Methodological and Ideological Options

The Effect of Gain-loss Framing on Climate Policy Preferences

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ABSTRACT

We designed a discrete choice experiment testing valence-based framing of climate policy outcomes for future generations, a moral good involving altruistic trade-offs. Specifically, we explore how a gain and loss framing influence social preferences for the distributional outcomes of climate policy. Respondents are asked to consider climate policy alternatives with two main outcomes affecting three regions of the world: Income effects for future generations caused by climate change, which the respondents may not be affected by, and a present generation co-benefit from mitigation efforts, which could benefit the respondents directly. Using a sample of the Danish population, we find a significant difference in the estimated preference structure for climate policies when future income effects are framed as losses in income for future generations relative to when framed as regained income. However, the welfare measures reveal that the framing did not generate significantly higher value estimates for the framed income effect attribute. Instead, the framing resulted in increased willingness to pay for additional climate policy initiatives per se, and higher value estimates for the unframed, present generation co-benefit. We interpret these results drawing on the behavioural science and economic literature on framing and reference point dependent preferences.

1. Introduction

Climate change presents itself as one of the great challenges of our time, and national and international communities have invested significant efforts in the design of climate policies to mitigate and adapt to the expected impacts of climate change. The design of efficient climate policies relies on such 6 policies having the support of the target population and framing have been found to influence both the attitudes and levels of support for climate policies (Lockwood, 2011; Drews and van den Bergh, 2015; Bain, 2012; Walker, 2018; Spence and Pidgeon, 2010).

A fundamental challenge of climate change is that many of the expected impacts befall other individuals, both in space and time (Pachauri et al., 2014). In this paper we examine how a framing of the outcomes of climate policies on others, influence the present generation's preferences and willingness to pay for climate policy. We apply valence-based framing effects, with valence referring to the typology developed by Tversky and Kahneman (1981) describing that information can be encoded in either positive or negative terms. Specifically, we asked a Danish sample of respondents to consider climate policy alternatives with two main outcomes affecting three regions of the world. The valence based framing targets one of these outcomes, namely the

climate policies effect on the income for future generations in all three regions; a moral good with altruistic elements for the present generation. The framing that we apply is consistent with goal or outcome framing, in the typology developed by Levin et al. (1998), in that what is framed is an outcome which, in both frames, is assumed to entail an improvement (climate policy ensuring less adverse future impacts of climate change). The framing varies how the information on this outcome is encoded. The other outcome, not targeted by the framing, is a current generation environmental co-benefit from climate change mitigation activities in a region. We apply a split design 29 discrete choice experiment (DCE) to evaluate our hypotheses. The future in30come effect attributes are framed in one split as losses and in the other split 31 as regains in income.

The typical finding in the environmental valuation literature is that changes framed as losses are valued higher than the same changes framed as gains (Horowitz and McConnell, 2002; Knetsch, 2010). The framing of income changes for future generations in terms of gains or losses draws upon prospect theory, and notably on its value function component (Kahneman and Tversky, 1979; Tversky and Kahneman, 1991). The theory predicts, that relative to a reference point, people will value changes in a state more if the change represents a loss, than if the

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changes represents a gain. Thus, peoples' perception of the framed change may depend on their perceived reference point (Knetsch, 2010). In context of our study, the identification and perception of what is a solid reference point for future generations' income is complex, an issue which has also been raised in the more general context of climate 44 change policies (Osberghaus, 2017), and we discuss this in detail.

The remainder of the paper is structured as follows. The next section reviews framing effects in the context of climate change and particularly attribute framing effects studied in relation to stated preference design. Section 3 introduces the choice context and the econometric approach used to study the effect of valence based attribute level framing, while section 4 presents the results. Section 5 discuss and concludes.

2. Related Literature and Hypothesis Formulation

The literature presents mixed evidence for the relative effects of gain and loss frames in the context of climate change (Nabi et al., 2018).[1] In a paper investigating support for climate change mitigation, Spence and Pidgeon (2010) examine both attribute and outcome framing and their findings suggest gain framing lead to higher support than loss framing. They base their expectation regarding the relative effects of a gain or loss framing on findings in the health and behavioural decision theory, which suggest that gain frames are more effective, because they trigger preventive behavior. They argue that climate change mitigation can be seen as a preventive action that lower the potential future impacts of climate change and find that the gain frame elicited more support for climate change mitigation. They also find evidence that distant impacts of climate change are perceived as being more severe than local impacts and that highlighting social aspects/benefits of climate change mitigation, increase willingness to engage in climate change mitigation (Spence and Pidgeon, 2010). As we in our study consider effects on future generations in three different regions, impacts are both removed in time and space, which suggest that we may see a strong willingness to engage in mitigation.

Hurlstone et al. (2014) examine how framing the cost of CO2 reductions in terms of future income losses influence the support for climate change mitigation in Australia. They find that framing emission cuts as a foregone gain in future income elicit a higher willingness to reduce carbon emissions, as compared to the elicited willingness to reduce emissions in a framing as a loss of income. Their study differs from ours both in terms of the time horizon considered (we consider 2100, they consider 2020), but also the spatial distribution of income effects (we consider three global regions, they consider only Australia). Furthermore, they focus on the cost of mitigation in terms of future income for Australians living in 2020, from (hypothetical) carbon emission reductions in 2012–13 (Hurlstone et al., 2014), whereas we frame the future *outcomes* of climate policy. A key challenge in their study is that their gain frame conveys more information than their loss frame, where respondents are not, in a clear graphical manner, made aware of the general increase in average income towards 2020. This means, that the information the respondents are considering in the two frames is not the same, which Hurlstone et al. (2014) refers to as a reference point bias. In our study, respondents in both frames are made explicitly aware of the reference point both in terms of loss in future income, but also on the general expected increase in income over time. However, as we will discuss in both Sections 3.1.2 and 5, the reference point bias might still influence our results. Nevertheless, findings of (Hurlstone et al., 2014)

also suggest gain framing lead to higher support than loss framing.

The role of the perceived reference point for an individuals assessment of alternative climate policies has been discussed recently by Osberghaus (2017). Drawing on the prospect theory framework (Kahneman and Tversky, 1979), he discusses how climate policy effects may be assessed differently by individuals, depending on their perceived reference points. For example, an individual may be convinced there is a substantial lock-in on climate change given current climate policies, leaving some degree of future income loss to be likely, if not certain. For such an individual, further and additional new climate policy actions could be perceived as attempts to *regain income*, which otherwise would be lost for future generations. Alternatively, if an individual thinks of a world without climate change as their reference point, climate policies, existing as well as new, could be perceived as measures to avoid any (further) *losses of income* for future generations. Our valence framing treatments are quite similar to these alternatives ways of perceiving the world. As pointed out by Knetsch (2010), such differences in reference point may very well explain differences in the willingness to pay for gains vs avoided losses.

