

Christian-Albrechts-Universität zu Kiel

**Essays in Sustainability Economics:  
Economic Distribution and Valuation,  
Environmental Scarcity,  
and Ethical Behavior**

Inaugural-Dissertation

zur Erlangung des akademischen Grades eines Doktors  
der Wirtschafts- und Sozialwissenschaften  
der Wirtschafts- und Sozialwissenschaftlichen Fakultät  
der Christian-Albrechts-Universität zu Kiel

vorgelegt von

Moritz Alexander Drupp, M.Sc.

aus Dortmund

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# 1 Introduction to the Dissertation

*“Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs. It contains within it two key concepts:*

- the concept of ‘needs’, in particular the essential needs of the world’s poor, to which overriding priority should be given; and*
- the idea of limitations imposed by the state of technology and social organization on the environment’s ability to meet present and future needs.”*

— (WCED 1987)

My motivation to pursue doctoral studies derived from the quest of contributing to a societal development that is in accord with the vision of sustainability as set out in the famous definition of the Brundtland Commission quoted above. This requires a better understanding of the determinants of, barriers to and possibilities for a sustainable development. My research activities are therefore driven by the mounting sustainability challenges that our societies face, resulting from the inefficient and unjust distribution of economic resources and opportunities over space and time. Some key challenges of particular importance for environmental and resource economics include climate change and the widespread loss of ecosystem services (IPCC 2014a, Millennium Ecosystem Assessment 2005).

This doctoral thesis is based on six individual research articles and contributes to different strands of the economics literature, among others to environmental and resource economics, ecological economics, public economics, as well as behavioural and experimental economics. First and foremost, however, I see the thesis contributing to the emerging research area of *sustainability economics* (Baumgärtner and Quaas 2010: 477), which addresses the question of how researchers and society can “*understand and manage the relationships between humans and nature over the long run so that scarce natural resources, goods and services, as well as their human-made substitutes and complements, are being used efficiently for the satisfaction of human needs and wants and in a just manner?*”. Herein, justice includes at least intra- and intergenerational justice among humans within and across generations, and may also

include justice towards the non-human nature. With its systemic perspective on the long-term relationships between humans and nature, and with its explicit normative footing, sustainability economics represents an ambitious endeavour at and beyond the intersection of different disciplinary boundaries, such as economics, philosophy, psychology and natural sciences. The challenges set out in the research agenda on sustainability economics are not only intellectually fascinating, but finding satisfactory answers to them is necessary for the prospering of the manifold beings that populate this planet.

Given the immensity of these sustainability challenges, no single academic paper or thesis can do them full justice. Instead of focussing on practical solutions on how to tackle, for instance, climate change, this thesis contributes to a better understanding of these sustainability challenges and general approaches to addressing them. Specifically, I address some core aspects of the broader research agenda on sustainability economics. Chapter 2 studies how the economic valuation of non-marketed environmental goods depends on the distribution of income within a society, thus speaking to the intra-generational dimension of the human-nature relationship. Chapter 3, in turn, is concerned with allocative and distributive issues across generations. Specifically, it examines how society should allocate costs and benefits of public projects, such as those aimed at mitigating climate change, over time. Furthermore, chapters 4 and 5 address the role of “*essential needs*” and “*limitations*” by studying to what degree scarce environmental goods and services indeed have human-made substitutes and complements if one takes subsistence consumption into consideration.

While these four chapters perhaps rather evidently contribute to genuine sustainability economic research questions, the relation of the two final chapters to this research agenda is more indirect. They can be regarded as contributing to the ontology of sustainability economics, by studying the notion of what constitutes a human being. While much of the economic literature builds on the idea of humans being well-described by the concept of homo oeconomicus, recent years have seen a strong surge in research on other-regarding preferences and norm-based behaviour, including inequality aversion, honesty, altruism etc. (see, e.g., Fehr and Fischbacher 2002; Levitt and List 2007). Chapters 6 and 7 make use of economic experiments to study

ethical behaviour of both fishermen and scientists, with a specific focus on honesty and truth-telling. While a better understanding of the behaviour of fishermen is directly relevant to the management of an important common pool resource, the question of whether scientists tell the truth is of fundamental importance for science at large and perhaps even more so for sustainability economics. The reason is that sustainability economics sees itself as a “relevant science” (Baumgärtner and Quaas 2010: 447) that not only follows a cognitive interest, but also a direct action or management interest in facilitating a transition towards a sustainable development. Scientific advice giving may therefore be even more crucial as compared to other scientific subfields. Correspondingly, the question to what degree the public can trust the knowledge derived in the scientific process becomes more prevalent.

In the following, I briefly introduce each chapter separately and provide an account of their publication status, co-authorship as well as my own contribution.<sup>1</sup>

Chapter 2, titled “**Income Inequality and Willingness to Pay for Environmental Public Goods**”, addresses the question of how the distribution of income within a society affects the economic valuation of environmental public goods, as measured in terms of societal mean willingness to pay (WTP) for environmental goods.

A fundamental challenge for environmental economics is that many environmental goods and services do not have established market prices as signals of their relative scarcity. The valuation of non-market-traded environmental goods, often by means of estimating WTP based on survey studies, has therefore become a major research area within environmental and ecological economics, yielding data that is much sought-after for informing environmental management decisions.<sup>2</sup> Given its importance for policy decisions, it is crucial to improve valuation methods as well as to study the determinants of WTP for environmental goods. While individual or mean income is often found to be a key determinant of WTP, the role of the distribution of income has been—with the exception of a seminal study by Ebert (2003)—largely ignored. But income inequality may be an important determinant of societal mean WTP. Frank and Schlenker (2016: 652) even conjecture that “*the income distribution might [...] be*

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<sup>1</sup>As much time and thought has been devoted to fine-graining formulations in the individual chapters, I will extensively draw directly on their content in describing them here.

<sup>2</sup>See, e.g., Atkinson and Mourato (2008) or Pearce et al. (2006).

*as important as overall economic growth*” for the valuation of environmental goods.

Chapter 2 sheds light on this conjecture using both theory and empirics. We build on a widely-used theoretical modelling framework with constant-elasticity-of-substitution preferences regarding a market-traded private consumption good and a non-market-traded pure public environmental good, and further assume that income is distributed log-normally. We show that social WTP for environmental goods decreases (increases) with income inequality if and only if environmental goods and manufactured goods are substitutes (complements). Furthermore, we find that – except for extreme cases – mean WTP changes more elastically with mean income than with income inequality. Based on this analysis, we derive adjustment factors for the transfer of estimated (environmental) values from one context to another (so called “benefit transfer”) that allow controlling for differences in income distributions between a study site and a policy site. For illustration, we quantify how social WTPs for environmental public goods depend on the respective income distributions for empirical case studies in Sweden and the World at large.

Our results are relevant in several respects. First, for benefit transfer, one should correct WTP-estimates for differences in both mean income and income inequality. We provide ready-to-use adjustment factors for this purpose. With data from empirical case studies we demonstrate that the size of this adjustment may be considerable: for example, a WTP-transfer for biodiversity conservation from a global case study with high income inequality to a society with relatively low income inequality, such as Sweden, would entail a WTP correction for income inequality of more than ten percent. In a subsequent, Jasper N. Meya, Nick Hanley and I (Meya et al. 2017) have explored this implication for benefit transfer in more detail drawing on a multi-country case study on valuing water quality improvement in the Baltic Sea. We find that income inequality adjustment reduces benefit transfer errors significantly, and by 1.5 percentage points on average across all transfers.

Second, when giving policy recommendations aimed at both allocative efficiency and distributive justice (*“sustainability policy”*), the effect of the income distribution on WTP has to be known. Assessment of allocative efficiency may require monetary valuation of non-market goods, while the distribution of income influences this

monetary valuation in turn. The two aspects are thus mutually interlinked and need to be studied and addressed simultaneously. For instance, one may correct WTP-estimates for unjust income inequality, and use inequality-corrected WTP-estimates for cost-benefit-analysis. In the case of global WTP for biodiversity conservation this adjustment might lead to an increase in WTP of up to 16 percent, depending on the (in-)equality preferences of society.

Finally, the analysis is relevant for the discussion of distributional implications of environmental policies. Media attention and much of research has focussed on the regressive (market-based) effects of environmental policies, i.e. that the burden of many environmental policies falls over-proportionally on the poorer members of society.<sup>3</sup> However, a comprehensive evaluation of the distribution of costs and benefits of environmental policies has to take the incidence of non-market effects into account. Our analysis implies that—for the empirically relevant case of a substitutive relationship between environmental goods and market-trade consumption goods (see chapter 5)—non-market benefits occur over-proportionally to poorer households. Overall, this suggests that intra-temporal equity concerns regarding the introduction of environmental policies may be over-stated in previous discussions and stresses the importance of considering distributional effects in a holistic fashion.

Chapter 2 is joint with work Stefan Baumgärtner, Jasper N. Meya, Jan M. Munz and Martin F. Quaas. This chapter has been published in the *Journal of Environmental Economics and Management*. I have contributed substantially to this paper during all major stages of the research process, including the initial design of the research question, the development of the modeling framework and deriving results, and, in particular, the design and execution of the empirical analysis as well as writing and revising the paper.

Chapter 3, titled “**Discounting Disentangled**”, reports the results of a survey of more than 200 experts on “*one of the most critical problems in all of economics*” (Weitzman 2001: 260) about which there has been a great deal of disagreement: the long-term social discount rate (SDR). The main reason why there has been such avid disagreement among experts in the past is that the economic values of investing in

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<sup>3</sup>See, e.g., Wier et al. (2005) for an analysis of the incidence of carbon taxation in Denmark.



long-term public projects, such as climate change mitigation, are highly sensitive to the SDR (Nordhaus 2007, Stern 2007). Making progress on how to appropriately take into account the interests of future generations in today’s decision-making is of utmost importance for sustainability. Yet, aside from these well-publicized cases, we lack a good understanding of the extent and the sources of this disagreement.

A key innovation of our survey is that we elicit information on fundamental determinants of the SDR, which allows us to disentangle the main sources of disagreement. To do this in a parsimonious manner, we structure the survey around a well-known framework for inter-temporal welfare evaluations: the simple Ramsey Rule. Specifically, we elicit expert responses on two key components of the SDR: the pure rate of time preference and the elasticity of marginal utility. In addition to these “*central normative parameters*” (Nordhaus 2008: 33), we ask experts to estimate growth and the risk-free rate of interest. In this way, we obtain information on both positive and normative arguments for the SDR (Arrow et al. 1996, 2012). However, we allow sufficient flexibility for experts not to be constrained by the simple Ramsey Rule when making their recommendations on the SDR. The experts’ acceptable ranges for the SDR are also elicited, which allows an examination of whether there is any space for agreement on discounting.

The responses make for interesting reading. The median (mean) recommended SDR of our experts is 2 percent (2.3 percent). Despite considerable disagreement on discounting procedures and point values for the SDR, we obtain a surprising degree of consensus among experts, with more than three-quarters finding the median SDR of 2 percent acceptable. The disentangled data we elicit also allow us to shed some light on which approaches to social discounting experts use. We show that the simple, deterministic Ramsey Rule, which is found in governmental guidelines on cost-benefit analysis across the world, such as in the guidelines by the German Environmental Protection Agency (UBA 2012), cannot explain the responses of most of our experts. The rich body of qualitative responses we received support the conclusion that more complex models for social discounting are required. Specifically, many respondents provided comments relating to a number of extensions and alternatives to the simple Ramsey Rule approach. These include issues such as uncertainty, relative prices of

non-marketed environmental goods as well as other societal evaluation approaches that policy guidance on social discounting should consider to ensure efficient and equitable decisions on long-term public projects.

Overall, our findings lead us to the conclusion that the prominence of the Ramsey Rule needs to be revisited and that much of current policy guidance concerning social discounting and the evaluation of long-term public projects requires updating. Our survey points to a long-term global SDR for certainty-equivalent cash flows of 2 percent. This SDR is lower than recommended by many governments around the world and prominent experts (Nordhaus 2008, Weitzman 2001).

By presenting the responses of a large number of experts on the determinants of the long-term SDR, this chapter provides detailed information for the discounting policy revisions taking place in several countries. We are therefore very pleased that a number of governments, such as those in Cyprus, the Netherlands and the UK, have already found our data and findings to be of interest when revising their guidelines.

Our study also provides impetus for further research in several directions. First, a crucial question in the face of the heterogeneous responses to our survey is what rate to use when discounting the certainty-equivalent cash flows from an intergenerational project. Deciding how best to adjudicate between conflicting opinions, and aggregate different forecasts, is a contentious issue to which no single accepted answer exists (e.g. Weitzman 2001; Freeman and Groom 2015; Heal and Millner 2014). Our disentangled data enable a clearer treatment of this challenge as it better allows dealing with disagreement on value judgments or uncertainty about forecasts, which Weitzman's (2001) survey data confounded in a single SDR. This has opened new research on combining expert opinion that makes use of our survey data (Drupp et al. 2017; Millner and Heal 2017; Millner 2016).

Second, one may ask: what have economists to say about the ethical implications that are embodied in addressing the question of how to determine intergenerational decision-making? Indeed, economists do not command a special ethical expertise and it is therefore a crucial question how representative the views of economic experts are for other groups of experts from related disciplines as well as the general public. On-going work thus, for instance, examines the views of expert philosophers.

Finally, experts have reported a number of specific extensions of the simple discounting framework of the Ramsey Rule. Chapter 5 will study in more detail one of the suggestions, specifically addressing the role of limited substitutability and the relative price of environmental goods for social discounting.

Chapter 3 is joint work with Mark C. Freeman, Ben Groom and Frikk Nesje. It has appeared as a *Grantham Research Institute on Climate Change and the Environment Working Paper* No. 172 at the London School of Economics and Political Science, and has been revised for and resubmitted to the *American Economic Journal: Economic Policy*. I proposed the research idea and have substantially contributed to this paper during all major stages, including the development of the survey and its execution, the empirical analysis, as well as writing and revising the paper.

Chapter 4, titled “**Subsistence, Substitutability and Sustainability in Consumer Preferences**”, contributes to the theory of sustainability economics. It develops a conceptual framework to examine the effect of a subsistence requirement in the consumption of environmental goods on substitutability between manufactured goods and environmental services as well as on the conditions for a sustainable development. It thereby incorporates the notion of “*essential needs, [...] to which overriding priority should be given*” (WCED 1987) into the economic theory of sustainability.

Much of the previous literature on sustainability has been set in a simple constant-elasticity-of-substitution (CES) framework. This has led to the prevalent distinction between weak and strong sustainability as two ‘opposing paradigms’ (Neumayer 2010). In this CES-framework, substitutability is determined by an exogenous parameter, and can take any value between perfect complements (a CES of zero) and perfect substitutes (a CES of infinity), where the Cobb-Douglas case of a CES value of unity marks the threshold between weak and strong sustainability. However, it is unreasonable that the elasticity of substitution between environmental and manufactured goods is constant in general, which calls into question this clear-cut distinction between weak and strong sustainability. Heal (2009a,b) therefore proposes to introduce a “*minimum level of ecosystem services needed for survival*” into the analysis and conjectures that in such a case “*the elasticity of substitution is not constant but depends on and increases with welfare levels*”.

This chapter generalizes and formalizes the conjecture by Heal (2009a,b) and explores its implications for the economics of sustainability. We find that the Hicksian elasticity of substitution is indeed non-constant and, above the subsistence threshold, strictly monotonically increases with the consumption of the environmental subsistence good or income. However, whether or not the goods are market substitutes does not only depend on the Hicksian elasticity of substitution but also on the level of income and the subsistence requirement. In a subsequent step, we apply this subsistence model to the analysis of optimal and sustainable use of a renewable natural resource. We find that a subsistence requirement may jeopardize the existence of an optimal consumption path that is also sustainable in the sense of non-declining utility over time and consumption being above the subsistence requirement.

The findings of this chapter are relevant first and foremost for the discussion on sustainability. It can offer new insights as its framework allows bridging the gap between the two opposing paradigms of weak and strong sustainability. Specifically, in a world of plenty, environmental goods are substitutable and weak sustainability may be the appropriate paradigm. However, in a world where environmental goods are in short supply, they may rather be considered complements to manufactured consumption goods, which calls for a strong sustainability approach. As such, this conceptual contribution can become relevant for environmental appraisal and management.

Chapter 4 is joint work with Stefan Baumgärtner and Martin F. Quaas and has been published in *Environmental and Resource Economics*. I have substantially contributed to this paper during all major stages of the research process. With input from Stefan Baumgärtner and Martin F. Quaas, I produced a first draft of the paper, which included the development of the modeling framework and its analysis, and have also contributed considerably to revising the paper.

Chapter 5, titled “**Limits to Substitution between Ecosystem Services and Manufactured Goods and Implications for Social Discounting**”, combines the discussion on social discounting (chapter 3) with the consideration of subsistence consumption (chapter 4). It examines implications of limits to substitution for estimating substitutability between ecosystem services and manufactured goods and for social discounting.

The survey of experts in chapter 3 revealed that considering limited substitutability between environmental and manufactured goods is one of the most mentioned issues lacking in discounting guidance. Yet, a key obstacle to advancing the discussion on limited substitutability has been the scarcity of empirical evidence. This paper therefore makes a twofold contribution to the literature.

First, based on the subsistence-substitutability model from chapter 3, it provides empirical evidence on substitution elasticities between ecosystem services and manufactured consumption goods. Chapter 2 already discusses the inverse relationship between the elasticity of substitution and the income elasticity of WTP in a constant-elasticity-of-substitution (CES) framework, which allows for indirectly estimating the degree of substitutability from environmental valuation studies. Of the 18 valuation studies that provide information on the income elasticity of WTP, 16 estimate an income elasticity of WTP that is smaller than unity, suggesting that in a CES setting, ecosystem services and manufactured goods are considered substitutes. The mean estimate of the CES is 2.31. However, when we introduce an environmental subsistence consumption requirement, the elasticity of substitution becomes non-constant and the direct relationship with the income elasticity of WTP breaks down. Using a simulation exercise that draws on empirical estimates and parameter values from Baumgärtner et al. (2015) as well as Hoel and Sterner (2007), I find that the mean elasticity of substitution decreases over time as ecosystem services become scarcer from an initial value of 2 to less than one, i.e. ecosystem services eventually become complementary to manufactured consumption goods.

Second, this chapter extends the theory of dual discounting and relative prices of environmental goods by introducing a subsistence requirement.<sup>4</sup> I find that the relative price effect of ecosystem services not only depends on the substitutability parameter and the difference in the two good-specific growth rates but also on the consumption of ecosystem services over and above the subsistence requirement. This extension produces results similar to the standard non-subsistence model only if ecosystem services are plentiful. If, however, the provision of ecosystem services is limited and in

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<sup>4</sup>For previous analyses of ecological or dual discounting and the relative price effect of environmental goods, see Baumgärtner et al. (2015), Gollier (2010), Hoel and Sterner (2007), Traeger (2011), Weikard and Zhu (2005).

decline—as suggested by empirical evidence—the model produces markedly different results compared to the non-subsistence case. In particular, I find that in such a case the ‘relative price effect’ is not constant but grows without bound as the consumption of ecosystem services declines towards the amount required for subsistence. Using a similar simulation exercise as for the estimation of substitutability suggests that the initial discount rate for ecosystem services is more than a percentage-point lower as compared to manufactured goods. This difference increases by a further half percentage-point over a 300-year time horizon. The results underscore the importance of considering limited substitutability in long-term public project appraisal.

The chapter’s findings are relevant in several respects. First, estimates on substitutability from sources other than contingent valuation studies are scarce and further research should be channeled into estimating substitution possibilities using other methodological approaches, such as choice experiments and revealed preference studies. Relatedly, the possibility to adequately estimating the elasticity of substitution is complicated by the existence of a subsistence requirement. This becomes directly relevant as it sheds light on the substantial magnitude by which previous CES approaches may have overestimated the elasticity of substitution.

Second, the results provide stronger support for the case of including ecological discount rates in project evaluation (Baumgärtner et al. 2015). I find that ecosystem services should be discounted at a rate that is 1.1 percentage points lower than the rate for manufactured consumption goods initially and 1.6 percentage points for a 300-year time horizon. Indeed, none of the estimates suggests that ecosystem services should be discounted at the same rate as manufactured goods.

Finally, the analysis has shown that the relative price effect of ecosystem services is very sensitive to the amount of ecosystem services required for subsistence. More research, as well as societal and political discussions, should therefore be channeled into determining the magnitude and composition of such a subsistence requirement.

Overall, I am therefore particularly delighted that the Dutch government is considering the use of relative prices of environmental goods in their most recent revision of discounting guidelines and that they make use of this chapter to inform their discussion (see Koetse et al. 2017). More work, however, is necessary to adequately inform

policy on the issue. Among others, we need better data on the drivers of the relative price effect, in particular of the degree of substitutability and a better understanding of the drivers of the relative price effect in different contexts. To the latter purpose, I currently study the drivers of the relative price effect of environmental goods in the appraisal of climate change together with Martin C. Hänsel, building on the seminal study by Sterner and Persson (2008).

Chapter 5 is a single-authored paper and has been published in *Environmental and Resource Economics*.

Chapter 6, titled **“Truth-Telling and the Regulator. Evidence from a Field Experiment with Commercial Fishermen”**, reports the result of a large-scale field experiment targeted at all German commercial fishermen.

The fishery is a prime example of a common pool resource (Ostrom 2009), yet so far detailed and controlled knowledge of what determines the behaviour of its users is largely missing.<sup>5</sup> A better understanding of the behaviour of fishermen is crucial to design policies that facilitate an efficient and equitable use of these common pool resources. To this aim, this chapter studies a particular facet of the behaviour of fishermen: truth-telling or honesty. We thereby contribute to the experimental economic literature on ethical behaviour, in particular truth-telling (cf. Abeler et al. 2014, 2016). Understanding what determines the truth-telling of economic agents towards their regulator is of major economic importance from banking to the management of common-pool resources such as European fisheries. Faced with uncertainty about how honest economic agents are, regulators need to decide how much to invest in monitoring and how to devise appropriate sanctioning schemes for misbehaviour. Appropriate monitoring and sanctioning mechanisms are especially crucial for the management of common pool resources (Ostrom et al. 1992, Rustagi et al. 2010).

This chapter extends the scope of previous studies and investigates to what extent regulator framing affects truth-telling. Our study therefore adds a new dimension to effective regulatory policy. We present evidence from an artefactual field experiment

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<sup>5</sup>Among the few existing studies, Stoop et al. (2012) examine cooperation among recreational Dutch anglers, while Jang and Lynham (2015) investigate the emergence of social preferences among lake fishermen in Kenya. Furthermore, previous studies scrutinize, among others, cooperativeness, competitiveness and impatience among fishermen in Brazil (Fehr and Leibbrandt 2011, Leibbrandt et al. 2013, Gneezy et al. 2015).

that examines truth-telling of German commercial fishermen. German commercial fishing is regulated by the European Union (EU), which is the world's fourth largest producer of fish, under the European Common Fisheries Policy. The EU has recently enacted a ban on returning unwanted fish catches to the sea (also called 'discard ban' or 'landing obligation'), as the practice of discarding ensues substantial costs to the public. The change in legislation has, as of yet, not been combined with more stringent monitoring. The regulator, and scientists assessing the status of fish stocks upon which recommendations for fishery management are based, thus depend on fishermen's truth-telling. Continuing to discard unwanted fish catches to the sea remains the individually optimal choice for fishermen in the present regulatory regime unless the regulator enforces the new policy. This, however, would require costly monitoring and sanctioning mechanisms.

For studying to what extent fishermen tell the truth towards their regulator, we conduct a coin-tossing game in a mail field experiment targeting all commercial fishermen in Germany. Adapting the 4-coin toss game of Abeler et al. (2014), we ask fishermen to toss a coin 4 times and report back their number of tail tosses. For each reported tail toss, they receive five Euros. In a between-subjects design, we test whether truth-telling in a baseline setting differs from truth-telling in two further treatments with different EU framings, where, first, the EU flag is made salient on the instruction sheet, and, second, a framing that states additionally that the European Commission has funded the research. Based on a simple model of reporting behavior of fishermen that considers bargaining between a pay-off maximizing 'selfish self' and a 'moral self', we hypothesize that the salience of the EU regulator may increase the bargaining power of the 'selfish self' vis-à-vis the 'moral self' and thus decrease overall lying costs, if the EU is ill-regarded. The fishery is an ideal test case for studying how truth-telling behavior may be affected by regulatory framing, as there is well-documented and wide-spread contempt among fishermen concerning stricter EU fishing regulation. If regulator framing impacts truth-telling, we will therefore expect an almost uniform direction of the effect.

We find overall that fishermen misreport coin tosses to their advantage, albeit to a significantly lesser extent than standard theory would predict. Specifically, we find an



average tail toss result of 2.46, while the expected truthful distribution would result in 2 and the payoff-maximizing choice in 4 tail tosses. Fishermen thus do not lie to their maximum advantage. Crucially, we find that misreporting is larger among fishermen who are faced with the EU flag. This confirms a hypothesis according to which many fishermen adhere to consequentialist moral principles and have lower moral lying costs towards the EU, which they dislike. This indicates that previously elicited degrees of truth-telling may not be appropriate for principal-agent relationships, where the principal or regulator is ill-regarded by the economic agents. In contrast, an additional treatment shows that fishermen do not report more tail tosses if the source of EU research funding is made salient but in particular that significantly more fishermen report 0 and 1 tail tosses. This rejects a hypothesis according to which fishermen would interpret the provided information as a means to acquire some of the EU's funds to compensate for the regulatory burdens imposed on them. Indeed, the salience of funding might increase internal lying costs by increasing misreporting aversion, thus mitigating some over-reporting of tails.

Our findings imply that regulators have to take into account not only some given degree of dishonesty among the regulated, but also that the nature and communication of the regulatory policy will affect truth-telling. Regulators may be able to encounter new, cost-effective means to curb dishonest behavior and improve fishery management.

Chapter 6 is joint work with Menusch Khadjavi and Martin F. Quaas. It has appeared as *Kiel Working Paper* 2063. I have substantially contributed to this paper during all major stages of the research process. All co-authors designed the research question and approach. With support from Menusch Khadjavi and Martin F. Quaas I took the lead in planning, preparing, and executing the fieldwork, analyzing the data as well as writing and revising the paper.

Finally chapter 7, titled **“Do Scientists Tell the Truth? Evidence from a Field Experiment”**, adds a meta-scientific perspective to the thesis and addresses the crucial aspect of academic honesty by presenting experimental economic evidence on truth-telling behavior of scientists.

Whether and to what degree scientists behave ethically sound and tell the truth is of fundamental importance for the development of science, for public trust in science,

and indeed for the future of mankind. Marshall (2000: 1162) called this “*a Million-Dollar Question*”, but this number is likely a gross underestimate. This is particularly true for times which call for more ‘evidence-based policy-making’ but are otherwise guided by low trust in scientists and a tendency to blur distinctions between objective knowledge and so-called ‘alternative facts’ and ‘post-truths’.

The quest for ensuring integrity in research conduct is probably as old as science itself, yet the reputation of truthful science has in particular suffered in recent times from prominent instances of scientific misconduct. Beyond such cases, survey evidence suggests that a considerable number of scientists engage in a broader set of questionable research practices (see, for example, John et al. 2012; List et al. 2001; Martinson et al. 2005; Necker 2014). This literature suggests that the search for general truths is not always conducted in a truthful manner. Yet, this evidence so far only relies on anonymous survey responses, with the fundamental challenge that there is no individual (monetary) incentive to participate and to report truthfully.

Our study provides incentivized experimental economic evidence on truth-telling of more than 400 scientists by means of an online field experiment. We thus provide complementary evidence to above mentioned survey approaches. Specifically, our aim is to investigate whether the professional identity as a scientist affects honesty, i.e. whether the professional identity as a scientist motivates and fosters truthful behavior. After all, science ‘consists in the search for truth’ (Popper 1996).

To this end, we employ the same simple coin-tossing task in which scientists are asked to toss a fair coin four times and report back their number of tail tosses, receiving five Euros per reported tail toss (Abeler et al. 2014). To study whether professional identity of scientists induces more honesty, we draw on the identity priming literature that was developed in social psychology and is now an active research field within economics (Cohn and Maréchal 2016). The idea is that individuals have multiple identities that are guided by different norms and behavioral patterns (Akerlof and Kranton, 2000). Individuals experience disutility if they deviate from norms prescribed by their respective salient identity. Our experiment accordingly consists of two treatments. The professional identity treatment aims at making the subject’s professional identity as a scientist salient, while the private identity (control) treatment aims at making

the private identity salient. In the context of our study, the priming intervention aims to reveal the behavioral difference between a subject’s private and professional identity and thus be indicative of the norms and behavioral patterns associated with the scientific identity of the subjects in terms of truth-telling and honesty.

Based on 437 responses to our coin-tossing task, our key result shows that significantly fewer scientists over-report winning tail tosses in the professional identity treatment. Furthermore, we find that over-reporting is positively associated with a scientist’s elicited degree of financial risk-taking, and that there seems to be some consistency in pro-social behavior, as subsequent donations fractions are negatively associated with over-reporting.

