

Drupp, Moritz A.; Meya, Jasper N.; Baumgärtner, Stefan; Quaas, Martin F.

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## Economic inequality and the value of nature

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# Economic Inequality and the Value of Nature

by Moritz A. Drupp, Jasper N. Meya, Stefan Baumgärtner  
and Martin F. Quaas



# Economic Inequality and the Value of Nature

Moritz A. Drupp<sup>a,\*</sup>, Jasper N. Meya<sup>b,c</sup>, Stefan Baumgärtner<sup>d</sup> and Martin F. Quaas<sup>a</sup>

<sup>a</sup> *Department of Economics, University of Kiel, Germany*

<sup>b</sup> *Department of Economics, University of Oldenburg, Germany*

<sup>c</sup> *Resource Economics Group, Humboldt-Universität zu Berlin, Germany*

<sup>d</sup> *Department of Environment and Natural Resources, University of Freiburg, Germany*

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**Abstract:** Understanding what influences the value of nature is crucial for informing environmental policy. From a sustainability perspective, economic valuation should not only seek to determine willingness to pay for environmental goods to devise an efficient allocation of scarce resources, but should also account for distributional effects to ensure justice. Yet, how economic inequality affects the value of non-market environmental goods remains understudied. Combining recently developed theoretical results with empirical evidence we show that more equal societies have a higher valuation for environmental public goods and that non-market benefits of environmental policy accrue over-proportionally to poorer households. On this ground, we identify a number of fruitful areas for future research and discuss implications for environmental valuation, management and policy-making. We conclude that environmental valuation should explicitly account for economic inequality, and that encompassing assessments of the distributional effects of environmental policies must consider the distribution of non-market environmental benefits.

**Keywords:** nature conservation, environmental goods, valuation, willingness to pay, income inequality, distribution

**JEL codes:** Q51, Q01, Q57, Q56, H43

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\* Corresponding author: Department of Economics, University of Kiel, Wilhelm-Seelig-Platz 1, 24118 Kiel, Germany.  
Phone: +49-431-880-4986; Drupp@economics.uni-kiel.de.

## 1. Introduction

Appropriately representing the value of non-market environmental goods or ecosystem services in societal decision-making poses a fundamental challenge for ecological and environmental economics.<sup>1</sup> Accordingly, approaches to value nature’s contributions to people are diverse and abound (Pascual et al. 2017). Most valuation studies follow the standard economic approach of capturing the economic value individual people attach to environmental goods by eliciting their individual willingness to pay (WTP) for the provision of environmental goods by use of stated and revealed preference methods,<sup>2</sup> and then summing up the individual WTPs over all members of society.<sup>3</sup> As values for natural goods and services are increasingly applied to inform regulatory or judicial decision-making (Atkinson and Mourato 2008; Bateman et al. 2013; Bishop et al. 2017), in particular the step of aggregating individual values needs more thorough reflection.<sup>4</sup>

*Ecological Economics* is not only oriented towards economic efficiency but also aims at sustainability and thus distributive justice (Costanza 1989; Baumgärtner and Quaas 2010). Therefore, the nexus of environmental valuation and economic inequality deserves particular attention. Beyond methodological concerns, it is timely to consider these two issues intertwined, as on the one hand the loss of environmental goods is widespread and accelerating (Butchart et al. 2010; Pimm et al. 2014; MEA 2005), and on the other hand concerns about economic inequalities are becoming more prevalent in science, policy and society (Stiglitz et al. 2012; Piketty 2014; OECD 2016; IMF 2017). However, with few notable exceptions, valuation studies largely ignore issues of economic distribution, even though it is known that the inequality of income or wealth may affect individual and societal environmental values (Barbier et al. 2009).

To shed light on this important nexus, we discuss how economic inequality affects the value of nature. We focus, in particular, on standard economic valuation approaches and the case of income inequality as the most studied measure of economic inequality. The literature on these issues is sparse, but provides promising ways to account for economic inequality within standard economic approaches. Indeed, there is a clear relationship between mean WTP and income inequality: For most empirically relevant cases, a reduction in income inequality increases the value society attaches to public environmental goods (Section 2). This implies that the incidence of environmental policies, defined as their distributional consequence across income groups, is such that non-market environmental benefits accrue over-proportionally to poorer households. We discuss further implications of economic inequality for environmental valuation, management and policy (Section 3), and point towards research needs within economic approaches to valuing environmental goods (Section 4). Overall, we conclude that it is neither necessary nor appropriate to ignore distributional aspects in standard economic valuation approaches (Section 5).

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<sup>1</sup> For the sake of brevity, we make no distinction between environmental goods and ecosystem services and only refer to “environmental goods”. Sections 2 and 3 focus in particular on the case of environmental public goods, i.e. goods that appear to be rationed from the viewpoint of the individual and whose consumption is non-rival. For example, one may think of clean air, biodiversity conservation, or climate regulation.

<sup>2</sup> Generally speaking, the value of a good is the increase in individual or societal well-being due to an increase in its level or quality. There are different benefit or welfare measures, such as equivalent or compensating surplus (Freeman 2003). For marginal changes and standard preferences, equivalent and compensating surplus are identical and equal the WTP.

