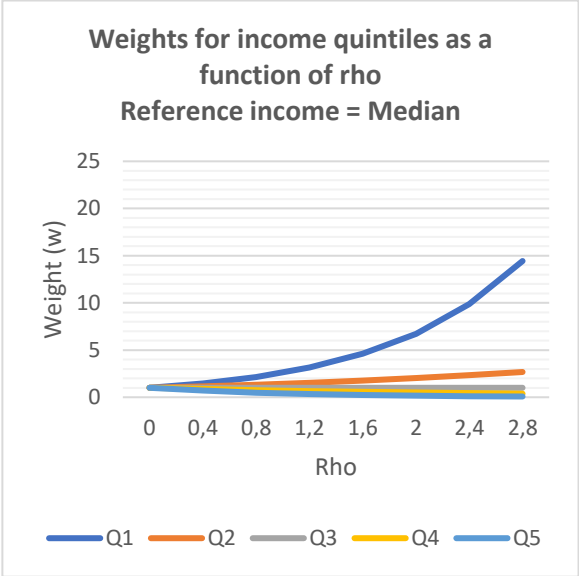

Figure 10. Weights for income quintiles as a function of rho, with as reference income the median income.

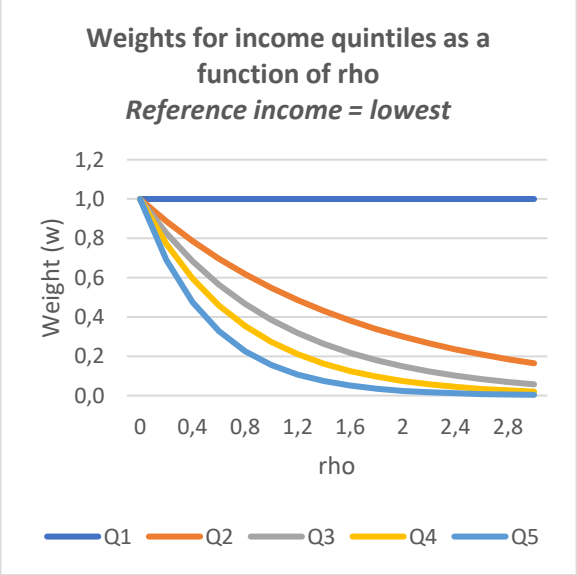

Figure 11. Weights for income quintiles as a function of rho, with as reference income the lowest income.

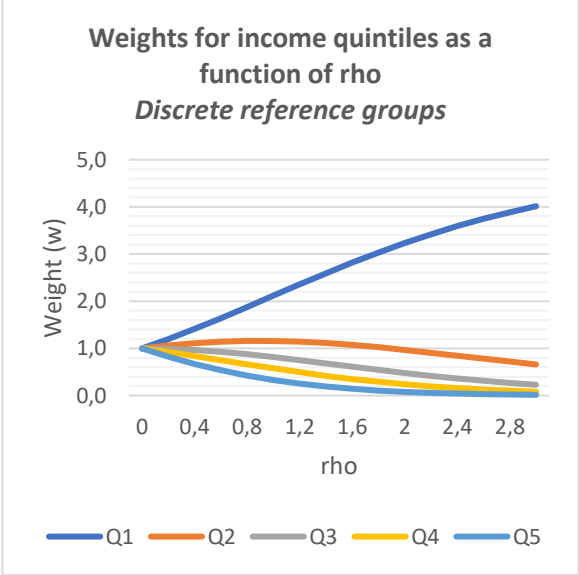

Figure 12. Weights for income quintiles as a function of rho, with discrete reference groups.

Based on these weights for the different income groups, the aggregated value of the income change is calculated. Figure 13 shows this total income change aggregated over all income quintiles in present value, under a range of values of ρ from 0 to 4, for each of the referencing methods. It is clear that the referencing method on which the weights are based is affecting the value that is attached to the income change to a large extent. The present value of the income loss at ρ = 0 is € 56 billion. With the use of median and average incomes as reference, the value of the income loss exponentially increases with ρ, but in different tempos. With the average income as reference, the value of income loss surpasses €100 billion at ρ = 2 and is almost €230 billion at ρ = 3. With the median income as reference (which is lower), the value of income loss surpasses €100 billion at ρ = 2.6 and reaches €200 billion around ρ = 3.5.