While we are able to provide causal evidence that professional identity effects associated with science foster truth-telling, we can pinpoint the underlying mechanism for this finding only inductively. Previous work that our simple model of truth-telling behavior builds upon (Benjamin et al. 2010; Cohn et al. 2015) suggests that this more frequent truth-telling is driven by stronger honesty norms associated with the professional (in this case scientific) identity. This interpretation suggests that academia fosters a culture of truth-telling that would be consistent with its general aim of searching for truths.<sup>6</sup> While our central treatment effect therefore seems to suggest that science fosters a culture of honesty, which is arguably good news for science, we still find that scientists over-report winning tail tosses compared to the expected truthful distribution. For the whole sample, we find that scientists report on average 2.32 tail tosses. Even in the professional identity treatment, we find that scientist significantly over-report winning tail tosses. Thus, the culture of honesty that academia seems to foster may not be sufficient to ensure that science does not get derailed from its quest for truths.

As scientific honesty is crucial, further measures have to be taken to prevent scientific misconduct. Meta-analyses (e.g. Abeler et al. 2016; Brodeur et al. 2016), replication studies (e.g. Camerer et al. 2016), more precise and transparent reporting practices (e.g. Miguel et al. 2014) as well as institutional incentives and arrangement for research integrity (e.g. Titus et al. , 2008; Titus and Bosch, 2010) are some important recent

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<sup>6</sup> Indeed, this cultural norm-based interpretation has featured prominently in related findings in experimental studies on the banking industry (Cohn et al. 2014; Villeval 2014).

steps into this direction. Besides showing that academia already seems to foster norms associated with truth-telling, our findings call for further steps that let this quest for improving research conditions and practices continue. This is particularly crucial in times that are simultaneously guided by a general skepticism in science, on the one hand, as well as by a more active engagement of science in policy advice through fora, such as the IPCC, on the other hand.

Chapter 7 is joint work with Menusch Khadjavi and Rudi Voss. We are considering a submission to a general science journal and have therefore not yet published this paper as a working paper. I have substantially contributed to this paper during all major stages of the research process. All co-authors designed the research question and approach. I took the lead in analyzing the data as well as writing the paper.

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## 2 Income Inequality and Willingness to Pay for Environmental Public Goods

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**Abstract:** We study how the distribution of income among members of society, and income inequality in particular, affects social willingness to pay (WTP) for environmental public goods. We find that social WTP for environmental goods decreases (increases) with income inequality if and only if environmental goods and manufactured goods are substitutes (complements). We derive adjustment factors for benefit transfer to control for differences in income distributions between a study site and a policy site. For illustration, we quantify how social WTP for environmental public goods depends on the respective income distributions for empirical case studies in Sweden and the World at large. We find that the adjustment for income inequality can be substantial.

**Keywords:** environmental goods, public goods, income distribution, inequality, willingness to pay, benefit transfer, sustainability policy

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### 3 Discounting Disentangled

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**Abstract:** The economic values of investing in long-term public projects are highly sensitive to the social discount rate (SDR). We surveyed over 200 experts to disentangle disagreement on the SDR into its component parts, including pure time preference, the wealth effect and return to capital. We show that only a minority of responses conform to the simple Ramsey Rule, a widely-used theoretical discounting framework. Yet despite disagreement on discounting procedures and point values for the SDR, we obtain a surprising degree of consensus among experts, with more than three-quarters finding the median SDR of 2 percent acceptable.

**Keywords:** Social discount rate, project appraisal, expert opinions, simple Ramsey Rule, disagreement.

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### 3.1 Introduction

We report the results of a survey of experts on “*one of the most critical problems in all of economics*” (Weitzman 2001: 260) about which there has been a great deal of disagreement: the long-term social discount rate (SDR). The sample contains over 200 academics who are defined as experts on social discounting by virtue of their publications. A key innovation of our survey is that we elicit information on the fundamental determinants of the SDR, which allows us to disentangle the main sources of disagreement. The experts’ acceptable ranges for the SDR are also elicited, which allows an examination of whether there is any space for agreement on discounting. Our findings lead us to the conclusion that current policy guidance on the evaluation of long-term public projects—such as climate change mitigation or long-lived infrastructure—requires significant revision, in particular, a departure from the simple, deterministic Ramsey Rule.

The appropriate SDR and the procedure for its calculation have long been a source of disagreement among economists. Historically, economists have found themselves either stumbling around in the “*dark jungles of the second best*” in pursuit of an answer or accused of “*stoking the dying embers of the British Empire*” if they claim to find one (Baumol 1968: 789; Nordhaus 2007: 691). Such disagreements resurfaced after the recommendations of the Stern Review on the Economics of Climate Change proved to be extremely sensitive to the choice of the SDR (Nordhaus 2007, 2008; Stern 2007). The extent of disagreement was book-ended by Lord Stern’s normative (prescriptive) position which lead to a central SDR of 1.4%, and Nordhaus’ positive (descriptive) position, which lead to an SDR of 4.5%. These opposing positions lead to radically different views on the appropriate level of climate change mitigation.

It is for reasons like these that discounting the distant future is viewed as such a “*critical problem*”. Yet, aside from these well publicized cases, we lack a good understanding of the extent and the sources of this disagreement. A survey by Weitzman (2001) provided some indication of the extent of disagreement by asking over 2000 economists for the appropriate ‘real interest rate’ for the analysis of climate change mitigation: responses ranged from -3% to 27%. Yet, the Weitzman survey was silent on the reasons for this huge variation in opinion, even on whether respondents were

using positive or normative principles to inform their response. Such information is crucial to understanding the basis for the SDR and the principles that guide long-term policy analysis. The need for clarity on this issue is an important motivation for our study.

In order to disentangle the causes of disagreement on the SDR we structure the survey around a well-known framework for inter-temporal welfare evaluations: Time Discounted Utilitarianism and the simple Ramsey Rule. Specifically, we elicit expert responses on two key components of the SDR: the pure rate of time preference and the elasticity of marginal utility. In addition to these “central normative parameters” (Nordhaus 2008: 33), we ask experts to estimate growth and the risk-free rate of interest. In this way we obtain information on both positive and normative arguments for the SDR (Arrow et al. 1996, 2012). These concepts are familiar to economists working on discounting, but also have the merit of being policy relevant.<sup>2</sup> Importantly though, we allow sufficient flexibility for experts not to be constrained by the simple Ramsey Rule when making their recommendations on the SDR.

The responses make for interesting reading. The median (mean) recommended SDR of our experts is 2 percent (2.3 percent). This is substantially lower than the median (mean) values of 3 percent (4 percent) reported by Weitzman (2001).<sup>3</sup> We also find that there remains substantial disagreement between experts over this value, with individual recommendations ranging between 0 and 10 percent. Despite this, 92 percent of experts report that they would be comfortable with a SDR somewhere in the interval of 1 percent to 3 percent, and over three-quarters find a SDR value of 2 percent acceptable.

Looking at the empirical distributions of individual discounting determinants, we find that expert opinion is particularly varied on the rate of pure time preference. The modal value is zero, in line with many prominent opinions. But with a median (mean) of 0.5 percent (1.1 percent), we cannot confirm the IPCC’s (2014: 229) conclusion that “*a broad consensus for a zero or near-zero pure rate of time preference*” exists. Also, while we find that experts recommend placing greater weight on normative than

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<sup>2</sup>A number of policy guidelines on cost-benefit analysis across the world are testament to this (HMT 2003; IPCC 2014; Lebegue 2005).

<sup>3</sup>Appendix A.1.1 discusses differences between the two surveys.



positive issues when determining the SDR, most believe that the SDR should be informed by both.

An unambiguous result of our survey is that the prominence of the simple Ramsey Rule in public policy needs to be revisited. When we impute the simple Ramsey Rule for all experts individually, we find wide discrepancies between these values and their recommended SDRs. The rich body of qualitative responses provided by our experts explains the need for long-term public decision-making to depart from the confines of this framework. Accounting for a comprehensive set of technical issues, such the inherent uncertainties and changing relative prices of non-marketed goods, was one set of recommended departures. Stressing the importance of different societal criteria, which embody broader notions of intergenerational equity and sustainability, was another. A third set of recommendations aimed at ensuring that decision-making is participatory and takes a more procedural approach.

Indeed, many argue for a more “democratic” approach to informing governmental guidance on social discounting (e.g. Dasgupta 2008: 158). Yet, because the questions raised by long-term cost-benefit analysis are highly complex, there are also arguments for so-called “genuine specialists” (Pindyck 2017; Sunstein 2014: 550) to play an active role. Indeed, the opinions of experts play an important role in public policy. Numerous expert panels held in recent years show that social discounting is no exception.<sup>4</sup> Precisely because discounting policy is so often influenced by experts, it is imperative to obtain a more complete picture of the range of opinions they hold. By presenting the responses of a large number of experts on the determinants of the long-term SDR, we contribute to the ongoing academic debate over improving approaches to intergenerational decision-making. We also provide detailed information for the discounting policy revisions taking place in several countries.

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<sup>4</sup>Since the Stern Review, expert advice on social discounting has been sought from specialists in the field, among others, by the US Environmental Protection Agency, and the Norwegian, French, UK, French and Dutch governments.

## 3.2 Survey design

### 3.2.1 Conceptual background

Even a cursory glance at the literature on long-term decision-making reveals a multitude of different conceptual approaches which could lead to different recommendations for the SDR. Some disagreement revolves around which rate of return to capital or interest rate best describes the opportunity cost of public investment. On the normative side, approaches such as Time Discounted Utilitarianism (TDU) and Prioritarianism, are consequentialist. Other approaches add procedural rules, such as sustainability requirements, to a consequentialist framework.<sup>5</sup> In each case extensions and variants abound.<sup>6</sup>

Our survey allows respondents to provide qualitative responses which could reveal the fine-grained details of their particular perspectives on intergenerational decision-making. However, the main part of the survey is structured around TDU, as it provides a clear means of disentangling key sources of disagreement on the SDR in terms of widely-understood concepts.

The standard TDU social welfare function takes the following form

$$W_0 = \int_{t=0}^T e^{-\delta t} U(C_t) dt, \quad (3.1)$$

where welfare at time 0 depends on all future time-separable utilities of a representative agent whose utility depends on comprehensive real per-capita consumption  $C_t$ . Utility is discounted at a constant rate of pure time preference,  $\delta$ , which determines how much weight is placed on future utilities from today's perspective. A frequently-used simplifying assumption is that utility is isoelastic:  $U(C_t) = (1 - \eta)^{-1}(C_t^{1-\eta} - 1)$  if  $\eta \neq 1$  and  $U(C_t) = \ln(C_t)$  if  $\eta = 1$ , where  $\eta$  is the constant elasticity of marginal utility of consumption, which reflects how averse society is to the differences in consumption that arise over time due to growth.<sup>7</sup>

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<sup>5</sup>For instance, see Sustainable Discounted Utilitarianism (Asheim and Mitra 2010) or the Chichilnisky criterion (Chichilnisky 1996).

<sup>6</sup>See, e.g., Harberger and Jenkins (2015) and Spackman (2017) for recent discussions on (positive) opportunity cost arguments, and Asheim (2010), Botzen and van den Bergh (2014) and Fleurbaey and Zuber (2015) for overviews of alternative normative criteria for long-term decision-making.

<sup>7</sup>This parameter may also reflect aversion to differences that occur in different states of the world,

The TDU framework thus captures some key features of the inter-temporal trade-offs that society faces and leads to a simple social discounting rule known as the Ramsey Rule. This was originally presented as an optimality condition for the saving decisions of a representative agent (Ramsey 1928):

$$r = \delta + \eta g, \tag{3.2}$$

where  $r$  is the risk-free return to capital, and  $g$  is the real, per-capita, growth rate of consumption. This optimality condition equates the returns to saving/investment in risk-free capital on the production side ( $r$ ) with the welfare-preserving inter-temporal trade-off on the consumption side ( $\delta + \eta g$ ). The latter comes from a Taylor series expansion of the first order condition for optimal consumption with a constant growth rate,  $g = g_t = t^{-1} \ln(c_t/c_0)$ . Although speaking to optimal saving, the Ramsey Rule also provides a theoretical foundation within TDU for determining the social discount rate in the absence of uncertainty (Arrow et al. 2012).

Disagreement on discounting usually focuses on the two key welfare parameters,  $\delta$  and  $\eta$  and their normative-positive content. There is also disagreement about the role of  $r$  in social discounting (Arrow et al. 1996; Nordhaus 2007). Two main interpretations of this rule in this context are in common use.

First, the opportunity cost of capital approach focuses on the trajectory of the risk-free capital stock, and its rate of return  $r$ :

$$SDR = r, \tag{3.3}$$

This approach anchors the SDR to the yield on government bonds. This is the positive approach to social discounting followed by the US Environmental Protection Agency (US EPA 2010), among others.

The second approach concerns the trajectory of consumption and asks how to optimally distribute the returns of a marginal project over time. In a deterministic

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and so under uncertainty  $\eta$  can also be interpreted as a measure of risk aversion.

world this consumption-side approach leads to the simple Ramsey Rule (SRR):

$$SDR = SRR = \delta + \eta g, \quad (3.4)$$

leading to two reasons why society might discount the future: the rate of societal pure time preference,  $\delta$ ; and a ‘wealth effect’,  $\eta \times g$ , which captures the idea that society may place less weight on future costs and benefits if the future is richer. The SRR is typically considered to be the normative approach to determining the SDR, and is the interpretation followed by Her Majesty’s Treasury in the UK (HMT 2003) or the German Environmental Agency (UBA 2012), for instance.

While this deterministic structure is helpful to organize ideas on social discounting and to pin down some main sources of disagreement within a parsimoniously structured survey, it is clear that long-term public decision-making has to deal with uncertainty. At the very least, two types of uncertainty matter. First, there is uncertainty in the growth rate of consumption. For example if growth in each year is independently and identically Normally distributed, we obtain the extended consumption-side Ramsey Rule (ERR):

$$SDR = ERR = \delta + \eta \bar{g} - 0.5 \eta (\eta + 1) \sigma^2, \quad (3.5)$$

with  $\bar{g} = \mu + 0.5 \sigma^2$ , where  $\mu$  is the mean of real, per capita logarithmic consumption growth and  $\sigma^2$  its variance (Gollier 2012). Second, besides uncertainty about baseline growth, the payoff from the marginal project itself could be uncertain. Project specific discount rates are not the focus of this study, and so our approach deals with such risks in the following way. Some experts, such as Zeckhauser and Viscusi (2009: 96), argue that *“economists generally agree that whoever is the decision maker, the discount rate should not be adjusted for risk. The preferred approach, roughly speaking, is to address risk by converting monetary payoffs to certainty equivalents, and then do the discounting.”* While not all economists would agree with this statement, almost all are familiar with the basis for dealing with uncertainty. We therefore frame the survey around certainty-equivalent cash flows. This approach brings with it the significant benefit of allowing us to concentrate on disentangling the risk-free SDR without drawing out the additional complexities raised when estimating project-specific discount rate risk premia. We do not, in this paper, address the question of how the

social planner estimates the certainty-equivalent value, which is in general a highly challenging exercise.<sup>8</sup>

Beyond the question of uncertainty, a number of other extensions are possible—e.g. relative price effects (Gollier 2010, Traeger 2011) and declining discount rates (Arrow et al. 2013)—as well as alternative approaches outside of Time Discounted Utilitarianism. Importantly, by eliciting the SDR separately from the individual components of the simple Ramsey Rule, and by including the option for qualitative responses, the survey does not force experts into the Procrustean bed of the simple Ramsey Rule.

### 3.2.2 The survey questions

The survey asked respondents about the SDR and some of its fundamental determinants.<sup>9</sup> The questionnaire began with the following contextual preamble, followed by seven brief quantitative questions and an optional comments section for qualitative responses:

*Imagine that you are asked for advice by an international governmental organization that needs to determine the appropriate real social discount rate for calculating the present value of certainty-equivalent cash flows of public projects with intergenerational consequences.*

*For its calculations, the organization needs single values for the components of the real social discount rate. While this does not capture all of the important complexities of social discounting, it does reflect most existing policy guidance on the matter. Your answers will therefore help to improve the current state of decision-making for public investments.*

*Specifically, you are asked to provide your recommendations on the single number, global average and long-term (>100 years) values of the following determinants of the social discount rate:*

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<sup>8</sup>Bansal et al. (2016), Lemoine (2015) and Weitzman (2009) are examples of a growing literature discussing this problem in the area of climate change, where uncertainties abound.

<sup>9</sup>We piloted different versions of the survey with selected experts, economists from different fields, and students to find the best trade-off between completeness and parsimony.

1. *Growth rate of real per-capita consumption [X% per year].*
2. *Rate of societal pure time preference (or utility discount rate) [X%].*
3. *Elasticity of the marginal utility of consumption [X].*
4. *Real risk-free interest rate [X% per year]. Remember that this should be a global average and long-term forecast.*
5. *What relative weight (summing up to 100%) should the governmental body place on the following rationales for determining the social discount rate:*
  - (a) *Normative issues, involving justice towards future generations [X%], and*
  - (b) *Descriptive issues, involving forecasted average future returns to financial assets [X%]?*
6. *What is your recommended real social discount rate for evaluating the certainty-equivalent cash flows of a global public project with intergenerational consequences [X% per year]?*
7. *What minimum and maximum real social discount rate would you be comfortable with recommending [X% to X% per year]?*
8. *Do you have any additional comments [X]?*

Questions 1–2 elicited responses on the two key normative parameters  $\delta$  and  $\eta$ . Questions 3–4 asked for forecasts of the long-term global average growth rate of real per-capita consumption,  $g$ , and real interest rate,  $r$ . Question 6 asked for the point-value of the SDR that should be recommended for evaluating the certainty-equivalent cash flows of a generic global public project with intergenerational consequences. Indeed, having this separate question on the SDR meant that respondents need not have relied on the simple Ramsey Rule to form their recommendation. The open comments section, Question 8, allowed for feedback on the survey, where respondents could, and often did, point towards various deviations from the rule.

Question 5 elicited information about each respondent's approach to discounting by asking for the relative weight that the governmental body should place on normative versus positive approaches to determining the SDR. Responses were measured on a sliding scale from 0 to 100 percent. This explores the disagreement in rationales that has been evident at least since Arrow et al. (1996): whether normative issues, involving intergenerational ethics and justice, or positive issues, involving forecasted future

returns to financial assets, or a mixture of both should determine the SDR. Importantly, the sliding scale admits many interpretations of normative and positive other than those associated with the Ramsey Rule. For instance, responses could reflect the relative weight that respondents place on different consequentialist or deontological ethical frameworks. Finally, in Question 7 we asked for the minimum and maximum values of the SDR that respondents would be comfortable with recommending, in order to elicit an ‘agreeable range’.

### 3.2.3 Expert selection and survey dissemination

Because our survey aimed at disentangling the determinants of the long-term SDR, we restricted our sample to scholars who have been involved with these complex issues. For the purposes of this paper, an individual is deemed to be a potential ‘expert’ if he or she is a (co-)author of at least one pertinent publication in the field of (social) discounting in a leading economics journal. A journal was classified as ‘leading’ if, according to the ranking of 600 economics journals by Combes and Linnenmer (2010, Table 15), it is rated A or higher, together with the topical Review of Environmental Economics and Policy. This amounts to 103 peer-reviewed journals. A publication is deemed to be ‘pertinent’ if it was published between January 2000 and March 2014 and, according to the Google Scholar engine, included at least one of the terms ‘social discounting’, ‘social discount rate’ or ‘social discount factor’.<sup>10</sup> Correcting for scholars with multiple publications, and discarding papers that did not pass a weak relevancy test, our sample includes 627 potential experts.<sup>11</sup>

There are a number of limitations to this selection strategy. First, by restricting the search to publications since the year 2000 to only capture scholars active in the current debate on social discounting, we potentially miss some relevant earlier contributors. Second, by selecting experts based on their publications, we necessarily include co-

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<sup>10</sup>To obtain a broader set of potential experts, we further performed a search based on abstracts for the term ‘discount rate’ within the same journals in EconLit. Using EconLit allowed restricting the search to more relevant papers that already discussed discounting in the abstract (a general Google Scholar search for the term ‘discount rate’ yields more than 300 000 hits, containing a large number of irrelevant papers that would need to be manually evaluated). Of the 627 potential experts, 219 were obtained through the EconLit search.

<sup>11</sup>See Appendix A.1.2 for further details on the selection procedure.

authors of relevant papers who are not themselves experts on discounting. Third, due to the rather generous weak relevancy test, we include a number of scholars who might not regard themselves as true experts on the issue. Fourth, we do not pick up relevant publications in the field that have used other terms to discuss discounting. Finally, we miss potentially relevant articles in lower-ranked journals.<sup>12</sup> This may introduce a geographical bias into our sample by under-representing those from developing nations. Despite these possible short-comings, the definition of expert that we deploy here is close to the one frequently used by policy makers, both in general policy contexts and in relation to social discounting.

Starting in May 2014, we sent out a link to the online survey (implemented in SurveyMonkey) via e-mail to all potential experts, and used three general rounds of reminders, each time slightly varying the subject line and motivation for answering the survey.<sup>13</sup> In later rounds, we offered the option of completing the survey in a Word document or in the e-mail itself to increase flexibility.

### 3.3 Survey results

Table 3.1 provides summary statistics for expert responses. By November 2014 we had received responses from 197 experts, including 12 who solely provided qualitative feedback containing important insights. We also received replies from 27 scholars explaining why they did not answer the survey, without warranting inclusion as qualitative responses. The most common reason for non-response was self-reported insufficient expertise, but it also included not having enough time or being unable to respond due to reasons of central bank confidentiality. Responses were also obtained after the survey closed from 38 previous non-respondents. This group is used to check for non-response bias.

Overall, we elicited 262 responses out of a pool of 627 potential experts. The response rate is 30 percent if we only consider the 185 quantitative responses. If we include all responses, the rate rises to 42 percent. Each is in line with comparable

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<sup>12</sup>An alternative quality signal, employed for example in the survey by Pindyck (2016), is to use a citation threshold.

<sup>13</sup>Appendix A.1.3 provides the initial e-mail text.



Table 3.1: Descriptive statistics on survey results

Variable	Mean	StdD	Median	Mode	Min	Max	N
Real growth rate per capita	1.70	0.91	1.60	2.00	-2.00	5.00	181
Rate of societal pure time preference	1.10	1.47	0.50	0.00	0.00	8.00	180
Elasticity of marginal utility	1.35	0.85	1.00	1.00	0.00	5.00	173
Real risk-free interest rate	2.38	1.32	2.00	2.00	0.00	6.00	176
Normative weight	61.53	28.56	70	50	0	100	182
Positive weight	38.47	28.56	30	50	0	100	182
Social discount rate (SDR)	2.27	1.62	2.00	2.00	0.00	10.00	181
SDR lower bound	1.12	1.37	1.00	0.00	-3.00	8.00	182
SDR upper bound	4.14	2.80	3.50	3.00	0.00	20.00	183
Quantitative responses							185
Qualitative responses							100
Responses used for analysis							197
Explained non-responses							27
Bias-check responses							38
Total number of responses							262

Note: “StdD” refers to standard deviation and “Min” (“Max”) to minimum (maximum) recommendation.

online surveys with economists (Necker 2014). Besides this, the sampling strategy was successful in obtaining responses from “blue ribbon” academic leaders on social discounting including 12 of the 13 experts of the Arrow et al. (2012) panel who advised the US EPA on this matter.

### 3.3.1 Quantitative responses

#### Recommended Long-Term Social Discount Rate

In recent years, prominent experts such as Gollier (2012), Nordhaus (2008), Stern (2007) and Weitzman (2007) have proposed very different SDRs. Figure 3.1 (a) illustrates the extent of disagreement on the SDR for discounting real certainty-equivalent cash flows of a global public project with intergenerational consequences. The lowest recommendation is 0 and the highest 10 percent. However, the vast majority of experts provide point recommendations in the range of 0 to 4 percent, while the interval

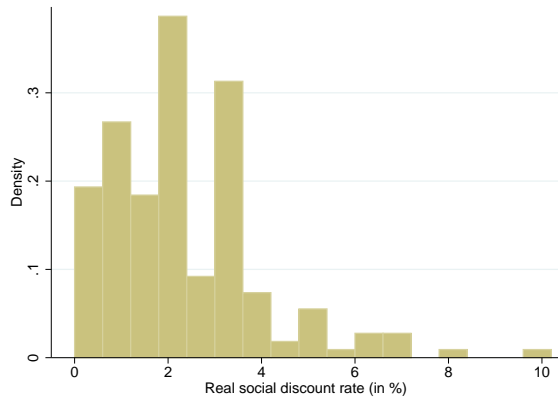
of 1 to 3 percent contains the point SDR recommendations of 68 percent of experts. The mean (median) value of the recommended SDR are 2.27 percent (2 percent), which are much lower than the corresponding values from Weitzman's (2001) survey of economists of 3.96 percent (3 percent). Yet the most common single value recommended in these two different surveys is 2 percent. These results deviate significantly from the discount rates recommended in important recent guidelines, including the IPCC Fifth Assessment Report (IPCC 2014: 230).

### **Rate of Societal Pure Time Preference**

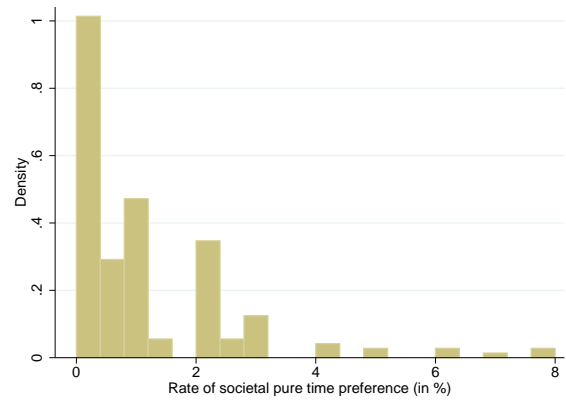
Positions on the rate of societal pure time preference,  $\delta$ , have historically been the subject of intense disagreement. Luminaries of economics, such as Pigou, Ramsey and Harrod, believed that the well-being of each generation ought to be weighted equally, and so pure time preference should be zero. This view stems from their classical impartial Utilitarian philosophy. Disagreement surfaced again more recently with the publication of the Stern Review (Stern 2007), which took the same classical Utilitarian stance. Many alternative arguments exist for the use of a positive rate of societal pure time preference (e.g. Arrow 1999; Koopmans 1960; Nordhaus 2007). Figure 3.1 (b) shows substantial disagreement among experts on their chosen value for this parameter. As the modal value, 0 percent is a focal point, and, if we include those responses that lie in the range of 0 to 0.1 percent, 38 percent take what might be called the Ramsey-Stern view. Yet, the distribution of responses is substantially right skewed with a median of 0.50 percent, a mean of 1.10 percent and a maximum recommendation of 8 percent. Based on these results, we cannot confirm the IPCC's (2014: 229) conclusion that "*a broad consensus for a zero or near-zero pure rate of time preference*" exists among experts.