<sup>3</sup> A Pareto efficient allocation of a public good is characterized by the Lindahl condition that the sum of individual WTPs within a society should equal the marginal costs of public good provision. Equivalently, one could take the mean WTP as found in a representative study, and multiply it with the number of individuals in a society. We will thus often refer to “mean WTP” when we speak about the aggregate WTP.

<sup>4</sup> Providing a comprehensive account of the critical questions surrounding environmental valuation is beyond the scope of this article. For instance, the key methodological question of how well valuation studies indeed capture individual preferences has been discussed at length under the headline ‘is some number better than no number?’ (Diamond and Hausman 1994; Kling et al. 2012) without being resolved.

## 2. How does the distribution of income affect the valuation of environmental goods?

In a recent contribution, Frank and Schlenker (2016: 652) conjecture that *"if preservation values increase with income but at a decreasing rate, as commonly assumed, then a more equal society will exhibit higher values for conservation. The income distribution might thus be as important as overall economic growth"*. Addressing this conjecture, Baumgärtner et al. (2017a) build on previous seminal work by Ebert (2003), who has been the first to analyze the incidence of non-market environmental public good provision. Specifically, they use a standard constant-elasticity-of-substitution utility function that allows for varying degrees of substitutability or complementarity between an environmental public good and a human-made consumption good. A constant income elasticity of WTP that is smaller (larger) than one implies that preservation values increase with income but at a decreasing (increasing) rate. Baumgärtner et al. (2017a) show that if the income elasticity of WTP is below one – as assumed in the conjecture by Frank and Schlenker (2016) – societies with a more equal distribution of income have a higher mean WTP.<sup>5</sup> Indeed, empirically the income elasticity of WTP seems to be below unity in most cases (Drupp 2016; Kriström and Riera 1996), as it is the case for biodiversity conservation at the global level (Jacobsen and Hanley 2009).

Figure 1 illustrates this result. Consider a society of two households with different incomes: household *B* has a higher income,  $Y_B$ , than household *A* with income  $Y_A$ . WTP increases with income,  $Y$ , but at a decreasing rate, such as depicted by the solid black line. Thus, the income elasticity of WTP is below unity, as found in most empirical valuation studies. Now consider a reduction in income inequality that leaves society's mean income unchanged (a "Pigou-Dalton-transfer"): the income of the relatively richer household *B* is decreased by the amount  $\Delta Y$  to  $Y'_B$ , and the income of the relatively poorer household *A* is increased by the same amount  $\Delta Y$  to  $Y'_A$  but still the richer household *B* is better off  $Y'_B > Y'_A$ . An income elasticity of WTP for environmental public goods below unity implies that, with this change in the income distribution, the increase of  $WTP_A$  of the poorer household *A* is larger than the decrease in  $WTP_B$  of the richer household *B*. Thus, mean WTP in the more equal society,  $\overline{WTP'}$ , is higher than in the more unequal society  $\overline{WTP}$ , i.e.  $\Delta WTP = \overline{WTP'} - \overline{WTP} > 0$ .

In their theoretical analysis, Baumgärtner et al. (2017a) consider not only two households, but a whole distribution of incomes within a large society. Specifically, they assume that income is distributed log-normally within society. They show that while income inequality is important, mean WTP for environmental public goods changes more elastically with mean income than with income inequality except for extreme cases. Hence, the conjecture of Frank and Schlenker (2016) can be qualified as follows: Income elasticities below one imply that reductions in income inequality increase mean WTP, but changes in mean income have a relatively stronger effect. Baumgärtner et al. (2017a) further derive correction or transfer factors that allow controlling for the effect of income inequality on mean WTP for environmental public goods, such as for differences in income inequality in different societies, or between the current unequal income distribution and normatively desired ones. We discuss three implications of these findings in the following section.

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<sup>5</sup> Some environmental goods are likely to be complementary to human-made consumption goods. In this case, the mechanism would go in the opposite direction: redistribution towards a more equal society in income terms would imply a lower mean WTP for non-market environmental goods.