For normalized weights with discrete groups weighed values cannot rise exponentially with ρ, as the average weight applied to each group always remains 1 and thus with a ρ approaching infinity the weight for Q1 approaches 5 and all other weights approach 0. This results counterintuitively to a decline of the income loss as the value of ρ increases, because although the income loss of the lowest-income groups is larger relative to income, in absolute terms the income loss of the lowest-income group is less than one-fifth of all the other income losses combined.

With the lowest income quintile as reference, the weighed PV of the net financial costs decreases as ρ increases, as the weight for Q1 is set at 1 while the weight for all other groups approach 0 as ρ becomes infinitely large. Therefore the value of the weighed PV loses any monetary interpretability.

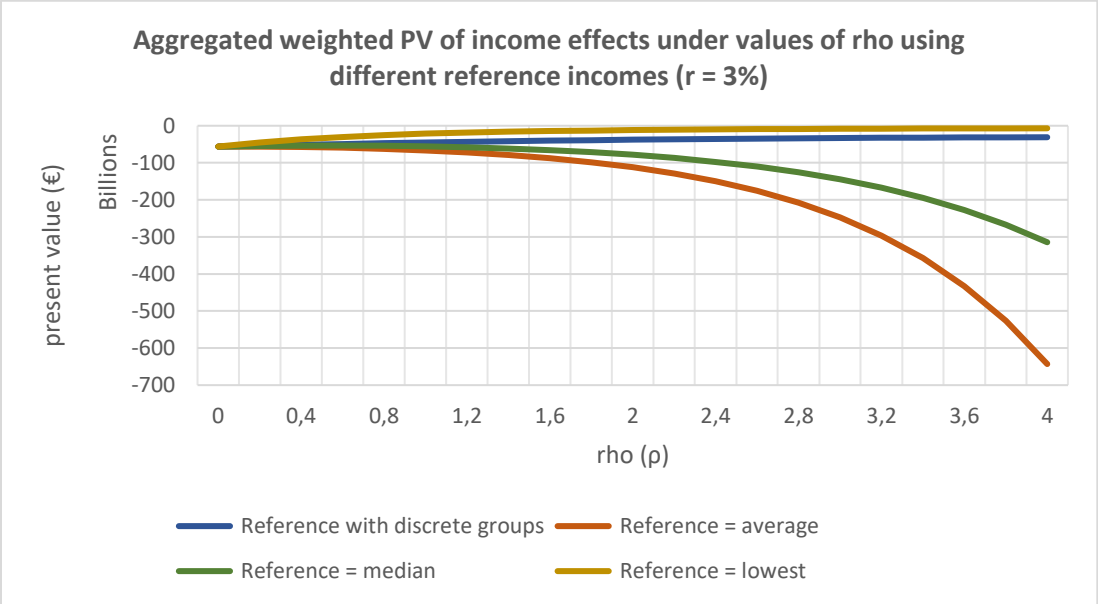

Figure 13. Total income change in present value, under values of rho, for each of the referencing methods: discrete, median, average and lowest income groups.

Also more in general, the behavior of these normalized weights under ρ raises questions on the interpretability of the value of these weighed net costs, especially when comparing these values to the CO_2 benefits which are not weighed. Figure 14 shows the weighed net financial costs with different normalization methods in comparison to the range of public benefits from CO_2 emission reduction with the CO_2 values of the low price path as the lower-bound values and the high price path values as the upper bound.