### **Elasticity of the Marginal Utility of Consumption**

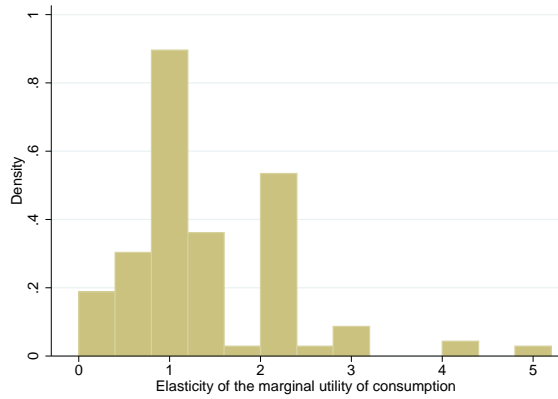
Settling on a value of the elasticity of the marginal utility of consumption,  $\eta$ , is an intricate affair. The reason is that it might capture vastly different concepts and thus lend itself to different interpretations. These are not only divided along the lines of normative (e.g., issues of distribution) and positive (e.g., preferences for consump-



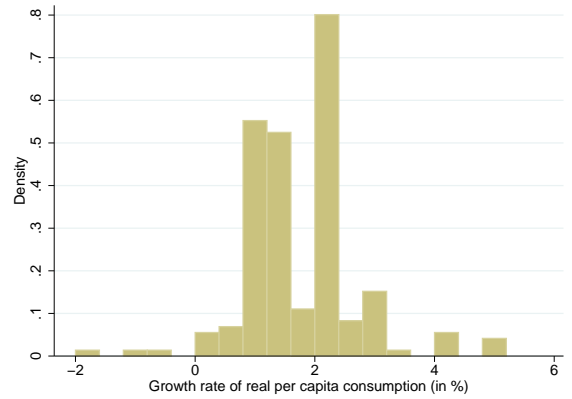
(a)



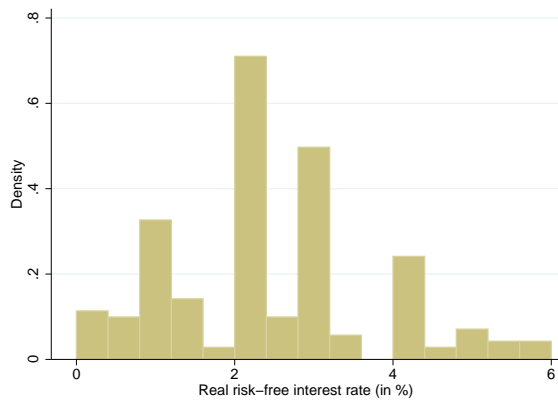
(b)



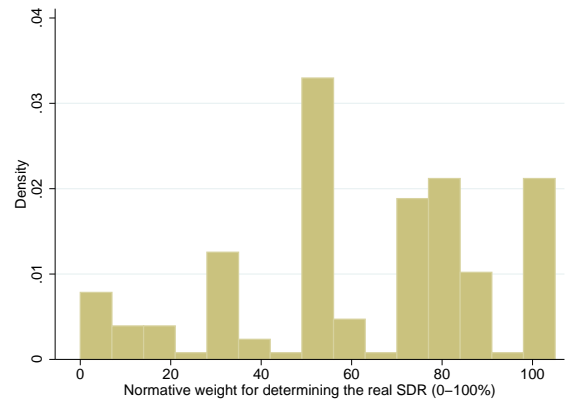
(c)



(d)



(e)



(f)

Figure 3.1: This figure provides histograms of expert recommendations and forecasts on discounting determinants. Figure (a) shows the real long-term SDR (in percent), (b) rate of societal pure time preference (in percent), (c) elasticity of marginal utility of consumption, (d) real growth rate of per capita consumption (in percent), (e) real risk-free interest rate (in percent), and (f) the normative weight for determining the SDR (in percent).

tion smoothing) determinants, but might also capture the inverse of the elasticity of intertemporal substitution or societal preferences for the aversion of consumption inequalities across space, time and also states of nature. All these rationales could have been used by different experts to inform their response, although the survey setting might reasonably have led respondents to primarily consider interpretations relating to an intertemporal consumption smoothing or inequality context, as opposed to representing aversion to risk. Previous discussions in the literature point towards a range of 0.5 to 4 (Cowell and Gardiner 1999; Dasgupta 2008), although Groom and Maddison (2017) argue strongly for a narrower range of between 1.5 and 2 for the UK based on revealed preference approaches. The resulting expert recommendations for elasticity of the marginal utility of consumption as presented in Figure 3.1 (c) are indeed widely dispersed, with a mean of 1.35 and a median and mode of 1. These values provide some support to the often made assumption of logarithmic utility.

### **Growth Rate of Real Per-Capita Consumption**

Figure 3.1 (d) presents the results of our respondents' forecasts of the growth rate of real per-capita consumption,  $g$ . The overwhelming majority forecast a positive growth rate, with a mean of 1.7 percent and a median of 1.6 percent (cf. Table 3.1). This is close to the 2 percent growth rate of consumption per-capita in the western world for the last two centuries (Gollier 2012) and the 1.6 percent growth rate in GDP per-capita over the period 1900 to 2000 in non-OECD countries (Boltho and Toniolo 1999). Three experts project a negative growth rate, and 55 respondents forecast a lower growth rate than the IPCC's (2000) lower bound projection of 1.3 percent for the period from 1990 to 2100. 28 experts forecast a growth rate larger than 2 percent.

### **Real Risk-Free Interest Rate**

Over the period 1900–2010, the global average real risk-free rate,  $r$ , was approximately 1 percent for bills and 2 percent for bonds (Dimson et al. 2011). For individual countries the rates are 1.1 percent for bills and 1.9 percent for bonds for the US, 0.8 percent and 2.0 percent for the UK and -0.5 percent and -0.6 percent for Japan (Dimson et al. 2011; see also Gollier 2012 for similar figures). The average response to our

survey was a real risk-free interest rate of 2.38 percent, with a standard deviation of 1.32 percentage points and a median value of 2 percent.<sup>14</sup> The maximum forecast is 6 percent, while the minimum value, forecasted by three experts, is 0. The forecasted long-term global real risk-free interest rate according to our sample of experts is thus slightly higher than the estimated world average real risk-free rate of return on bonds over the past century.

### Normative versus Positive Approaches

A central point of disagreement on the SDR concerns the question of whether normative issues, involving justice towards future generations, or positive issues, involving forecast average future risk-free rates, or a mix of the two should determine the SDR (Arrow et al. 1996, 2014). Not everyone agrees that Time Discounted Utilitarianism is the correct ethical basis for intergenerational decision-making in the first place. For instance, some prefer deontological ethics which emphasise duties, while others prefer rights-based approaches. In line with this history of disagreement on the SDR, our intention for Question 5 is to establish the extent to which recommendations on the SDR are influenced by “*positive predictions and ethical judgments*” (Ricketts and Shoemith 1992: 210–211). A clear finding from our data is that a large majority of experts (80 percent) think that both dimensions are relevant (see Figure 3.1 (f)). However, they generally recommend that governmental institutions should place greater weight on normative issues in determining the SDR; this has a mean (median) weighting of 61.53 percent (70 percent). When considering extremes, 14 percent (5 percent) of experts placed 0 (100 percent) weight on positive considerations, while 42 experts were divided equally between the two rationales; making this the modal response. These findings emphasise that setting the SDR requires both forecasts and value judgments.

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<sup>14</sup>While our question explicitly asked for a forecast of a *risk-free* interest rate, we cannot exclude the possibility that some respondents were instead providing a forecast return on production, or even equity, capital. Such returns include the premium associated with investing in risky assets and therefore are not appropriate for discounting certainty-equivalent cash-flows. This potentially leads to an upward bias in the sample responses.

### 3.3.2 Qualitative responses

More than half of our respondents provided comments ranging from short remarks, such as “*risk matters*”, to explanations over multiple pages. The qualitative observations provide a rich body of evidence which sheds light on various complexities of the theory and practice of social discounting. We group these comments into four main categories that address (i) individual survey questions Q1-Q5, (ii) technical issues, (iii) methodological issues, and (iv) concerns about limited expertise. Each category has multiple subcategories.

Table 3.2 provides an overview of the most common issues raised, including the number of experts commenting on it and an exemplary quote, sometimes edited for brevity. The five most often raised are: ‘declining discount rates and time-horizon’, ‘uncertainty’, ‘substitutability and environmental scarcity’, ‘heterogeneity and aggregation’, and ‘comparison to the Ramsey Rule’.

Table 3.2: Overview of qualitative responses

Issue	N	Exemplary quote
Q1: Growth rate	14	I foresee a very bright economic future with a continued 2 percent growth rate for the coming century.
Q2: Pure time preference	10	I see no reason to treat generations not equally.
Q3: Elasticity of marginal utility	12	The elasticity of marginal utility of consumption is heterogeneous, and using a single value is a crude simplification.
Q4: Real risk-free interest rate	8	There is no interest rate for 100 year horizon (to my knowledge).
Q5: Normative vs. positive	16	The components of the SDR are overwhelmingly normative in nature.
Declining discount rates and time horizon	20	I am more comfortable with declining discount rates [...] due both to declining time preference rates and to uncertainty about future consumption growth.
Heterogeneity and aggregation	19	Ideally, the input for our [social welfare function] would be a utility function that allows for heterogeneous preferences.
Opportunity cost of funds	8	SDRs should reflect the social opportunity cost of borrowed funds.
Project risk	6	We would have to consider very carefully the risk structure of the investment to get a correct discount rate.
Relative prices of non-marketed goods	20	If future costs/benefits accrue e.g. to environmental amenities, I would argue for a very low discount rate, based on an expectation of increasing relative prices for these goods.
Uncertainty	20	We need to admit that the current state of the world is full of uncertainties. [Yet] most uncertainties are neglected, and sometimes few remain when these are considered most important, [...] or easiest to accommodate.
Alternatives to discounting	15	Instead of imposing a [social welfare function] and calculate the corresponding optimum, it is 'better' to depict a set of feasible paths of consumption, production, temperature, income distribution, etc. and let the policy maker make a choice.
Comments on the survey	14	The search for THE discount rate, if that is your project, is deeply flawed.
Confidence intervals	8	I would also insist on providing confidence intervals.
Ramsey Rule	17	My discount rate is less than implied by the Ramsey rule because I use the extended rule, incorporating uncertainty.
Role of experts	7	I really think economists have very little special expertise in knowing the 'right' number. These parameters should be chosen in an open, iterative way with an eye toward understanding the consequences of different choices.
Limited confidence	13	Please ignore my response to Q4: I don't have the knowledge to make a meaningful forecast.
Limited expertise	5	I am not a real expert on these issues.

### 3.3.3 Non-response bias and representativeness

We followed several standard procedures to test for the existence of non-response bias. First, from December 2014 to April 2015 we contacted via e-mail and telephone 60 randomly selected non-respondents. This allowed us to obtain a further 38 responses, with 14 of these experts providing qualitative data and 24 giving reasons for their initial non-responses.<sup>15</sup> Second, our sample includes quantitative responses from 11 of the 13 “blue ribbon” experts on social discounting from the Arrow et al. (2012) panel that advised the US EPA.<sup>16</sup> Third, we divide the sample between early and late responses (Dalecki et al. 1993, Necker 2014), defined by the subsample of 58 experts that directly responded to the first e-mail and those that answered a reminder e-mail. We check for potential non-response bias by comparing mean and median responses of each of these groups (see Table 3.3). While there are differences regarding some discounting determinants, we find that there are no statistically significant differences in SDR values across different groups.

A further common measure for potential non-response bias is to consider groups by gender and location (Necker 2014).<sup>17</sup> We find that male experts selected into responding to our survey relative to the non-response group (91 percent versus 81 percent). The proportions of respondents and non-respondents are balanced in terms of characteristics such as being a full Professor (49 percent versus 48 percent) and average year of Ph.D. completion (1993.6 versus 1993.7). Experts currently based in Europe selected into responding (49 percent of respondents versus 32 percent of non-respondent). This may have led to a slight underestimation of the mean SDR given the propensity of Europeans to be more normative than non-Europeans.<sup>18</sup>

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<sup>15</sup>Reasons include having insufficient time (11 times) as well as insufficient expertise (10 times), which may indicate self-selection of experts into responding to the survey.

<sup>16</sup>A twelfth panel member initially provided qualitative evidence only, but stated after the survey was completed that he would “follow the view of the median panelist.”

<sup>17</sup>Personal characteristics were obtained from experts’ own web pages. We collected information on continental location, gender, professorial title, and year of Ph.D. graduation as a proxy for (academic) age. We identify 89 respondents from Europe, 80 from the Americas and 14 from the Rest of the World. We have 167 male respondents, while only 16 women gave quantitative answers to our questionnaire. Approximately half our sample are full professors and the mean year of Ph.D. graduation is 1994.

<sup>18</sup>Appendix A.1.4 provides a more detailed analysis of non-response bias checks. For instance, European experts recommend SDRs that are 0.68 percentage points lower.



Table 3.3: Comparison with non-respondents and Arrow et al. (2012) experts

	$g$	$\delta$	$\eta$	$r$	Normative	SDR	SDRmin	SDRmax
<i>Results from the 185 quantitative responses</i>								
Mean	1.70	1.10	1.35	2.38	61.53	2.27	1.12	4.14
Median	1.60	0.50	1.00	2.00	70.00	2.00	1.00	3.50
N	181	180	173	176	182	181	182	183
<i>Results from the 14 randomly selected previous non-respondent responses</i>								
Mean	1.63	1.46	1.23	1.96	71.36	2.02	1.01	3.09
Median	1.50	1.00	1.00	1.75	75.00	2.00	0.63	3.00
N	12	12	8	12	12	13	14	13
<i>Results from 11 of the 13 Arrow et al. (2012) panel experts</i>								
Mean	1.80	0.60	1.51	2.66	57.27	2.62	1.30	4.00
Median	2.00	0.50	1.50	3.00	50.00	3.00	1.00	4.00
N	11	11	11	11	11	11	11	11
<i>Results from the 58 early responses</i>								
Mean	1.49	0.73	1.47	2.26	60.14	1.99	0.92	3.68
Median	1.50	0.38	1.50	2.00	50.00	2.00	0.75	3.00
N	58	58	56	58	58	58	58	58
<i>Results from the 127 late responses</i>								
Mean	1.80	1.27	1.29	2.44	62.18	2.40	1.21	4.35
Median	1.80	0.90	1.00	2.00	70.00	2.00	1.00	4.00
N	123	122	117	118	124	123	124	125

Overall, our findings do not suggest substantial and systematic unidirectional non-response biases for SDR recommendations.

## 3.4 Analysis

### 3.4.1 Determinants of the SDR

We now examine the relationship between experts' recommended SDRs and its fundamental determinants. In line with what one would expect from the theoretical Ramsey framework, the correlations between the rate of societal pure time preference,  $\delta$ , as well as the 'wealth effect',  $\eta \times g$ , and expert's SDR recommendation are positive. More precisely, a univariate increase in  $\delta$  of one percentage point increases the SDR recommendation by 0.34 percentage points ( $p < 0.01$ ).<sup>19</sup> The effect of an increase in  $\eta \times g$  by one percentage point increases the SDR by 0.15 percentage points ( $p < 0.01$ ).<sup>20</sup> The main driver of the wealth effect is the forecasted growth rate, while  $\eta$  is not significantly associated with higher SDR recommendations in isolation. An increase in  $r$  by one percentage point is associated with an increase of the SDR by 0.52 percentage points ( $p < 0.01$ ).

A very robust and sizable determinant of the SDR is the weight that experts would put on normative as compared to positive issues ('normative weight') when forming their SDR recommendation. We find that each additional percentage-point of the relative weight put on normative issues reduces the SDR by 0.02 percentage points ( $p < 0.01$ ). This implies that a pure 'positivist' (normative scale = 0) would recommend a SDR that is 2 percentage points higher than a pure 'normativist' (normative scale = 100 percent).

We further examine how other considerations expressed through experts' qualitative comments may determine SDR recommendations. For this, we build on the categorization of qualitative comments as shown in Table 3.2 and analyze the relation of the SDR to the three most-mentioned categories. Experts commenting on declining discount rates (DDR) recommend an SDR that is 0.70 percentage points lower ( $p < 0.05$ ), consistent with arguments provided in the pertinent literature.<sup>21</sup> Furthermore, experts commenting on uncertainty recommend an SDR which is 0.69

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<sup>19</sup>All test are based on two-sided t-tests.

<sup>20</sup>When evaluated multivariately the partial effects are 0.32 and 0.11 (both  $p < 0.01$ ).

<sup>21</sup>See, e.g., Arrow et al. (2013), Cropper et al. (2014), Gollier et al. (2008), Groom et al. (2005), Newell and Pizer (2003), Weitzman (2001).

percentage points lower ( $p < 0.01$ ), also consistent with the view that uncertainty tends to lower the appropriate SDR.<sup>22</sup> For those experts commenting on environmental scarcity and relative price effects, we find recommended SDR values that are lower by 0.97 percentage points ( $p < 0.01$ ). Again, this is consistent with the literature on dual discounting and the relative price effects of non-marketed goods.<sup>23</sup>

As our survey was only designed to capture select fundamental determinants of the SDR for reasons of parsimony, it is clear that we only capture some of the determinants of the SDR.<sup>24</sup> Overall, however, this analysis suggests that responses appear to be theoretically motivated.

### 3.4.2 Experts' SDRs and the Ramsey Rule framework

An important issue for governmental guidance on social discounting is to consider which theoretical framework may form the basis of recommendations on the SDR. The previous analysis of discounting determinants has revealed that experts' SDR responses are indeed informed by some of its fundamental determinants in a way that would be based on theories discussed in Section 3.2.1. Thus, we now scrutinize in more detail whether and to what extent experts' SDR recommendations may be in line with the simple Ramsey Rule (SRR) or the extended Ramsey Rule (ERR).

We first impute the SRR using responses on individual components from each expert. We find that its median (mean) [modal] value is 3 (3.48) [4] percent. The mean SRR is thus 1.21 percentage points higher than the mean recommended SDR. Figure 3.2 displays a histogram of the differences between individual SDRs and imputed SRRs, excluding five outliers. The SDR coincides with the SRR for only 36 respondents.<sup>25</sup> This strongly suggests that the simple, deterministic Ramsey Rule is

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<sup>22</sup>See, e.g., Gollier (2008), Traeger (2009), Weitzman (1998), Weitzman and Gollier (2010).

<sup>23</sup>See, e.g., Baumgärtner et al. (2015), Drupp (2016), Gollier (2010), Sterner and Persson (2008), Traeger (2011).

<sup>24</sup>For example, it seems likely that contained within our normative-positive measure is a variety of unexplained and unobserved normative positions. Variation could also reflect differences within the positive school stemming from, for instance, differences or asymmetries in the information used to provide a global forecast.

<sup>25</sup>It is important to note that these coincidences need not necessarily imply that experts indeed determined the SDR based on the SRR.

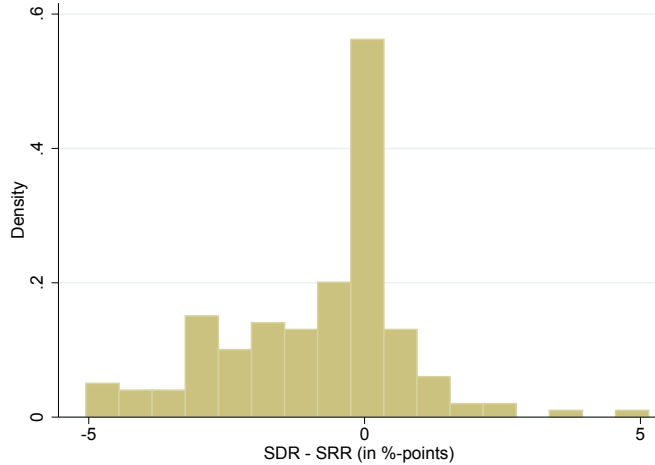


Figure 3.2: Histogram of the difference between the recommended SDR and the imputed simple Ramsey Rule ( $SRR = \delta + \eta \times g$ ), in the interval  $[-5.5, 5.5]$ .

not the preferred model for determining the SDR for the majority of experts. Indeed, the qualitative responses of many experts reveal well-motivated reasons for departing from this framework. We now explore potential reasons for the large heterogeneity in differences between the SDR and the SRR depicted in Figure 3.2.

One prominent alternative to the SRR that many experts might have relied upon is the more general ERR. Indeed, a number of respondents explicitly stated that they considered uncertainty in the economy’s baseline growth when forming their SDR recommendation.<sup>26</sup> In the extended Ramsey Rule, a precautionary savings motive results in  $ERR - SRR = -0.5\eta(\eta + 1)\sigma^2 \leq 0$ , where  $\sigma^2$  is the volatility of real per-capita consumption growth (Gollier 2002, 2011).<sup>27</sup> If respondents use the ERR for determining their SDR, we would expect that  $SDR < SRR$ . Indeed, this seems to be the case for most respondents, as revealed in Figure 3.2. While we do not elicit forecasts of  $\sigma$ , we can indirectly infer the value of this parameter that would make the ERR consistent with the SDR for any given expert. We can reconcile the SDR of only seven respondents with the Social Rate of Time Preference as given by the ERR if their applied estimate of  $\sigma \in (0\%, 3.6\%]$ . This is the value of  $\sigma$  used by Gollier (2012, Table 3.1). Allowing  $\sigma \in (0\%, 9\%]$ , the SDR response of 41 experts can be reconciled

<sup>26</sup>For example, an expert stated: “my discount rate is less than implied by the Ramsey rule because I use the extended rule, incorporating uncertainty about long term growth”.

<sup>27</sup>Note that the interpretation of  $\eta$  here may differ from that of our survey, as the survey does not explicitly focus on risk aversion and prudence.

with the ERR. The mean (median) value of  $\sigma$  that would ensure consistency between the SDR and ERR response for the 97 experts for whom  $SDR < SRR$  is 11 percent (10 percent), which is considerably higher than standard estimates for this parameter value (Gollier 2011). This implies that even though a number of experts may have relied on the ERR, the precautionary savings motive is unlikely to have been the only driving determinant for recommending lower SDRs.

Indeed, a number of other arguments have been provided by experts for lower SDRs. Among others, these point towards the use of declining discount rates or the consideration of relative price effects of non-marketed environmental goods. Yet, Figure 3.2 also shows a number of experts recommended SDRs that are higher than the imputed SRR and thus also the ERR. Such positions were often motivated by arguments relating to opportunity cost of governmental funds, indicating the need to evaluate intergenerational projects using the opportunity cost of capital, rather than the SRR or ERR, and the idea that the former will typically be higher.

Beyond these technical arguments, which largely require extensions to the SRR framework, further criticism focused on the need for alternative approaches to inform intergenerational decision-making.<sup>28</sup>

Overall, the analysis demonstrates that within the expert community there are several distinct schools of thought on how to discount intergenerational projects, which are more nuanced than the standard normative-positive dichotomy. In particular, our analysis highlights that many experts are sceptical about the central role of the simple Ramsey Rule in determining policy recommendations on long-term public projects.

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<sup>28</sup>Experts recorded doubts about whether “a representative agent model with a standard Ramsey social welfare function is adequate in either descriptive or normative terms”. They also point towards “richer ways of framing questions of intergenerational justice than simply tweaking the discount rate” by developing alternative criteria for intergenerational decision-making. Such approaches might “set limits in physical terms to the future development that must not be exceeded for reasons of intra- and intergenerational justice [...]. Then use a discounted utilitarian approach to optimise development only within these limits”.

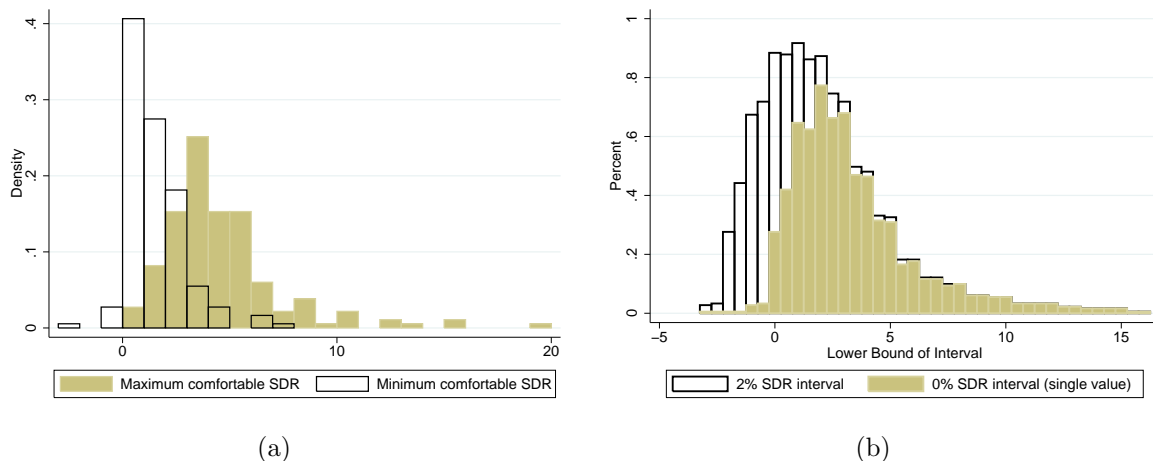


Figure 3.3: Figure (a) depicts the minimum and maximum SDR values that individual experts are still comfortable with recommending. The x-axis in Figure (b) shows the lower bound of an interval of given size (e.g. 2 percent) and the y-axis the proportion of experts whose acceptable SDR range has some overlap with an interval of a particular size starting at that point.

### 3.4.3 Disagreement on social discount rates

Point recommendations on the SDR range from 0 to 10 percent. It is therefore unsurprising that the minimum acceptable SDRs reported by some experts are above the maximum acceptable SDRs of others (Figure 3.3 (a)). Yet, a closer inspection of the experts' acceptable ranges shows that there is considerable space for agreement on the SDR.

The colored histogram in Figure 3.3 (b) shows the proportion of experts whose acceptable SDR range includes any given SDR value. From this histogram we can also conclude that, besides being the median and modal point SDR recommendation (cf. Table 3.1), a SDR of 2 percent is also contained in the acceptable range of more experts than any other value (77 percent). The transparent histogram shows, for any given SDR value,  $x$ , the proportion of experts whose acceptable SDR range overlaps the interval  $[x, x+2\%]$ . Looking at  $x = 1\%$  on this histogram reveals that the interval  $[1\%, 3\%]$  is overlapped by the acceptable range of the SDR for 92 percent of experts.

These data on SDR ranges shed light on which of the prominent positions voiced in the academic and public debate – the long-term SDR of 4.5 percent in Nordhaus (2008), or Stern's (2007) central SDR value of 1.4 percent – is more representative of the expert community. Based on the point SDR recommendations, we find that while

30 percent of experts recommend Stern’s SDR of 1.4 percent or lower, only 9 percent of experts recommend Nordhaus’ value of 4.5 percent or higher, with 61 percent forming the middle ground between these two. The SDRs employed by Nordhaus (2008) and Stern (2007) are included in the acceptable range of 31 percent and 58 percent of experts, respectively. While there is more support for Stern’s position, our findings suggest that neither may be deemed robust enough by policy-makers, who might prefer instead to take a position between the two.

### 3.5 Discussion

In this section we discuss advice on determining an appropriate SDR for long-term policy making from the survey evidence. Three immediate questions arise. First, what role should experts play in providing the raw materials for the SDR? Second, how should heterogeneities in expert views be treated when calculating the appropriate SDR? Third, how should uncertainty be treated?

The first question has itself been a source of disagreement (Dasgupta 2008; Weitzman 2001). One typical criticism is that guidance on social discounting should be informed via more “democratic” means (Dasgupta 2008: 158). It is often claimed that economists do not command any special expertise in matters of ethics. Yet some discussants explicitly advocate an active role for “genuine specialists” to steer the process of setting SDRs (Pindyck 2017; Sunstein 2014: 550). This comes as no surprise, as the questions raised by intergenerational discounting are highly complex. Compared to members of the general population, experts will have spent considerably more time considering the intricate issues that arise. We also note that governmental guidance on social discounting is generally influenced by expert opinion, as are other areas of policy as evidenced by, for example, membership of Monetary Policy Committees. There is also a distinction to be drawn within economics between genuine specialists and general economists. Monetary Policy Committee members typically fall into the former category, as do those who have provided recent advice to international governments on social discounting. Therefore, while there are good arguments for more inclusive approaches, it is also imperative that advice is heard from genuine experts on the determinants of the long-term SDR.

Based on the heterogeneous responses to this survey, a decision-maker might reasonably ask which single rate to use when discounting the certainty-equivalent cash flows from an intergenerational project. Deciding how best to adjudicate between conflicting opinions, and aggregate different forecasts, is a contentious issue to which there is no single accepted answer.<sup>29</sup>

Given the lack of clear theoretical guidance on how to aggregate individual expert responses, what remains may be to rely on a data-driven approach. Fortunately, this points towards a rather clear recommendation: a long term SDR of 2 percent is not only the modal and median recommendation but also the SDR value that is included in the acceptable ranges of most experts (77 percent). This long-run SDR of 2 percent is lower than the equivalent recommendations of the UK, French and US governments.

Finally, we must remember that this SDR should be applied to certainty-equivalent cash flows. However, in most circumstances, governments use expected cash-flows instead. This approach has been theoretically motivated by the Arrow-Lind theorem, but has become under increased scrutiny in recent years (e.g., Baumstark and Gollier 2014; Lucas 2014). If there are project-specific risks, and these are correlated with macroeconomic (consumption) risk then the appropriate SDR for evaluating the net benefits will vary from one project to another depending on its risk profile. The SDR for a climate change mitigation project, for example, is likely to differ vastly from that appropriate for health, transport or education projects depending on their contribution to macro-economic risk. Such contributions should be penalised/rewarded using a project specific risk adjustment depending on whether a project contributes/reduces macroeconomic risk (Gollier 2012: 193). Our survey does not provide guidance on risk premiums themselves but does provide the risk-free component of the SDR to be used even in this risk-adjusted world.

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<sup>29</sup>One proposal is to calculate the discount *factor* for each respondent, and then construct the social discount factor as a weighted average of individual discount factors. This is the approach taken by Weitzman (2001) and leads to a declining term structure of SDRs. The difficulty with this approach is that it is not clear what weights to assign to each of the expert discount factors. While Weitzman (2001) gives each response equal importance, this has been a controversial choice (Freeman and Groom 2015; Heal and Millner 2014; Jouini et al. 2010; Millner and Heal 2017; Weitzman and Gollier 2010; Gollier and Zeckhauser 2005). In particular, Freeman and Groom (2015) show that the appropriate weighting depends on whether responses reflect disagreement on value judgments or uncertainty about forecasts.



### 3.6 Conclusion

We have presented evidence from a survey of over 200 experts on the determinants of the long-term real social discount rate (SDR). This is, perhaps, the single most important driver of any cost-benefit analysis evaluating long-term public projects. We find that the median (mean) recommended SDR of our experts is 2 percent (2.3 percent). While there is considerable disagreement between respondents on point recommendations, which range from 0 to 10 percent, more than three-quarters of those surveyed would find the median and modal SDR of 2 percent acceptable. More than 90 percent are comfortable with a SDR somewhere in the interval of 1 percent to 3 percent.