More broadly, evidence from the environmental valuation literature suggests that framing a public good provision around the positive effects of providing this public good increases the mean WTP for the public good (Munro and Hanley, 2002). Similar results has been found in the behavioural and experimental literature, where public good provision has been found easier to establish if framed as a public good, as opposed to a provision of a public bad (Andreoni, 1995; Sonnemans, 1998; Vergnaud, 1999).

The effects of framing has also been studied in the methodological literature on DCE-methods (Johnson and Nemet, 2010). A large literature has investigated how design decisions influence the observed choices and the inference drawn in statistical models, discussing implications for validity and reliability of such survey results (Johnston et al., 2017). The effect of *attribute level framing* in DCE have not been extensively studied, however, and to the best of the authors knowledge, only the study by Kragt and Bennett (2012) has been published on the subject. Their study resembles our set up in some aspects. In their paper they vary two dimensions of the attribute presentation; 1) whether the attribute is presented in absolute or relative levels and 2) the framing of the attribute levels as either positive or negative, with the latter manipulation being similar to the one applied in this study. With a choice experiment build on water catchment management in Australia, they find that framing does not influence the general preference structure significantly, but they find that the significance of other attributes decrease when the level of another attribute is framed as a loss. In terms of how attribute level framing influence marginal willingness-to-pay (WTP), they find a significantly higher WTP for a loss-framed attribute level, but their results also indicate a form of spill-over effect from the framed attribute to another co-occurring attribute, which has a significantly lower WTP, compared to a sample with no loss framing applied. There are of course significant differences between their study and ours, due to the different cases considered. Their respondents are likely to be affected by the policy outcomes evaluated, while our respondents are asked to value policies with both an immediate and a future policy outcome. Thus, with this design, our study creates a more distant, respondent-removed context, in which to study the effect of attribute level framing. Furthermore, the Kragt and Bennett (2012) paper apply a more subtle valence framing than applied in this study. Their framing of the attribute levels were *a loss of a species* or *a presence of a species*, and in our setup the valence framing is made more explicit, with the attribute levels described in terms of *loss in income* (loss frame) or *regained income* (gain frame).

Lastly, it should be noted that the literature also discuss the possibility that experimental framing effects could be insignificant in comparison to the inherent framings that individuals build and acquire in their everyday life. Examples of these could be individuals' political orientation, gender, general economic conditions and social norms (All

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[1] It should be noted that the literature on the effects of gain-loss framing effects in general, is highly varied, including for example studies on uncertainty and expected utility in games (Payne, 2005) or the neural representation of strategic choices, under uncertainty and a gain-loss framing (Venkatraman et al., 2009). We have chosen to delimit our review of the literature to gain-loss framing in the valuation literature strand, more specifically related to the climate change context.

and Loureiro, 2014; Bernauer and McGrath, 2016; Nabi et al., 2018). Furthermore, framing effects are likely to be policy dependent and target-group sensitive (Lockwood, 2011) and apparent effects of framing upon public opinions might not be directly translatable into expected behavior (Levine and Kline, 2017). While this, of course, does not lessen the findings regarding framing effects in experiments and surveys, it should sober the discussion of the policy implications of these results.

Thus, the literature present findings that gain framing results in higher support/willingness-to-pay than loss framing as well as findings of the opposite result. Acclaimed theoretical work like prospect theory, predict loss framing may result in higher willingness-to-pay; but that assumes a joint reference point, which is not always obvious or even possible in different framing treatments. However, we chose to base our core hypothesis on the predictions from prospect theory and the recent empirical evidence regarding attribute level framing in DCE. Thus, we formulate our main hypothesis as:

Hypothesis 1. Framing the climate policy impacts on future income changes in three regions as losses of income, results in a significantly larger willingness to-pay estimates for the future income variable in all three regions, compared to the treatment framing of future income changes as regaining income.

Note that there are two alternative hypotheses to this: First, the reverse may be true, and secondly, we may find no difference between the framing treatments. We do not formulate a priori hypotheses about the non-framed attributes, but note that spill-over effects of framing have been found in the cited literature.

Below we describe the experimental setup, the data and the econometric model specification we apply to evaluate this hypothesis.

3. Materials and Methods

3.1. The Case Study and Survey Design

We obtained our data from a set of DCEs designed to elicit and study preferences for present and future distributional effects of climate policy under various incentives, formats and framings. The part of the data we study here concerns a two-split design DCE (a gain and a loss framing split) that we ran with the specific purpose of evaluating the role of valence-based framing.

The survey consisted of three sections. The first section contained information on the case study, including warm-up questions on beliefs and attitudes about climate change and elements of the presented case study. In the second section, respondents were asked to make their choice of climate policy and the last section elicited socio-demographic information and asked follow-up questions pertaining to the respondents choices in the previous section. Our treatment design concerned the second section of the survey, the DCE, and we now describe the design of this in detail.

3.1.1. The Choice Context and Experimental Design

In the DCE, respondents were asked to consider and choose between different alternative climate policies with different outcomes of. Climate policies could include either a combination of mitigation and adaptation efforts or only adaptation efforts. Respondents were asked to consider that climate policies implemented now would have a present-generation outcome in the form of co-benefits from mitigation efforts, as well as a future outcome in the form of income effects, generated by lowering the expected impacts of climate change, as a result of both mitigation and adaptation efforts. The impact of both policy attributes was described for three distinct regions of the world; Western Europe (WE), Southeast Asia (SEA) and Sub-Saharan Africa (SSA). These regions were selected to

be in accordance with the typical geographic representation in the integrated assessment model FUND[2] and to allow us to capture social preferences (among Danes) for supporting climate policy-related public goods for both current and future generations in different regions. The final design included five attributes, see Table 1, present in all of three alternatives; a 'No Policy' status quo decision alternative, and two alternative climate policies. Each respondent is presented with eight unique choice sets, and through their choices indirectly reveal their WTP for each attribute (Johnston et al., 2017). The first attribute in each alternative was the co-benefit attribute. The co-benefits were described qualitatively as fewer cases of respiratory diseases, as a result of the mitigation instruments being technology change in the energy, transportation and household sector, which at the same time would also reduce the level of health affecting air pollutants. Respondents were additionally informed that the level of the co-benefit attribute would indicate whether the presented policy included any mitigation effort. If the level indicated *"no effect"*, then the presented policy would only include adaptation efforts. Thus, the co-benefit could take one of four levels in each alternative; either *"no effect"* or the qualitative statement of *"fewer cases of respiratory diseases"* in one of the three regions. Then followed three attributes describing the future income effect that would occur in each of the three regions, from selecting a given climate policy. The future impacts of climate change were aggregated and expressed in monetary terms for future generations, such that respondents had to consider changes to the average income levels in the year 2100 in the three regions. In both splits, a policy alternative of no additional climate policy efforts was included in all choice sets. Respondents were told that this no additional climate policy alternative would result in an average loss of 5% in yearly per capita income in all three regions. The additional climate policy options that respondents considered, all resulted in a lower loss in average income, through reducing the expected impacts of climate change in the three regions. The three regions represented a natural gradient in average income level, over which individuals could trade-off distributional outcomes. Thus, these three regional future income attributes could each take four levels. These levels were set using the online appendix to Anthoff and Tol (2010) as a baseline for further

Table 1
Attributes and attribute levels of the discrete choice experiment.