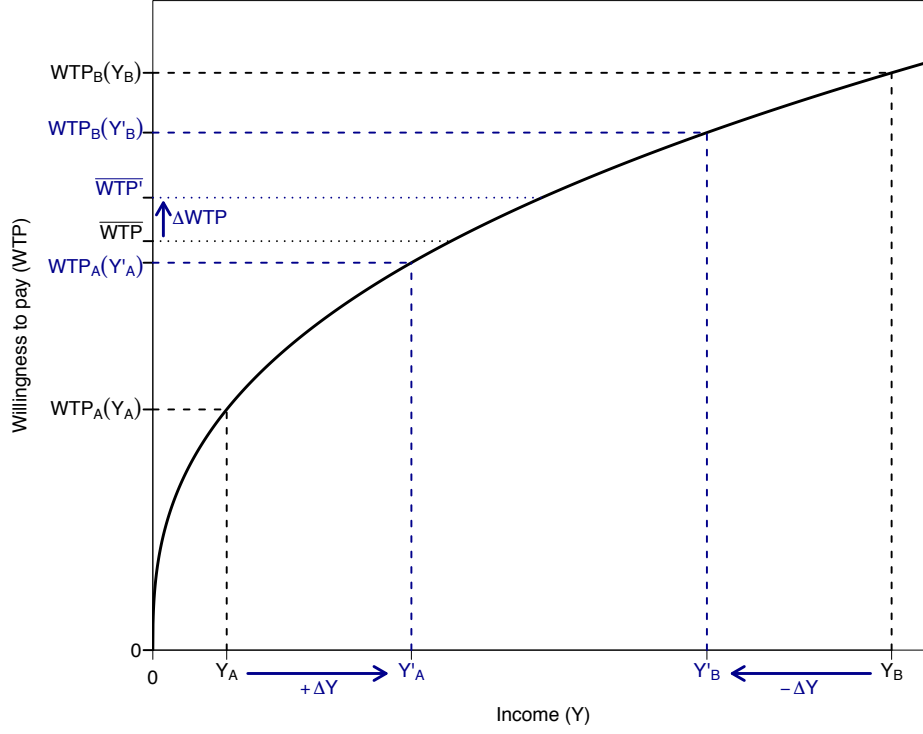


Figure 1: Income inequality affects mean willingness to pay (WTP) for environmental public goods of two households. Compared to a more unequal distribution of income ( $Y_A, Y_B$ ) with a mean WTP ( $\overline{WTP}$ ), a more equal distribution of income ( $Y'_A, Y'_B$ ) increases mean WTP ( $\overline{WTP}'$ ) for the same mean income ( $\Delta WTP = \overline{WTP}' - \overline{WTP} > 0$ ), if the income elasticity of WTP is below unity.

### 3. Implications

#### 3.1 Account for income inequality in value or benefit transfer

As conducting primary environmental valuation studies is time-consuming and costly, the transfer of environmental values from a study site to a policy site (“benefit transfer”) has become one of the most commonly used approaches for obtaining environmental values (Pearce et al. 2006; Richardson et al. 2015). Strictly speaking, it is only valid to perform benefit transfer if the study and the policy site are identical in all aspects that determine mean WTP for the environmental goods. However, in practice, benefit transfer is applied much more widely. It is therefore crucial to control for differences in important determinants of WTP in this process, including differences in the distribution of income. While a number of guidelines, such as in Germany (UBA 2012), the OECD (Pearce et al. 2006), and the UK (Defra 2007), already suggest how to account for differences in mean income, accounting for income inequality has been neglected so far. Baumgärtner et al. (2017a) theoretically derive closed-form benefit transfer factors to account for income inequality and show that WTP adjustments can be substantial.<sup>6</sup> Meya et al. (2017) empirically investigate the adjustment for income inequality in benefit transfer for a multi-country valuation study. They find that

<sup>6</sup> The transfer factor to adjust mean WTPs for differences in income inequality between a policy and a study site, with  $\overline{WTP}^{policy} = T_{cv}(\cdot) \times \overline{WTP}^{study}$ , is  $T_{cv}(CV_Y^{policy}, CV_Y^{study}) = \left( \frac{1 + CV_Y^{policy^2}}{1 + CV_Y^{study^2}} \right)^{\eta(\eta-1)/2}$ , where  $CV_Y^{policy}$  ( $CV_Y^{study}$ ) is the coefficient of variation of income at the policy (study) site, and  $\eta$  is the income elasticity of WTP.

adjusting for income inequality indeed increases the accuracy of benefit transfer considerably, and by more than 1.5 percentage points on average across all transfers studied.

These two studies suggest on theoretical and empirical grounds that benefit transfer studies should employ a transfer factor for differences in income inequality above and beyond controlling for differences in mean income. Likewise, this adjustment for differences in income inequality is relevant for scaling up mean WTP values from single sites or unrepresentative samples, to assess mean WTP for environmental goods of larger areas and actual society. An exemplary case is the assessment of the benefits from Natura 2000 sites (European Commission 2013), which covers more than 18 percent of European terrestrial territory. To estimate Europe-wide values for environmental goods from Natura 2000 sites, benefit estimates from only 34 values from 20 valuation studies were scaled up – controlling for differences in mean income but not for income inequality – to a total value of more than 300 billion euros per year.

### **3.2 Adjust mean WTPs for an undesired degree of income inequality**

Sustainability policy has the dual objective of allocative efficiency and distributive justice (Baumgärtner and Quaas 2010). While pursuing efficiency may require the monetary valuation of non-market environmental goods, we have shown in the previous section that economic distribution influences monetary valuation in turn. Environmental valuation and the distribution of income are thus intertwined and need to be studied simultaneously. For instance, if the societally desired degree of income inequality is different from the actual distribution, and if one pursues the dual objective of allocative efficiency and distributive justice, one must redistribute income for distributive justice, and for efficiency one must also adjust mean WTP estimates that were empirically estimated based on the current income distribution that was deemed unjust. For this purpose, one can employ the transfer factors derived for benefit transfer to adjust mean WTP estimates by using the societally desired level of income inequality instead of the existing one and then use the inequality-adjusted mean WTP estimates for social cost-benefit-analysis (Baumgärtner et al. 2017a). Such an adjustment can be substantial: Baumgärtner et al. (2017a) show that for the case of global mean WTP for biodiversity conservation it might lead to an increase in mean WTP of up to 16 percent for the extreme case when income inequality is undesired.