A key innovation of our survey is that we not only elicit responses on the appropriate and acceptable SDR itself, but also on individual discounting determinants: recommendations on the rate of pure time preference and the elasticity of marginal utility of consumption, as well as predictions of long-term per-capita consumption growth and the average real risk-free rate of interest. This disentangled data allow us to shed some light on which approaches to social discounting experts use. Importantly, our disentangled data show that the simple, deterministic Ramsey Rule, which is still found in governmental guidelines on cost-benefit analysis across the world, cannot explain the responses of the majority of our experts. The conclusion that more complex models for social discounting are required is supported by the rich body of qualitative responses we received. Many of our respondents provided comments relating to a number of extensions and alternatives to the simple Ramsey Rule approach. These include issues such as uncertainty, heterogeneity, relative prices of non-marketed goods as well as other societal evaluation approaches that policy guidance on social discounting should consider to ensure efficient and equitable decisions on long-term public projects.

Further inspection of the data on individual discounting determinants yields findings that transcend their value as potential inputs to governmental discounting guidelines. First, we find that the modal value of the pure rate of time preference is zero, but with a median (mean) of 0.5 percent (1.1 percent), our results cannot confirm the IPCC's (2014: 229) conclusion that *"a broad consensus for a zero or near-zero pure*

*rate of time preference*” exists among experts. Second, our data suggest that the IPCC should consider lower growth scenarios in future assessments. Third the median and modal recommended elasticity of marginal utility of consumption of unity provides some support for the often made assumption of logarithmic utility. Lastly, we find that there exists considerable disagreement between experts on the relative importance of normative and positive approaches to discounting. Most report that the SDR should reflect both, highlighting that these previously accepted categories overly polarise more nuanced expert views. Engaging with both disagreement about values and uncertainty over forecasts is therefore an essential task for informing decision-making on long-term public projects.

Overall, our findings lead us to the conclusion that the prominence of the Ramsey Rule needs to be revisited and that much of current policy guidance concerning social discounting and the evaluation of long-term public projects requires updating. While not uncontentious, our survey points to a long-term global SDR for certainty-equivalent cash flows of 2 percent. This SDR is lower than recommended by many governments around the world and prominent experts (Nordhaus 2008, Weitzman 2001), yet closer to recent revealed evidence on long-term discounting from the housing-market (Giglio et al. 2015).

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## A.1 Appendix to Chapter 3

### A.1.1 Comparison to Weitzman’s (2001) Survey

A natural reference comparison for our results is the seminal survey of Weitzman (2001), who asked more than 2000 Ph.D.-level economists to report a single appropriate “*real discount rate*” or “*rate of interest*” with which to discount projects aimed at mitigating climate change. The key difference between the response data of Weitzman (2001) and our results is that we find a substantially lower mean (median) SDR recommendation, with 2.27 percent (2 percent) compared to 3.96 percent (3 percent). Furthermore, we find a much lower standard deviation of the SDR responses of 1.62 percent compared to the 2.94 percent of Weitzman’s (2001) respondents, and the range of point recommendations on the SDR is much more condensed (0 to 10 percent compared to -3 percent to 27 percent).<sup>1</sup> The modal recommended value for the SDR of 2 percent, however, is the same in both surveys.

We can point to at least three potential explanations for these differences. First, experts who have graduated from their Ph.D.s since Weitzman’s survey was conducted generally recommend lower SDRs than those who have been in the profession for longer. Second, the literature that has influenced this new generation of academics — for example, on declining discount rates and the arguments articulated in the Stern Review — may have led more established scholars to reduce their SDR recommendations during their careers. Third, Weitzman’s pool of potential respondents is a general economics audience, while we select only those scholars who have published directly on discounting and can be considered specialists in this sense.<sup>2</sup>

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<sup>1</sup>The standard deviation, minimum and maximum of the imputed SRRs (3.52%, -2% and 26% respectively) are, by contrast, similar to the values reported in Weitzman (2001).

<sup>2</sup>That real growth and interest rates in many countries are now below the rates that prevailed at the start of the Century is unlikely to be a core driving factor. The mean real risk-free interest rate response of 2.38 percent does not closely correspond to current real bond yields in major economies and is above the 2 percent long-term global average for bonds reported by Dimson et al. (2011). Similarly, the mean forecasted growth rate of real per-capita consumption of 1.7 percent is only slightly lower than the historical global average. Finally, if low current interest rates are driving the lower SDRs we would expect those who put the highest weight on positive issues for determining the SDR to be influenced more by current yields. Yet these experts tend to recommend higher SDRs.

### A.1.2 Further Detail on the Selection of Experts

Based on full-text analysis in the Google Scholar engine, we searched the 102 leading economics journals (according to the ranking of Combes and Linnenmer 2010) plus the Review of Environmental Economics and Policy for publications since the year 2000 including the terms ‘social discounting’, ‘social discount rate’ or ‘social discount factor’ (in March/April 2014). As a result, we identified 778 potential experts. As not all pertinent contributions to the field use the term ‘social discount rate’, but often ‘real discount rate’ or simply ‘discount rate’, we further performed an EconLit search for the term ‘discount rate’ (in April 2014). To avoid picking up a large number of papers that only mention ‘discount rate’ in passing somewhere in the paper, we limited the scope to a within-abstract search. This search yielded an additional 241 potential experts. We thus identified a total of 1019 unique potential experts. We then manually discarded – using a weak relevancy test – publications that are clearly not of direct relevance for our study. The criteria used to judge whether a publication is not relevant are listed below:

- If the search phrases do not appear in the article itself, but only in the reference list.
- If the publication is a book review or another non-original contribution.
- If a value for the SDR is simply applied in an analysis without reference to the literature.
- If one of the phrases is mentioned but not elaborated on.
- If the publication relies on a discount rate that is clearly not relevant to long-term social discounting by governmental bodies, such as discounting of profits or university fees.

A publication is labeled irrelevant if it meets at least one of the listed criteria. If at least one of the publications of a scholar is regarded to be relevant (i.e. passes this weak relevancy test), he or she is considered to be an expert. As a result of the above relevancy test, we exclude 365 scholars from the pool of potential experts, thus

being left with 654 potential experts. For 27 of these scholars we could not obtain an e-mail address because, for example, they have left academia or are deceased. Our final population of potential experts thus contains 627 experts.<sup>3</sup>

### **A.1.3 E-mail Text**

This Appendix provides the text of the initial e-mail introducing experts to the online survey.

Dear [Personal identifier],

We are targeting a select group of academics with expertise in social discounting. The objective is to elicit recommendations on fundamental issues of discounting to inform long-term public investment decision-making.

We would be most grateful if you could find the time to complete the very short survey appended below.

<https://www.surveymonkey.com/s/discounting-survey>

Your individual response will be held in the strictest confidence.

Many thanks for your time and cooperation,

Ben Groom (LSE), Moritz Drupp (Kiel, LSE),

Frikk Nesje (Oslo, LSE), Mark Freeman (Loughborough)

### **A.1.4 Further Checks of Non-Response Bias**

We carried out a series of robustness checks to test for potential non-response bias (see Johnson and Wislar (2012) and Necker (2014) for discussions of different testing strategies).

In the main body of the paper, we first compare our 185 quantitative responses with a random sample of 60 potential experts who had not replied by November 2014.

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<sup>3</sup>Although potential experts have published in leading economics journals, a small number of them do not have a Ph.D. in economics but come from diverse fields, including law and the natural sciences.

Second, we compare our 185 quantitative responses with the sub-sample responses of the Resources for the Future (RFF) Arrow et al. (2012) panel on intergenerational decision-making. Third, we consider differences in observable characteristics – academic age, location and gender – among respondents and non-respondents. A related check is to test for self-selection of environmental economists into responding.<sup>4</sup> Indeed, we observe that they do: 48% of respondents are environmental economists, while only 33% of the non-respondents are environmental economists. Yet, we find that environmental economists’ mean and median SDRs are not statistically significantly different (at the 10 percent level) to non-environmental economists.

Table A.1: Alternative comparison of early and late responses

	$g$	$\delta$	$\eta$	$r$	Normative	SDR	SDRmin	SDRmax
<b>Split by time of response in SurveyMonkey</b>								
<i>Results from the 88 early responses</i>								
Mean	1.63	0.93	1.44	2.42	61.72	2.18	1.07	3.89
Median	1.50	0.50	1.25	2.00	70.00	2.00	1.00	3.25
N	88	88	85	88	88	87	88	88
<i>Results from the 88 late responses</i>								
Mean	1.81	1.26	1.27	2.38	61.00	2.34	1.17	4.38
Median	2.00	1.00	1.00	2.00	68.50	2.00	1.00	3.50
N	85	85	83	81	88	87	87	87

Lastly, we consider differences between experts who responded to the initial wave, and those who responded to a reminder. In Table 3.3) we report the results of a comparison of those who had responded to the first survey and those who had responded

<sup>4</sup>We regard an expert to be an environmental economist if the publication that led us to select her or him as a potential expert is in one of: American Journal of Agricultural Economics, Ecological Economics, Energy Journal, Environmental and Resource Economics, Journal of Environmental Economics and Management, Land Economics, Resource and Energy Economics, or Review of Environmental Economics and Policy.

to a reminder to obtain a further indirect measure of potentially biasing participation. At the 10 percent level of significance only the mean forecasted per-capita growth rate and recommended social rate of pure time preference are different between the samples of early and late respondents. The mean forecasted per-capita growth rate and recommended social rate of pure time preference are higher for the sub-sample of respondents that required a reminder. On the other hand, the median recommendation on the elasticity of marginal utility is the only median response significantly different between the subsamples, with the median of those responding immediately being higher. As a robustness check, we also divided early and late respondents into equal sized groups and found that the results were similar. The results of this additional exercise are reported in Table A.1. While we find some effect for those requiring a reminder versus those that responded right away, we do not find significant differences in mean and median recommendations and forecasts when we split the whole sample into equal halves and consider early and late respondents based on this definition.

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## 4 Subsistence, Substitutability and Sustainability in Consumption

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**Abstract:** We propose a representation of individual preferences with a subsistence requirement in consumption, and examine its implications for substitutability and sustainability. Specifically, we generalize the standard constant-elasticity-of-substitution (CES) utility specification for manufactured goods and environmental services, by adding a subsistence requirement for environmental services. We find that the Hicksian elasticity of substitution strictly monotonically increases with the consumption of environmental services above the subsistence requirement, and approaches the standard CES value as consumption becomes very large. Whether the two goods are market substitutes depends on the level of income. We further show that the subsistence requirement may jeopardize the existence of an intertemporally optimal and sustainable consumption path. Our results have important implications for growth, development and environmental policy.

**Keywords:** Elasticity of substitution, environmental services, Stone-Geary function, subsistence in consumption, substitutability, sustainability.

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## 5 Limits to Substitution between Ecosystem Services and Manufactured Goods and Implications for Social Discounting

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**Abstract:** This paper examines implications of limits to substitution for estimating substitutability between ecosystem services and manufactured goods and for social discounting. Based on a model that accounts for a subsistence requirement in the consumption of ecosystem services, we provide empirical evidence on substitution elasticities. We find an initial mean elasticity of substitution of two, which declines over time towards complementarity. We subsequently extend the theory of dual discounting by introducing a subsistence requirement. The relative price of ecosystem services is non-constant and grows without bound as the consumption of ecosystem services declines towards the subsistence level. An application suggests that the initial discount rate for ecosystem services is more than a percentage-point lower as compared to manufactured goods. This difference increases by a further half percentage-point over a 300-year time horizon. The results underscore the importance of considering limited substitutability in long-term public project appraisal.

**Keywords:** Limited substitutability; Dual discounting; Ecosystem services; Subsistence; Project evaluation; Sustainability.

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# 6 Truth-Telling and the Regulator. Experimental Evidence from Commercial Fishermen

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*Kiel Working Paper 2063.\**

**Abstract:** Understanding what determines the truth-telling of economic agents towards their regulator is of major economic importance from banking to the management of common-pool resources such as European fisheries. By enacting a discard-ban on unwanted fish-catches without increasing monitoring activities, the European Union (EU) depends on fishermen's truth-telling. Using a coin-tossing task in an artefactual field experiment, we test whether truth-telling in a baseline setting differs from behavior in two treatments that exploit fishermen's widespread ill-regard of their regulator, the EU. Fishermen misreport coin tosses to their advantage more strongly in a treatment where they are faced with the EU flag. Yet, some fishermen are more honest in an additional treatment where the source of EU research funding is revealed. Our findings imply that lying is more extensive towards an ill-regarded regulator, and that regulators can affect truth-telling behavior by the nature and communication of their policies.

**Keywords:** Truth-telling, lying, field experiment, regulation, fishermen.

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*“fishermen hold an almost entirely negative view of the EU”*

— McAngus (2016: 4) reporting survey results for UK fishermen

## 6.1 Introduction

Although honesty is regarded as a virtue or even a moral duty (Kant 1785), lying and deception permeate economic life (Gneezy 2005). Studying truth-telling has accordingly become a focus of inquiry for economics.<sup>1</sup> An area of particular public economic importance is the truth-telling of economic agents towards their regulating authorities—from the banking industry (Cohn et al. 2014), and tax reporting (Jacobsen and Piovesan 2016, Kleven et al. 2011) to environmental regulation (Duflo et al. 2013). The recent case where the German car manufacturer Volkswagen systematically lied about cars’ emissions is but one prominent example. Faced with uncertainty about how honest economic agents are, regulators need to decide how much to invest in monitoring and how to devise appropriate sanctioning schemes for misbehavior.

Appropriate monitoring and sanctioning mechanisms are especially crucial for the management of common pool resources (Ostrom et al. 1992, Rustagi et al. 2010), with the fishery as a prime example (Wilén 2000, Stavins 2011). Fishery management comes in many different forms around the globe. It ranges from stringent restrictions on fish catches using individual transferable quotas—as in New Zealand (Newell et al. 2005) or Iceland (Arnason 2005)—to largely unregulated open-access fishing, as it is still the case for most high-seas fisheries. The costs of illegal, unreported and unregulated fishing are substantial and amount to US\$ 10 to 23 billion per year (Global Ocean Commission 2013). Due to its economic importance and the heterogeneity of its regulatory structures, the fishery has recently gained substantial interest in experimental economic work.<sup>2</sup>

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<sup>1</sup>For instance, see Abeler et al. (2014, 2016), Cappelen et al. (2013), Cohn et al. (2014, 2015), Fischbacher and Föllmi-Heusi (2013), Gächter and Schulz (2016), Gibson et al. (2013), Gneezy (2005), Gneezy et al. (2013), Houser et al. (2016), Mazar et al. (2008), Pasqual-Ezama et al. (2015), Potters and Stoop (2016), Rosenbaum et al. (2014).

<sup>2</sup>Among others, previous studies scrutinize cooperativeness, competitiveness and impatience among fishermen in Brazil (Fehr and Leibbrandt 2011, Leibbrandt et al. 2013, Gneezy et al. 2015). Stoop et al. (2012) examine cooperation among recreational Dutch anglers, while Jang and Lynham

This paper extends the scope of previous studies and investigates to what extent regulator framing affects truth-telling. Our study therefore adds a new dimension to effective regulatory policy. We present evidence from an artefactual field experiment that examines truth-telling of German commercial fishermen. German commercial fishing is regulated by the European Union (EU), which is the world’s fourth largest producer of fish, under the European Common Fisheries Policy. The EU has recently enacted a ban on returning unwanted fish catches to the sea (also called “discard ban” or “landing obligation”), as the practice of discarding ensues substantial costs to the public.<sup>3</sup> The change in legislation has, as of yet, not been combined with more stringent monitoring. The regulator, and scientists assessing the status of fish stocks upon which recommendations for fishery management are based, thus depend on fishermen’s truth-telling. Continuing to discard unwanted fish catches to the sea remains the individually optimal choice for fishermen in the present regulatory regime unless the regulator enforces the new policy. This, however, would require costly monitoring and sanctioning mechanisms.<sup>4</sup> This trade-off for the regulator between more costly monitoring and reliance on regulatee’s honesty is not only relevant in the fishery for the newly enacted European “discard ban” or compliance with fishing quotas, but holds more generally.

For studying to what extent fishermen tell the truth towards their regulator, we conduct a coin-tossing game in a mail field experiment targeting all commercial fishermen in Germany. Adapting the 4-coin toss game of Abeler et al. (2014), we ask fishermen to toss a coin 4 times and report back their number of tail tosses. For each reported tail toss, they receive five Euros. In a between-subjects design, we test whether truth-telling in a baseline setting differs from truth-telling in two further treatments with different EU framings, where, first, the EU flag is made salient on the

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(2015) investigate the emergence of social preferences among lake fishermen in Kenya.

<sup>3</sup>Unused catches imply opportunity costs for fishermen and society. Patrick and Benaka (2013) estimate that bycatch discards represent a loss of \$4.2 billion in potential sales in the US alone.

<sup>4</sup>More stringent monitoring could come in different forms, such as more frequent patrolling of sea police, sending observers on-board or installing video cameras on ships to monitor whether fishermen comply with the law. Associated cost estimates are substantial, ranging from \$8,000 to \$13,000 per ship annually for remote camera monitoring in Canada and Denmark (Mangi et al. 2013), to 200,000€ for on-board observers in Denmark (Kindt-Larsen et al. 2011). FAO estimates that discard-related spending by regulating authorities worldwide totals annual costs of \$4.5 billion (Alverson 1994).

instruction sheet, and, second, a framing that states additionally that the European Commission has funded the research. Based on a simple model of reporting behavior of fishermen that considers internal Nash bargaining among a pay-off maximizing ‘selfish self’ and a ‘moral self’, we hypothesize that the salience of the EU regulator may increase the bargaining power of the ‘selfish self’ vis-à-vis the ‘moral self’ and thus decrease overall lying costs if the EU is ill-regarded. The fishery is an ideal test case for studying how truth-telling behavior may be affected by regulatory framing, as there is well-documented and wide-spread contempt among fishermen concerning stricter EU fishing regulation. We confirm the almost entirely negative view of the EU prevalent among UK fishermen (McAngus 2016) for our field experimental setting in Germany: Besides ample anecdotal evidence, our survey results indicate that 90% of participating fishermen have a low trust in the EU, while this is only the case for 32% of a student control group. If regulator framing impacts truth-telling, we will therefore expect an almost uniform direction of the effect.

We find that fishermen misreport coin tosses to their advantage, albeit to a lesser extent than standard theory predicts. As hypothesized, misreporting is larger among fishermen who are faced with the EU flag. However, a control treatment reveals that some fishermen are more honest if the source of EU funding is made salient. Our findings imply that regulators have to take into account not only some given degree of dishonesty among the regulated, but also that the nature and communication of the regulatory policy will affect truth-telling. Regulators may be able to encounter new, cost-effective means to curb dishonest behavior and improve public policy. We close by discussing further policy relevance of our results.

## **6.2 Field setting, experimental design and hypotheses**

The fishery has economic relevance in the German coastal regions at both the North Sea and Baltic Sea. According to the European Union’s Common Fisheries Policy (CFP), the Council of Ministers of the European Union and the European Parliament set fishing quotas for the German fisheries. The German Federal Office for Agriculture and Food distributes the national catch quotas to fishing organizations or individual fishermen. Monitoring and enforcement of compliance are the duty of EU



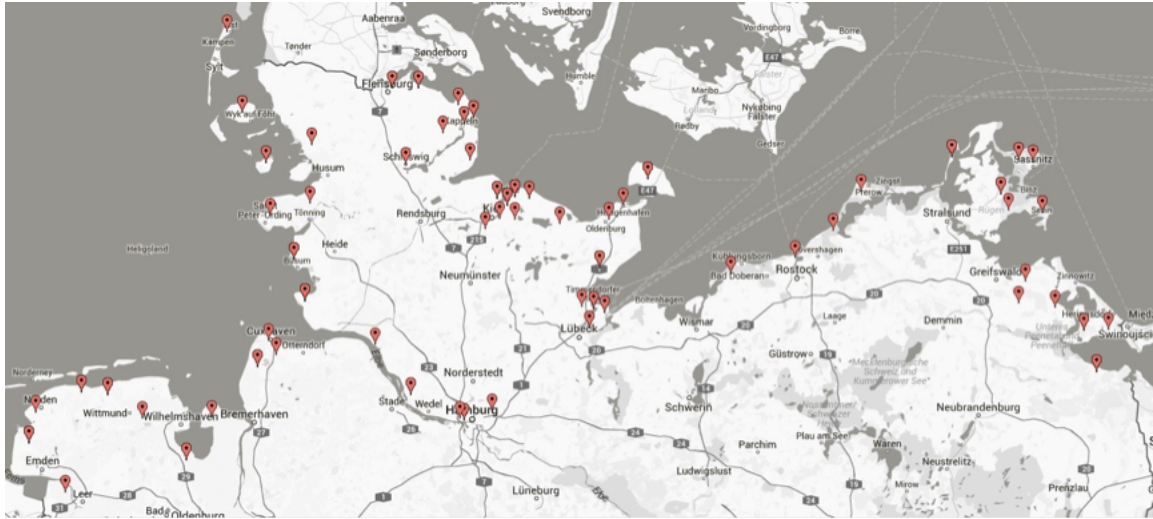


Figure 6.1: Map of North Germany. The red balloons represent the zip-codes of participating fishermen.

member states, and ultimately of the federal states in the case of Germany. A total of 896 commercial fishermen, owning 1,465 fishing vessels (German Fishery Association 2015), are registered at the German Federal Office for Agriculture and Food as holders of catch permits for the North Sea or Baltic Sea. Cutter type trawlers and coastal vessels constitute the core of the fleet with 300 boats. Small coastal fishing with passive gear such as gill nets and fish traps on vessels of less than 12 meters length, composed of 1,139 vessels, is predominantly operated at the Baltic coast. The German fishing fleet also includes seven deep-sea trawlers and two special vessels for pelagic fishing that operate in long distant waters, and 46 shell- and other special boats. Figure 6.1 depicts a map of Germany’s coastal regions, where the red balloons indicate the zip codes of fishermen who have participated in our experiment.

The recent economic literature on honesty and lying has made substantial progress to foster our understanding on what determines when and to what extent individuals lie. Abeler et al. (2016) conduct a meta-analysis of more than 30 studies using coin-tossing and die-rolling tasks. This meta-analysis shows that, on average, individuals lie to some, but not to an exhaustive, extent and that the extent of lying does not seem to increase with the stakes. This paper contributes a new dimension to the analysis of truth-telling behavior: How the salience and communication of the regulator, who depends on truth-telling behavior in the policy context, affects the behavior of those being regulated. To this end, we adapt the 4-coin-tossing game of Abeler et al. (2014)

for our mail field experiment. The fishermen’s task was to toss a fair coin exactly 4 times, and report their result in a table printed on the instructions sheet. For each instance they reported that the winning toss “tails” (in German “Zahl”, meaning “number”) laid on top, they received 5€. A key feature of this task is that lying can be detected on aggregate when examining the distribution of decisions, but not at the individual level. Thus, depending on luck and honesty, each fisherman received between 0 and 20€ for this task. Besides the participant sample, the major difference to the study by Abeler et al. (2014) is that they conducted their 4-coin experiments via telephone or in the lab and the decision whether to report truthfully or to cheat was immediate, while our subjects had several weeks to decide on whether to report honestly or to lie.

In absence of a possibility to detect individual lying, a fisherman is assumed to face a trade-off between monetary incentives and moral costs of lying (Akerlof and Kranton 2000, 2005; Cohn et al. 2015; Levitt and List 2007).<sup>5</sup> Here we propose the following extension of the standard model where an individual maximizes a utility function that describes this trade-off: We assume that an individual fisherman faces an internal bargain between two ‘selves’, one being a pay-off maximizing ‘selfish self’, the other one being a ‘moral self’ interested in compliance with the moral standard to tell the truth. While the ‘selfish self’ derives utility only from its payoff proportional to the reported number  $r_i$  of coin tosses, the ‘moral self’ suffers a disutility from reporting a number  $r_i$  that deviates from the true number of tail tosses,  $R_{it}$ . Specifically, we assume utility functions

$$u^s(r_i) = -e^{-\beta_i r_i} \quad \text{for the ‘selfish self’}, \quad (6.1)$$

$$u^m(r_i) = -e^{\frac{\gamma_i}{2} (r_{it} - r_i)^2} \quad \text{for the ‘moral self’}. \quad (6.2)$$

Here,  $\beta_i > 0$  is a parameter capturing the marginal utility of income from reported tail tosses. The parameter  $\gamma_i > 0$  can be interpreted as the misreporting aversion of the

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<sup>5</sup>Based on different schools of ethics, it is not trivial to assume an optimization problem of truth-telling. There may be some individuals who behave in line with Kantian deontological ethics and do not lie, out of a duty to tell the truth independent of the consequences. While studies like Gneezy (2005) and Gibson et al. (2013) find that many participants of their studies appear to be consequentialists, most studies also report at least some fraction of participants who never lie. It is therefore an implicit assumption that a sizeable fraction of fishermen are consequentialists.

‘moral self’. The larger  $\gamma_i$ , the more the individual suffers from dishonest reporting.

These two selves engage in a standard Nash bargaining (Binmore et al. 1986), i.e. they ‘agree’ on the reported number  $r_i$  of tail tosses that solves

$$\min_{r_i} (\bar{u}^s - u^s(r_i))^{\alpha_i} (\bar{u}^m - u^m(r_i, r_{it}))^{1-\alpha_i}. \quad (6.3)$$

That is, the resulting number  $r_i$  of reported tail tosses minimizes the weighted geometric mean of the deviation of utilities from respective upper reference levels  $\bar{u}^s$  and  $\bar{u}^m$ .<sup>6</sup> To facilitate the analysis, we set  $\bar{u}^s = 0 \geq \sup_{r_i} u^s(r_i)$  and  $\bar{u}^m = 0 \geq \sup_{r_i} u^m(r_i)$  in the following. The parameter  $\alpha_i$  captures the bargaining power of the ‘selfish self’ relative to the ‘moral self’.

The first-order condition for the bargaining problem (3) is given by

$$\alpha_i \beta_i \left( e^{\frac{\gamma_i}{2} (r_{it} - r_i)^2} \right)^{1-\alpha_i} \left( e^{-\beta_i r_i} \right) + (1-\alpha_i) \gamma_i (r_{it} - r_i) \left( e^{\frac{\gamma_i}{2} (r_{it} - r_i)^2} \right)^{1-\alpha_i} \left( e^{-\beta_i r_i} \right) = 0. \quad (6.4)$$

Solving for  $r_i$  yields the optimal tail toss reporting of an individual:

$$r_i^* = r_{it} + \frac{1}{\lambda_i} \quad (6.5)$$

with

$$\lambda_i = \frac{1 - \alpha_i \gamma_i}{\alpha_i \beta_i}, \quad (6.6)$$

which can be interpreted as an aggregated lying cost parameter (cf. Cohn et al. 2015). The number of reported tail tosses  $r_i$  monotonically decreases in  $\lambda_i$  towards the actual number of tail tosses  $r_{it}$ . An array of factors may impact lying costs, including an individual’s gender, religion, and moral framing (Abeler et al. 2016, Arbel et al. 2014, Bucciol and Piovesan 2011, Rosenbaum et al. 2014, Utikal and Fischbacher 2013).<sup>7</sup> Our model captures some of these effects. In line with intuition, our theory

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<sup>6</sup>We assume that there always has to be an agreement, thus we consider the problem to minimize the deviation from some ‘ideal’ reference point, as opposed to the more often considered problem to maximize the improvement compared to some minimum utility levels of respective outside options.

<sup>7</sup>Lying costs may also be affected by identity priming (Cohn et al. 2014, 2015; Cohn and Marechal 2016). In our setting, fishermen were targeted in their identity as German fishermen. Therefore professional identity considerations may increase lying costs due to reputational concerns inflicted on the profession, reducing the level of reported tail tosses across all treatments.

predicts that lying costs increase with the coefficient of ‘misreporting aversion of the ‘moral self’,  $\gamma_i$ , and decrease with the relative bargaining power of the ‘selfish self’,  $\alpha_i$ , and with the marginal utility of income of the ‘selfish self’,  $\beta_i$ . The relative bargaining power of the ‘selfish self’ is a parameter that is contingent on the particular decision situation. In the following we derive hypotheses on how the treatments affect the relative bargaining power and thus lying costs.

In addition to previously studied effects, we hypothesize that the salience of the regulator affects individual lying costs. Salience of the regulator, in this case the EU, may decrease (increase) the ‘selfish self’s’ bargaining power,  $\alpha_i$ , if the EU is well (ill) regarded. In our experiment we take advantage of the fact that there is well-documented and wide-spread contempt among fishermen concerning stricter EU fishing regulation.<sup>8</sup> That is, we unambiguously predict an increase in the ‘selfish self’s’ bargaining power,  $\alpha_i$ , if the salience of the regulator matters for truth-telling.<sup>9</sup>

In order to test our prediction, we sent out three versions of the instructions in a between-subjects design: (i) a baseline setting (‘Baseline’) in which only the logos of both university institutions were present on the letterhead, (ii) a version where the EU flag is made salient in the letterhead of the instruction sheet (‘EU\_Flag’), and (iii) an additional treatment where the framing states—besides showing the EU flag—that this research has been funded by the European Commission (‘EU\_Flag\_Funding’). These framings were included on all three experimental sheets.<sup>10</sup> Figure 6.2 depicts the three letterheads and Appendix B.1.1 includes the experimental instructions.