Attributes	Climate policy levels					Status quo levels
Co-benefit from regional mitigation effort						
Western Europe	Fewer cases of respiratory diseases					No effect
Southeast Asia	Fewer cases of respiratory diseases					
Sub-Saharan Africa	Fewer cases of respiratory diseases					
Income effect in terms of per capita income, DKK						
Loss frame	*5%*	*4%*	*2%*	*1%*	*No change*	
Western Europe	42,000	33,600	16,800	8,400	42,000	
Southeast Asia	21,000	16,800	8,400	4,200	21,000	
Sub-Saharan Africa	10,500	8,400	4,200	2,100	10,500	
Gain frame	*0%*	*1%*	*3%*	*4%*	*No change*	
Western Europe	0	8,400	25,200	33,600	42,000	
Southeast Asia	0	4,200	12,600	16,800	21,000	
Sub-Saharan Africa	0	2,100	6,300	8,400	10,500	
Price, DKK						
Increase in income tax	0, 100, 200, 400, 600, 900, 1200, 2000					0

Note: The size of the monetary loss/gain is indicated as a percentage of the yearly expected income in 2100, for each of the three regions.

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[2] The acronym FUND stands for "The Climate Framework for Uncertainty, Negotiation and Distribution", http://www.fund-model.org/

calculations, which remained within reasonable bounds of the original estimates from the FUND model. All levels were purchase-power-parity corrected in order to secure full comparability across the three regions. Note that levels were set for each treatment to be corresponding to each other.

Finally, each alternative included a cost attribute for the respondent, varying in eight levels. Respondents were explained that the presented climate policies would be financed through an increase in income tax, which is a common payment vehicle in a Danish context. Respondents were informed that Denmark is engaged in both international and national policy efforts to mitigate and adapt to climate change. They were informed that the results of the study would be published and could potentially inform policymakers about the general public's attitude towards climate policy, which was done in order to enhance the perceived consequentiality of participating in the survey (Carson and Groves, 2007; Vossler et al., 2012).

The experimental design was optimized according to D-efficiency, using a main-effects dummy-coded MNL model, and consisted of 8 choice-tasks each with 3 alternatives, with the choice -tasks distributed into 2 blocks, resulting in 16 different designs of the choice cards. The optimization was carried out in Ngene (ChoiceMetrics, 2012) and resulted in a D-error of 0.3072. The design optimization relied on priors obtained from pilots of the survey.[3]

3.1.2. Implementing the Valence-based Framing

The valence-based framing was carried out by framing the information given on the attribute levels for the future income effect attribute. This was done by informing respondents that additional climate policy would secure a reduced loss in income of XX DKK (loss frame) or that additional climate policy would secure a regain in income of XX DKK (gain frame). In both frames the absolute levels of the income effect attribute were identical, what varied was how this income effect was framed. An example of a choice card with the same identical income effect, used in the two frames can be found in Fig. 1. Here we see that Policy 1 secures a 1% loss of 8400 DKK in Western Europe in the loss frame, and this same loss is presented as a regain in income of 33,600 DKK in the gain frame, both compared to the loss of 42,000 DKK in the status quo. The introductory text used in the two frames was identical, except in the explanation of the future income effect. As an example, in the loss frame respondents were informed that a given climate policy would for SEA mean that *"the loss in income associated with Climate Policy 1 corresponds to 2% of the yearly income of 420,000 DKK in the year 2100"*, while this same income change was explained as *"the regained income associated with Climate Policy 1 corresponds to 3% of the yearly income of 420,000 DKK in the year 2100".*[4]

There is a possibility that the two different framings in combination with the estimated impacts of climate change, relative to the case of no further additional climate policy, imply two different reference points, as illustrated in Fig. 2. The loss framing could imply a reference point equal to the expected income level in the absence of climate change impacts.

The maximum loss possible in this situation is the result of no additional policy initiatives being implemented, ensuring a loss of 5% in income. The additional climate policies thus lower this expected loss, but the individual is, with this reference point, making choices of climate policy in the loss domain. The gain framing, however, could imply a reference point equal to the income level in the absence of additional policy initiatives being implemented, i.e. a sure loss of 5%, and all gains from climate policy are found in the gain domain, relative to that reference point. This difference in reference point may work to reduce the effect of the framing, as the curvature of the value function

may be affected by respondents consider the future generations to be better off in one reference point than in the other - as a form of endowment or wealth effect (Hanemann, 1991; Knetsch, 2010). This would reduce the curvature of the loss domain (where reference point have people relatively better of) and increase it in the regain domain (where reference point has people relatively worse of). In Fig. 2, we have not implemented hypotheses about such differences in curvature, but the issue is if the curvature in regain framing becomes more similar to the curvature in the gain loss framing (albeit reversed). We note that we abstained from outlining the two reference points very explicitly to respondents, but instead relied on the perception being implied by the framing.

3.2. Survey Strategy and Construction of Dataset

The survey company Userneeds, which is experienced in handling the collection data for discrete choice experiments, handled the data collection. Userneeds maintains an online, web-based panel consisting of more than 95,000 members of the general Danish public. Members of the panel answer a broad range of surveys and are paid for their effort in the form of points, which can be exchanged for scratch cards, gift certificates or donated, to different humanitarian organizations. The survey was conducted on 1634 respondents (14,831 were invited to participate),[5] of which 23 was characterised as protesters in the loss frame and 16 in the gain frame, and thus dropped from subsequent estimations.[6] The final sample size consisted of respondents in the gain frame and respondents in the loss frame, thus almost identical sample sizes, resulting in 6376 choice observations in the gain frame and 6384 observations in the loss frame. The average response time was approximately 21 min in both the gain and loss frame.

The sampling was designed to be representative in regards to age, gender and income. From Table 2, it can be seen that both sample frames are on average rather similar on all sample characteristics and that they matched the general population fairly well for gender and income, whereas both frames are slightly older than the general population. Both sample frames do not completely match the general population in terms of educational level. The share of people with a tertiary education is lower in the two samples, compared to the population average, whereas the results of Table 2 indicate that the shares of people with a secondary and vocational education are higher for both samples than the population average.[7] However, for the current study, these differences are of little concern as our focus is on the differences between the two treatment splits, and as these samples are not significantly different from each other, we can ignore these aspects.