A related but different approach to account for distributional effects is the use of distributional weights (Adler 2016; Fleurbaey and Abi-Rafteh 2016), as, for example, applied in the UK Greenbook (HMT 2011) or in climate change policy appraisal (e.g. Anthoff et al. 2009).<sup>7</sup> Employing such distributional weights gives more importance to preferences of poorer households in social cost-benefit analysis. This may have a comparable effect as the use of the WTP-adjustment described above. Take the case of an income elasticity of WTP smaller than unity as an example. In this case, poorer households have an over-proportionally high individual WTP. If society's targeted level of income inequality is more equal than it is currently, the mean WTP adjustment as described above would increase mean WTP. Likewise, when employing distributional weights, those poorer households with an over-proportionally high individual WTP would matter more, the resulting effect would thus go in the same direction as the WTP adjustment. Yet, the adjustment mechanism is conceptually different. While the distributional or equity weighting literature assigns lower weights to some of the members of society in the measurement of total welfare, which entails taking a rather strong normative stance, mean WTP adjustment builds on a descriptive relationship between mean WTP and its determinants in society and would only lead to an adjustment of mean WTP if a society's distributional target implies a different level of income inequality than the current one.

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<sup>7</sup> In standard cost-benefit analysis all benefits and cost are weighted equally regardless to whom they accrue. In contrast, the distributional weights approach explicitly accounts for distributional effects by increasing the relative importance of cost and benefits accruing to lower income households through the introduction of distributional weights (Adler 2016).

### 3.3 Consider the incidence of non-market benefits from environmental policies

Public discourse and decision-making is often concerned with the distributional consequences (“incidence”) of environmental policies. Most studies focus on the incidence of different instruments for pollution control in environmental policy, often showing regressive effects of price instruments, like fuel and electricity taxes, or regulatory standards (Fullerton and Muehlegger 2017). This means that these policies put an over-proportionate burden on poorer households (Bento 2013; Fullerton 2011).<sup>8</sup> These findings have motivated the design of policy instruments with neutral or progressive distributional effects, such as through revenue recycling (Chiroleu-Assouline and Fodha 2014; Klenert et al. 2016). However, with few exceptions (e.g. Ebert 2003; Heal and Kriström 2007; Kriström and Riera 1996), this literature has so far ignored the distribution of non-market benefits resulting from environmental policies (Hsiang et al. 2017).

In order to gain an encompassing picture of how the design of environmental policies affects economic distribution it is important to not just look at the distribution of market costs of these policies, but to also consider the distribution of their non-market benefits. Indeed, our discussion on how the distribution of income affects mean WTP for environmental goods can contribute to understanding the distributional effects of environmental policy and environmental degradation. If, as in Figure 1, societies with a more equal distribution of income exhibit a higher mean WTP than more unequal societies, the non-market benefits of environmental policies are distributed regressively, and thus in contrast to most of their market-based costs, accrue in favor of poorer households. Yet, by the same token, losses of non-market benefits due to environmental degradation also fall over-proportionally on poorer households. Thus, even if net market benefits of environmental policies occur over-proportionally in favor of higher income groups,<sup>9</sup> the net distributional effect – when also the distributional effects of environmental benefits are considered – might be neutral or favor poorer households.

## 4. Perspectives for further research

While our discussion of the sparse existing literature has already highlighted the importance of considering economic distribution for environmental valuation, further research is needed to derive more robust conclusions and to broaden the scope of the analysis. In the following, we briefly sketch a number of pertinent open research areas.

First, more elaborate theories of environmental valuation and economic distribution are required that capture heterogeneous preferences and environmental goods that are not pure public goods. For example, different individuals may put different utility weights on environmental goods, or may differ in their willingness to substitute environmental goods with consumption goods. Of particular interest with regard to impure public goods may be the analysis of a coupled spatial distribution of environmental goods and housing, since hedonic pricing is a popular valuation method for local public goods. Relatedly, in the sectors of tourism and agriculture, the provisioning of local public environmental goods largely drives private market incomes. Particularly in those cases, valuation of environmental goods and distribution of incomes should be studied simultaneously.

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<sup>8</sup> There are only few studies that find that environmental policies do not put an over-proportionate burden on poorer households. For example, Bento et al. (2015) find that the benefits of air quality improvements in the United States from the 1990 Clean Air Act Amendments accrued over-proportionally to lower-income households.

<sup>9</sup> For example, because market-based environmental policies, such as fuel taxes, are frequently found to bring over-proportionate costs to poorer households (Fronzel et al. 2015), or because the monetary benefits associated with environmental policies, such as subsidies (renewable energy support, or payment for environmental goods), require a house or land ownership and thus over-proportionally benefit richer households (e.g. Haan and Simmler 2016).