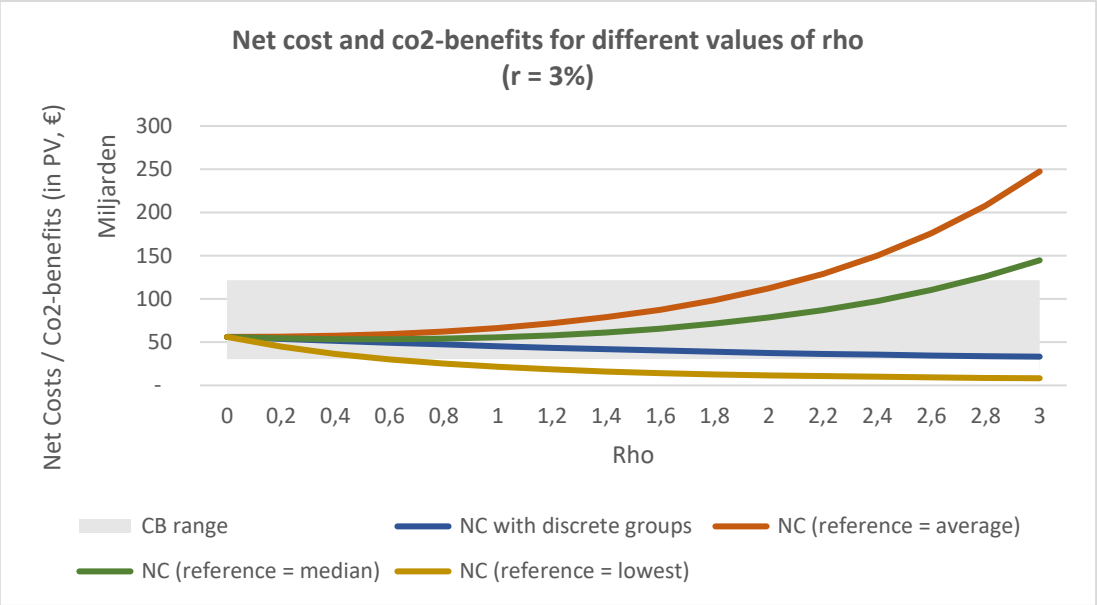

Figure 14. Net cost and CO_2-benefits for different values of rho, for each of the referencing methods: discrete, median, average and lowest income groups. The WMO-high and low scenarios are shown as the upper- and lower bound range.

The utilitarian assessment criteria of NPV ≥ 0 can also be defined as PV of benefits ≥ PV of costs. Because in this particular case it was not possible to give a distribution of the public benefits and thus cannot be weighed, the assessment criteria applied here is PV of unweighted public benefits ≥ PV of net financial costs. From ρ > 2 this assessment criterion entails to different conclusions depending on the normalization method chosen when considering the upper-bound CO_2 benefits.

5.3. MAXIMIN/LEXIMIN

For the application of the leximin principle to this data, it was required to distribute the public benefits over the different income quintile, so that the net benefits for the lowest income quintile could be assessed in isolation. Figure 15 shows the unweighted NPV per income quintile which is calculated as the Public Benefits from CO_2 abatement minus the net financial cost, where the public benefits are distributed either equally over all income groups, or distributed relative to their income level. This provides four different calculations for the NPV per income quintile, with: 1) CO_2 emission abatement valued with the low price path and distributed equally over the income quintiles, 2) CO_2 emission abatement valued with the high price path and distributed equally over the income quintiles, 3) CO_2 emission abatement valued with the low price path and distributed proportionally over the income quintiles, and 4) CO_2 emission abatement valued with the high price path and distributed proportionally over the income quintiles.