3.3. Econometric Models

The econometric framework used to analyse the data builds on the Random Utility framework (McFadden, 1973) along with Lancasters characteristics demand theory (Lancaster, 1966). Following the Random Utility framework, the utility of agent n for alternative i can be described by an observable part x_{ni} and an unobservable part ε_{ni}, which is the individual stochastic error term. This allows the utility of agent n to be

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[3] The survey development included 3 focus groups and two pilot data collections, which all provided valuable inputs

[4] For the full text, please refer to the translated survey

[5] The survey was closed once a minimum population of representative respondents had replied, thus a standard response rate cannot be estimated.

[6] In the loss frame 42 respondents always chose the SQ alternative in each of the 8 choices, in the gain frame this number was 36. Respondents were identified as protesters if they had agreed to one of the follow-up questions; 1) not wanting to pay more in taxes, 2) climate change is a global problem so not only Denmark should act or 3) not wanting to pay for a policy where the amount of CO2 reduced is not indicated.

[7] Chi-square tests reveal no statistically significant difference in gender between the two samples, whereas the distribution of age, income and education is statistically significantly different in the two samples.

Fig. 1. Example of choice card with identical attribute levels as depicted in the loss (top panel) and gain frame (bottom panel).

formulated as follows:

$$U_{ni} = \beta x_{ni} + \epsilon_{ni} \qquad (1)$$

Here x_{ni} may contain both individual characteristics and the characteristics of the alternatives, and β is a vector containing parameter coefficients to be estimated. Depending on the specified distribution of the error term ϵ_{ni}, estimation of the choice probability and relevant parameters is possible through different models. Here it is assumed the

error terms are independent and identically distributed (i.i.d.) extreme value type I, which results in the derivation of the multinomial logit model, MNL. Assuming that agent n picks the alternative with the highest associated utility, here called i, the probability of choosing alternative i (out of J available alternatives) in a sequence of T choices, can be described as
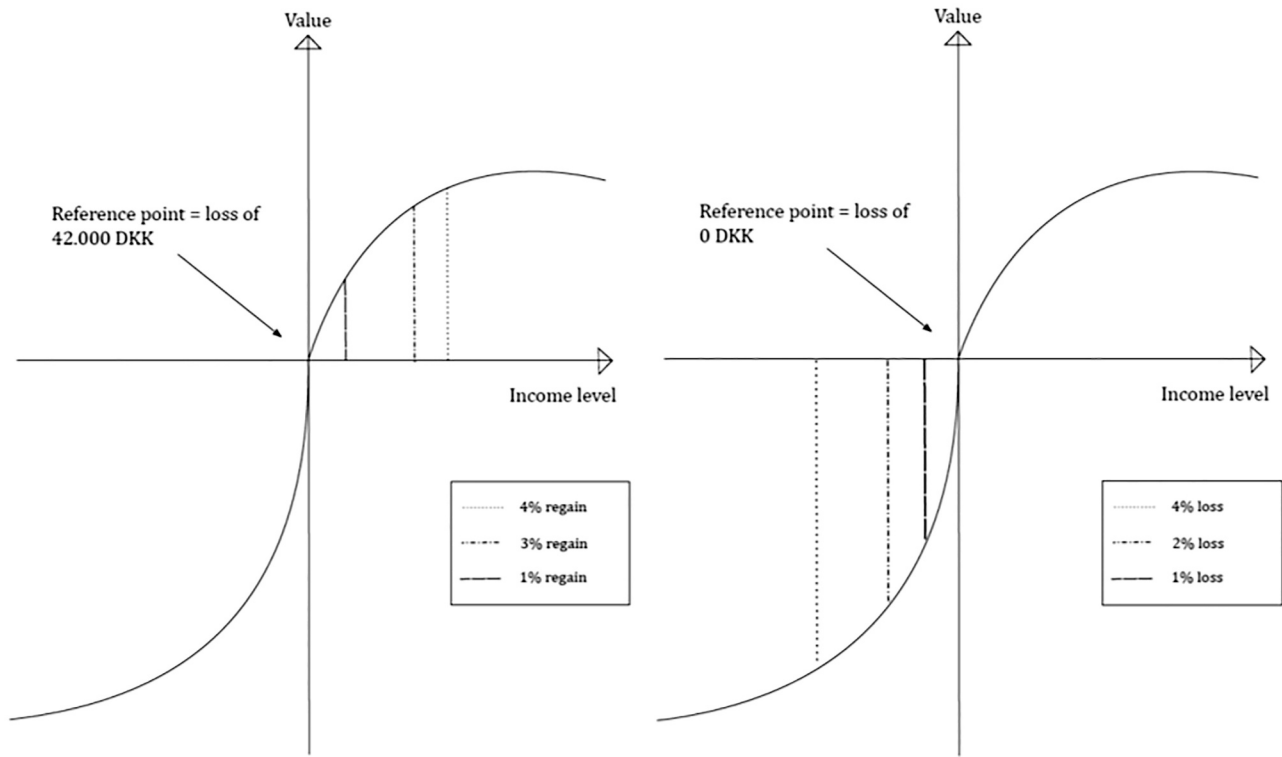
Fig. 2. Illustration of divergent reference point between the loss (right panel) and gain (left panel) frame. Reference to the SQ loss is made for the region WE, where the expected loss in income from no additional climate policy is 5%, which is equal to 42.000 DKK in WE.

Table 2
Socio-demographic characteristics of the samples, compared with the population of Denmark.

	Gain frame	Loss frame	Population of Denmark
	N = 797	N = 798	
Female	0.50	0.50	0.50
Age	44.9	45.3	41.1
Income	250,000–274,999	250,000–274,999	261,323
Education - tertiary	0.08	0.09	0.27
Education - secondary	0.14	0.11	0.09
Education vocational	0.52	0.55	0.30
Education - primary	0.25	0.24	0.27

Note: Income indicated the mean interval- income per respondent, in DKK, for the samples. Education levels are provided for the population aged above 15 years.

$$P_{ni} = \sum_{t=1}^{T} \frac{exp(\beta x_{nit})}{\sum_{j=1}^{J} \beta x_{njt}} \qquad (2)$$