Second, there is a need to study different concepts of economic resources that may be distributed unequally. For example, besides simple annual income, one may consider other measures of income, such as lifetime income or wealth (Heal and Kriström 2007; Teixidó and Verde 2017). Since sustainability concerns not only the distribution of resources within a generation at a given point in time, but in particular also questions of intergenerational justice, one should study the effect of relevant economic inequalities, such as inequalities in wealth or income from capital, on environmental values in a dynamic context.<sup>10</sup> Such a dynamic theory of environmental valuation and economic distribution should pay particular attention to a project's time horizon, as the economic distribution might change in the meantime (see Section 3.2). In such a case, not only the economic distribution at the start of the project will matter, but also its development over time. How to account for this in measures of equivalent or compensating variation is an open question.

Third, one may consider the effect on the valuation and value of environmental goods of an unequal distribution in other 'resources' than economic ones, such as power and political influence (Boyce 1994; Boyce et al. 1999). Also, one may consider how inequality in power and political influence affects the design of institutions, which can be viewed as determining the outcome of environmental valuation (Vatn 2009). While economic valuation may form a starting point for such analyses, such approaches will have to draw on other research methods as well.

Fourth, further research should also depart from the standard assumption of atomistic, self-regarding economic agents and take into account behavioral effects as pertaining to inequality and environmental valuation, such as through other-regarding preferences. This may include, for example, investigating both theoretically and experimentally the roles of inequality aversion or relative consumption concerns (Broberg 2014; Johannsson-Stenman and Konow 2010; Johannsson-Stenman and Sterner 2015). Previous research has shown that the incidence and thus the distributional impacts of environmental policies may influence individual valuation of nature if people have other-regarding preferences (Cai et al. 2010). Considering behavioral effects could thus reinforce the importance of income inequality for the value a society attaches to environmental goods.

Fifth, since sustainability economics has to deal with multiple market and government failures, it is not unreasonable to assume that much of environmental policy and actual environmental valuation are conducted in second-best settings. Thus, due to constraints it may not be possible to achieve the dual objective of allocative efficiency and distributive justice. For example, it could be that there are certain barriers to implementing a desired degree of income inequality.<sup>11</sup> Future research should examine if and how mean WTP should be adjusted for income inequalities in such circumstances.

Sixth, it is an open question how the distribution of economic resources affects the value of environmental goods as elicited through alternative (that is: non welfare-economic) valuation approaches, such as deliberative monetary valuation, democratic valuation or other participatory valuation methods (e.g. Lienhoop et al. 2015; Schläpfer 2016; Spash 2007).

Seventh, while we have mainly discussed the implication of economic distribution on environmental valuation, a comprehensive reflection on the interplay between the two should study whether environmental valuation might in turn affect the economic distribution (Corbera 2015; Matulis 2014, 2015).

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<sup>10</sup> This relates to the literature on discounting and economic inequality (e.g. Gollier 2015; Emmerling et al. 2017; Emmerling 2017), as well as on dual discounting and the relative price of environmental goods (Baumgärtner et al. 2015; Drupp 2016; Gollier 2010; Hoel and Sterner 2007; Sterner and Persson 2008; Weikard and Zhu 2005; Traeger 2011).

<sup>11</sup> For example, it may be that actual redistribution of income is lower than what society's inequality aversion would suggest to incentivize richer households to exert more work effort, or that distributional effects resulting from environmental policies are in practice not offset by changes to the general redistribution scheme. A number of studies, such as Barrage (2016), accordingly model distinct social planners for environmental management and general tax policy.

Finally, there is a need for better data on the relationship between economic distribution and environmental valuation. In particular, better estimates of income elasticities of WTP for environmental goods are required to more robustly investigate the finding that the benefits of environmental goods are distributed in favor of poorer households and qualify the conditions under which this is indeed the case. For example, it may well be that the income elasticity of WTP varies across goods. Poorer households may value environmental goods related to local recreation over-proportionally, while richer households may value the preservation of certain species or cultural ecosystem services over-proportionally. This necessitates more and better data on income elasticities across different goods and services as well as across countries. Further, it requires systematic studies that assess to what degree income effects captured in environmental valuation studies are indeed informative of income elasticities of WTP for environmental goods or relate to confounding factors such as warm glow and strategic behavior etc. (e.g. List 2017; Schläpfer 2008). Lastly, this calls for more theoretical and empirical work that allows judging whether income elasticities of WTP for environmental goods are constant or whether they systematically vary with income.<sup>12</sup>

## 5. Conclusions

How to value the non-market benefits of environmental policies is a crucial yet contested research endeavor. The challenge of sustainability sets further requirements on this endeavor in demanding that distributional considerations are adequately addressed. We have highlighted that the distribution of economic resources within society, notably income inequality, affects the value society attaches to public environmental goods. We find that it is crucial to consider distributional impacts not only because this is called for from a sustainability economics perspective, but because it carries important implications for environmental valuation and management already from a standard economics perspective concerned with allocative efficiency.