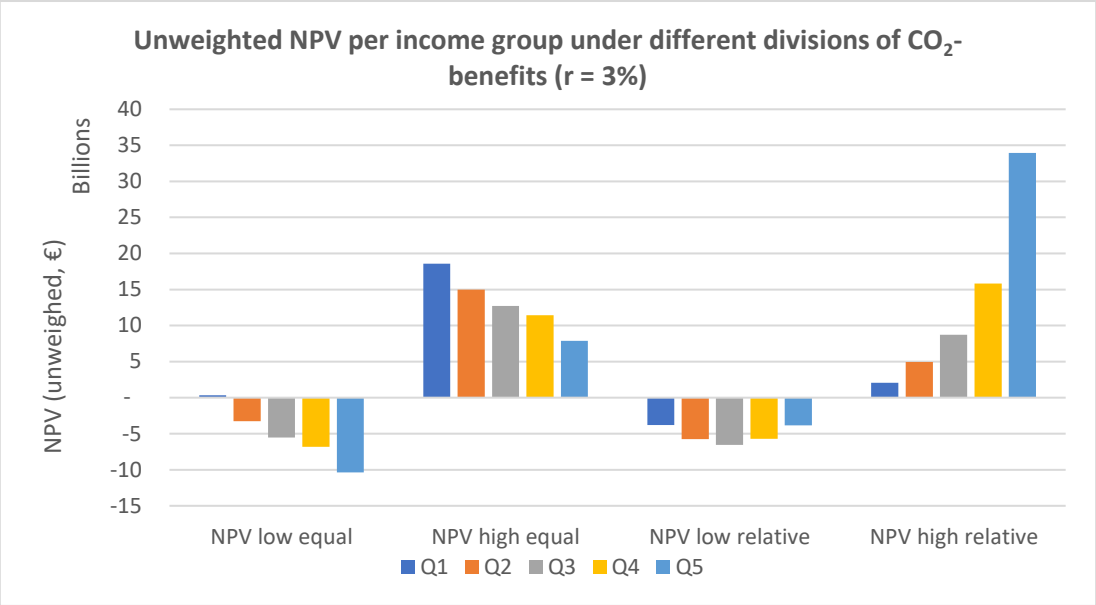

Figure 15. Unweighted net present value (NPV) per income group under different divisions of CO_2-benefits at a 3% discount rate.

It was shown earlier that applying the Rawlsian maximin principle through distributional weights results in a weight of 1 or infinity for the NPV of the lowest income group, depending on the chosen reference and zero for the NPV of all other groups. The leximin principle additionally prescribes that if the NPV of the lowest is zero, the weight for the NPV second-lowest income group becomes 1.

In practice, this assessment criterium can thus be applied by looking at the sign of the NPV of the lowest income group Q1 in isolation. Table below provides the NPV for the lowest income group according to the four different calculations of the public benefits for this group.

Table 4. NPV for Q1 with 4 different values for the public benefits (in € billion).

	CO_2 low, equal distribution	**CO_2 high, equal distribution**	**CO_2 low, distribution relative to income**	**CO_2 high, distribution relative to income**
Net Financial Cost	-5.8	-5.8	-5.8	-5.8
Public benefit (CO_2 abatement)	6.1	24.3	2.0	7.8
NPV	0.3	18.6	-3.8	2.1

If the benefits from CO_2 reduction are equally divided over income groups the NPV for Q1 > 1 for any CO_2 price path. However, if the benefits are distributed over the income groups relative to income, the NPV for Q1 < 0, for the low CO_2 price path. Thus, the two alternatives for assigning a proportion can lead to a different decision on the desirability of the policy according to the Rawlsian decision rule.

6. DISCUSSION

6.1. SUMMARY OF THE KEY FINDINGS

6.1.1. Creation of justice criteria per theory

This thesis discussed four different approaches to justice and tried to translate and operationalize them into quantifiable assessment criteria for environmental policies. Those criteria/justice theories were incorporated into social cost-benefit analysis. For Utilitarianism a distributional weights model was defined based on the definition of a Social Welfare Function (SWF) that allows for incorporation of risk aversion and inequality aversion. When the weights are applied, the justice criterium is equal to the assessment criterium in unweighted cost-benefit analysis (CBA): an NPV of at least 0. For the incorporation of Rawlsianism, a specific leximin form of SWF is defined which results in the assessment of the net present value of the worst-off group. The benefits principle was defined as the assessment criterium from a Libertarian perspective. Both the leximin SWF and the benefits principle require that the public benefits of a climate policy are divided and ascribed to the defined income groups. The Capabilities Approach (CA) does not allow policy assessment in one singe criterium. The assessment criteria from a CA approach should reflect the enablement of human capabilities and should be set through a policy-specific and democratic process.

6.1.2. Case study and Weighed CBA

The quantifiable justice assessment criteria that were directly compatible with a social cost-benefit analysis (SCBA) were applied in practice with a case study on the Dutch climate policy, in the form of a distributional weights model. The quantifiable justice assessment criteria were utilitarianism with a defined SWF and Rawlsianism through the leximin principle. The results show that the value of the weights is highly dependent on the reference value chosen, which inflicts on the monetary interpretability of the weighed present value outcomes of the net financial costs. Discrete weights increase the value of the effects on the lower-income groups, but the aggregate effect only increases if the absolute effect on the lower-income groups is higher than for the higher-income groups, which was not the case.