Eq. (2) suppresses the notation on the scale parameter, which is not separately identifiable from the parameter estimates (Train, 2009). The scale parameter is especially relevant in the later comparisons of preference structure and scale differences between the two framed datasets since it allows us to examine whether framing influence the overall scale of preferences. A key assumption of the MNL model is that respondents are assumed to react homogenously to marginal changes in the choice attributes, which is not likely to be an accurate description of individuals behavior (Train, 2009). We, therefore, specify a random parameter logit model (RPL) which will allow for preference heterogeneity in the modelling of choice behavior. The choice probability of the RPL model is described as

$$P_{ni} = \int \sum_{t=1}^{T} \frac{exp(\beta_n x_{nit})}{\sum_{j=1}^{J} \beta_n x_{njt}} f(\beta)d\beta \qquad (3)$$

With the subscript β_n capturing that the parameter estimates now vary over respondents as described by the density $f(\beta)$.[8] It is left to the researchers discretion to specify the type of density used to capture the distribution of each estimated random parameter, and given the distributional assumption the researcher estimates the mean and standard deviation of said distribution (Train, 2009). All estimated climate policy parameters are specified as following a normal distribution, thus allowing for a behavioural response in both the positive and negative domain. For all attributes, except the price, this assumption is reasonable with the given theoretical framework, e.g. people might dislike/like the provision of co-benefits and future income effects. However, the theoretical assumption regarding the price is that people should react negatively to increases in price, e.g. have positive marginal utility of income. This theoretical assumption could have been met by specifying a distributional form such as the lognormal distribution that would exclude the possibility of positive price parameters. However, previous work on a subset of this data indicated that a non-trivial share of respondents may have made choices implying a positive price parameter, which could be linked to signalling (Svenningsen and Thorsen, 2019). The choice context presented to respondents, with intergenerational and distributional aspects, is undeniably of moral content. As such, one could expect non-rational behavior as expressed by people reacting positively to an increase in the income tax dedicated to additional climate policies, simply to signal commitment to the cause. We therefore

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[8] In relation to the scale parameter, the RPL specification also ensures that the taste parameter heterogeneity is explicitly modelled and thus not captured in the scale parameter, as would have been the case if the MNL model was specified (Hess and Train, 2017), which could have biased any conclusions regarding scale heterogeneity of the two framed datasets

specify the price parameter to follow a normal distribution, in order to allow for this behavioural anomaly to occur.[9] In addition we allow for a full correlation matrix between the random parameters, as this specification of the RPL model has been shown to be the most flexible model in capturing both taste and scale heterogeneity (Hess and Train, 2017).

4. Results

4.1. Econometric Models

All models were estimated in Stata (StataCorp, 2013), using the *mixlogiti* (Hole, 2007) and *gmnxl* (Gu et al., 2013) commands, with 1000 Halton draws to simulate the log-likelihood function. Table 3 illustrates the results of three RPL models with full correlation matrix among the random parameters; Model 1 based on the gain frame, Model 2 based on the loss frame and Model 3 based on the pooled dataset of the gain and loss samples with scale modelled explicitly. The results of Model 1 and 2 suggest the same apparent average preferences structure for climate policy, with the expected signs on all parameter coefficients. In both

Table 3
Correlated Random Parameters logit model results.

	Model 1	Model 2	Model 3
	Gain frame	Loss frame	Pooled data
Mean			
asc	−4.510***	−3.887***	−6.030***
	(0.426)	(0.355)	(0.580)
Income WE	−0.035***	−0.020***	−0.039***
	(0.003)	(0.002)	(0.004)
Income SEA	−0.020***	−0.007*	−0.020***
	(0.004)	(0.004)	(0.004)
Income SSA	−0.069***	−0.048***	−0.082***
	(0.008)	(0.008)	(0.010)
coB WE	1.533***	1.635***	2.191***
	(0.097)	(0.104)	(0.176)
coB SEA	0.890***	1.067***	1.342***
	(0.079)	(0.080)	(0.118)
coB SSA	0.886***	0.972***	1.307***
	(0.090)	(0.089)	(0.124)
Price	−0.643***	−0.348***	−0.728***
	(0.078)	(0.060)	(0.087)
Standard deviation			
asc	3.613***	3.739***	3.402***
	(0.382)	(0.346)	(0.246)
Income WE	0.031***	0.026***	0.026***
	(0.004)	(0.004)	(0.003)
Income SEA	0.029***	0.020**	0.023***
	(0.006)	(0.007)	(0.005)
Income SSA	0.099***	0.066***	0.074***
	(0.014)	(0.015)	(0.010)
coB WE	1.206***	1.550***	1.231***
	(0.142)	(0.144)	(0.117)
coB SEA	1.084***	1.149***	1.089***
	(0.120)	(0.123)	(0.092)
coB SSA	1.131***	1.196***	1.069***
	(0.128)	(0.127)	(0.095)
Price	1.563***	1.158***	1.324***
	(0.098)	(0.089)	(0.063)
Scale gain			−0.228***
			(0.0489)
N	19,512	19,704	39,216
LL	−4350.2	−4642.9	−9036.4
AIC	8788	9374	18,165
BIC	9135	9721	18,559

Significance levels: *** 0.001 ** 0.01 * 0.05. 0.10. Std. Error in parentheses.

frames, there is an average tendency to prefer investing in any additional climate policy, with the alternative-specific-constant (ASC) being negative and statistically significant.[10] Lower future income generates statistically significant dis-utility for the respondents in all three regions, with lower income in WE generating significantly more dis-utility than lower income in SEA (Wald test, chi-square value = 9.84 [gain] and 7.63 [loss]). Lower income in the poorest region, SSA, generates more dis-utility than in the other two regions (Wald tests, WE-SSA chi-square value = 16.43 [gain] and 12.39 [loss], SSA-SEA chi-square value = 33.51 [gain] and 25.40 [loss]). The preference for the provision of regional co-benefits reveals that provision of co-benefits in the respondents own region (WE) generates the largest gain in average utility, with the difference between the regional coefficients in WE and SEA/SSA being statistically significant (Wald tests, WE-SEA chi-square value = 62.02 [gain] and 50.14 [loss], WE-SSA chi-square value = 71.66 [gain] and 68.58 [loss]). In both frames increases in the price of additional climate policy generates statistically significant dis-utility. The results of Model 1 and 2 also indicate the presence of significant preference heterogeneity for all climate policy attributes included in the model. The coefficients of preference heterogeneity for income effects in SSA and the price of climate policy are larger than the mean parameter coefficient, indicating that especially for these two attributes, respondents varied considerably in their preferences.[11]

4.1.1. The Effect of Framing Upon Preference Structure and Scale

Comparing the results of Model 1 and 2 indicates that the relative coefficients on the income effects in all three regions as well as the coefficient on price appear to be smaller in the loss frame. This could be explained by a different preference structure in the loss frame with lower sensitivity to these four climate policy attributes, perhaps indicating that climate policies are less attractive when outcomes are in a loss frame. It could also be that the gain/loss framing influences the scale factor, which is not separately identified from the attribute parameters, but is inversely related to the error variance (Swait and Louviere, 1993). The smaller coefficients which are observed in the loss frame could be caused by a lower degree of error variance in this frame, compared to the gain frame. In order to investigate if the observed difference between the two datasets is caused by preference or scale heterogeneity, a Swait-Louviere two-stage test is performed (Swait and Louviere, 1993).