We have argued that while a lot more research is needed, some first clear findings emerge on how the distribution of income affects the societal value of nature. If individual WTP increases less (more) than proportionally with income, a reduction in income inequality will lead to an increase (decrease) of the mean and aggregate WTP a society attaches to public environmental goods. Given this relationship between mean WTP and income inequality, already standard valuation approaches can and should explicitly account for economic distribution. In particular, three important implications for environmental valuation, policy and management emerge: First, as the distribution of income affects mean WTP, studies that transfer environmental values from some population to another – may it be in international benefit transfer or for scaling-up environmental values from an unrepresentative sub-population – should account for how income inequality affects WTP. Second, given the dual objective of distributive justice and allocative efficiency in sustainability economics, existing mean WTP estimates should be adjusted according to the targeted degree of income inequality when informing regulatory bodies using cost-benefit analysis. This would likely result in an increase of the estimated benefits society derives from the public-good type services provided by nature. Third, an encompassing assessment of distributional effects of environmental policies has to account not only for direct monetary cost and benefits, but also for the distribution of non-market benefits of environmental goods. While the market-based costs of environmental policies are often deemed to favor higher-income households, our discussion has shown that non-market benefits might indeed over-proportionally favor poorer households. As distributional implications are often used as an argument against more stringent environmental policies, it is particularly crucial to consider this pro-poor distribution of non-market benefits, which may provide a further argument for more stringent environmental policies.

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<sup>12</sup> There is some empirically evidence that income elasticities are non-constant (e.g. Barbier et al. 2016). This could be due to a range of circumstances that are not captured in the simple workhorse model of a constant-elasticity-of-substitution utility function, including subsistence consumption (Baumgärtner et al. 2017b; Drupp 2016).

## References

- Adler, M.D. (2016). Benefit–cost analysis and distributional weights: An overview. *Review of Environmental Economics and Policy*, 10(2), 264-285.
- Anthoff, D., Hepburn, C., and Tol, R.S. (2009). Equity weighting and the marginal damage costs of climate change. *Ecological Economics*, 68(3), 836-849.
- Atkinson, G., and Mourato, S. (2008). Environmental cost-benefit analysis. *Annual review of environment and resources*, 33, 317-344.
- Barbier, E.B., Baumgärtner, S., Chopra, K., Costello, C., Duraiappah, A., Hassan, R., Kinzig, A.P., Lehman, M., Pascual, U., Polasky, S. and Perrings, C. (2009). The valuation of environmental goods, in: Naeem, S., Bunker, D.E., Hector, A., Loreau, M., and Perrings, C. (eds), *Biodiversity, Ecosystem Functioning, and Human Wellbeing*, Oxford University Press, Oxford, pp. 248-262.
- Barbier, E.B., M. Czajkowski and N. Hanley (2016). Is the income elasticity of the willingness to pay for pollution control constant? *Environmental and Resource Economics*, doi: 10.1007/s10640-016-0040-4.
- Bateman, I.J., Harwood, A., Mace, G.M., Watson, R., Abson, D.J., Andrews, B., Binner, A., Crowe, A., Day, B.H., Dugdale, S., Fezzi, C., Foden, J., Haines-Young, R., Hulme, M., Kontoleon, A., Lovett, A.A., Munday, P., Pascual, U., Paterson, J., Perino, G., Sen, A., Siriwardena, G., van Soest, D., and Termansen, M. (2013). Bringing environmental goods into economic decision making: land use in the UK. *Science*, 341 (6141), 45–50.
- Barrage, L. (2016). Be careful what you calibrate for: Social discounting in general equilibrium. Working Paper.
- Baumgärtner, S., Klein, A.-M., Thiel, D. and Winkler, K. (2015). Ramsey Discounting of Ecosystem Services. *Environmental and Resource Economics*, 61(2), 273-296.
- Baumgärtner, S., Drupp, M.A., Munz, J.M., Meya, J.N., and Quaas, M.F. (2017a). Income inequality and willingness to pay for environmental public goods. *Journal of Environmental Economics and Management*, 85, 35–61.
- Baumgärtner, S., Drupp, M.A. and Quaas, M.F. (2017b). Subsistence, substitutability and sustainability in consumption, *Environmental and Resource Economics*, 67(1), 47-66.
- Baumgärtner, S. and M.F. Quaas (2010). What is sustainability economics? *Ecological Economics* 69(3), 445-450.
- Bento, A.M. (2013). Equity impacts of environmental policy. *Annual Review of Resource Economics* 5(1), 181-196.
- Bento, A., Freedman, M., and Lang, C. (2015). Who benefits from environmental regulation? Evidence from the clean air act amendments. *Review of Economics and Statistics*, 97(3), 610-622.
- Boyce, J.K. (1994). Inequality as a cause of environmental degradation. *Ecological Economics*, 11(3), 169-178.
- Boyce, J.K., Klemer, A. R., Templet, P. H., and Willis, C. E. (1999). Power distribution, the environment, and public health: A state-level analysis. *Ecological Economics*, 29(1), 127-140.
- Broberg, T. (2014). Relative Income and the WTP for Public Goods—A Case Study of Forest Conservation in Sweden. *CERE Working Paper* 2014: 6.
- Butchart, S., Walpole, M., Collen, B., van Strien, A. J. Scharlemann, E. Almond, ..., and Watson, R. (2010). Global biodiversity: Indicators of recent declines. *Science*, 328(5982): 1164-1168.
- Cai, B., Cameron, T.A. and Gerdes, G.R. (2010). Distributional preferences and the incidence of costs and benefits in climate change policy. *Environmental and Resource Economics*, 46(4), 429-458.
- Chiroleu-Assouline, M. and Fodha, M. (2014). From regressive pollution taxes to progressive environmental tax reforms. *European Economic Review*, 69, 126-142.