The net financial costs of the Dutch climate policy were compared against the public benefits in the form of CO_2 abatement, for which a lower and upper bound were established. Without weighing, the net financial costs are in the middle between the lower bound and the upper bound public benefits. When the financial net costs are weighed with distributional weights, it depends on the chosen reference income whether the aggregate of financial net costs actually increases or decreases with the chosen value for ρ. For $0 < \rho < 2$, the financial net costs remain between the upper and lower bound of public benefits, regardless of whether average or median income serves as a reference or weights for discrete groups are used. However when $\rho > 2$ using the average income as the reference, the financial net costs become higher than the upper bound of the public benefits. This upper threshold for ρ is higher when the median income is used as a reference. With weights for discrete groups, the financial net costs remain below the upper bound and above the lower bound public benefits for any realistic value of ρ . This analysis showed that when we apply the utilitarian assessment criterium of $NPV > 0$ to a distributional weighed CBA, the decision on the desirability of this climate policy is strongly dependent on the chosen value range for ρ and the chosen reference income.

6.2. LIMITATIONS

6.2.1. Theories of justice and application of assessment criteria

This thesis is not a complete reflection of all the possible approaches to assess the justness of policies. It was impossible to take all theories of justice into account. Other approaches might also provide

valuable insights and alternative assessment criteria. An example is the work of Dworkin (1981, 2002) with his theory of Egalitarianism and the connected concept of equality of resources.

For the theories that were included , it was not always possible to operationalize certain conceptions of justice within the framework of a CBA for a diverse range of reasons. That however does not mean that other options for quantifiable assessment are unavailable. For example, the Capabilities Approach could have an application in the form of a multi-criteria analysis (Robeyns, 2005). However, the challenge still lies in the operationalization process of those different criteria as there is no consensus on how to address the problem of scaling different capabilities (Kuklys & Robeyns, 2005). Applications of theories of justice into policy assessment fully outside the realm of CBA can certainly be developed, but were not within the reach of this thesis.

There were also limitations in the data requirements for some of the justice criteria to be translated into quantifiable analysis. Some theories require the availability of data on lower level of aggregation in the distribution of effects. In addition, some theories require more information on variables that are not easily measured. Because of this, the data requirements for some of the assessment criteria lie beyond what is possible to obtain. For example for libertarianism, aggregation of the distributional effects over any obtainable group is not sufficient. There is also a lack of data on how public benefits should be measured in terms of the value of individual protection that is required for Libertarian assessment.

The Capabilities Approach requires that the aspects on which justice is assessed should be defined through democratic decision-making processes, with data gathering specifically curtailed to those aspects. Such data was not available for the chosen case. It lies outside the scope of the thesis to gather these ex-ante for any chosen policy case. Therefore quantifiable assessment according to these justice principles was not possible in this thesis.

6.2.2. Case study with distributional weights

This thesis showed there are serious limitations to distributional weighed CBA with the use of existing data that is not specifically produced for the use in distributional weights analysis. First, there is the problem of monetizing and taking into account the public benefits of the climate policy under assessment. The distributional income effects data from CPB that was used in the analysis captured both public and private costs. Public costs are borne by the government and paid for by taxes, while private costs are borne by households or by companies, who charge households extra. However on the benefits side, the income effect data only captured private benefits and those public benefits that lead to increased government income, a lowering taxes and thereby to increasing disposable income (CPB, 2019). Private benefits include structural economic growth, employment growth, and lower prices for certain products all leading to higher disposable income. Public benefits in the form of CO_2-emission abatement, do increase people's well-being, but do not directly alter peoples disposable income and are thus excluded from the CPB distributional effects data. Therefore, the data available on disposable income changes, which is disaggregated over income quintiles, cannot be considered the complete net benefits. There is currently no developed methodology to disaggregate the monetized benefits of CO_2 abatement in the form of SCC over different groups of people or households. Developing this methodology and applying it to this data was beyond the scope and possibilities of this research.

Secondly, the distributional effects data from CPB only provided the static average changes to disposable income per income group, without taking into account changes to behaviour or other developments to disposable income. Certain assumptions were made to transform this static data in to yearly income effects (see section 4.4). These were assumptions on the implementation path, the kind of effects to include and the magnitude of economic growth Furthermore the data was disaggregated into five income groups, for which only the averages were available. Because of within-group variation in effects, the data could have been different when the effects were disaggregated differently in for example quartiles or deciles.