The Swait-Louviere two-stage procedure tests identify scale and parameter equality between different datasets and the first stage tests the assumption of parameter equality while allowing the scale to differ between datasets, referred to as testing the H1A hypothesis. This involves estimating a model on a pooled dataset, including explicitly modelling a relative scale parameter, with the scale of one of the datasets set to unity. If the assumption of equal parameter structure between the two datasets cannot be rejected, the second step is to test the assumption of an equal scale parameter between the two datasets, referred to as the H1B hypothesis. The two test values are chi-square distributed, with degrees of freedom equal to the number of parameters estimated minus 1 (Swait and Louviere, 1993). Table 4 presents the result of the Swait-Louviere test and the chi-square test value indicates that we can reject the assumption of equal preference structure in the gain and loss frame, which suggest that the framing of the income effect attributes significantly influenced the preference for climate policy. The rejection of equal preference structure also results in an inability to

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[9] We have run additional sensitivity tests specifying price to be log-normally distributed, and the results of these models can be found in the Appendix

[10] This follows from the ASC being defined as 1 for the No additional policy alternative.

[11] The robustness check using a lognormal distribution for price reveals that significant preference heterogeneity for these two variables, but the magnitude is somewhat smaller, with the standard deviation being about the same size as the mean coefficient, except for the standard deviation of the price coefficient in the gain frame, which is estimated as being larger than the mean coefficient. See Table 7 in Appendix for the robustness check models.

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Table 4
Swait Louviere test.

	Gain	Loss	Pooled	Pooled
			Scale modelled	Scale *not* modelled
Log-likelihood	−4350.2	−4642.9	−9036.4	−9047.2
H1A: chi-square value	86.6			

reject scale factor equality between the two datasets, rendering the estimated scale parameter useless for interpretation (Swait and Louviere, 1993).

4.1.2. The Effect of Framing Upon Welfare Measures

Another approach to investigating the influence of attribute level framing is to compare the implicit prices for the six climate policy attributes. When calculating willingness to pay (WTP) estimates, the scale parameter cancels out (Train, 2009), thus enabling a direct comparison of the WTP estimates. Since the price parameter was assumed normally distributed, the calculations of WTP involves the ratio of two normally distributed random coefficients, and the moments of this distribution of WTP is likely to be unidentified (Daly et al., 2012). We, therefore, calculate the median of the distribution of WTP, since the median is always finite and can be used as an approximation of the mean (Bliemer and Rose, 2013). Furthermore, a test for the difference between the two distributions of WTP is undertaken, applying the convolutions approach (Poe et al., 1994, 2005). Table 5 presents the median marginal WTPs for all six climate policy attributes, across the gain and loss frame and a boxplot of the simulated WTP values can be found in Fig. 3. We first compare the total WTP for climate policies across the two frames, as the ratio of the alternative-specific-constant to the price coefficient. The median WTP for the base alternative is −6.99 in the gain frame, compared to −11.16 in the loss frame, with a *p*-value for the difference indicating that the WTP is significantly more negative in the loss frame, compared to the gain frame (Poe test, p-value = 0.038).

This indicates that respondents in the loss frame have a significantly higher WTP for additional climate policies compared to respondents in the gain frame. For the three regional income effect attributes, the median WTPs are fairly comparable across the gain and loss frame, which is also revealed in the insignificant difference between the two distributions of WTP. However, when comparing the median WTPs for the regional provision of co-benefits, the median WTP in the loss frame is

Table 5
Median marginal WTP in DKK/year per 1.000 DKK change in income in the year 2100. For ASC and co-benefit it is DKK/year for the attribute. We report p values for differences in WTP between gain and loss frame.

Median WTP	Gain	Loss	p-Value for difference WTP loss > WTP gain
asc	−6991.4 (−3947.1 to −10,035.6)	−11,162.5 (−4483.5 to −17,841.6)	0.038
incWE	−0.0547 (−0.0312 to −0.0782)	−0.0558 (−0.0201 to −0.0916)	0.538
incSEA	−0.0305 (−0.0126 to −0.0483)	−0.0209 (0.0064 to −0.0483)	0.214
incSSA	−0.1073 (−0.0594 to −0.1551)	−0.1358 (−0.0445 to −0.2271)	0.793
cobWE	2375.3 (3161.7 to 1588.9)	4698.3 (7068.1 to 2328.6)	0.000
cobSEA	1376.7 (1927.0 to 826.4)	3055.6 (4767.4 to 1343.7)	0.000
cobSSA	1373.3 (1906.0 to 840.6)	2803.6 (4313.7 to 1293.5)	0.001

Note: 95% confidence interval in brackets, calculated using the Krinsky Robb procedure. The p-value for differences is calculated based on the convolutions approach suggested by Poe et al. (1994), using draws.

statistically significantly higher in the loss frame. This result indicates that when respondents are asked to value climate policies that are framed as generating future income losses, their valuation of the present time effect (the provision of co-benefits), is significantly higher, compared to when respondents value climate policies that secure future gains in income. The results suggest that the observed difference in preference structure between the two frames found in the Swait-Louviere test is likely caused by a difference in how respondents value the mitigation attribute of climate policy, e.g. the provision of co-benefits.

4.2. Interpretation of Choice Cards, Attitudes and Expectations of Climate Change

In order to investigate whether there were systematic differences in attitudes and expectations of climate change, as well as ability to understand the choice cards between the two samples, which might influence the observed differences in preference parameters, this subsection looks at differences in selected variables both before and after the choice elicitation phase. In the pre-elicitation phase, respondents were asked to indicate their attitudes towards several statements about climate change and air pollution (See questions 1–7 in Table 6). We find no statistically significant difference between the two samples for questions 1–5, but we do find that more respondents in the gain frame agree or partly agree to being concerned about high levels of air pollution than respondents in the loss frame (Wilcoxon-Mann-Withney test, z = −2.516, p = 0.0119), and that more respondents in the gain frame see air pollution as a more serious problem in Sub-Saharan Africa and Southeast Asia compared to Denmark (Wilcoxon-Mann-Withney test, z = −1.713, p = 0.0867).