- Corbera, E. (2015). Valuing nature, paying for environmental goods and realizing social justice: a response to Matulis (2014). *Ecological Economics*, 110, 154-157.
- Costanza, R. (1989). What is ecological economics? *Ecological Economics*, 1(1), 1-7.
- [Defra 2007] Department for Environment, Food and Rural Affairs (2007). An introductory guide to valuing environmental goods. London: Department for Environment, Food and Rural Affairs.
- Diamond, P.A., and Hausman, J.A. (1994). Contingent valuation: Is some number better than no number?. *The Journal of Economic Perspectives*, 8(4), 45-64.
- Drupp, M.A. (2016). Limits to substitution between environmental goods and manufactured goods and implications for social discounting. *Environmental and Resource Economics*, doi: 10.1007/s10640-016-0068-5.
- Ebert, U. (2003). Environmental goods and the distribution of income, *Environmental and Resource Economics*, 25(4), 435-459.
- Emmerling, J., Groom, B., and Wettingfeld, T. (2017). Discounting and the representative median agent. *Economics Letters*, 161, 78-81.
- Emmerling, J. (2017). Discounting and intragenerational equity. *Environment and Development Economics*, doi 10.1017/S1355770X17000365.
- European Commission (2013). *The Economic Benefits of the Natura 2000 Network*. Synthesis report. Luxembourg: Publications Office of the European Union.
- Fleurbaey, M. and Abi-Rafeh, R. (2016). The use of distributional weights in benefit–cost analysis: Insights from welfare economics. *Review of Environmental Economics and Policy*, 10(2), 286-307.
- Frank, E.G. and Schlenker, W. (2016). Balancing economic and ecological goals. *Science*, 353(6300), 651–652.
- Freeman, III, A.M. (2003). *The Measurement of Environmental and Resource Values. Theory and Methods*. Second edition. Resources for the Future, Washington D.C.
- Frondel, M., Sommer, S., and Vance, C. (2015). The burden of Germany’s energy transition: an empirical analysis of distributional effects. *Economic Analysis and Policy*, 45, 89-99.
- Fullerton, D. (2011). Six distributional effects of environmental policy. *Risk Analysis*, 31(6): 923-929.
- Fullerton, D., and Muehlegger, E. (2017). Who Bears the Economic Costs of Environmental Regulations? *NBER Working Paper* No. 23677.
- Gollier, C. (2010). Ecological discounting. *Journal of Economic Theory*, 145, 812-829.
- Gollier, C. (2015). Discounting, inequality and economic convergence. *Journal of Environmental Economics and Management*, 69, 53-61.
- Haan, P., and Simmler, M. (2016). Wind Electricity Subsidies = Windfall Gains for Land Owners? Evidence from Feed-In Tariff in Germany. *DIW Berlin Discussion Paper* No. 1568.
- Heal, G., and Kriström, B. (2007). Distribution, sustainability and environmental policy. In: Atkinson, G., Dietz, S. and Neumayer, E. (eds), *Handbook of Sustainable Development*, Edward Elgar Publishing Ltd, Cheltenham, UK and Northampton, USA, 155-170.
- Hoel, M. and Sterner, T. (2007). Discounting and relative prices. *Climatic Change*, 84, 265-280.
- Hsiang, S., Oliva, P., and Walker, R. (2017). The Distribution of Environmental Damages, *NBER Working Paper* No. 23882.