These two limitations of the available distributional data inflict on the interpretability of the case study. The results of the CBA with distributional weights cannot be used to make claims on the desirability of the Dutch climate policy, based on the pre-defined justice criteria. Rather, it should be interpreted as an experiment to test the suitability of distributional weights CBA on environmental policies given the current level of data availability. This study has shown the limitation of the method of applying distributional weights when assessing environmental policies. These policies will always involve public benefits that are not only difficult to monetize, but for which it is even more difficult to determine a distribution over the population and thus assign those benefits to certain groups. In addition, it remains difficult to assign other costs and benefits to certain income groups, even when they are in financial form, because the effects of national climate policies are so multi-faceted and widespread over economic sectors. Making decisions on the desirability of climate policies by CBA with distributional weights, or any other quantifiable criteria on justice, requires new methods of data collection.

An additional limitation of the distributional weights analysis over different income groups is that it does not sufficiently address the long time horizon over which the effects of climate policy take place. Calculating weights over different static income groups, without taking into account how these income groups might change in composition over time, , ignores other legitimate distinctions over which an assessment of distributional justice could be made. It might for example be more legitimate to assess the justice of climate policy by its distribution of costs and benefits over generations, for which Tol (2013) provides an analytical model.

6.3. EMBEDMENT EXISTING LITERATURE

This thesis stands in a long tradition of linking environmental policy to different principles of justice. On the one hand, it builds on the theoretical and conceptual work regarding the different definitions of justice. On the other hand, it links these theories to existing methodologies in policy assessment and distributional analysis.

First, the theoretical work of this thesis serves as an addition to the work of Sen (2000), who provided a synthesis of the differences and similarities of the theories of justice used here and discussed their normativity regarding the distribution of income on a conceptual level. In addition, Sen provided the main analytical framework for dissecting the different approaches to justice. This thesis extents this work by specifically focussing on how justice can be operationalized and assessed in practice for a change in that distribution of income as the result of a policy.

Second, the findings of this research are complementary to the work of Goulder & Parry (2008), Fullerton (2011), Sieg et al. (2004), and others who are focused on the equity impacts of environmental policies and have devised methods to model, measure and quantify the distribution of the costs of these policies. This thesis has shown the difficulties when applying assessment criteria on distributional justice of climate policy in case of limited data availability on how the effects are actually distributed over different groups. Justice assessment (in the form of equity weights, leximin or any other assessment criterium) can only be done properly if it is combined with detailed data on the distribution of effects which can be obtained through these modelling and measurement methods (for an overview, see: Bento, 2013).

Thirdly, this thesis allows to make a reflection on the theoretical work on the definition of the social welfare function in the construction of welfare weights, mainly by Adler (2016), Atkinson 2009;2011) and Pearce et al. (2017). As far as the author is aware, this is one of the first known application of such a distributional weights model based on a SWF on the assessment of a climate policy. The practical application of this methodology has been mostly limited to issues regarding health care (see Fleurbaey, Luchini, Muller, & Schokkaert, 2013). Applying it to climate policies lays bare specific challenges and caveats to the methodology, for example regarding the distribution of public benefits, the dynamic and multi-faceted dimensions of climate policy impacts and the sensitivity to the normalization process

for weights (see section 6.2.3). This shows the difficulty of translating the theory of SWFs and equity weights into practice and provides an explanation for the limited use in CBAs on climate policy.

Finally, it adds to the work of Tol on the normative assessment of the distributional justice of emission abatement policies through equity weights. Tol tested the use of equity weights on valuing the impact of greenhouse gas emissions between countries (Anthoff et al., 2009; Fankhauser et al., 1997)and the construction of the social cost of carbon using international equity weights (Anthoff & Tol, 2010). In addition Tol (2013) used welfare weights to assess optimal abatement paths based on the distribution of effects over different generations. Instead, this thesis applies welfare weights for the assessment of distributional justice of climate policy within a country between wealth groups. Despite this difference, there are similarities in the findings on the impact of using equity weights with CBAs regarding climate policies. Anthoff, Hepburn & Tol (2009) come to the conclusion that: 1) equity weights can severely alter the value of costs and benefits of mitigation policy and might even change the sign of the net present value, 2) the order of magnitude of the costs and benefits is highly sensitive to the chosen reference to which equity weights are normalized, and 3) equity-weighted results are sensitive to the resolution, or level of aggregation, at which the estimated effects are measured. This thesis confirms these conclusions are not only valid for between country equity weighting, but also for within country and between income group equity weighting.