Based on the insights from previous studies on lying behavior summarized in Abeler et al. (2016) and our treatments regarding the new regulatory dimension, we test three main hypotheses:

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<sup>8</sup>This is confirmed by fishermen’s self-reported trust in the EU concerning fishery policy in our survey. First, trust in the EU was substantially lower as compared to the German Fishery Association and the German Federal Government. Second, we find that trust in the EU is substantially lower as compared to a student control group. For further visual anecdotal evidence, see Appendix B.1.2. This antipathy towards the EU is not unique for German fishermen and may even be stronger in other countries. Indeed, UK fishermen played a key role in the ‘Brexit’ campaign, and they overwhelmingly have a very negative view of the EU (McAngus 2016).

<sup>9</sup>Note that our model describes the potential effects of our treatments on the intensive margin, not the extensive margin. We discuss how the treatments might impact the extensive margin below.

<sup>10</sup>Note that the EU funding information is true and is also mentioned in the acknowledgements.

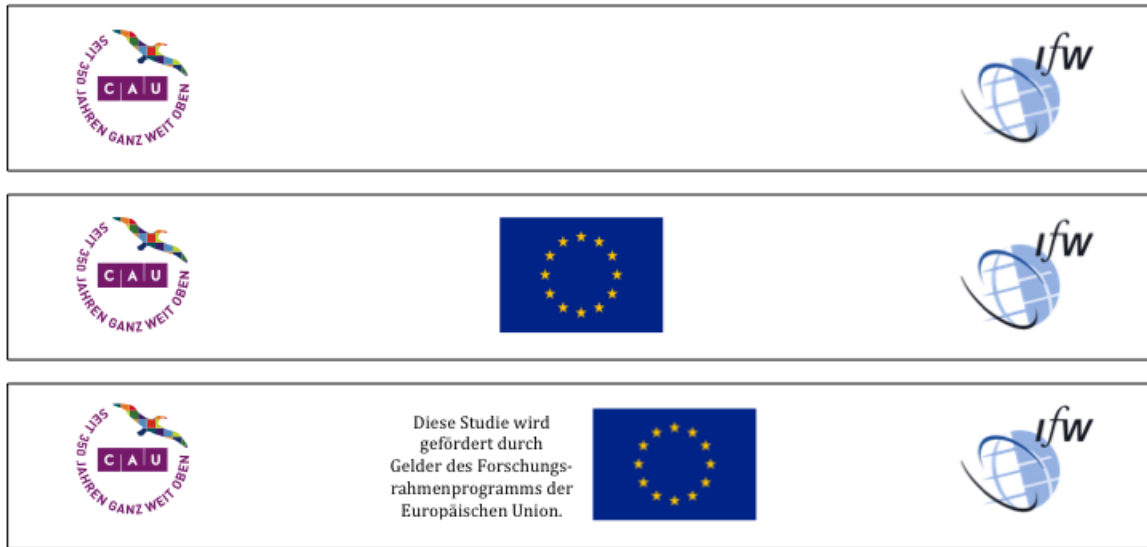


Figure 6.2: Letterheads of the three treatments (from top to bottom: Baseline, EU\_Flag and EU\_Flag\_Funding).

*HYPOTHESIS 1: Fishermen report higher tail-tosses than the truthful distribution, but do not fully misreport in the Baseline treatment.*

The standard economic hypothesis of pure selfishness is that fishermen report their own payoff-maximizing option, i.e. every fisherman would report 4 times tails. This hypothesis has been called into question by recent empirical evidence on various lying costs (e.g. Fischbacher and Föllmi-Heusi 2013, Abeler et al. 2016). We therefore expect that fishermen, on average, report coin toss results in-between the expected outcome of 2 times tails if all fishermen reported truthfully and the payoff-maximizing outcome of 4 times tails. Explanations for not reporting four winning tail tosses may include individual lying costs and internalized reputational costs for the profession. It may also mirror fishermen's professional behavior of misreporting somewhat instead of lying to the full extent, for example declaring some part but not all of their bycatch. This yields:

*HYPOTHESIS 2: Fishermen over-report more tail tosses in the EU\_Flag treatment compared to the Baseline treatment.*

As documented above, there is evidence for a widespread antipathy towards the EU among German fishermen, since most of new regulations by the EU have been regarded as burdensome for the fishermen. This makes the context of our study very useful to test Hypothesis 2, compared to cases in which the attitude towards the regulator is ambiguous. We therefore hypothesize that the presence of the EU logo will increase the bargaining power of the ‘selfish self’ relative to the ‘moral self’ thus decreasing lying costs and that fishermen in this treatment will thus report less truthfully out of ill-regard towards their regulator.

However, fishermen may also perceive the difference in the Baseline and the EU\_Flag treatment as a difference in wealth of the specific institutions and the research institutions being backed by the EU. This may affect truth-telling, as previous research has shown that costs to others matter for lying behavior (e.g. Gneezy 2005). To disentangle the effect of the funding body from the direct effect of a particular attitude towards their regulator, we include the third EU\_Flag\_Funding treatment.

*HYPOTHESIS 3: Fishermen over-report even more substantially in EU\_Flag\_Funding compared to the EU\_Flag treatment.*

We hypothesize that fishermen may regard the additional informational cue as an indication that there is plenty of funding available to those conducting the study. This may reduce the moral cost of lying, reducing the ‘misreporting aversion’ of the ‘moral self’, and lead fishermen to report less truthfully. Fishermen may also regard the provided information as an opportunity to acquire some of the EU’s funds to compensate for the regulatory burdens imposed on them, thus giving more bargaining power to the ‘selfish self’, and leading fishermen to report less truthfully as well.

To examine truth-telling of fishermen towards their regulator, we targeted all commercial fishermen in Germany in a mail field experiment. Due to rigorous data protection by the German Federal Office for Agriculture and Food, the address data of fishermen were not available to us. For the purpose of our study, the Thünen Institute of Sea Fisheries, the national fishery research institute responsible for carrying out fishery surveys, sent out the study documents to all 896 fishermen on our behalf. We prepared the envelopes with the survey materials, including stamped return-envelopes,

at the University of Kiel. We then delivered the envelopes to the Thünen Institute and were present when the address data was added. The envelopes were sent out on Friday, December 4, 2015, and the closing date for the experiment was January 31, 2016. We assigned anonymous ID numbers to 1200 prepared surveys, which were numbered according to their treatment cell. After having randomly shuffled all envelopes, 896 of these envelopes were sent out to fishermen by the Thünen Institute.<sup>11</sup>

The experimental material consisted of 7 pages, including a cover letter, three experimental tasks with one page each, a two-page questionnaire and a sheet for payment information. Appendix B.1.1 contains an English translation of the material. Besides the coin-tossing game, it includes an experimental task to elicit fishermen's risk preferences, and an experimental task on competitiveness.<sup>12</sup> Fishermen were told that the payment for participating in the study was limited to 100€, with an expected average payoff of 50€ for around 30 minutes of work. Payment was made via bank transfer or by check via regular mail.

To ensure availability of a coin to toss, we enclosed a 1€ coin that we stuck on the page of the task (see Appendix B.1.2). To examine the impact of changing the decision environment (from the lab to our mail experiment) on honesty, we ran the same mail experiment with 50 business and economics undergraduate students at the University of Kiel at the same time, 44 of whom participated.<sup>13</sup>

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<sup>11</sup>Additionally, fishermen could contact us directly by responding to advertisements in the journal of the German Fishery Association. Three fishermen responded to this open call. If a fisherman contacted us, we cast a 6-sided die to determine which of the three treatments he would receive. Casting numbers 1 and 4 (2 and 5) [3 and 6] resulted in the Baseline (EU\_Flag) [EU\_Flag.Funding] treatment. We also randomly distributed envelopes to 34 junior fishermen, five of which participated in the study.

<sup>12</sup>We do not find any significant correlations of truth-telling and risk or competitive choices and therefore do not discuss these tasks in more detail here.

<sup>13</sup>One of the authors distributed 50 envelopes to students in the lecture "Cost- and Performance Accounting" on December 4, 2015, and the closing date for the survey was also January 31, 2016.

### 6.3 Results

We received 136 responses by fishermen, amounting to a response rate of 15%.<sup>14</sup> 120 responses included results for the coin-tossing task (see Table 6.1 for descriptive statistics).<sup>15</sup> Figure 6.3 shows the theoretical binomial distribution for four tosses of a fair coin (blue dots connected by the dashed line), which is the distribution that we would expect if all fishermen truthfully report the outcome of their four coin tosses. The probability that four times tossing a coin results in  $r_{it} = 0$  or 4 (1 or 3) [2] times tails is 6.25% (25%) [37.5%]. We refer to this distribution as the “truthful distribution”, where the mean truthful response is  $R_t = \frac{1}{N} \sum_{i=1}^N r_{it} = 2$  tail tosses. The payoff-maximizing choice would be the reporting of  $r_p = 4$  times tails, with its mean denoted by  $R_p$ . Standard economic theory in the absence of lying costs predicts a distribution with 100% of reported coin tosses being tails. The colored bars in Figure 6.3 show actual reporting behavior of fishermen. With fishermen’s actual mean response

$$R = \frac{1}{N} \sum_{i=1}^N r_i^* = \frac{1}{N} \sum_{i=1}^N \frac{1}{\lambda_i} (1 + \lambda_i r_{it}) = R_t + \frac{1}{\bar{\lambda}}, \quad (6.7)$$

we construct an ‘honesty index’  $H$  that serves as a summary tool for comparing aggregate truth-telling behavior across groups and treatments. This honesty index depends on the mean level of lying costs  $\bar{\lambda} = \frac{1}{N} \sum_{i=1}^N \lambda_i$ , with  $\bar{\lambda}^2 \in [0.5, \infty)$ :

$$H = \frac{R_p - R}{R_p - R_t} \times 100 = \left(1 - \frac{1}{2\bar{\lambda}}\right) \times 100. \quad (6.8)$$

The index describes the deviation of the average response from the truthful average response. It ranges from 0 (all respondents report only winning tosses) to 200 (all respondents report no winning tosses), with the average response being equal to the truthful average response at 100. As we have no information on individual lying

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<sup>14</sup>The response rate is comparable to Fischbacher et al. (2015), greater than in typical charity solicitation mail experiments (Gneezy et al. 2014, List and Lucking-Reiley 2002) and, depending on the reward, similar to mail experiments with ‘hot list’ store customers (Gneezy and Rey-Biel 2014).

<sup>15</sup>We follow standard procedures to test for response-bias and find no indication that observable characteristics or time of response drive the reporting behavior of fishermen (see Appendix B.1.4).

<sup>16</sup>In contrast to previous approaches to identifying the proportion of cheaters (e.g. Houser et al. 2012), this index does not necessitate the assumption that no one misreported to their own disadvantage, as it can also result in values greater than 100.



Table 6.1: Descriptive statistics on coin toss reporting results

Treatment	N	Honesty index value $H$	Mean number of tails $R$	Fraction of 0/4 tail tosses	Fraction of 3/4 tail tosses	Fraction of 4/4 tail tosses
Fisher_All	120	77	2.46	0.03	0.43	0.11
Fisher_Baseline	42	81	2.38	0.02	0.45	0.05
Fisher_EU_Flag	36	68	2.64	0.00	0.39	0.17
Fisher_EU_Flag_Funding	42	81	2.38	0.05	0.43	0.12
Fisher_Coin_Back	22	88.5	2.23	0.00	0.41	0.00
Fisher_Coin_Kept	98	74.5	2.51	0.03	0.43	0.13
Students_Baseline	44	43	3.14	0.00	0.45	0.34

behavior, also the index gives information only on average behavior. In particular, it does not distinguish between outcomes in which all respondents report truthfully and outcomes in which half of the sample lies to their advantage and half of the sample lies to their disadvantage.

Aggregating all of our three treatments, we find that overall reporting by fishermen differs significantly from the truthful distribution as well as from payoff-maximization: fishermen report to have tossed 2.46 winning tails on average.<sup>17</sup> The honesty index  $H$  is thus 77 and indicates substantial lying costs in line with the previous literature. 10.83% of fishermen report that they have obtained four times tails, and 42.50% report three times tails. The distribution of reported outcomes is statistically highly distinguishable from both the payoff-maximizing outcome as well as from the truthful distribution. Binomial tests of the expected truthful against the observed frequency for 3 tails and for the payoff maximizing decision of 4 reported tails yield  $p < 0.01$

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<sup>17</sup>It goes without saying that this statement only relates to those fishermen who have participated in our study and that we cannot claim that it equally applies to all non-respondents.

and  $p = 0.055$  respectively.<sup>18</sup> In particular, we find reporting of 3 tail tosses at the expense of reporting 0 or 1 coin toss (the latter differs significantly from the truthful distribution at  $p < 0.01$ ). We therefore confirm Hypothesis 1 and previous findings in the literature. Next, we analyze the effects of our treatments on truth-telling.<sup>19</sup>

In the Baseline treatment fishermen report an average coin toss result of 2.38 winning tails. In the EU\_Flag treatment the average coin toss result was 2.64 tails. As Figure 6.3 shows, no fisherman in the EU\_Flag treatment reported 0 tail tosses, fewer fishermen reported 1 tail tosses compared to the Baseline treatment (8.33% vs. 11.90%) and more fishermen reported 4 tail tosses (16.67% vs. 4.76%). While the frequency of fishermen reporting 4 tail tosses in the Baseline treatment does not differ significantly from the expected truthful reporting frequency, the result on 4 tail tosses of the EU\_Flag treatment against the truthful distribution is statistically different ( $p = 0.023$ ). Furthermore, 4 tail tosses that yield the highest payoff are over-reported in the EU\_Flag treatment as compared to the Baseline treatment (chi-squared test:  $p = 0.084$ ). Summarizing yields:

*RESULT 1. Fishermen misreport more severely when faced with the EU flag compared to the Baseline treatment.*

These findings provide confirmation for Hypothesis 2: The salience of the regulator does seem to play a role for truth-telling and the wide-spread ill-regard for the EU seems to translate into stronger over-reporting of tail tosses. As we cannot rule out effects of our treatment on the extensive margin by design, i.e. that participants selected on responding depending on treatment assignment, an alternative explanation for this finding would be that there is a fixed proportion of honest and dishonest

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<sup>18</sup>If not reported otherwise, all p-values reported in this paper are based on two-sided tests.

<sup>19</sup>In terms of response rates across treatments, we find that these are roughly equally distributed, with 45 (43) [48] in the Baseline (EU\_Flag) [EU\_Flag\_Fund] treatment. Non-response concerning coin toss reporting is somewhat higher in the two EU treatments, with 7% (16%) [13%] in Baseline (EU\_Flag) [EU\_Flag\_Fund]. Concerning questionnaire responses that are significantly correlated with truth-telling, we have no indication of bias across treatments for those 16 fishermen that did not report coin tosses. For instance concerning, the two major covariates of lying (year of birth and how often a fishermen has moved) go in opposite directions for the EU\_Flag treatment: While fishermen in the EU\_Flag treatment that did not report their coin-toss have only moved once in their lifetime on average, as compared to 3.5 [3.3] in the Baseline [EU\_Flag\_Fund] treatment, their mean birth year is 1952, as compared to 1960 [1957] in the Baseline [EU\_Flag\_Fund] treatment.

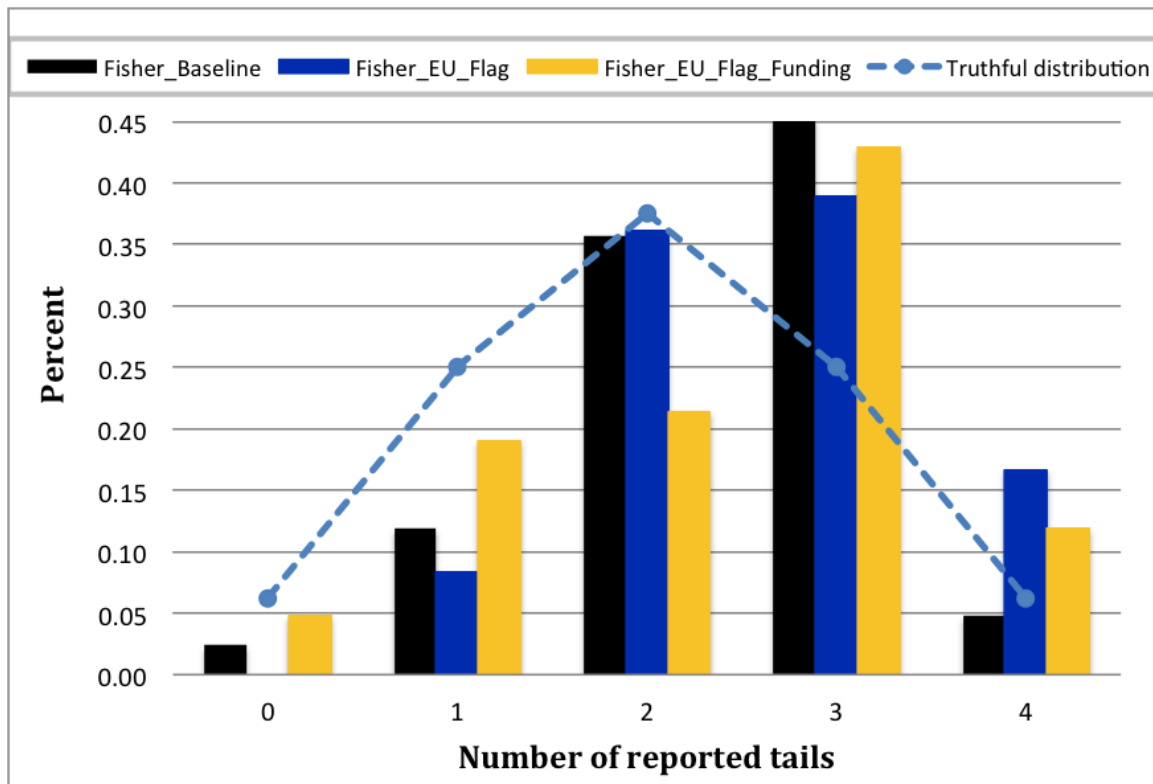


Figure 6.3: Tail toss reporting behavior of fishermen in the Baseline (black bars), the EU\_Flag (blue bars) and the EU\_Flag\_Funding treatments (yellow bars). The blue dots connected by the dashed line represent the expected distribution if all report coin toss outcomes truthfully ('truthful distribution').

fishermen and that the honest participants were less likely to send in the study when being confronted with the EU flag. We do not regard this as a likely mechanism.

We now examine differences in reporting behavior across the EU\_Flag and the additional EU\_Flag\_Funding treatments: While fishermen report on average 2.64 tails in the EU\_Flag, they report only 2.38 tails in the EU\_Flag\_Funding treatment (see Figure 6.3). We find no material and significant differences between the EU\_Flag and the EU\_Flag\_Funding treatments in terms of 3 and 4 tail toss reporting. However, we find that fishermen in the EU\_Flag\_Funding treatment report significantly more 0 and 1 tail tosses (combined: 23.81% in the EU\_Flag\_Funding vs. 8.33% in the EU\_Flag treatment; Chi-squared test:  $p = 0.067$ ).<sup>20</sup> While combined 0 and 1 tail toss reporting in the EU\_Flag treatment differs significantly from the truthful distribution (binomial test:  $p < 0.01$ ), we cannot reject the null hypothesis that fishermen in the

<sup>20</sup>Although subjects report a higher frequency of 2 tail tosses in the EU\_Flag\_Funding as compared to the EU\_Flag treatment, this difference is not statistically significant (chi-squared test:  $p = 0.151$ ).

EU\_Flag.Funding treatment report combined 0 and 1 tail tosses truthfully (binomial test:  $p = 0.405$ ). Taken together, this yields:

*RESULT 2. More fishermen report lower tail tosses when information on EU funding is made salient compared to the treatment that only includes the EU flag.*

These findings reject Hypothesis 3. First, we do not find support for the ‘wealth-of-funding-institutions’ or ‘taking-back from the EU’ hypotheses as fishermen in the EU\_Flag.Funding do not report more 4 or combined 3 and 4 tail tosses. However, we find that the EU\_Flag and the Funding effects seem to affect fishermen’s reporting behavior in two opposing directions. We therefore conjecture that the salience of research funding may have increased the ‘misreporting aversion’ of the ‘moral self’, thus increasing lying costs and inducing more fishermen to report truthfully. This effect may provide an indication on how policy could curb misreporting and lying.

Next, we compare fishermen in the Baseline treatment with our student sample that faced the exactly same study design as the fishermen (see Figure 6.4). While fishermen reported to have tossed 2.38 tails on average, students report 3.14 tails on average. The honesty index  $H$  among fishermen in the Baseline treatment is 81, while it is only 43 among the student sample. This level of cheating among students closely approximates what has been found in other studies so far (Abeler et al. 2016). A Mann-Whitney test rejects the null hypothesis against a significant difference at  $p < 0.01$ .

*RESULT 3. Fishermen over-report significantly fewer tail tosses compared to student subjects.*

Two further observations from the study offer the possibility to underscore truth-telling or lying behavior. First, we deliberately left the ownership about the coin that we included on the coin tossing decision page unclear. A related aspect of fishermen’s fidelity is thus whether they sent back the 1 € coin with their decision sheets. We find that the 22 fishermen who sent back the 1 € coin report a coin toss result of 2.23 tails on average, compared to 2.51 tails for those who did not send back the coin (see Figure B.3 in Appendix B.1.3). This difference is not significant (t-test:  $p = 0.205$ ),

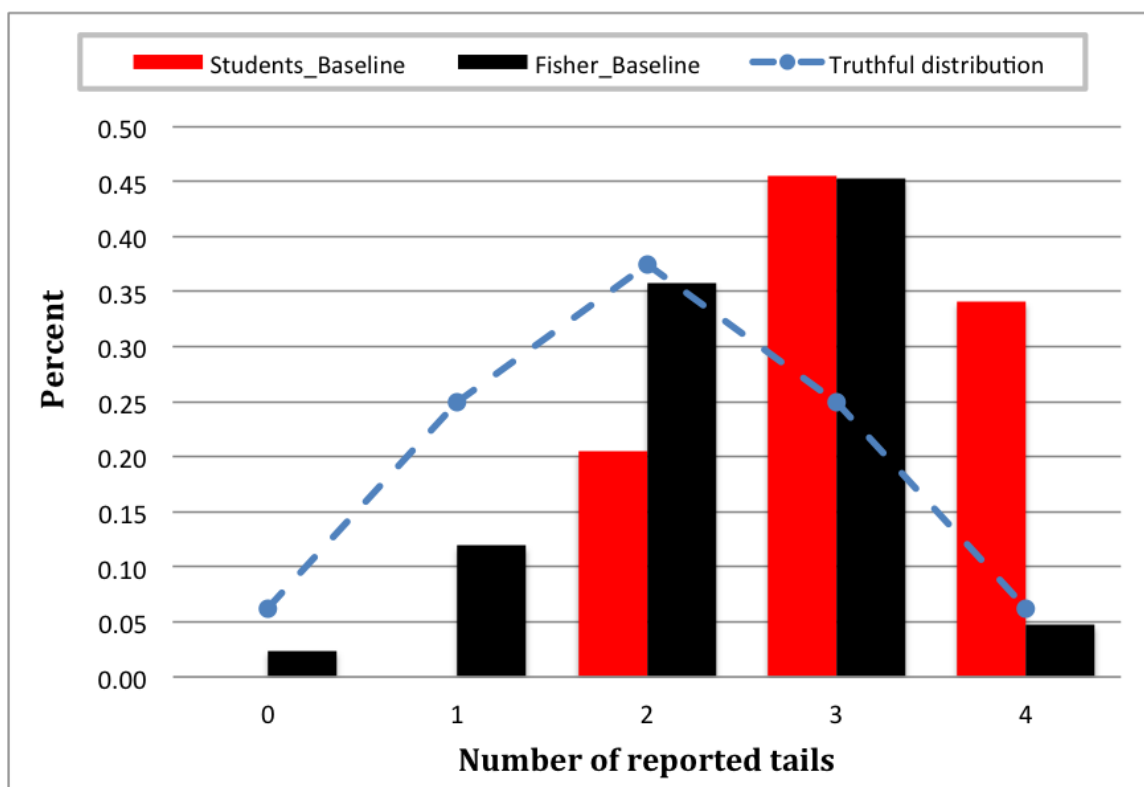


Figure 6.4: Aggregate reporting behavior of fishermen in the 4-coin-toss task (black bars) versus the student sample (red bars), both in the Baseline version.

yet tentatively suggests consistent behavior between the coin-tossing task and this hidden measure and therefore some external validity.

Second, we conducted a separate task to measure fishermen’s competitiveness using a real production task where fishermen have to produce paper shreds by hand from an A7-sized (74×105mm) piece of paper. Fishermen decided on whether they want to be paid 0.05€ per piece, or whether they want to play competitively and receive 0.15€ per piece if they perform better than a randomly drawn other participant. As the A7-sized paper we sent the fishermen was of standard white format, dishonest fishermen could add additional alien paper shreds to increase their payoff. To control for this possibility, we measured the weight of the returned paper shreds on an analytical scale from the physical chemistry lab. We find that the 10 heaviest envelopes with paper shreds, i.e. those where paper shreds have been added most likely to unduly increase payoff, report a mean coin toss result of 3.00 tails, compared to 2.41 tails for the rest (t-test:  $p = 0.062$ ).<sup>21</sup> We summarize these two indicative findings as:

<sup>21</sup>Qualitatively, we find a similar pattern among students: The eight students sending back the 1

*RESULT 4. Reporting behavior is consistent with behavior in other parts of the study.*

These findings are in line with growing and distinct evidence on the external validity of experimental lab measures of truth-telling in the literature (Cohn and Maréchal 2015, Cohn et al. 2015, Dai et al. 2016, Gächter and Schulz 2016, Potters and Stoop 2016). For instance, Potters and Stoop (2016) observe a positive and significant correlation between truth-telling in the lab and truth-telling in the field where students received payoffs that were greater than their actual earnings. The likelihood of reporting overpayment was greater for students who were less likely to have lied in the lab. Another example is the study of Cohn and Maréchal (2015) who observe that truth-telling of public school students in a classroom experiment correlates with measures of school misbehavior. Our indicative evidence, together with the so far robust findings in the literature, therefore suggests that our truth-telling measure may also correlate with fishermen’s professional truth-telling behavior.

Finally, we consider the effect of questionnaire responses on reporting behavior. Table B.1 in Appendix B.1.3 reports descriptive statistics for key questionnaire data. Only few covariates are significantly correlated with reporting behavior in univariate regressions. The number of times a fishermen has moved in his lifetime, indicating mobility, is negatively correlated with over-reporting at  $p = 0.050$ . Year of birth is positively correlated with over-reporting at  $p = 0.020$ , i.e. older fishermen report more honestly. Receiving a base salary from the fishery is also positively correlated with the number of tail tosses reported ( $p = 0.070$ ). We also find that fishermen report more tail tosses the longer their planning horizon in the fishery ( $p = 0.062$ ) and the higher their expectance of a medium-term income increase ( $p = 0.004$ ), which are both highly correlated with age.<sup>22</sup>

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€ coin report 3.00 tails on average, compared to 3.17 tails for those who did not send it back. The four students with the heaviest envelopes report 3.75 tails as compared to 3.08 tails for the rest.

<sup>22</sup>None of these explanatory variables remain significant in a multivariate regression. Note that we do not find a significant imbalance across treatments for the pertinent questionnaire responses, except for the case that the five fishermen who receive a base salary are only represented in the EU\_Flag and EU\_Flag\_Funding treatments (cf. Table B.2). Excluding these five observations keeps all findings on treatment effects qualitatively unchanged, except that the p-value for the comparison of EU\_Flag vs. Baseline for 4 tail tosses reduces to  $p = 0.125$  (Result 1).

## 6.4 Discussion and conclusion

This paper presents field experimental evidence on truth-telling of German commercial fishermen who are regulated by the European Union (EU). To our knowledge, this is the first artefactual field experiment with professional common-pool resource users on truth-telling.<sup>23</sup> Examining truth-telling of German fishermen is of direct relevance, as the member states of the European Union stand to decide on how much costs to incur to monitor a recently enacted ban on discarding unwanted fish catches to the sea. The regulator thus currently depends on fishermen’s honesty, while standard economic theory predicts substantial lying behavior. This paper not only studies fishermen’s overall degree of dishonesty but extends the scope of previous studies by asking how regulator framing affects truth-telling—a dimension that is relevant for the effective and efficient design monitoring and sanctioning mechanisms. Our results are therefore not only relevant for the specific fishery context, but crucial for a broader understanding of truth-telling, the management of common pool resources around the world, and for regulatory policy more generally.