For the post-elicitation phase we consider the answers to three specific questions: 1) answer to a short choice-card interpretation test, 2) their"best" guess expectation of future climate change in the three regions and 3) whether they perceived the future income effect as certain when making their choice of climate policy. Regarding the first question, respondents were asked to indicate, on an exemplary choice card, which of the climate policy alternatives that offered the highest reduction in income loss in Sub-Saharan Africa. Testing the difference in the shares of respondents that were able to answer the question correctly, we find that respondents in the gain frame were better able to read the choice card correctly, with 64% of respondents making the correct interpretation in the gain frame, compared to 58% in the loss frame. The difference is statistically significantly different (Wilcoxon-Mann-Withney test, z = −2.646, p = 0.0082). In the light of possible effect of framing on information processing, from which there is some evidence that a loss framing highlights attention to details (Spence and Pidgeon, 2010), we would have expected that respondents in our loss frame performed better in this follow-up test, however, our results does not support this conclusion.

Respondents in both samples were asked to indicate their"best" expectation regarding the future temperature increases in 2100 in the three regions. On average, respondents in both samples expect higher temperatures in SEA and SSA (approx. 2.7 degree Celsius) compared to WE (approx. 2.3 degree Celsius), and we find no statistical difference between the two samples. Lastly, we asked respondents whether when making their choices of climate policies, they considered the income change in year 2100 as being certain (Question 8 in Table 6). Overall, the majority of respondents in both samples indicate that they partly disagree or disagree to this question (63% in the gain and 59% in the loss frame), suggesting that they *did* perceive the income effects as uncertain or risky. Interestingly, we find a that a statistically significant higher share of respondents in the loss frame believed the income effects to be certain (Wilcoxon-Mann-Withney test, z = 1.876, p = 0.0607). This suggest their reference point would be the full loss in the absence of additional climate policies. Overall, the differences between the two treatment samples across all these different attitude or perception
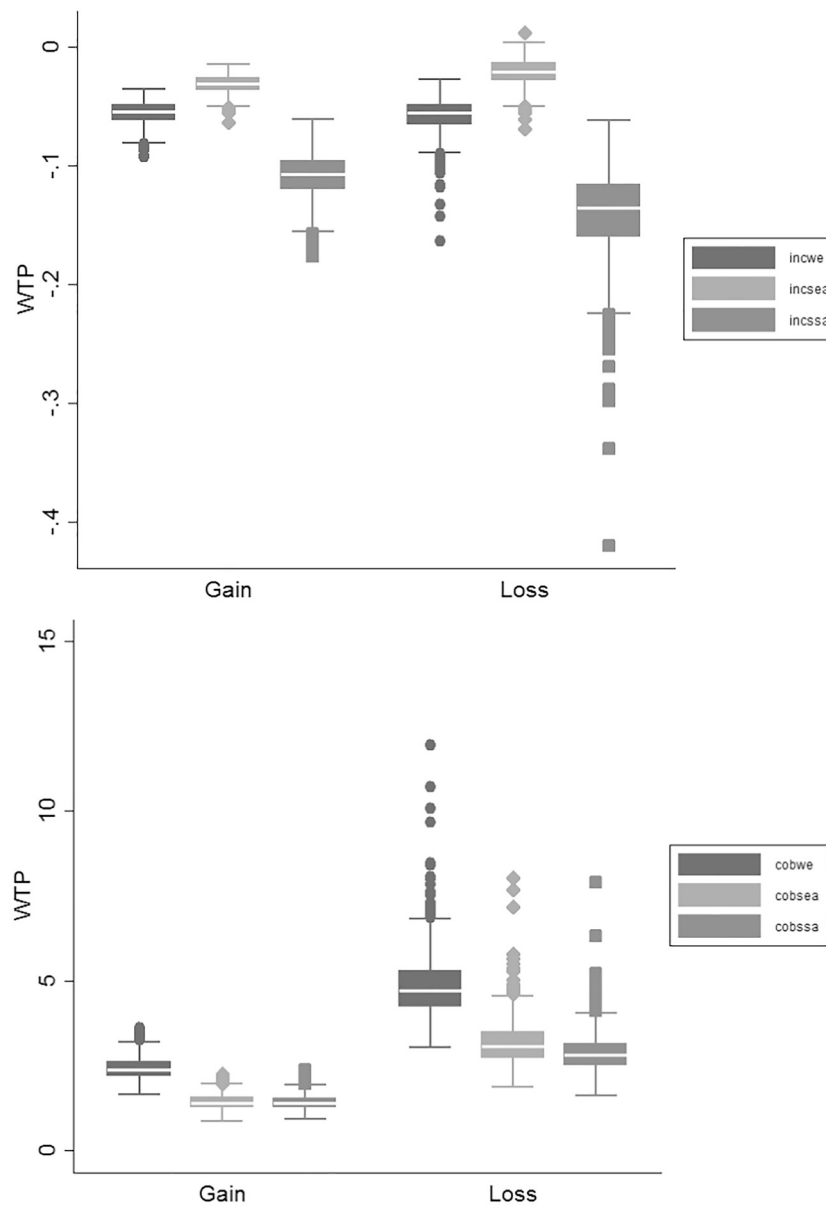
Fig. 3. Boxplot of Krinsky Robb WTP draws for income effects (top panel) and cobenefits (bottom panel). Median is indicated by white line within each box, the upper hinge of box capturing the 75th percentile, lower hinge indicating the 25th percentile. Full circles denote outlier values.

questions are too small and incidental to be able to explain the observed differences in preference parameters across the treatments, and thus our finding are robust to these small differences.

5. Concluding Discussion

This paper investigates how a valence-based gain/loss framing of climate policy outcomes at attribute level, influence the observed preference structure and implicit prices for climate policy attributes. Drawing upon prospect theory and the limited literature on attribute level framing effects in DCE's, we hypothesized that loss framing would result in a higher willingness to pay for reducing climate change impacts on the income of future generations, relative to the regain framing. We did not find find a significant difference between the willingness to pay for reducing income effects for future generations between the two treatments. As we outlined in our literature section, evidence in related studies is indeed mixed as to the framing effects. However, our results indicate that the overall preference structure is significantly different when future income effects from climate policy are framed as losses in

income, relative to income effects being framed as regained income. Comparing the willingness to pay estimates, we find that respondents in the loss frame are willing to pay more for any additional climate policy than people in the gain frame. Turning to the specific outcomes of climate policies the picture is, however, more mixed. For the expected impact on future income, which is the framed attribute, we find no significant difference in WTP. The WTP for regaining another DKK in income for the future generations appears not different from the WTP for avoiding a loss of that same DKK. Turning to the attribute representing mitigation efforts, e.g. the regional co-benefits, we find that the WTP for this policy attribute is significantly higher when individuals are presented with a loss framing of the future income effects than when presented with a regain framing.

Kragt and Bennett (2012) undertook a valence-based framing of reductions in the number of rare native plant and animal species in a coastal catchment area, framing a reduction of species relative to the total current number of species present, either as a loss of these species or as a presence of the number left. In their setting, they find a significantly higher WTP for the loss-framed species attribute, but moreover

Table 6
Attitude questions.