- [HMT 2011] Her Majesty's Treasury (2011). The Green Book. Appraisal and Evaluation in Central Government. London: TSO. 114 pp.
- IMF (2017). Understanding the downward trend in labor income shares In: World Economic Outlook, April 2017: Gaining Momentum? <http://www.imf.org/en/Publications/WEO/Issues/2017/04/04/world-economic-outlook-april-2017#Chapter%203>
- Jacobsen, J. and Hanley, N. (2009). Are there income effects on global willingness to pay for biodiversity conservation? *Environmental and Resource Economics*, 43(2), 137-160.
- Johansson-Stenman, O. and Konow, J. (2010). Fair air: distributive justice and environmental economics. *Environmental and Resource Economics*, 46(2), 147-166.
- Johansson-Stenman, O., and Sterner, T. (2015). Discounting and relative consumption. *Journal of Environmental Economics and Management*, 71, 19-33.
- Klenert, D., Schwerhoff, G., Edenhofer, O., and Mattauch, L. (2016). Environmental Taxation, Inequality and Engel's Law: The Double Dividend of Redistribution. *Environmental and Resource Economics*, doi: 10.1007/s10640-016-0070-y.
- Kling, C.L., Phaneuf, D.J., and Zhao, J. (2012). From Exxon to BP: Has some number become better than no number? *Journal of Economic Perspectives*, 26(4), 3-26.
- Krström, B., and Riera, P. (1996). Is the income elasticity of environmental improvements less than one? *Environmental and Resource Economics*, 7(1), 45-55.
- Lienhoop, N., Bartkowski, B., and Hansjürgens, B. (2015). Informing biodiversity policy: the role of economic valuation, deliberative institutions and deliberative monetary valuation. *Environmental Science & Policy*, 54, 522-532.
- List, J.A. (2017). Behavioral economics and the environment. *Keynote lecture at the 19th Annual International BIOECON conference*, Tilburg, 22.09.2017.
- Matulis, B.S. (2014). The economic valuation of nature: A question of justice? *Ecological Economics*, 104, 155-157.
- Matulis, B. S. (2015). Valuing nature: A reply to Esteve Corbera. *Ecological Economics*, 110, 158-160.
- [MEA 2005] Millennium ecosystem assessment (2005): ecosystems and human well-being: Biodiversity synthesis, Published by World Resources Institute, Washington, DC.
- Meya, J.N., Drupp, M.A., and Hanley, N. (2017). Income inequality and the international transfer of environmental values. *Kiel Economics Working Paper No 2017-03*.
- OECD (2016). Income inequality remains high in the face of weak recovery. <https://www.oecd.org/social/OECD2016-Income-Inequality-Update.pdf>
- Pascual, U., Balvanera, P., Díaz, S., Pataki, G., Roth, E., Stenseke, M., Watson, R.T., Dessane, E.B., Islar, M., Kelemen, E., Maris, V., Quaas, M.F., Subramanian, S.M., Wittmer, H., Adlan, A., Ahn, S., Al-Hafedh, Y.S., Amankwah, E., Asah, S.T., Berry, P., Bilgin, A., Breslow, S.J., Bullock, C., Cáceres, D., Daly-Hassen, H., Figueroa, E., Golden, C.D., Gómez-Baggethun, E., González-Jiménez, D., Houdet, J., Keune, H., Kumar, R., Ma, K., May, P.H., Mead, A., O'Farrell, P., Pandit, R., Pengue, W., Pichis-Madruga, R., Popa, F., Preston, S., Pacheco-Balanza, D., Saarikoski, H., Strassburg, B.B., van den Belt, M., Verma, M., Wickson, F., and Yagi, N. (2017). Valuing nature's contributions to people: the IPBES approach. *Current Opinion in Environmental Sustainability*, 26, 7-16.
- Pearce, D., Atkinson, G. and S. Mourato, S. (2006), Cost-benefit analysis and the environment: recent developments, Organisation for Economic Co-operation and Development(OECD).

- Piketty, T. (2014). *Capital in the twenty-first century*, Cambridge, MA: The Belknap Press of Harvard University Press. University College London.
- Pimm, S.L., Jenkins, C. N., Abell, R., Brooks, T.M., Gittleman, J.L., Joppa, L.N., Roberts, C.M. and Sexton, J.O. (2014). The biodiversity of species and their rates of extinction, distribution, and protection. *Science*, 344(6187).
- Richardson, L., Loomis, J., Kroeger, T. and Casey, F. (2015). The role of benefit transfer in ecosystem service valuation, *Ecological Economics* 115: 51–58.
- Schläpfer, F. (2008). Contingent valuation: a new perspective. *Ecological Economics*, 64(4), 729-740.
- Schläpfer, F. (2016). Democratic valuation (DV): Using majority voting principles to value public services. *Ecological Economics*, 122, 36-42.
- Spash, C.L. (2007). Deliberative monetary valuation (DMV): Issues in combining economic and political processes to value environmental change. *Ecological Economics*, 63(4), 690-699.
- Sterner, T., and Persson, M. (2008). An even sterner review: introducing relative prices into the discounting debate. *Review of Environmental Economics and Policy*, 2(1): 61-76.
- Stiglitz, J. E., Sen, A., and Fitoussi, J.P. (2010). *Report by the Commission on the Measurement of Economic Performance and Social Progress*. Paris: Commission on the Measurement of Economic Performance and Social Progress.
- Teixidó, J.J., and Verde, S.F. (2017). Is the gasoline tax regressive in the twenty-first century? Taking wealth into account. *Ecological Economics*, 138, 109-125.
- Traeger, C.P. (2011). Sustainability, limited substitutability, and non-constant social discount rates. *Journal of Environmental Economics and Management*, 62(2), 215-228.
- [UBA 2012] Umweltbundesamt (2012). Methoden der ökonomischen Bewertung. Anhang A der “Methodenkonvention 2.0 zur Schätzung von Umweltkosten”, Dessau-Roßlau: Umweltbundesamt.
- Vatn, A. (2009). An institutional analysis of methods for environmental appraisal. *Ecological Economics*, 68(8), 2207-2215.
- Weikard, H.-P., and Zhu, X. (2005). Discounting and environmental quality: when should dual rates be used?. *Economic Modelling*, 22, 868-878.