Adapting an established coin-tossing game (Abeler et al. 2014), where subjects have to toss a coin 4 times and receive 5 € for each of the 0 to 4 reported tail tosses, we test whether truth-telling in a baseline setting differs from behavior in two treatments with different EU framings. The fishery is an ideal test case for studying how truth-telling behavior may be affected by regulatory framing, as there is almost uniform contempt among fishermen concerning stricter EU fishing regulation. We therefore hypothesized that if regulatory framing affects truth-telling, it would lower lying costs and thus result in higher misreporting among the treated fishermen.

We find overall that fishermen misreport coin tosses to their advantage, albeit to a significantly lesser extent than standard theory would predict. Specifically, we find an average tail toss result of 2.46, while the expected truthful distribution would result in 2 and the payoff-maximizing choice in 4 tail tosses. Fishermen thus do not lie to their maximum advantage, but partial misreporting is prevalent among fishermen.

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<sup>23</sup>Previous studies examining social behavior among common pool resources users have either reported cooperativeness in standard public goods games, common pool resources or ultimatum games (e.g. Gneezy et al. 2015, Jang and Lynham 2015, Velez et al. 2009) or more severe forms of anti-social behavior (e.g. Prediger et al. 2014).

Crucially, we find that misreporting is larger among fishermen who are faced with the EU flag. This confirms a hypothesis, according to which many fishermen adhere to consequentialist moral principles and have lower moral lying costs towards the EU, which they dislike. This indicates that previously elicited degrees of truth-telling may not be appropriate for principal-agent relationships, where the principal or regulator is ill-regarded by the economic agents. In contrast, an additional treatment shows that fishermen do not report more tail tosses if the source of EU research funding is made salient but in particular that significantly more fishermen report 0 and 1 tail tosses. This rejects a hypothesis, according to which fishermen would interpret the provided information as a means to acquire some of the EU's funds to compensate for the regulatory burdens imposed on them. By contrast, the salience of funding might increase internal lying costs by increasing misreporting aversion, thus mitigating some over-reporting of tails. Moreover, we find evidence tentatively suggesting consistent behavior between the coin-tossing task and two other measures of truth-telling or lying behavior.

Overall, our findings imply that regulators not only have to consider some exogenous degree of dishonesty among the regulated, but also take into account that truth-telling depends on the nature and communication of the regulatory policy. Faced with a variable degree of dishonesty, the regulator can act strategically in adopting its regulatory approach, considering how the regulated will adapt their behavior. This consideration may yield effective and low-cost policy alternatives (or complements) to current approaches.

Whereas the substantial number of fishermen who likely report honestly might suggest that softer monitoring approaches could be sufficient, the strategic aspect of regulatory experience calls for a more deliberate approach. One possible solution to coping with this strategic dimension of dishonesty would be to choose the 'corner solution' and comprehensive control.<sup>24</sup> In practice, this would mean a monitoring scheme relying on on-board observers or camera systems. Yet, our treatment results on funding salience suggest that low-cost informational approaches, which might include framing the environment in which fishermen have to report their catches, could increase

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<sup>24</sup>For determining optimal fishery regulation and enforcement, the regulator must also consider the cost of enforcement (Nøstbakken 2008, Sutinen and Andersen 1985).



truth-telling considerably. Therefore, instead of directly incurring the high costs to the regulator and fishermen of comprehensive control, a recommended approach could be to introduce monitoring of different degrees of stringency selectively to study the effects of monitoring on honesty. Besides camera systems, on-board observers and patrolling boats, this may also include targeted information campaigns on how fishermen's own discarding and misreporting harms other fishermen as well as the public. Studying this new dimension of truth-telling in further detail is a promising avenue for future research.

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## Appendix

### B.1 Appendix to Chapter 6

#### B.1.1 Instructions and Decision Sheets.

##### Cover letter

Dear fishermen,

we kindly invite you to participate in a scientific study on the conditions of the German fishery by institution 1 and institution 2.

In our research project “sustainable consumption and management of marine resources”, **we are dependent on your cooperation**. The research project is funded in particular from the German Ministry of Education and Research (and the European Commission). The project is supported with fishery-specific advice by Peter Breckling (German Fishery Association) and Benjamin Schmöde (fishery cooperative of the North and Baltic Sea Fishermen). We not only aim at improving the available data for economic studies on the fishery, but also to better understand the economic behavior of people who regularly use natural common pool resources. With our study, we strive for basic insights, which can be applicable to different questions in economic and sustainability research. For this, we conduct the present study among German fishermen, for which we kindly ask you to work on three easy **tasks on economic decision-making** and answer a small number of **questions**. These tasks may seem a bit exceptional, but they are based on validated methods in economic research and are also suited for being conducted with other subject groups. With these tasks, we can study economic behavior in abstract decision-contexts. To obtain reliable results, you will decide upon **real money payoffs**.

The participation in the study usually takes **less than 30 minutes**, and the total payoffs amount to a maximum of **100 Euro, on average around 50 Euro**. The total payoffs are comprised of payoffs for the single tasks and for the questionnaire. In addition, we hold a draw of 500 Euro among all participants of task 3 until the deadline on **31.01.2016**.

For the purpose of this scientific study, the Thünen Institut für Seefischerei in Hamburg will by way of exception send you a letter to your address that is only known



to the Thünen Institut. If you would like to voluntarily participate in the study, you should provide us with your address so that we can send you your payments. You will find details on the last page. Under no circumstances will be passing on personal data to third parties. We would be happy to personally inform you of the results of the study. In addition, we will make use of the **anonymized data** in our scientific research that focuses on economic aspects of the fishery. We will make openly available the results of these studies to the public.

We very much hope that you will participate in this study. If you have any questions, do not hesitate to contact us.

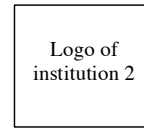
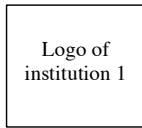
With kind regards

(signatures)

Names

E-mail address

Institutions



**Task 2 (Baseline treatment)**

The payoff in task 2 is determined by a coin toss, which you toss yourself.  
**For this, we have sent you enclosed a 1 Euro coin.**

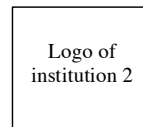
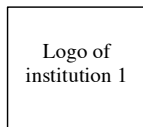
Your task is to toss this coin **exactly 4 times**. For each case that **“tails”** lies on top, you will receive 5 Euro.

Afterwards, please record your result in the table below.

<b>Times of coin tosses where „tails“ came out top</b>	<b>Payment</b>	<b>Your outcome (please make one cross)</b>
0	0.00 €	
1	5.00 €	
2	10.00 €	
3	15.00 €	
4	20.00 €	

**Examples:** If the number of coin tosses, for which “tails” came out top, is 1, you will receive 5.00 €. If the number of coin tosses, for which “tails” came out top, is 3, you will receive 15.00 €.

**Important:** Your result will only be paid out if you make **exactly one cross** in the table and send all materials to us until the closing of the survey on 31.01.



### Task 2 (EU\_Flag treatment)

The payoff in task 2 is determined by a coin toss, which you toss yourself.  
**For this, we have sent you enclosed a 1 Euro coin.**

Your task is to toss this coin **exactly 4 times**. For each case that **“tails”** lies on top, you will receive 5 Euro.

Afterwards, please record your result in the table below.

Times of coin tosses where „tails“ came out top	Payment	Your outcome (please make one cross)
0	0.00 €	
1	5.00 €	
2	10.00 €	
3	15.00 €	
4	20.00 €	

**Examples:** If the number of coin tosses, for which “tails” came out top, is 1, you will receive 5.00 €. If the number of coin tosses, for which “tails” came out top, is 3, you will receive 15.00 €.

**Important:** Your result will only be paid out if you make **exactly one cross** in the table and send all materials to us until the closing of the survey on 31.01.

Logo of  
institution 1

This research is funded by  
money from the scientific  
framework programme of the  
European Commission.



Logo of  
institution 2

### Task 2 (EU\_Flag\_Funding treatment)

The payoff in task 2 is determined by a coin toss, which you toss yourself.  
**For this, we have sent you enclosed a 1 Euro coin.**

Your task is to toss this coin **exactly 4 times**. For each case that **“tails”** lies on top, you will receive 5 Euro.

Afterwards, please record your result in the table below.

Times of coin tosses where „tails“ came out top	Payment	Your outcome (please make one cross)
0	0.00 €	
1	5.00 €	
2	10.00 €	
3	15.00 €	
4	20.00 €	

**Examples:** If the number of coin tosses, for which “tails” came out top, is 1, you will receive 5.00 €. If the number of coin tosses, for which “tails” came out top, is 3, you will receive 15.00 €.

**Important:** Your result will only be paid out if you make **exactly one cross** in the table and send all materials to us until the closing of the survey on 31.01.

## Questionnaire

You would help us a lot, if you would answer the following short questions by marking the respective boxes with an X. If you answer all 24 questions, you will get a remuneration for your time of 10€

1. In which year were you born? 19
2. What is your highest degree of education?  
Hauptschule  Realschule  Berufsschule  Abitur   
Hochschulstudium  Other: \_\_\_\_\_
3. Have you finished a vocational training outside the fishery? YES  NO   
If YES, which: \_\_\_\_\_
4. How often have you moved in your lifetime?  times.
5. How many years have you been working in the fishery?  years.
6. How many years do you plan to continue working in the fishery?
7. Was/is your father or mother also working in the fishery? YES  NO
8. How many kids do you have?  How many are/will be working in the fishery?
9. Do you live for rent  or in your own house/flat  ?
10. What is your position in the fishery? Multiple answers possible.  
Boat owner  captain/skipper  crew member/employee
11. What is the registry number of the boat you work on?
12. How large is the crew on average, yourself included?
13. If you are a boat owner, how many do you own?   
How many of these boats are completely paid off, i.e. debt-free?
14. Are you a full-time  or part-time fishermen  ?  
How many days were you fishing in the last twelve months?
15. Which types of gear do you use? Multiple answers possible.  
Set gillnets  Botton trawls  trawls  pelagic trawl   
Dredges  Pots/traps  set longlines  Other: \_\_\_\_\_





## B.1.2 Supporting materials

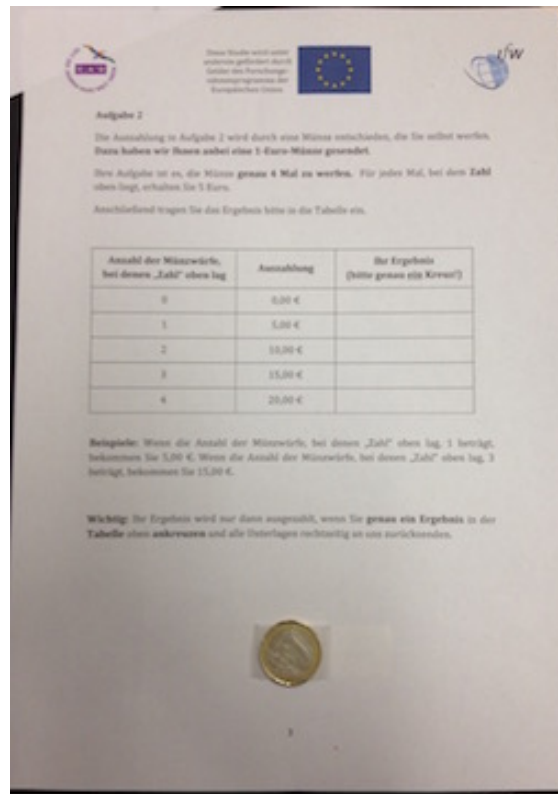


Figure B.1: Experimental instructions for task 2 (treatment version “EU\_Flag\_Funding”) with the 1 € Coin attached.



Figure B.2: Fishing vessel in Burg Staaken, the port with the most registered fishing vessels in Germany, indicating the attitude to the EU.



### B.1.3 Supplementary materials for further analysis

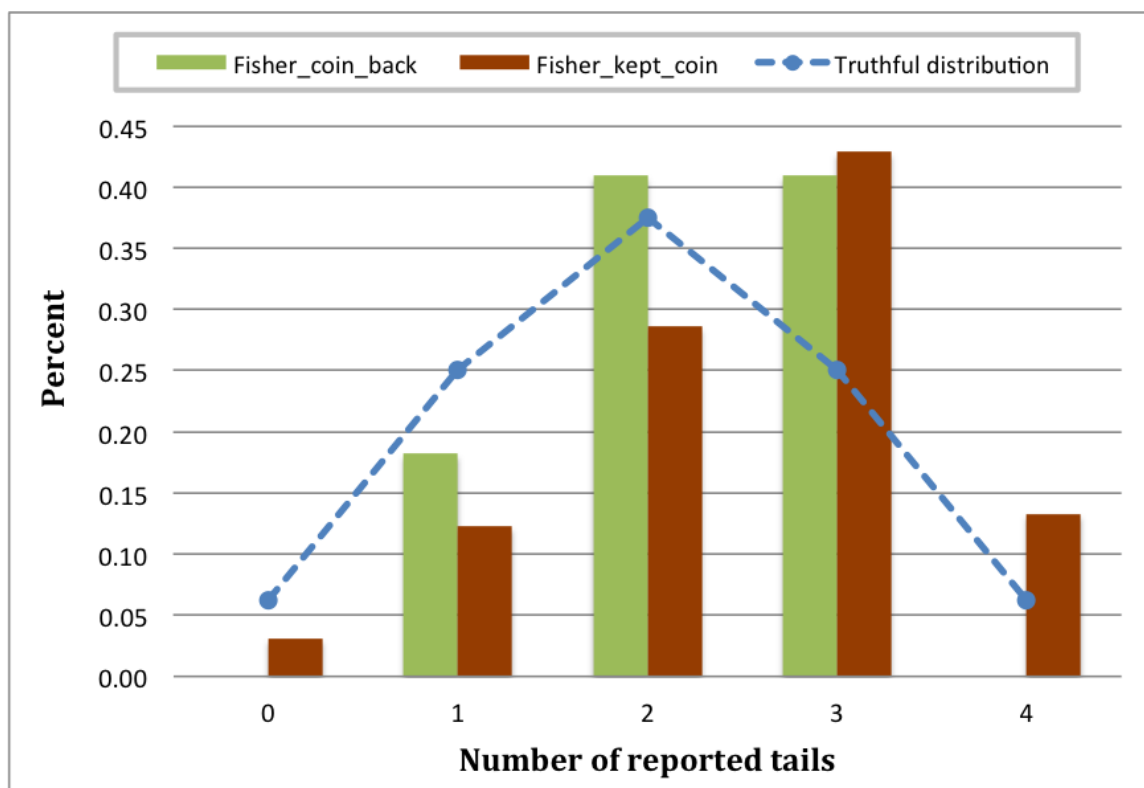


Figure B.3: Aggregate reporting behavior in the 4-coin-toss task of those fishermen that sent back the 1 € coin (green bars) vs. those that did not send it back (orange bars).

Table B.1: Descriptive statistics on main questionnaire results

Survey Question	Mean	Median	StDev	Min	Max	N
(1) Year of birth	1963	1962	14	1933	1997	119
(4) Moved how often?	3.02	3	2.42	0	12	118
(5) Years in fishery	30.69	31	15.40	1	70	117
(12) Number of crew members	1.70	2	0.86	1	6	119
(13a) How many boats do you own?	1.56	1	1.07	0	7	116
(14b) How many days fishing in last 12 month?	147	150	94	0	350	116
(19) Income relative to other fishermen	4.02	5	2.18	1	8	118
(18) Share of income from fishery	62.14	98	43.29	0	100	113
(22a) Trust-worthiness of the German Fisheries Association?	5.47	6	1.98	1	9	118
(22b) Trust-worthiness of German Government?	2.98	3	1.69	1	8	117
(22c) Trust-worthiness of European Commission?	2.40	2	1.65	1	9	117

Table B.2: Covariates across treatments and treatment robustness checks

Variables / Treatment	Fisher_ Baseline	Fisher_ EU_Flag	Fisher_ EU_Flag_Fund
(1) Year of birth	1961	1962	1965
(4) Moved how often	3.07	3.31	2.69
(5) Years in fishery	29.5	32.03	30.04
(6) Planned years in fishery	18.28	13.94	15.92
(12) Fishing alone	54.76%	52.78%	38.10%
(13a) How many boats do you own	1.68	1.4	1.54
(14b) How many days fishing in last 12 month	151	146	147
(17a) Salary	0	8.33%**	4.76%*
(19) Income relative to other fishermen	4.10	3.94	4.02
(22c) Trust-worthiness of European Commission	2.29	2.42	2.46
(23) Probablity of income increase	27.39%	37.94%	27.22%

Note: The difference between the proportions of fishermen being alone on a boat is (borderline) significantly higher in the Fisher\_EU\_Flag\_Fund treatment as compared to the Baseline at  $p = 0.06$  (EU\_Flag at  $p = 0.0993$ ). However, this is not significantly correlated with lying behaviour. Receiving a salary as fishery income is significantly higher among EU\_Flag [EU\_Flag\_Funding] compared to Baseline at  $p=0.03$  [ $p=0.08$ ] and is significantly correlated with lying behaviour. A robustness check excluding the five fishermen who receive a salary, changes our treatment effects as follows: The comparison of the EU\_Flag results with the truthful distribution for 4 tail tosses is now significant at  $p=0.052$ , while the p-value for the comparison of EU\_Flag vs. Baseline for 4 tail tosses is reduced to  $p=0.125$  (Result 1). The comparison of EU\_Flag\_Funding compared to EU\_Flag for reporting 0 and 1 tail tosses is significant at  $p=0.077$ , while it also remains that 0 and 1 tail toss reporting in the Baseline and EU\_Flag treatments differs significantly from the truthful distribution (at  $p=0.01$  and  $p=0.003$ ), while this is not the case for the EU\_Flag\_Funding treatment results ( $p=0.25$ ).

Table B.3: Descriptive statistics on fishing vessels

	Mean	Median	StDev	Min	Max
<i>Vessels whose owners responded</i>					
Length (in meters)	11.39	9.24	6.49	3.82	45.54
Construction year	1982	1981	14	1930	2014
<i>Vessels of all officially registered fishermen</i>					
Length (in meters)	9.15	6.40	6.55	3.75	45.54
Construction year	1984	1984	15	1919	2015

Table B.4: Fishing personnel and participating fishermen by German states

State	Fraction (in per cent) of	
	overall personnel	fishermen with coin toss
Hamburg	1.85	1.68
Bremen	0.22	0
Mecklenburg- Vorpommern	43.21	22.69
Niedersachsen	16.23	16.81
Schleswig-Holstein	38.49	58.82

#### B.1.4 Testing for non-response bias

To test for the existence of non-response bias, we follow standard procedures (Dalecki et al. 1993, Necker 2014) and compare officially registered respondents to the population of fishermen along a range of observable characteristics of their fishing vessels. These observables include, among others, boat construction year and length, location as well as fishermen’s primary fishing gear. Table B.3 in the Appendix shows descriptive statistics on fishing vessels for the whole sample of officially registered fishermen as well as those participating in the study.<sup>25</sup>

We observe that responding fishermen tend to have somewhat longer (total length 11.39m vs. 9.16m) and older boats (year of construction 1982 vs. 1984) compared to the whole distribution of officially registered fishermen. As vessel length and construction year are not significantly correlated with lying behavior, our results should not be biased by the lower representation of smaller vessels. Figure 6.1 shows that participating fishermen are spread out rather evenly all along the German coasts. Table B.4 in the Appendix lists the distribution of overall fishing personnel and fishermen who participated in the study by German States. We find that participating fishermen come over-proportionately from Schleswig-Holstein (59% compared to 39%) and under-proportionally from Mecklenburg-Vorpommern (23% vs. 43%). Yet, this non-representative response behavior does not seem to bias coin toss results, as the average coin toss result is 2.41 tails in Mecklenburg-Vorpommern and 2.37 tails in Schleswig-Holstein (a Mann-Whitney test cannot reject the hypothesis of equal tail toss reporting in the two States). Finally, we compare officially registered and participating fishermen in terms of their fishing gear. The primary gear for all 1465 officially registered vessels is distributed as follows: set gillnets (75%), beam trawls (15%), bottom trawls (4%), and pots/traps (3%). We could link response data to data from the official registry via the elicited boat’s registry number for 103 fishermen that participated in the coin-tossing task. Among this subsample, the primary gear as reported in the registry is as follows: set gillnets (58%), beam trawls (32%), bottom trawls (7%), and pots/traps (2%). We thus overall have an under(over)-representation

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<sup>25</sup>We asked participating fishermen for their vessels’ registry numbers. This allows us to link their questionnaire answers to the official vessel registry. For this and the following comparisons, we exclude the 8 high-sea fishery boats.

of fishermen using set gillnets (beam trawls). In terms of coin toss reporting between these two groups, we find that beam trawlers report an average of 2.44 tail tosses and set gillnet fishermen report 2.52 tails. We therefore have no indication of bias due to the under-proportionate representation of set gillnet fishermen.

Furthermore, we divide the sample in early and late responses. While the 62 responses that we had received until the Christmas break (22.12.2015) reported an average tails toss of 2.40, the remaining 58 reported 2.52 tail tosses. A (two-sided) Mann-Whitney test cannot reject the null hypothesis of no difference, thus providing no indication for a response bias.



## 7 Do Scientists Tell the Truth? Evidence from a Field Experiment

*This chapter has not been published yet. It may be referenced as:*

Drupp, M.A., Khadjavi, M. and R. Voss (2017).

Do Scientists Tell the Truth? Evidence from a Field Experiment.

Mimeo, University of Kiel.\*

**Abstract:** Academic honesty is crucial for the advancement of and trust in science. However, survey evidence suggests that a considerable number of scientists engage in questionable research practices. We provide evidence on incentivized truth-telling behavior of scientists by means of an online field experiment. We conduct an established coin-tossing task with 437 members of an international scientific organization, in which participants face a trade-off between monetary incentives of lying and honest reporting. In particular, we compare reporting behavior across two treatments, either making the private or professional identity more salient. We find that fewer scientists over-report winning tail tosses in the professional identity treatment. Yet, even in the professional identity treatment scientists over-report tail tosses compared to the truthful distribution. While honesty norms associated with the scientific identity thus seem to increase truth-telling, academia has to further foster norms of honest behavior and enforce measures for preventing scientific misbehavior.

**Keywords:** Truth-telling, lying, professional identity, science, field experiment

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## 7.1 Introduction

Whether and to what degree scientists behave ethically sound and tell the truth is of fundamental importance for the development of science, for public trust in science and, as such, indeed for the future of mankind. Marshall (2000: 1162) called this “a Million-Dollar Question”, but this number is likely a gross underestimate. This is particularly true for times which call, on the one hand, for more ‘evidence-based policy-making’ and are otherwise guided by low trust in scientists and a tendency to blur distinctions between objective knowledge and so-called ‘alternative facts’ and ‘post-truths’.<sup>1</sup>

The Merriam-Webster Dictionary (2017) defines science as “knowledge or a system of knowledge covering general truths or the operation of general laws especially as obtained and tested through scientific method”. The quest for ensuring integrity in research conduct is probably as old as science itself, yet the reputation of truthful science has suffered in recent times from prominent instances of scientific misconduct.<sup>2</sup> A famous, now retracted article by Wakefield et al. (1998) suggested that vaccinating children against measles, mumps and rubella increases their risk of autism. Poland and Jacobson (2011) describe the public reaction of anti-vaccination campaigns to the now disproved article. In the time following the publication of Wakefield et al. (1998), there was a record of hundreds of cases of measles outbreaks and even some children dying (Poland and Jacobson, 2011), providing some indication of the tremendous social costs of scientific misconduct.

Beyond the prominent cases of scientific misconduct mentioned above, survey evidence suggests that a considerable number of scientists engage in a broader set of questionable research practices (see, for example, John et al. 2012; List et al. 2001; Martinson et al. 2005; Necker 2014).<sup>3</sup> A meta-study by Fanelli (2009) summarizes

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<sup>1</sup>In fact, ‘post-truth’ was the word of the year 2016, as elected by Oxford Dictionaries (see BBC 2016).

<sup>2</sup>These include, among others, cases such as of the cloning expert Hwang Woo-suk, the evolutionary biologist Marc Hauser, and social psychologist Diederik Stapel. Articles by Sang-Hun (2009), Wade (2010) and Bhattacharjee (2013) provide more information on the respective misconduct.

<sup>3</sup>Besides anonymous survey-based approaches, there exist a number of other recent examples testing research integrity and the robustness of scientific research: For example, Camerer et al. (2016) replicated eighteen recent prominent experimental economic works. They find that about two-thirds of all findings can be replicated; Brodeur et al. (2016) provide recent evidence that the reporting of

findings from 21 individual studies and shows that around two percent of scientists admit to having committed serious forms of scientific misconduct at least once, such as fabricating, falsifying or modifying data or results. It further supports findings of a previous study by Martinson et al. (2005), showing that as many as one-third of scientists admit to have engaged in questionable research practices, such as ‘using another’s ideas without obtaining permission or giving due credit’, ‘failing to present data that contradict one’s own previous research’, or ‘inappropriately assigning authorship credit’. This literature suggests that the search for general truths is not always conducted in a truthful manner. Yet, this evidence so far only relies on anonymous survey responses, with the fundamental challenge that there is no individual (monetary) incentive to participate and to report truthfully.<sup>4</sup>

Our study provides experimental economic evidence on truth-telling of more than 400 scientists by means of an online field experiment.<sup>5</sup> We thus provide evidence that can be viewed as complementary to above mentioned survey approaches. Specifically, our aim is to investigate whether the professional identity as a scientist affects honesty, i.e. whether the professional identity as a scientist motivates and fosters truthful behavior.<sup>6</sup> After all, science ‘consists in the search for truth’ (Popper 1996).

To this end, we employ a simple coin-tossing task in which scientists are asked to toss a fair coin four times and report back their number of tail tosses (Abeler et al. , 2014). For each reported tail toss, they receive five Euros. While individual (dis)honesty is not detectable, we can estimate the deviation of reported tosses against the expected truthful distribution. Studying individuals’ truth-telling in this manner

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empirical findings tends to be biased towards regression specifications that favor rejecting the null hypothesis. In order to improve research practices, Simmons et al. (2011) recently proposed rules of sound scientific conduct in order to decrease so-called experimenter degrees of freedom.

<sup>4</sup>John et al. (2012)’s design aims at inducing truth-telling by respondents. Yet their incentive consists in a donation to a public good, which might attract relatively pro-social scientists.

<sup>5</sup>We thereby also contribute to the still rather scarce literature on the behavioral economics of science and academia. Among others, Gächter et al. (2009) study how framing impacts the decision to choose when to register for an academic conference, Löfgren et al. (2012) scrutinize the impact of a default option on uptake of carbon offsetting among environmental economists, and Chetty et al. (2014) conduct an experiment on pro-social behavior with referees of the *Journal of Public Economics*.

<sup>6</sup>Recently, two studies have examined how the professional identity of participants and associated norms affect truth-telling behavior. Cohn et al. (2014, 2015) provide experimental evidence that bankers and prisoners behave less honestly when their respective professional identity is made salient as compared to a (private) control identity (cf. Villeval 2014).

has become a major research focus in economics.<sup>7</sup> Furthermore, this measure has been shown to correlate with truth-telling behavior beyond the simple experimental task.<sup>8</sup>

To study whether professional identity of scientists induces more honesty, we draw on the identity priming literature that was developed in social psychology and is now an active research field within economics (see Cohn and Maréchal, 2016, for a recent review).<sup>9</sup> The idea is that individuals have multiple identities that are guided by different norms and behavioral patterns (Akerlof and Kranton, 2000). Individuals experience disutility if they deviate from norms prescribed by their respective salient identity. Our experiment accordingly consists of two treatments. The professional identity treatment aims at making the subject’s professional identity as a scientist salient, while the private identity (control) treatment aims at making the private identity salient. To prime participants, we use nine questions that are designed to capture common features of a professional or private context, that are unrelated to truth-telling and as similar as possible across the two treatments. For example, subjects in the professional identity treatment were asked “Where did you last go to for a conference/workshop?” and “What activity in your work do you enjoy the most?”, while subjects in the private identity (control) treatment were asked “Where did you last go on holiday?” and “What activity in your leisure time do you enjoy the most?”. In the context of our study, the priming intervention aims to reveal the behavioral difference between a subject’s private and professional identity and thus be indicative of the norms and behavioral patterns associated with the scientific identity of the subjects in terms of truth-telling and honesty.

Based on 437 responses to our coin-tossing task, we find that fewer scientists over-

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<sup>7</sup>For instance, see Abeler et al. (2014, 2016), Cappelen et al. (2013), Cohn et al. (2014, 2015), Fischbacher and Föllmi-Heusi (2013), Gächter and Schulz (2016), Gibson et al. (2013), Gneezy (2005), Gneezy et al. (2013, 2016), Houser et al. (2016), Mazar et al. (2008), Pasqual-Ezama et al. (2015), Potters and Stoop (2016), Rosenbaum et al. (2014).