Number	Question
Pre-elicitation questions	
1	I believe that human activity affects the climate
2	I do not believe that we can do anything to stop climate change
3	I am seriously considering to do more to lessen my contribution to climate change
4	I do not believe that climate change is going to have a significant negative impact on global food production, health and the economy
5	I believe that the most negative economic impacts of climate change will befall poorer regions like Southeast Asia or Sub-Saharan Africa
6	I am concerned about high levels of air pollution
7	I believe that air pollution is a more serious problem in Sub-Saharan Africa and Southeast Asia than in Denmark
Post-elicitation questions	
8	When making my choices, I considered the income change in year 2100 to be certain

Note: Answers were given on a four-point likert scale, with levels being: agree, partly agree, partly disagree and disagree.

also find an effect on another unframed attribute, where the WTP is significantly lower for this attribute in the loss frame. The authors suggest that this could be interpreted as the loss frame generating an increased focus on the framed attribute. They do not discuss the potential switches in reference points, the formulations imply. For example, stressing that a number of species are present could cause respondents to evaluate the attribute level using no species present as a reference point, whereas the same level of an attribute framed as a loss of a number of species, would likely induce a reference point equal to the current number of species. The two reference points imply different levels of wealth, and this could affect the evaluation, both according to prospect as well as neoclassical theory (Hanemann, 1991; Knetsch, 2010). In our case, we evaluate a similar type of framing, but we do so in the much more complex case of climate policy. It is more complex as it involves both mitigation actions (embedded in the co-benefit attribute, and only when present in an alternative, also in the income attributes) aimed at reducing the overall climate change impacts to come and adaptation actions aimed at reducing the impacts of climate changes (embedded in the future income attribute). It is also more complex in that all attributes, but in particular, those concerned with the income of future generations, rely almost entirely on some degree of social preferences, altruistic motivations in the respondents. The additional layers of complexity in our case could challenge a clear effect of attribute-level framing, simply because our respondents were already facing high cognitive demands when making their choice of climate policy.

One explanation for failing to find a difference in WTP between our two framings could be the different implied reference points. As noted above, our two framings imply two different reference points (Hanemann, 1991; Knetsch, 2010). The loss framing may imply a reference point equal to the income level in the absence of climate change impacts, whereas the gain framing, may imply a reference point equal to the income level in the absence of additional policy initiatives being implemented, i.e. a loss of 5% of income for future generations. This difference in reference point may work to reduce the effect of the framing as the regain-related reference point could be perceived to represent a lower overall wealth level of the future generations, which in turn could increase their WTP for gains ceteris paribus, and a similar ef606 fect could result in lower WTP for avoiding a loss in the loss-framed split. 607The effect may be to reduce the hypothesized gap

between the two splits WTP for income changes. A key distinctive feature between the two types of attributes included in our study is the timing and who they benefit. The income effects are occurring in the far future, where the majority of respondents are not expected to live for any significant period of time, and thus concerns an altruistic component of utility. The provision of co-benefits, on the other hand, could potentially influence the respondents fairly soon, but nevertheless, we see that respondents have a significantly higher WTP for the mitigation effort attribute in all of the three regions when they have been exposed to the loss framing. We interpret this as the loss framing encouraging the respondents to form stronger preferences for mitigation efforts, which could be perceived as the policy attribute most able to actually reduce the potential future losses. A similar interpretation relates to the loss framing inducing higher preferences for additional climate policies per se as reflected in the significantly larger and negative ASC associated with sticking to current climate policy. A higher degree of urgency seems to have been induced, but this is not reflected in the WTP to avoid income losses for future generations. Overall, however, the finding that the general WTP (as assessed by the impact of all parameters, including the ASC) to pay for climate policies is higher, when they are presented in a loss framing, is in accordance with at least some findings and theoretical expectations in the literature on framing effects and reference points in stated preference studies as well as lab experiments (Levin et al., 1998; Tversky and Kahneman, 1991; Knetsch, 2010).

Knetsch (2010) points out the importance of establishing what people perceive the reference point to be. We note that we abstained from outlining the two reference points, implied by the framings very explicitly to respondents, but instead relied on the perception being evident from the framing. If respondents have not adopted the scenario of future changes in income in 2100, the framing and the associated reference points, then it becomes even more difficult to predict the impacts of the framing and assess the results observed (Knetsch, 2010). The fact that our policy alternatives apart from the income tax involve changes mostly for others, e.g. in other regions and/or in other future time periods, and relates to the dynamic and uncertain phenomenon of climate change, may of course not only complicate the choice of climate policy itself, but could also influence the formation of any firm perceptions about reference points.

Our results seem to support the general tendency to talk about climate change impacts as a development potentially causing losses across the world, as seen in the IPCC reports (Pachauri et al., 2014). The overall result of this study is that respondents overall WTP for additional climate policies increases when evaluating these in a context of avoiding future losses. This suggests that framing climate policy in a context of acting to avoid losses for future generations creates a greater sense of urgency and a higher willingness to pay for additional climate policies and notably mitigation efforts, than a framing focusing on making life better and income higher for future generations.

Declaration of Competing Interest

None.

Acknowledgements

Appendix A. Appendix

Table 7
Correlated Random Parameters logit model results. Log-normally distributed price parameter.

	Model 1	Model 2
Mean		
asc	−4.870***	−3.961***
	(0.468)	(0.353)
income WE	−0.036***	−0.020***
	(0.003)	(0.002)
income SEA	−0.029***	−0.016***
	(0.004)	(0.004)
income SSA	−0.054***	−0.043***
	(0.009)	(0.007)
coB WE	1.684***	1.686***
	(0.105)	(0.099)
coB SEA	1.001***	1.144***
	(0.089)	(0.083)
coB SSA	1.016***	1.052***
	(0.095)	(0.088)
mprice	−2.164***	−4.283***
	(0.282)	(0.542)
Standard deviation		
asc	3.859	3.717***
	(0.408)	(0.334)
Income WE	0.031	0.030***
	(0.004)	(0.004)
Income SEA	0.029	0.020***
	(0.006)	(0.006)
Income SSA	0.058	0.047***
	(0.014)	(0.014)
coB WE	1.320	1.500***
	(0.124)	(0.123)
coB SEA	1.315	1.253***
	(0.124)	(0.117)
coB SSA	1.158	1.169***
	(0.122)	(0.119)
mprice	3.003	4.058***
	(0.213)	(0.327)
N	19,512	19,704
BIC	9082.2	9726.4
LL	−4323.7	−4645.7

Significance levels: *** 0.001 ** 0.01 * 0.05. 0.10. Std. Error in parentheses.

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