Tol (2013) also provides an alternative social welfare function for assessing climate policy that allows explicit weighing between Rawlsianism and Utilitarianism regarding intergenerational justice. He defines the Bentham-Rawls SWF, which is "the weighted sum of the [unweighted] net present welfare (Bentham) and the welfare of the worst-off generation (Rawls)" (p.424). Although this SWF is not used in this thesis, it could also be applied to intra-generation assessment of distributional justice between wealth groups, as an in-between form of Rawlsian and Utilitarian definitions of justice.

As there are very few to no other examples where climate policies are assessed using distributional weights or other incorporations of justice-related criteria, it would be valuable to apply the same distributional weights model on other policy cases to verify the results presented here. Equity weighting is the prescribed methodology for the assessment of climate policy in the Netherlands (Van der Pol et al., 2017). However, the case study has shown that for practical application, better data standards on the distribution of effects are necessary. This requires the division of more detailed measurements and modelling, which should be incorporated in the CBA process itself.

7. CONCLUSION

The aim of this research was to *critically explore the ways in which different definitions of social justice can be explicitly incorporated in cost-benefit analysis of climate and environmental policy.* This aim was obtained by answering the three research questions, for which the conclusions are set out below.

RQ 1: How and to what extent can the different economic justice approaches be translated into quantifiable policy assessment criteria?

The analysis of the four theories of justice has shown that there are different degrees of transformability of these theories into quantitative assessment criteria for the desirability of environmental policies. Three main reasons can be given for this. First, there are differences between the theories in the level of abstraction and focus in the conceptualization of justice. Some theories assess justice only in a single dimension, such as utilities or liberty, while others conceptualize justice in a multi-dimensional manner, such as capabilities. Second, there are differences in the ability to operationalize the distribuendum, the aspect over which justice is assessed. Utilities are easily abstracted from monetary, measurable elements, , while operationalizing capabilities requires a more profound understanding of the multi-faceted ways in which measurable aspects of human behaviour impact their quality of life. Third, the justice theories differ in the level of aggregation that they allow, both over the separate dimensions that make up the distribuendum, as well as over individuals or households in the population under assessment.

RQ 2: How and to what extent can these approaches identified in RQ1 be applied in practice in social CBA?

Due to these differences between the theories the resulting assessment criteria are not all compatible with SCBA to the same extent. The assessment criteria can be divided into three levels of application in SCBA. Utilitarian and Rawlsian approaches to justice can be fully incorporated into SCBA through the definition of a Social Welfare Function. However the basic data structure of a SCBA is incompatible with the application of assessment criteria from the other justice theories. A Libertarian assessment criteria would serve as a substitution to CBA as it does not allow for the level of aggregation necessary for incorporation in CBA. The Capability Approach can provide assessment criteria that are complementary to CBA and better reflect the effects of policies on what people are able to be and do. This led to the decision that we could not apply the assessment criteria defined for Libertarianism and the Capabilities Approach For the assessment criteria that in theory can be fully incorporated into SCBA on environmental policy, the practical applicability strongly depends on the quality, availability and structure of the data on the distribution of effects of those policies.

RQ 3: What is the effect of applying these distributional methods to the results of a practical climate policy CBA?

To answer this question, the assessment criteria were applied on a case study of the costs and benefits of the Dutch climate policy through a distributional weights model. The case study showed that the chosen value of ρ might impact which decision is made on the desirability of the assessed policy. In addition, Ican conclude that the weights assigned for each income group, and therefore also the value of the total net financial costs, were highly sensitive to the choice of reference in the normalization method. The differences between the normalization methods are so large, that choosing between one normalization (with average income as reference) and the other (discrete groups), changes the answer to the decision rule on the desirability of the policy were the weighed NPV should be larger than 0. It can also be concluded that a major issue for the application of these assessment criteria was the inclusion or exclusion of public benefits into the distributional weighing process. It is difficult to be able to define the distribution of public benefits over separate groups or individuals.

Based on these conclusions, a number of recommendations for future research can be made. Firstly, for the incorporation of distributional issues from different approaches to justice into policy

assessment, there is a need for new methods on operationalization of those justice criteria. Especially for theories that are fundamentally incompatible with CBA, such as Libertarianism and the Capabilities approach, it is necessary to further operationalize the aspects of justice into measurable elements. Secondly, there is a need for more empirical work in which practical policy cases are assessed through alternative justice-related criteria.