<sup>8</sup>See, for instance, Cohn et al. (2015), Cohn and Maréchal (2015), Dai et al. (2016), Drupp et al. (2016), Gächter and Schulz (2016), as well as Potters and Stoop (2016).

<sup>9</sup>As our study concerns the technique of priming and focuses on truth-telling behavior, it is worthwhile to note that there are doubts about the robustness of results obtained in the priming literature in social psychology and suspicions that questionable research practices have been employed. As a response to this critique, Daniel Kahneman called for systematic replication efforts in this field (Young, 2012). Not specifically scrutinizing priming studies, Camerer et al. (2016) and Open Science Collaboration (2015) have recently demonstrated that such large-scale replication attempts are feasible and fruitful.

report winning coin tosses in the professional identity treatment compared to the private identity control. The scientific identity therefore seems to entail stronger honesty norms that induce more frequent truth-telling. Nevertheless we find that even those who were primed in their professional identity over-report winning tail tosses compared to the expected truthful frequency. While honesty norms associated with scientific identity thus already serve to increase truth-telling, science still has to establish rigorous measures for preventing scientific misbehavior to ensure that science is not derailed from its path to generate truths.

## 7.2 Experimental design and hypotheses

To study truth-telling of scientists, we conducted our online field experiment with members of an international scientific organization that was established more than 100 years ago.<sup>10</sup> The administrative office of the organization provided an e-mail list of its 1930 members. In the summer of 2016 we contacted all members by e-mail and invited them to participate in a short online study that consisted of ten pages and took about 15 minutes to complete. We told them that they could earn 25 € on average (equivalent to \$27 at the time of the experiment) for participating, with the exact individual earnings depending on chance and their choices. We ensured that their individual responses are kept confidential and informed the participants about the confidentiality.

Upon clicking the link to the online study in the invitation e-mail, subjects were assigned to one of two treatments by the online platform: either the professional identity treatment (abbreviated *Professional* or *PROF*) or the private identity (control) treatment (*Private* or *PRIV*). A preamble page provided further details on the experiment and the mode of payment (Amazon vouchers). The study then began with simple descriptive questions on age, gender and nationality. This was followed by our manipulation that consisted of nine questions either relating to their professional identity (*Professional* treatment) or relating to their private identity (*Private* treatment). The

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<sup>10</sup>The members are predominantly natural scientists, with a focus on the marine environment. We do not report the name of the scientific organization to increase the anonymity of our respondents.

purpose of these questions was to make the subjects' professional identity as scientists, and associated norms, more salient in *Professional* as compared to *Private*.

The behavioral intervention of identity priming builds on a by now established strain of the experimental economics literature.<sup>11</sup> The idea—based on Akerlof and Kranton (2000)—is that people have multiple identities that are guided by different norms and behavioral patterns. Individuals experience disutility if they deviate from norms prescribed by their respective salient identity. This depends on the relative weight of that identity. The technique of identity priming aims at making a given identity, such as the professional identity of being a scientist, temporarily more salient (see Benjamin et al. 2010, 2016; Cohn and Maréchal 2016, Cohn et al. 2014, 2015).

In the context of this study, the priming intervention should reveal the behavioral difference between a subject's private and professional identity. Thus, the intervention should be indicative of the norms and behavior associated with the scientific identity as compared to the private identity of the subjects in terms of truth-telling and honesty. In an effort to reduce potential confounding due to priming effects that are unrelated to their private or professional identity, we designed the questions to capture salient features of their professional work or private life identity, yet to be as similar as possible in terms of their content and context. For example, subjects in the professional treatment were asked “Where did you last go to for a conference/workshop?”, while subjects in the private control treatment were asked “Where did you last go on holiday?” (see Table 7.1 for a list of all priming questions posed and Appendix C.1.1 for screenshots from the online survey). These priming questions were the only difference between the two treatment conditions.<sup>12</sup>

This identity manipulation was followed by three experimental tasks. First, subjects were asked to complete a risk preference elicitation task based on Binswanger (1981) and Eckel and Grossman (2002), the results of which we analyze in a companion

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<sup>11</sup>Cohn and Maréchal (2016) provide a review of identity priming in economics and discuss how this builds on a previous substantial literature in social psychology. The first economic experiments on identity priming were Chen and Li (2009) as well as Benjamin et al. (2010). There are two general approaches to studying how behavioral measures differ across identities: (1) artificially inducing certain identities or (2) studying the effect of identity priming in natural populations, such as bankers (Cohn et al. 2014), criminals, (Cohn et al. 2015), or scientists, as in our study.

<sup>12</sup>The only other difference was that on the preamble page we stated that the study was on either on “Work [Life] satisfaction, including individual attitudes and behavior” in *Professional* [*Private*].

Table 7.1: Identity priming questions

<i>Professional</i> identity treatment	<i>Private</i> identity treatment
Who is your current employer?	What is your current city of residence?
How many years have you worked for this institution?	How many years have you lived in your current accommodation?
Do you have a tenured position?	Are you married?
How large is your direct working team (yourself included)?	How large is your direct family (yourself included)?
Where did you last go to for a conference/workshop?	Where did you last go on holiday?
In which year did you start your PhD?	In which year did you kiss the first boy/girl?
At what time do you usually arrive at the office?	At what time do you usually arrive at home?
What activity in your work do you enjoy the most?	What activity in your leisure time do you enjoy the most?
How satisfied are you with your work in general?	How satisfied are you with your life in general?

paper (Drupp et al. 2017). The risk task was followed by the truth-telling task based on Abeler et al. (2014) that is the main focus of this paper. We present this task in more detail below. Finally, we posed a hypothetical social time preference task. The three tasks were always presented in this order and it was not possible to switch back once a subject had proceeded to the next page. The lottery outcome of the risk task was only revealed at the end of the experiment.

Following the experimental tasks, participants were also asked to complete a short follow-up survey that included a word-completion task designed to provide an implicit measure of how well the identity priming manipulation had worked (cf. Cohn et al. 2014). Subjects were presented with eight word fragments and they were asked to fill

in the gaps with letters to form existing words. The idea is that when the professional identity is salient, other words come to the participants' mind as compared to when the private identity is salient. For example, they were shown the word fragment “j o u r \_ \_”, which they could complete with the word “journal” that scientists would frequently encounter in their professional lives, or the word “journey,” which might be more salient to those in the *Private* treatment.<sup>13</sup> We classified all completed words and either assigned the number 1 to words related to the professional work identity or number 0 to words classified as related to a private life. Words that could not be classified as relating to either context or words without actual meaning were coded as missing.<sup>14</sup>

Together with the payoff from the risk elicitation task, which ranged from 2 to 16 €, and a 5 € compensation for completing the short follow-up survey, each subject could earn up to 41 €.<sup>15</sup> Finally, we offered the possibility to donate fractions of the earnings to the charity ‘Doctors Without Borders’. This option was not pre-announced and the donation decision could not have influenced coin toss reporting.

For studying the truth-telling of scientists, we adapt the 4-coin-tossing task of Abeler et al. (2014) for our online field experiment. Subjects were asked to use any coin that has the usual “tails” and “heads” format (see Appendix C.1.1 for a screenshot of the task). The subject’s task was then to toss this coin exactly 4 times, and report their tail toss result by clicking on the relevant button in a table.<sup>16</sup> For each instance they reported that the winning toss “tails” laid on top, they received 5 €. An important feature of this task is that lying can be detected only on aggregate when examining the distribution of decisions, but not on the individual level. Thus, depending on chance and honesty, each subject received between 0 and 20 € for this task. Similar

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<sup>13</sup>The first two of the eight word fragments (“\_ a l k” and “\_ o o k”) had no unambiguous professional science interpretation. These two were meant as an easy start for participants and served, following Cohn et al. (2014, forthcoming), the purpose of disguising the purpose of the task. The other word fragments were: “\_ i s \_”, “\_ \_ s s i o n”, “c o \_”, “\_ \_ o c k” as well as “\_ \_ p e r”.

<sup>14</sup>When in doubt about a word’s meaning we relied on the Merriam-Webster dictionary.

<sup>15</sup>The design thus aimed at paying out all participants. Overall, we spent 3389 Euros on subject remuneration and donated 6199 Euros to ‘Doctors Without Borders’ on our participants’ behalf.

<sup>16</sup>As we could not ensure the availability of coins to toss remotely, we offered the option of to proceed without reporting one of the five tail toss possibilities in case they could not organize a coin to toss. They were told that they would not receive a payoff for this task in this case. No subject clicked this option.

experiments using coin tosses or die rolling have been conducted to answer a whole range of related research question. Abeler et al. (2016) provide a meta-study on truth-telling behavior summarizing results based on 72 individual studies. Several key insights emerge from this burgeoning literature: (i) Subjects only over-report on average a quarter of the possible maximum pay-off and thus exhibit substantial lying costs; (ii) Subject’s reporting behavior is not influenced by stake sizes; (iii) female subjects over-report somewhat less compared to males; (iv) students over-report more than other subjects. Testing different models that can be used to explain reporting behavior, Abeler et al. (2016) find that models, which combine a preference for being honest, i.e. that entail a utility cost for deviating from the truthful response, and preference for being seen as honest, i.e. that entail individual reputation concerns, perform best in explaining experimental data.<sup>17</sup>

As our main contribution is not a focus on modeling lying costs but more directly on the effect of making the professional scientific identity more salient vis-a-vis the private identity, we follow Benjamin et al. (2010) and Cohn et al. (2015) in relying on a simple behavioral choice model that features the salience of distinct identities. The model of reporting behavior considers an overall lying aversion due to deviating from the truthful response that may differ between the two identities, which may be guided by different norms and behavioral patterns.<sup>18</sup>

In absence of a possibility to detect individual lying, an individual  $i$  faces a trade-off between monetary incentives and (moral) costs of lying. While the individual derives utility only from her payoff proportional to the reported number of coin tosses  $r_i$ , she also suffers disutility from reporting a number that deviates from the true number of tail tosses,  $r_{it}$ . The individual payoff-maximizing choice is given by  $r_{ip}$ . Aggregating over all  $n$  individuals of a population yields the mean tail toss reporting  $\bar{R} = \frac{1}{n} \sum_{i=1}^n r_i$ ,

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<sup>17</sup>Another recent study by Gneezy et al. (2016) investigates how lying costs depend on the size of the lie in various dimensions using both unobservable as well as observable lying tasks. Besides intrinsic lying costs considered in our model, they find that an important role for reputational concerns driving honest reporting in unobservable games, such as our coin tossing experiment. Furthermore, they find that only one out of 602 subjects under-reports to his or her disadvantage.

<sup>18</sup>Besides the application of identity-priming model to truth-telling behavior of criminals by Cohn et al. (2015), this model has been employed for explaining effects of religious identity on a suite of economic preferences (Benjamin et al. 2016) and on risk preferences (Cohn et al. forthcoming; Drupp et al. 2017).



which can be disaggregated for different groups within a population. For instance, we denote the mean tail toss reporting in the *Professional* identity treatment as  $\bar{R}^{PROF}$ .<sup>19</sup>

Furthermore, let  $\hat{R}^{PROF}(\hat{R}^{PRIV})$  denote the expected reporting behavior implied by prevailing norms in the professional environment (private identity context). In the context of our study, these norms imply certain lying costs, with  $\hat{R} = \frac{\lambda}{2}(r_i - r_{it})$ , where  $\lambda$  is a parameter determining the degree of overall lying aversion. As the degree of lying aversion may depend on expected behavior and prevailing norms in different contexts, it may in particular differ across the private and the professional identity conditions, i.e.  $\lambda^{PROF} \neq \lambda^{PRIV}$  and thus  $\hat{R}^{PROF} \neq \hat{R}^{PRIV}$ . Furthermore, let  $s$  denote the strength of the identification with the professional environment. Let  $w_i(s) \in [0, 1]$  denote how much weight the individual puts on complying with expectations in the professional environment, which depends on the strength of identifying with the respective environment, with  $\frac{\partial w_i}{\partial s} \geq 0$ . In this set-up, the individual chooses her reporting of tail tosses  $r_i$  to maximize utility

$$\max_{r_i} U_i(r_i) = -\frac{1}{2} (1 - w_i(s)) \left( r_i - \hat{R}^{PRIV} \right)^2 - \frac{1}{2} w_i(s) \left( r_i - \hat{R}^{PROF} \right)^2. \quad (7.1)$$

The optimal tail toss reporting  $r_i^*$  is a weighted average of the expected reportings under both identities,

$$r_i^* = (1 - w_i(s)) \hat{R}^{PRIV} + w_i(s) \hat{R}^{PROF}. \quad (7.2)$$

In terms of the model, our priming experiment aims at varying the salience of the *Professional* or the *Private* identity and thus the strength  $s$  of identifying with the professional identity. Priming subjects with the professional identity (the *Professional* treatment) should increase  $s$ , while priming the private identity (the *Private* treatment) should decrease  $s$ . Subjects should therefore (weakly) experience an increase in the weight to one identity or the other while filling out the priming question and are assumed to be still affected by this when completing our experimental task. As such,

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<sup>19</sup>While the model considers continuous reporting, our subsequent experiment is based on a setting where possible reporting levels are discrete, with  $r_i, r_{it} \in \{0, 4\}$ . Furthermore, the mean truthful response is given by  $R_t = \frac{1}{n} \sum_{i=1}^n r_{it} = 2$ , and the payoff-maximizing choice is given by  $R_p = \frac{1}{n} \sum_{i=1}^n r_{ip} = 4$ .

any treatment difference should reveal the behavioral impact of the primed identity and its associated norms compared to the other treatment condition:

$$\frac{\partial r_i^*}{\partial s} = \frac{\partial w_i}{\partial s} \left( \hat{R}^{PROF} - \hat{R}^{PRIV} \right). \quad (7.3)$$

Based on previous findings in the experimental literature (Abeler et al. 2016), we expect heterogeneity regarding individual truth-telling  $r_i^*$  in our sample of scientists. Translating the average standardized estimate of the meta-study of Abeler et al. (2016) into our context predicts an average tail toss report  $\bar{R}$  of 2.44. We formulate:

*HYPOTHESIS 1: Average over-reporting is in-between the truthful and the payoff maximizing choice.*

While previous research has shown that professional identity is associated with higher over-reporting of winning coin tosses (i.e. lower truth-telling) for bankers and criminals (Cohn et al. 2014, 2015), we hypothesize that the norms and behavioral patterns associated with working as a scientists implies greater truth-telling. After all, science is a system of knowledge covering general truths (Popper, 1996). We therefore assume greater lying costs in the professional science context,  $\lambda^{PROF} > \lambda^{PRIV}$ , and accordingly norms associated with lower expected mean tail toss reporting,  $\hat{R}^{PROF} < \hat{R}^{PRIV}$ . Our model thus predicts that  $\frac{\partial r_i^*}{\partial s} < 0$ , summarized as

*HYPOTHESIS 2: Average over-reporting of scientists is lower in the professional identity treatment.*

Even though we expect that stronger honesty norms are present in the professional scientific as compared to the average private context, the accumulating evidence on the use of questionable research practices among scientists suggests that we should not expect truthful reporting on average even in the professional identity treatment. For example, if one-third of scientists would lie partially by over-reporting one tail-step, as the anonymous survey evidence cited above might suggest, we would expect an average tail toss reporting of 2.31 tails, leading to

*HYPOTHESIS 3: Even in the professional identity treatment, average reporting behavior differs from the truthful distribution.*

As part of a comprehensive analysis of truth-telling behavior of scientists in the next section, we will confront these hypotheses with our experimental data.

### 7.3 Results

We have received 599 responses to the survey, amounting to a response rate of more than 30%.<sup>20</sup> 437 responses contain a coin toss report. Figure 7.1 depicts a world map, in which the red balloons indicate the locations of scientists participating in the coin-toss experiment. Participants come from all major continents, and predominantly from Europe and North America. There are 58% male subjects in our sample. The mean age of our subjects is 43 years, and 52% of our participants have a tenured position.

Before we turn to scrutinizing the decisions in the coin-tossing task, we test whether our implicit measure of identity priming using the word completion task indicates that priming has been successful. For each subject, we aggregate over the given numbers assigned to completed words for the six potential word checks (1 for words associated with professional life, 0 for words associated with private life) and compare the mean value of these aggregate numbers for the two treatments. Furthermore, we create an index that captures the relative frequency of mentioning words associated

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<sup>20</sup>Overall, 946 individuals clicked on the link to our study. We dropped 10 observations because they responded more than once and one observation because we could not identify her as still being a master student. 162 subjects completed some parts of the initial demographic questions, priming questions, or the risk task, but did not complete the coin-tossing task. Appendix C.1.2 provides a comprehensive investigation of potential response bias and selection effects concerning the balance across treatments. Comparing participants and drop-outs, we find that there are no differences across observable characteristics except that drop-outs are older. Yet, age is not correlated with lying behavior among those participating in the experiment (t-test:  $p = 0.747$ ). Comparing the balance of observable characteristics across treatments, we find that our treatments are balanced except for gender: We have more males in the *Private* treatment as compared to the *Professional* treatment (chi-squared test:  $p = 0.032$ ). Yet, gender is not correlated with overall tail toss reporting behavior (chi-squared test:  $p = 0.588$ ). We further perform a number of simulation exercises hypothetically adding these ‘statistically missing’ males in the *Professional* treatment, which reveals that these would have to be substantially less honest as our respondents such that selection would drive our main treatment effect. Thus, we are confident that our main results indeed capture differences due to varying the salience of professional versus private identity and are not driven by response and selection effects.



Figure 7.1: Map of the world, including the locations of participating scientists indicated by the red balloons.

with professional life. We find that the mean number of ‘professional’ words, such as “journal”, “paper” or “session”, is with 2.89 higher in *Professional* as compared to the 2.66 ‘professional’ words in *Private* (t-test:  $p = 0.053$ ).<sup>21</sup> Furthermore, the relative frequency of mentioning words associated with professional life is higher in *Professional*, with 59%, as compared to *Private*, with 55% (t-test:  $p = 0.088$ ). We thus find some supportive evidence that our *Professional* treatment was able to make the professional scientific identity more salient compared to the *Private* treatment.

We now examine the coin toss reporting behavior of scientists. Figure 7.2 shows the theoretical binomial distribution for four tosses of a fair coin (blue dots connected by the dashed line), which is the distribution that we would expect if all subjects report the outcome of their four coin tosses truthfully. The probability that four times tossing a coin results in  $r_{it} = 0$  or 4 (1 or 3) [2] times tails is 6.25% (25%) [37.5%]. We refer to this distribution as the ‘truthful distribution’, with a mean truthful response of  $\bar{R}_t = 2$  tail tosses. The mean payoff-maximizing choice would be the reporting of  $\bar{R}_p = 4$  tail tosses. The colored bars in Figure 7.2 show actual reporting behavior of the participating scientists across the two treatments: *Private* and *Professional*.

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<sup>21</sup>All p-values reported in this paper are based on two-sided tests.

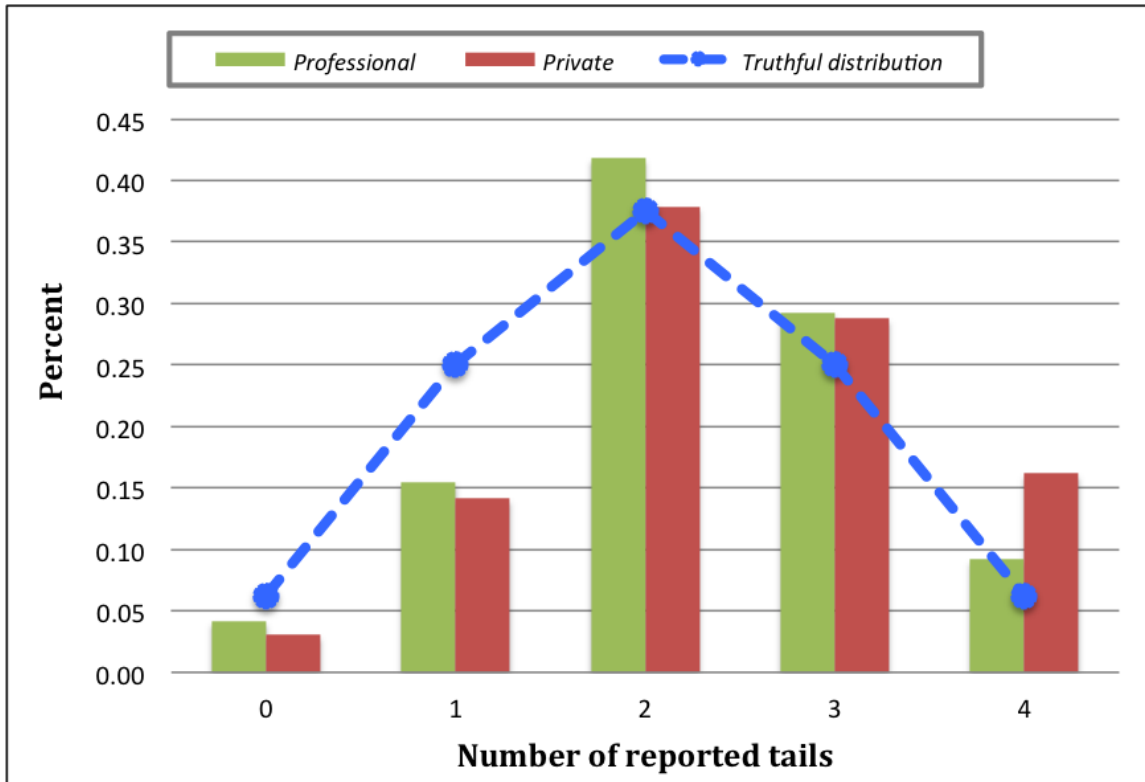


Figure 7.2: Tail toss-reporting behavior of scientists in the Private identity treatment (red bars) versus the Professional identity treatment (green bars). The blue, dashed line with dots corresponds to the expected distribution if every scientist reported the true outcomes of their coin tosses. The payoff was five Euros times the number of tails reported, i.e. the payoff-maximizing reporting was four times tails.

First, we analyze overall coin toss reporting of all scientists by aggregating results from both treatments. We find that reporting by scientists differs highly from payoff-maximization. Scientists report on average 2.32 tail tosses, thus indicating substantial lying costs. However, we also find that scientist over-report tail tosses to their advantage: A Kolmogorov–Smirnov test for comparing overall reporting behavior against the binomial distribution confirms that scientists over-report tail tosses ( $p < 0.001$ ). We therefore cannot reject Hypothesis 1 and previous findings in the literature also for scientists.

We now analyze truth-telling in our two treatments. Figure 7.2 shows reporting behavior of scientists in the private compared to the professional identity treatment. While subjects in *Private* report 2.41 tail tosses on average, subjects in *Professional* only report 2.24 tail tosses on average (t-test:  $p = 0.073$ ). In particular, we find that

scientists in *Professional* report fewer four times tails as compared to those in *Private* (9.21% vs. 16.16%; chi-squared test:  $p = 0.028$ ). This confirms our central Hypothesis 2 and establishes

**RESULT 1: Reporting behavior under identity priming**

*Scientists in the professional identity treatment report, on average, lower tail tosses compared to those in the private identity treatment.*

Even though there is fewer over-reporting of higher tail tosses among scientists in *Professional* compared to the *Private* control treatment, we still find that there is over-reporting of tail tosses among those primed with their professional identity: A Kolmogorov–Smirnov test for comparing overall reporting behavior in *Professional* against the expected truthful binomial distribution rejects the null hypothesis at  $p < 0.01$ . That is, the coin-toss reporting in *Professional* still deviates from the truthful distribution, thus confirming Hypothesis 3. Summarizing this finding yields

**RESULT 2: Reporting behavior under *Professional* identity compared to truthful distribution**

*Scientists in the professional identity treatment over-report tail tosses compared to the expected truthful distribution.*

As the marginal behavioral impact of increasing the salience of the professional or private identity will depend on the individual baseline salience level (cf. Benjamin et al. , 2010), we make use of having inquired about the participant’s location when completing the survey to explore differences in reporting behavior across locational contexts.<sup>22</sup> We compare responses of participants who respondent from their usual workplace “at work” ( $n = 252$ ) with those being “not\_at\_work”, composed of “at home” as well as “home office” ( $n = 139$ ). We find that the identity priming treatment effect is particularly strong for those scientists responding while not being at their usual workplace. While the mean number of ‘professional’ words in *Private* is with 2.65 roughly the same as for the whole sample, we find that the mean number of

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<sup>22</sup>Pre-offered options were “at work”, “at home”, and “home office”, and a residual “other” option.

‘professional’ words in *Professional* is 3.11 and thus considerably higher than in *Private* (t-test:  $p = 0.044$ ). While there is no tail toss reporting difference across treatments for scientists responding from their workplace (t-test:  $p = 0.821$ ), the priming intervention had a particularly strong effect on tail toss reporting for those that were not at their usual workplace (at home, home office, on travel, on vacation etc.): Average tail tosses reported are 2.53 in *Private* and 2.10 in *Professional* (t-test:  $p = 0.008$ ). For four times tails reporting, we find relative frequencies of 18.18% in *Private* and 4.11% in *Professional* (t-test:  $p = 0.007$ ).

### **RESULT 3: Identity priming effects at different locations**

*The professional identity priming and treatment effect on lower (more truthful) over-reporting is particularly pronounced when participants respond from locations other than their usual workplace.*<sup>23</sup>

Finally, we relate tail toss reporting to the two other behavioral measures collected as part of the same study: risk preferences and donations.<sup>24</sup> First, we elicited risk preferences using the so-called Eckel-Grossmann task (Binswanger, 1981; Eckel and Grossman, 2002).<sup>25</sup> Unlike a number of previous studies that examined the relationship between risk-taking and truth-telling,<sup>26</sup> we find that higher tails reporting is associated with higher risk-taking (correlation-coefficient: -0.13; t-test:  $p = 0.007$ ).<sup>27</sup> We explore the effects of professional identity priming on risk-taking behavior of scientists in more detail in a companion paper (Drupp et al. 2017). As there is no difference

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<sup>23</sup>Note that as the variables “at\_work” and “treatment” are not correlated (t-test:  $p > 0.55$ ), this locational effect does not drive our main treatment effect.

<sup>24</sup>Tail toss reporting is not associated with participants’ elicited degree of social time preference (t-test:  $p = 0.736$ ). The same holds for the year of birth ( $p = 0.747$ ), gender ( $p = 0.908$ ), being married ( $p = 0.187$ ), and having tenure ( $p = 0.380$ ), as revealed by t-tests.

<sup>25</sup>In this task, subjects are asked to choose one out of six lotteries, each with two outcomes that occur each with 50 percent probability. These lotteries increase in riskiness, from a safe option (with 7 Euros each) to a lottery number 6 that elicits risk-seeking behavior (with the possible outcomes of 2 and 16 Euros), i.e. where the expected value is the same but the standard deviation higher as compared to lottery 5 (with 3 and 15 Euros).

<sup>26</sup>For example, Abeler et al. (2014), who rely on a stated preference measure for the German population, or Drupp et al. (2016), who use the same wEckel-Grossmann risk-elicitation task.

<sup>27</sup>Zimmerman et al. (2014) examine the relationship between a stated-preference measure of risk-taking specifically in the domain of ethical risks and find that the stated measure of risk-taking in ethical context is positively correlated with dishonest behavior as elicited using a coin tossing task.

in the overall identity priming treatment effect on risk-taking, we are confident that the negative correlation between risk-taking and truth-telling is not driving the key results of the present paper.

#### **RESULT 4: Relationship between over-reporting and risk-taking**

*Lower (over)-reporting of tail tosses is, on average, associated with lower risk-taking.*

Second, we allowed participants to donate fractions (in 10% steps, from 0 to 100%) of their earnings at the end of the experiment to the NGO ‘Doctors Without Borders’, providing us with an eleven-point step measure of the payoff-fraction donated. This option was not announced earlier, so their donation decision could not have impacted tail toss reporting, but their coin toss reporting and resulting pay-off level might have impacted subsequent donations. We find that participants reporting higher tail tosses are associated with lower step-level donations (correlation-coefficient: -0.17; t-test:  $p = 0.001$ ). Indeed, the donation fraction decreases monotonically with reported tail tosses (from 94% for 0 tail tosses to 52% for 4 tail tosses). Yet, we find that the absolute donation amount increases monotonically with reported tail tosses (from 11 € for 0 tail tosses to 17 € for 4 tail tosses), resulting from higher pay-offs for people with higher reported tail tosses (t-test:  $p = 0.004$ ).<sup>28</sup> Furthermore, we find that those who do not donate at all report on average 2.50 tail tosses as compared to only 2.17 tail tosses for those who donate all of their pay-off (t-test:  $p = 0.009$ ). Overall, this suggests some consistency of behavior related to social preferences as revealed by both truth-telling and donation levels and finally yields

#### **RESULT 5: Relationship between reporting behavior and donations**

*Lower (over)-reporting of tail tosses is, on average, associated with a higher share of subsequent donations.*

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<sup>28</sup>We find no difference in fractions donated across *Private* and *Professional* (t-test:  $p > 0.60$ ). Also for the absolute donation amount we find no differences across treatments (t-test:  $p > 0.35$ ).