In addition, this study has laid bare some of the limitations to incorporating justice in policy assessment, specifically regarding the application of distributional weights. For practical application, better data standards on the distribution of effects are necessary. Data on the effects disaggregated over different groups for this specific purpose should be collected or established beforehand. Furthermore, practitioners should be aware of the sensitivity of the results of equity-weighted CBA to choices made in the methodology, such as the normalization process. The assessment criteria developed and tested here can provide additional tools of policy assessment that also reflect issues of social and environmental justice and thereby add to better informed decision-making. This requires the development of other complementary assessment frameworks and distributional analysis frameworks that reflect those approaches to justice.

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ANNEX

Table 5. Matrix of values for ρ, under a range of values for labda (risk aversion) and gamma (inequality aversion).

λ \ γ	0	0,2	0,4	0,6	0,8	1	1,2	1,4	1,6	1,8	2	2,2	2,4	2,6	2,8	3	3,2	3,4	3,6	3,8	4
0	0	0,2	0,4	0,6	0,8	1	1,2	1,4	1,6	1,8	2	2,2	2,4	2,6	2,8	3	3,2	3,4	3,6	3,8	4
0,1	0,1	0,28	0,46	0,64	0,82	1	1,18	1,36	1,54	1,72	1,9	2,08	2,26	2,44	2,62	2,8	2,98	3,16	3,34	3,52	3,7
0,2	0,2	0,36	0,52	0,68	0,84	1	1,16	1,32	1,48	1,64	1,8	1,96	2,12	2,28	2,44	2,6	2,76	2,92	3,08	3,24	3,4
0,3	0,3	0,44	0,58	0,72	0,86	1	1,14	1,28	1,42	1,56	1,7	1,84	1,98	2,12	2,26	2,4	2,54	2,68	2,82	2,96	3,1
0,4	0,4	0,52	0,64	0,76	0,88	1	1,12	1,24	1,36	1,48	1,6	1,72	1,84	1,96	2,08	2,2	2,32	2,44	2,56	2,68	2,8
0,5	0,5	0,6	0,7	0,8	0,9	1	1,1	1,2	1,3	1,4	1,5	1,6	1,7	1,8	1,9	2	2,1	2,2	2,3	2,4	2,5
0,6	0,6	0,68	0,76	0,84	0,92	1	1,08	1,16	1,24	1,32	1,4	1,48	1,56	1,64	1,72	1,8	1,88	1,96	2,04	2,12	2,2
0,7	0,7	0,76	0,82	0,88	0,94	1	1,06	1,12	1,18	1,24	1,3	1,36	1,42	1,48	1,54	1,6	1,66	1,72	1,78	1,84	1,9
0,8	0,8	0,84	0,88	0,92	0,96	1	1,04	1,08	1,12	1,16	1,2	1,24	1,28	1,32	1,36	1,4	1,44	1,48	1,52	1,56	1,6
0,9	0,9	0,92	0,94	0,96	0,98	1	1,02	1,04	1,06	1,08	1,1	1,12	1,14	1,16	1,18	1,2	1,22	1,24	1,26	1,28	1,3
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1,1	1,1	1,08	1,06	1,04	1,02	1	0,98	0,96	0,94	0,92	0,9	0,88	0,86	0,84	0,82	0,8	0,78	0,76	0,74	0,72	0,7
1,2	1,2	1,16	1,12	1,08	1,04	1	0,96	0,92	0,88	0,84	0,8	0,76	0,72	0,68	0,64	0,6	0,56	0,52	0,48	0,44	0,4
1,3	1,3	1,24	1,18	1,12	1,06	1	0,94	0,88	0,82	0,76	0,7	0,64	0,58	0,52	0,46	0,4	0,34	0,28	0,22	0,16	0,1
1,4	1,4	1,32	1,24	1,16	1,08	1	0,92	0,84	0,76	0,68	0,6	0,52	0,44	0,36	0,28	0,2	0,12	0,04	-0,04	-0,12	-0,2
1,5	1,5	1,4	1,3	1,2	1,1	1	0,9	0,8	0,7	0,6	0,5	0,4	0,3	0,2	0,1	0	-0,1	-0,2	-0,3	-0,4	-0,5