## 7.4 Discussion and conclusion

We have investigated whether scientists tell the truth by means of an incentivized coin-toss truth-telling task within an online field experiment with 437 members of an international scientific organization. In particular, we compare truth-telling behavior, in the form of coin toss reporting, across two treatments that either made participants' professional or private identity more salient using nine identity priming questions. Our key result is that fewer scientists over-report winning tail tosses in the professional identity treatment. This professional priming treatment effect on truth-telling is particularly strong for those responding to the study while not being at their usual workplace. Furthermore, we find that truth-telling is negatively associated with a scientist's elicited degree of financial risk-taking, and that there seems to be some consistency in pro-social behavior, as subsequent donations fractions are positively associated with truth-telling.

While we are able to provide causal evidence that professional identity effects associated with science foster truth-telling, we can pinpoint the underlying mechanism for this finding only inductively.<sup>29</sup> Previous work that our simple model of truth-telling behavior builds upon (Benjamin et al. 2010; Cohn et al. 2015) suggests that this more frequent truth-telling is driven by stronger honesty norms associated with the professional (in this case scientific) identity. This main interpretation suggests that academia fosters a culture of truth-telling that would be consistent with its general aim of searching for truths. Indeed, this cultural norm-based interpretation has featured prominently in related findings in experimental studies on the banking industry (Cohn et al. 2014; Villeval 2014). Yet, stronger honesty norms may not be the only facet of the professional identity of scientists that drives truth-telling behavior. For example, it is often suggested that competitiveness ('publish or perish') is a central feature of behavioral patterns and thus perhaps also associated norms in academia (see, e.g., Fanelli 2010; Necker 2014). If this were the case, our main treatment effect finding would be a conservative estimate of the truth-telling norms that science nurtures, as

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<sup>29</sup>Taking the study by Cohn et al. (2014) as an example, Vranka and Houdek (2015) discuss the difficulty of pinpointing underlying mechanisms of observed priming effects.

also inherent competitiveness norms might have a detrimental effect on truth-telling.<sup>30</sup>

Besides the interpretation that honesty norms associated with the scientific identity drive truth-telling behavior, it could also be the case that other professional identity concerns may impact our results. Specifically, it could be that scientists strategically report more honestly as they might seek to paint a more positive picture of science. That is, they may take reputational concerns at the level of the profession into account.<sup>31</sup> We regard this alternative explanation as a rather unlikely mechanism. A necessary condition for this strategic influence explanation is that participating scientists believe that they can favorably influence the overall outcome, i.e. their contribution is non-marginal. The participants in our study knew that we targeted all members of the scientific organization, i.e.  $\frac{1}{n}$  was small. Given our between-subjects design, participants were also not aware that they were part of an experiment, i.e. that there was another treatment.<sup>32</sup> Thus, even though we cannot rule out the presence of professional reputation concerns by design, it seems rather unlikely that this will be a main driver of our observed treatment effect.<sup>33</sup>

While our central treatment effect therefore seems to suggest that science fosters a culture of honesty, which is arguably good news for science as well as for all of us relying on scientific results, we still find that scientists over-report winning tail tosses compared to the expected truthful distribution. For the whole sample, we find that scientists report on average 2.32 tail tosses.<sup>34</sup> Even in the professional identity

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<sup>30</sup>For example, Shleifer (2004) discusses how (market) competition may have detrimental effects on ethical behavior. More recently, a series of experimental economic studies have found that competition may lead to more dishonesty (see, e.g., Cartwright and Menezes 2014; Conrads et al. 2014; Faravelli et al. 2015; Rigdon and D’Esterre 2015; Schwieren and Weichselbaumer 2010). However, while Fanelli et al. (2015) find that scientific misconduct is more likely in countries where individual research output yields monetary rewards, their results do not support the hypothesis that pressure to publish seems to drive dishonest behavior. Furthermore, Cohn et al. (2014) do not find an identity priming effect for bankers on a stated preference question on competitiveness.

<sup>31</sup>This strategic behavior could thus be present in both treatments, but due to our experimentally induced higher salience it would likely be higher in the professional identity treatment.

<sup>32</sup>Also note that while truth-telling approaches are well-known in behavioral economics and psychology by now, the participating natural scientists had very limited exposure to such experiments.

<sup>33</sup>Furthermore, if portraying a positive image of science would drive our treatment effect in truth-telling behavior, one might also expect that such strategic behavior to show up in subsequent donation decisions. Yet, we find no differences across the two treatments for both the fraction of pay-off reported and for the absolute size of donations.

<sup>34</sup>For example, this result would occur if one-third of scientists lied partially, as is suggested in a

treatment, we find that scientist over-report winning tail tosses. The culture of honesty that academia seems to foster thus does not seem sufficient to ensure that science does not get derailed from its quest for truths. This finding is in line with anonymous survey based approaches that provide evidence that a considerable fraction of scientists engage in questionable research practices (see, e.g., Fanelli 2009; John et al. 2012; List et al. 2001; Martinson et al. 2005; Necker 2014).

As scientific honesty is crucial for scientific development as well as the public's trust in the results of science and thus for the evolution of mankind, further measures have to be taken to prevent scientific misconduct. This quest for improving research practices and debunking misconduct is as old as science itself. Meta-analyses (Abeler et al. 2016; Brodeur et al. 2016), replication studies (Camerer et al. 2016; Dreber et al. 2015; Open Science Collaboration 2015), more precise and transparent reporting practices (Christensen and Miguel 2016; Miguel et al. 2014; Nosek et al. 2015; Simmons et al. 2011) as well as institutional incentives and arrangement for research integrity (Titus et al. 2008; Titus and Bosch 2010) are some important recent steps into this direction. Besides showing that academia already seems to foster norms associated with truth-telling, our findings thus call for further steps that let this quest for improving research conditions and practices continue.

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number of anonymous surveys on scientific misbehavior.

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# Appendix

## C.1 Appendix to Chapter 7

### C.1.1 Screenshots from the online survey

What is your current city of residence?

How many years have you lived in your current accommodation?

Are you married?

Yes  No

How large is your immediate family (yourself included)?

Where did you last go on holiday?

In which year did you kiss the first boy/girl?

At what time do you usually arrive at home?

00:00 (XX:XX)

Which activity in your leisure time do you enjoy the most?

How satisfied are you with your life in general?  
(1 to 9; not very satisfied to extremely satisfied)

1 2 3 4 5 6 7 8 9

Please proceed.

Continue

Figure C.1: Priming questions for the *Private* identity treatment

**Who is your current employer?**

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**How many years have you worked for this institution?**

---

**Do you have a tenured position?**

Yes  No

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**How large is your direct working team (yourself included)?**

---

**Where did you last go to for a conference/workshop?**

---

**In which year did you start your PhD?**  
(please put 1111 if not applicable)

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**At what time do you usually arrive at the office?**

(00:00)

---

**Which activity of your work do you enjoy the most?**

---

**How satisfied are you with your work in general?**  
(1 to 9; not very satisfied to extremely satisfied)

1 2 3 4 5 6 7 8 9

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Please continue.

Figure C.2: Priming questions for the *Professional* identity treatment

### Task 2

In this task, you can also gain money. Your payoff is determined by a coin toss, which you toss yourself. Please take any coin at hand that has the usual "tails" and "heads" format. Your task is to toss this coin **exactly 4 times**. For each case that **"tails"** lies on top, you will receive 5 Euro. Afterwards, please record your result in the table below.

Your outcome (please make one choice).

Times of coin tosses where „tails“ came out top.

- 0 Times - Payment 0.00 €
- 1 Times - Payment 5.00 €
- 2 Times - Payment 10.00 €
- 3 Times - Payment 15.00 €
- 4 Times - Payment 20.00 €

Examples: If the number of coin tosses, for which "tails" came out top, is 1, you will receive 5.00 €. If the number of coin tosses, for which "tails" came out top, is 3, you will receive 15.00 €.

In case you cannot organise a coin, you may click the continue button. If this is the case, you will not receive a payoff for this task.

Continue

Figure C.3: Screenshot for the coin toss-reporting task.

### C.1.2 Testing for response and selection bias

Laboratory experiments implicitly constrain participants to make choices and remain in the laboratory for the entire length of a study in order to complete it. Conversely, (online) field experiments potentially suffer from response bias and attrition.

To test for obvious response bias, we carry out several checks suggested in the previous literature. In particular, we test whether there are observable differences for early versus late respondents (e.g. Necker 2014) as well as consider observable characteristics of our respondents and non-respondents. First, for earlier versus later respondents, we do not find significant differences in tail toss reporting between the first half, with a mean tail toss of 2.33, and the second half of respondents, with a mean tail toss of 2.31 (t-test:  $p = 0.847$ ).

Table C.1: Descriptive statistics for participants and drop-outs

	Coin toss	No coin toss	p-values
	n = 437	n = 244/162/39	
Share from Europe	0.78	0.81	0.377
Share <i>Professional</i>	0.55	0.52	0.507
Mean year born	1972.85	1968.32	0.000
Share male	0.59	0.63	0.311
Mean risk choice	3.92	3.46	0.135

Note: The p-values for binary data are based on chi-squared tests and the p-values for interval data are based on t-tests.

Second, we compare observable characteristics of our 437 respondents who completed the coin-tossing task and those who dropped out of the study that we still have some information on (see Table C.1).<sup>35</sup> There are no significant differences across participants and dropouts except for their age: Those participating in the coin toss experiment are 4.53 years younger than those dropping out (t-test:  $p = 0.000$ ). As

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<sup>35</sup>On those who have dropped out, we have information on the assigned treatment as well as the continent on which they were located when clicking on the participation link for 244 drop-outs, and on gender and their mean year born for 162, and their experimental risk choices for 39 drop-outs.

age is not significantly correlated with overall reporting behavior among participants (t-test:  $p = 0.747$ ), this does not provide an indication for obvious response bias.

We further examine balance across our experimental treatments. For this, we compare *Professional* and *Private* for observable information that we collected in both treatments. We know that the computer-generated randomization roughly worked: about one half, 52.85%, of the 946 clicks on the e-mail’s invitation link were randomly assigned to *Professional* and the remainder to *Private*. Compared to the 52.85% who were assigned to *Professional* when they clicked the invitation link in the e-mail, we have 54.69% (239 out of 437) of participants who remained in *Professional* and completed the coin-tossing task. The numbers point to slightly greater attrition in *Private* compared to *Professional*. Table C.2 shows further descriptive statistics for the participants who completed all subsequent stages of our study including the coin-tossing task.

Table C.2: Descriptive statistics across treatments.

	Overall	<i>Professional</i> treatment	<i>Private</i> treatment	p-values
	n = 437	n = 239	n = 198	
Share from Europe	0.78	0.80	0.76	0.416
Mean year born	1972.85	1972.25	1973.58	0.219 / 0.180
Share male	0.59	0.54	0.64	0.032
Share tenured	0.52	0.50	0.53	0.544
Share “at work“	0.65	0.66	0.63	0.564
Mean risk choice	3.92	3.89	3.96	0.677 / 0.656

Note: The p-values for binary data are based on chi-squared tests and the p-values for interval data are based on two-sided t-tests / rank-sum tests.

On average, the participants in the study were born in 1973, meaning that—as of 2016—they were 43 years old on average. Around half of the participants held tenured positions. 20% lived in the US, while 78% lived in Europe. 59% of the participants are male, the rest is female. Comparing the characteristics across treatments shows that

our treatments are balanced, except for gender. The share of males in *Professional* is 54% compared to 64% in *Private* (chi-squared test:  $p = 0.032$ ). As we find that gender is not significantly correlated with overall tail toss reporting behavior (chi-squared test:  $p = 0.588$ ), this does not appear as problematic at first sight, especially given that in our between-subjects design it was not possible for subjects to actively select themselves into any treatment. Further, they did not know that a second treatment existed. However, the main treatment effect in Result 1 is particularly pronounced for males: We find that there are no significant differences in overall reporting behavior across the 254 male and 181 female subjects: mean tail toss reports are 2.32 and 2.30 tails respectively (chi-squared test:  $p = 0.588$ ). However, there are differences in the treatment effect across gender: While there is no significant difference in reporting behavior of females across the identity priming treatments (t-test:  $p = 0.695$ ),<sup>36</sup> male participants significantly over-report tail tosses in *Private* compared to *Professional* (t-test:  $p = 0.061$ ). It is therefore worthwhile to explore potential explanations of this gender balance difference in more detail.

Fortunately, we have information on the gender distribution in our population (the e-mail list of the scientific organization). We know that about 66% of the members in the population are male. This figure is very close to the 64% of males in *Private* (binominal probability test,  $p = 0.497$ ). Thus, there are significantly fewer males in *Professional* compared to the expected 66% (binomial probability test,  $p < 0.001$ ). In other words, we find the expected share of males in the *Private* treatment, while there are significantly fewer males and conversely relatively more females in *Professional* than expected. We do not have detailed information on most dropouts, as these occurred before subjects provided any information in the survey. However, we can extend the analysis of dropouts above to consider differences across treatments within the dropouts.

First, the sequential nature of our experimental tasks allows comparing the risk-taking behavior of those 39 participants who have completed the risk elicitation task but not the coin-tossing task. Among these 15 are from the *Private* and 24 from the *Professional* treatment, i.e. we had somewhat greater attrition in *Professional*.

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<sup>36</sup>Furthermore, chi-squared tests:  $p > 0.40$  for all single tail tosses.



Those in *Private* not completing the coin-tossing task had a mean risk choice of 4.00. Those in *Professional* had a mean risk choice of 3.13. Although this difference is not significant due to the small number of observations (t-test:  $p = 0.210$ ), as higher risk choices are significantly correlated with lower truth-telling, if at all this may suggest that our observed main treatment effect may be a conservative estimate.

Next, we consider dropout rates across gender per treatment (see Table C.3). For this, we consider all dropouts for whom we have information on their gender and divide this by the respective combined number of dropouts and tail toss respondents. We find that overall and also across both genders there are higher dropout rates in *Private* as compared to *Professional*. Furthermore, we find more frequent attrition of males, as compared to females, yet this difference is not significant (see Table C.1).

Table C.3: Dropout rates per treatment and gender

	<i>Private</i> treatment	<i>Professional</i> treatment
Male	0.30	0.27
Female	0.26	0.24
Overall	0.29	0.26

Note: 54 (25) males (females) in *Private* and 48 (35) males (females) in *Professional* dropped out of the study.

This analysis of dropouts therefore cannot explain why we find significantly fewer males and conversely more females in *Professional* than expected. It thus seems that the more frequent relative participation of females in the *Professional* treatment occurs at a stage that precedes our experimental treatments and thus cannot be driven by a selection effect of females or males into the treatments. We refrain from speculating about these males' reasons for dropping out or those females participating more frequently.

What we can do, however, is to explore the robustness of our results by means of simulations. Table C.2 has shown that there are only 54% males in *Professional*, as compared to 64% in *Private*. For our simulations, we therefore hypothetically add another 25 males to the *Professional* treatment, such that the proportion of males would

be equalized across treatments to 64%. We consider five cases that assume different distributions of lying behavior for those 25 additional males. They would report: First, as males in the *Professional* treatment (Simulation 1); Second, as all of those in the *Professional* treatment (Simulation 2); Third, as all respondents across both treatments (Simulation 3); Fourth, as all those in the *Private* treatment (Simulation 4); Finally, they would report on average as the group with the highest overall lying behavior: males in the *Private* treatment (Simulation 5). These different simulations (summarized in Table C.4) thus add observations whose tail toss reporting is shifted to the right by varying degrees as compared to the expected truthful distribution.<sup>37</sup>

Table C.4: Robustness simulations of treatment differences in tail toss reporting

	Overall tail tosses p-values	4 times tail tosses p-values
Original participants	0.073	0.028
Simulation 1	0.067	0.021
Simulation 2	0.061	0.021
Simulation 3	0.074	0.030
Simulation 4	0.089	0.043
Simulation 5	0.098	0.059

Note: The p-values for overall tail tosses are based on t-tests and the p-values for the 4 times tail tosses are based on chi-squared tests.

We find that the treatment effect in terms of overall truth-telling behavior is qualitatively robust across all simulations when considering a t-test ( $p < 0.10$ ).<sup>38</sup> For the difference in four tails reporting we find that the treatment effect is qualitatively robust across Simulations 1-4 ( $p < 0.05$ ). For Simulation 5 we still find a significant

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<sup>37</sup>The number of 0/1/2/3/4 tail tosses for these three cases are as follows: 1/4/10/8/2 for as males in *Professional*, 1/4/11/7/2 for as in *Professional*, 1/4/10/7/3 for as in overall, 1/4/9/7/4 for as in *Private*, and 1/4/9/6/5 for as males in *Private* (this compares to 2/6/9/6/2 in the expected truthful distribution). Note however that when considering a rank-sum test, the treatment effect is not robust for Simulations 4 and 5 (with  $p = 0.109$  and  $p = 0.116$ , respectively).

<sup>38</sup>Note however that when considering a rank-sum test, the treatment effect is not robust for Simulations 4 and 5 (with  $p = 0.109$  and  $p = 0.116$ , respectively).

treatment effect at  $p = 0.059$ , i.e. at  $p < 0.10$ .

Overall, this simulation exercise suggests that those 25 ‘statistically missing’ males in the *Professional* treatment would have to be substantially less honest as our respondents such that selection would drive our treatment effect. Thus, although it is not possible to rule out selection and response bias in field experiments due to attrition, we are confident that our main results indeed capture differences due to varying the salience of professional versus private identity and are not driven by response and selection effects.



## Eidesstattliche Erklärung

Ich erkläre hiermit an Eides Statt, dass ich meine Doktorarbeit

*Essays in Sustainability Economics:*

*Environmental Scarcity and Valuation, Economic Distribution, and Ethical Behavior*

selbständig und ohne fremde Hilfe angefertigt habe und dass ich alle von anderen Autoren wörtlich übernommenen Stellen, wie auch die sich an die Gedanken anderer Autoren eng anlehnenden Ausführungen meiner Arbeit, besonders gekennzeichnet und die Quellen nach den mir angegebenen Richtlinien zitiert habe.

Unterschrift:

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Datum:

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# Moritz A. Drupp – Curriculum Vitae

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CONTACT INFORMATION	Department of Economics Kiel University Wilhelm-Seelig-Platz 1, 24118 Kiel, Germany	+49-151-21221557 drupp@economics.uni-kiel.de sites.google.com/a/fulbrightmail.org/moritzdrupp
EDUCATION	PhD Candidate in Quantitative Economics, Kiel University · PhD Thesis: <i>Essays in Sustainability Economics: Economic Distribution and Valuation, Environmental Scarcity, and Ethical Behavior</i> [summa cum laude] MSc in Environmental Economics and Climate Change, London School of Economics (LSE) and Political Science [Distinction] BSc in International Economics, University of Tübingen [Very good]; Exchange year at Tufts University Abitur, Rudolf Steiner School Dortmund [Very good]	10/2013–09/2017  09/2013  10/2011  07/2006
AFFILIATIONS & PROFESSIONAL EXPERIENCE	Researcher in the Group of Environmental, Resource and Ecological Economics, Department of Economics, Kiel University Lecturer in the Studium Oecologicum, University of Tübingen Visiting Research Fellow, Chair of Environmental Economics and Resource Management, University of Freiburg Internship with the United Nations Environment Programme (UNEP) Internship with the Centre for European Economic Research (ZEW) Research Assistant, Department of Economics, University of Tübingen Advisor to the student council for environmental issues and mobility	10/2013–present  04/2012–present 08/2015–08/2016  10–12/2011 06–08/2010 02/2009–06/2011 11/2007–10/2009
RESEARCH INTERESTS	Environmental and Resource Economics, Public Economics, Behavioral and Experimental Economics, Sustainability Science	
JOURNAL PUBLICATIONS	Baumgärtner, S., Drupp, M.A., Meya, J.N., Munz, J.M. and M.F. Quaas (2017). Income Inequality and Willingness to Pay for Environmental Public Goods. <i>Journal of Environmental Economics and Management</i> <b>85</b> : 35–61. Baumgärtner, S., Drupp, M.A. and M.F. Quaas (2017). Subsistence, Substitutability and Sustainability in Consumer Preferences. <i>Environmental and Resource Economics</i> <b>67</b> (1): 47–66. Drupp, M.A. (2016). Limits to Substitution between Ecosystem Services and Manufactured Goods and Implications for Social Discounting. Forthcoming in <i>Environmental and Resource Economics</i> . Drupp, M.A. (2011). Does the Gold Standard label hold its promise in delivering higher Sustainable Development benefits? A multi-criteria comparison of CDM projects, <i>Energy Policy</i> <b>39</b> (3): 1213–27.	
WORKING PAPERS	Drupp, M.A., Freeman, M.C., Groom, B. and F. Nesje (2015). Discounting Disentangled. <i>Grantham Research Institute on Climate Change and the Environment Working Paper No. 172</i> . Revised and resubmitted to the <i>American Economic Journal: Economic Policy</i> . Drupp, M.A., Freeman, M.C., Groom, B. and F. Nesje (2016). Combining Expert Advice on Social Discounting: Implications for Climate Policy. Drupp, M.A. and M.C. Hänsel (2017). The Relative Price of Environmental Goods and Climate Policy Evaluation. Meya, J.N., Drupp, M.A. and N. Hanley (2017). Income Inequality and the International Transfer of Environmental Values. <i>University of Kiel Economics Working Paper 2017-03</i> . Drupp, M.A., Meya, J.N., Baumgärtner, S. and M.F. Quaas (2017). Economic Distribution and the Value of Nature.	

Drupp, M.A. and S. Baumgärtner (2017). Estimating the Economic Insurance Value of Ecosystem Resilience.

Drupp, M.A., Khadjavi, M. and M.F. Quaas (2016). Truth-Telling and the Regulator. Evidence from a Field Experiment with Commercial Fishermen. *Kiel Working Paper 2063*.

Drupp, M.A., Khadjavi, M., Riekhof, M.-C. and R. Voss (2017). Professional Identity and the Gender Gap in Risk-Taking. Evidence from a Field Experiment with Scientists. *Kiel Working Paper 2077*.

Drupp, M.A., Khadjavi, M. and R. Voss (2017). Do Scientists Tell the Truth? Evidence from a Field Experiment.

OTHER  
PUBLICATIONS  
(PEER-  
REVIEWED\*)

Meisch, S., Hagemann, N., Geibel, J., Gebhard, E. and M.A. Drupp (2015). Indicator-Based Analysis of the Process Towards a University in Sustainable Development: A Case Study of the University of Tübingen (Germany). In Leal Filho, W. (Ed.): *Integrative Approaches to Sustainable Development at University Level*, Springer International Publishing, Switzerland, pp. 169–183.\*

Drupp, M.A., Esguerra, A., Keul, L., Loew Beer, D., Meisch, S. and F. Roosen-Runge (2012). Change from below – student initiatives for universities in sustainable development. In: Leal Filho, W. (Ed.): *Sustainable Development at Universities: New Horizons*, Peter Lang Scientific Publishers, Frankfurt, pp. 733–42.\*

Meisch, S., Drupp, M.A., Roosen-Runge, F., Keul, L., Esguerra, A. and J. Geibel for Greening the University e.V. (Eds.), *Wissenschaft für nachhaltige Entwicklung! Metropolis, Marburg 2012*.

Roosen-Runge, F., Drupp, M.A., Keul, L. and A. Esguerra (2012). Bottom-up Engagement für Nachhaltige Entwicklung: Erfahrungen, Chancen und Grenzen, in: *Greening the University e.V.* (Eds.): *Wissenschaft für nachhaltige Entwicklung! Metropolis, Marburg 2012*, pp. 91–118.

TEACHING  
EXPERIENCE

Economic policy for sustainability [with J. Geibel], University of Tübingen	2012–2016
Seminar in resource economics [with M.F. Quaas et al.], Kiel University	2014–2015
Defining and measuring sustainability [with S. Meisch / with E. Gebhard, J. Geibel], University of Tübingen	2012, 2015
Teaching Assistant for Intermediate Macroeconomics, University of Tübingen	2010–2011
Teaching Assistant for Introduction to Economics, University of Tübingen	2008–2009

SCHOLARSHIPS  
& AWARDS  
(SELECTION)

Fellow of the German National Academic Foundation	2008–2013
Grantee of the Fulbright program	2009–2010
Sustainability prize for best Bachelor theses, University of Tübingen	2012
Graduate-Scholarship, German Academic Exchange Service (DAAD)	2012–2013
UK-ESRC-scholarship for doctoral studies at LSE (offered)	2013
Studium Professionale Teaching Prize, University of Tübingen	2013
LSE's Geography & Environment departmental prize for best overall performance	2013
Best MSc dissertation prize; ClientEarth prize for MSc best dissertation; George & Hilda Ormsby prize for best departmental MSc dissertation	2013
Conference-Scholarship, European Economic Association (EEA)	2015
Best paper award, EAERE-FEEM-VIU Summer School with John List et al.	2016
Young Economists International Presentation Award, Verein für Socialpolitik	2015, 2016

RESEARCH  
FUNDING

LSE Seed Funding for 'The Social Discount Rate for Intergenerational Projects' (with B. Groom et al.), £5K	2013–2014
Innovation Fund of the Tübingen School for Sustainability for 'Indicators for Sustainable Development' (with S. Meisch et al.), 12K	2014–2016
LSE G&E Cluster Seed Funding for 'Valuing the Future' (with Groom et al.), £3K	2016
LSE-STICERD grant for 'Combining expert opinion and public preferences' (with Groom et al.), £5K	2016–2017

## PRESENTATIONS

**2017:** AEA meetings, Chicago; UCSD Spring School in Behavioral Economics, San Diego; Bren School, UC Santa Barbara; Workshop ‘The Economics of Climate Change and Sustainability’, Rimini; University of Hamburg; EAERE conference, Athens; EEA, Lisbon; University of Gothenburg; BIOECON Conference, Tilburg.

**2016:** The Choice Lab, NHH Bergen; BIOECON, Cambridge; ICES ASC, Riga; Sustainable Economy Conference (NaWiKo), Wuppertal; EAERE-FEEM-VIU Summer School, Venice; EAERE, Zürich; SURED, Banyuls-sur-Mer; University of Freiburg; European Public Choice Society Meeting, Freiburg; NaWiKo, Templin; Climate Ethics and Climate Economics ESRC seminar, Oxford.

**2015:** BIOECON, Cambridge; ZEW Lunch Seminar, Mannheim; EEA, Mannheim; World Conference on Natural Resource Modeling, Bordeaux; EAERE, Helsinki; PhD Workshop on International Climate Policy, Berlin; University of Freiburg; AURÖ young researcher workshop, Hamburg.

**2014:** BIOECON, Cambridge; International Conference on Degrowth, Leipzig; WCERE, Istanbul; IfW Centenary Conference ‘Fair and Sustainable Prosperity in the Global Economy’, IfW Kiel; SURED, Ascona; Netzwerk Bildung durch Verantwortung ‘Nachhaltigkeit im Service Learning’, CAU Kiel; AURÖ young researcher workshop, IfW Kiel.

**Pre-2014:** EnvEcon, Royal Society, London; EAERE, Prague; Symposium ‘Die Hochschule auf dem Weg zur Nachhaltigkeit’, FH Kiel; The Economics of Ecosystems and Biodiversity (TEEB), Leipzig; Volkswirtschaftlicher Workshop, University of Tübingen; Leuphana University Lüneburg; Hearing on Sustainability Science, Parliament of Baden-Württemberg;

WORKSHOP  
& SESSION  
ORGANIZATIONS

Workshop in Sustainability Economics: ‘Experiments on Intergenerational Justice under Uncertainty’, Camp Reinshlen, October 2015, Co-organizer.

Thematic Session on ‘Intergenerational decision-making under uncertainty and disagreement’ at the 21<sup>st</sup> EAERE conference, Helsinki, June 2015, Co-chair.

Workshop in Sustainability Economics: ‘Intergenerational Equity and Efficiency under Uncertainty’, Camp Reinshlen, August 2014, Local organizer.

Symposium ‘Greening the University – Perspectives for a University in Sustainable Development’, University of Tübingen, June 2008, Co-organizer.

SOCIAL SERVICE  
& PROFESSIONAL  
ACTIVITIES

Founding member and former co-chairman of *Greening the University e.V.*; 2007–present  
Project of the UN Decade ‘Education for Sustainable Development’ and best-practice example of the German university presidents’ conference; Recipient of the EE Visionary Award 2012 of the Energy Efficiency Global Forum and the German student council’s 2011 price for student commitment

Founding member of the *netzwerk n (former Netzwerk Nachhaltigkeitsinitiativen)* 2010–present

Member of the *Arbeitskreis Klima, Energie und Umwelt am Forum Scientiarum* 2008–2011

Member of the *Council for Sustainable Development, University of Tübingen* 2010–2011

Member of the *European Association of Environmental and Resource Economics* 2012–present

Member of the *American Economic Association*, the *European Economic Association* and the *Verein für Socialpolitik* 2015–present

Reviewer: *Climate Change Economics, Ecological Economics, Economic Inquiry, Energy Policy, Environmental and Resource Economics, Journal of Environmental Economics and Management, Resource and Energy Economics* 2012–present