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Florian Diekert

Linda Nøstbakken

Andries Richter

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Florian Diekert
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Modern Compliance Policies in Fisheries

Florian Diekert[1,2], Linda Nøstbakken[3], and Andries Richter[2,4]

[1]AWI, Heidelberg University
[2]CEES, University of Oslo
[3]Norwegian School of Economics
[4]Wageningen University

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Abstract

Successful fisheries management relies on compliance. Compliance in turn relies on the perceived legitimacy of the existing rules and regulations, the effectiveness of enforcement, and on the positive feedback loop between legitimacy and effectiveness. Against the backdrop of increasing incentives to violate rules and regulations in modern fisheries, there is a widespread view that traditional control policies are no longer effective in guaranteeing sustainable fisheries management. This paper presents evidence from a large-scale survey among Norwegian fishers, showing that expectations about and experiences of control activities affect compliance behavior. Moreover, survey respondents have a mixed attitude towards modern compliance policies based on remote sensing and open data, while appreciating competent fisheries inspectors. Thus, modern compliance policies are a promising complement, but no substitute, to physical inspections.

Keywords: Fisheries, Compliance, Preferences, Survey

JEL Classification Codes: Q22; Q28; K42

1 Introduction

Compliance with rules and regulations is a prerequisite for sustainable fisheries. The benefits of not complying with rules and regulations are particularly high if the fishery is very profitable. Under an open-access regime, rents are dissipated and there is little gain from violating the rules and regulations that might exist (Schaap and Richter, 2019). In many fisheries, effective management and rationalization of fishing fleets, however, have led to the creation of large rents (Hilborn et al., 2020). Not following the rules and regulations can now yield significant economic payoff. Hence, the better the overall resource management, the better compliance policies must be.

There is a widespread concern that traditional compliance policies based on physical inspections are no longer effective. For example, less than 1% of all landings in Norway are currently being controlled and the resources allocated to inspections at sea are decreasing (NOU, 2019). This creates leeway for non-compliance to go undetected, and in conjunction with increased incentives to cheat, a vicious cycle of non-compliance may emerge. Such erosion of compliance is particularly concerning because it could alter the prevalent social norm of compliance into non-compliance, thus triggering "contagious" behavior of rule violation among fishers (Richter and Grasman, 2013).

In a survey among Norwegian cod fishers, about 40% state that cheating is accepted and about 60% state that they know others who underreport their landings (Svorken and Hermansen, 2014). The Norwegian police authorities, in turn, describe fisheries as an area of concern in their annual threat assessment (Økokrim, 2018). Taken together, these facts are serious warning signs about the deterioration of effective resource management. As a reaction, fisheries managers turn to modern compliance policies based on remote sensing, digitalization, and automatic collection and processing of data (Plet-Hansen et al., 2017; Probst, 2019).

The economic literature on non-compliance is deeply rooted in the work of Gary Becker, who established the idea of a 'rational criminal' (Becker, 1968).[1] The idea is that a criminal act is not different than any other economic action, where the expected benefits are weighed against the expected costs. In the words of Becker (1968, p.176): "Some persons become 'criminals,' therefore, not because their basic motivation differs from that of other persons, but because their benefits and costs differ."

The expected cost of non-compliance are the product of the punishment and the probability of being detected. The form of punishment plays an important role in determining the degree of non-compliance, both along the extensive margin (whether or not a given actor complies with a given regulation, for example, a discard ban) and along the intensive margin (the degree of non-compliance, for example, how much is discarded). As detection is typically probabilistic, non-compliance is risky. Hence, the standard economic model of non-compliance behavior predicts a strong role of risk aversion (Becker, 1968; Dhami and al Nowaihi, 2007). The decision of whether to follow a rule is essentially a trade-off between the gain and the expected penalty from non-compliance. Clearly, the more risk averse a person is, the heavier weighs the expected penalty, and the less likely she or he is to cheat.

Given that the detection risk is negligible, and that pecuniary penalties are low compared to the potential financial gains, one would expect widespread rule violations. Yet, evidence from previous research and inspections suggests that rule violations are not very common. It is puzzling that non-compliance is not much more widespread in reality. The economic calculus of trading off costs and benefits cannot explain observed non-compliance rates, even under very risk averse preferences. Instead, it has been suggested

[1] Nøstbakken (2008) provides an overview of the theoretical economic literature on non-compliance in fisheries.

that fishers are largely intrinsically motivated to follow rules, regardless of sanctions. If users are complying, regulators may be tempted to reduce enforcement to save costs or rely on cheaper enforcement mechanisms, relying in modern technology, such as drones, cameras, and automated data.

In this paper, we present three sets of results from a large survey among Norwegian fishers (N=668) about modern and traditional compliance policies. Specifically, we relate compliance behavior to expected and experienced control activities on land and at sea. First, we show that there are significant differences in control exposure and compliance behavior across fishery types. We find that participants in the small-scale, open fishery for cod have the lowest chance of being controlled, and at the same time, the highest likelihood for violating rules and regulations. Second, we document medium levels of the acceptance for policies that are based on new technologies, such as remote electronic monitoring, usage of drones, or open data. Third, we reject the hypothesis that traditional compliance policies are ineffective. In particular, we find that higher expectations of being controlled is related to lower non-compliance of gear regulations, and more control experiences in the last year are related to lower non-compliance of misreporting size or species during landing. These results, in combination with the argument that rules and regulations need to be salient and expressively enforced to be effective, lead us to the conclusion that modern compliance policies can be a complement, but no substitute, to traditional compliance policies.

The paper is structured as follows: In the next section, we present the material and methods and in particular the setup of the survey that we have conducted among Norwegian fishers in the fall of 2019. That section also gives an overview of the data that we have collected. In section 3, we present difference in expected and experienced control activities at land and at sea across the different groups in Norwegian fisheries, while the attitudes towards modern compliance policies are presented in section 4. In section 5, we present results from an econometric model, trying to explain which personal and regulatory factors explain compliance behavior. Finally, we discuss our results in light of the existing literature and potential policy implications in section 6. Section 7 concludes.

2 Data and Methods

We conducted the survey among Norwegian fishers between September 12 and October 1, 2019. We invited respondents to participate via invitations sent from the Norwegian sales organizations on behalf of the authors. The survey was online, using a survey platform provided by the University of Oslo (*Nettskjema*).

In total, we have 668 respondents. This is the number of respondents who completed the main part of the survey. A subset of 462 respondents (69%) also completed the last part of the survey, where we measured participants' risk aversion using an incentivized

lottery-choice task (Gneezy and Potters, 1997).

There was no compensation for filling out the main part of the survey. Before answering the last question on risk aversion, participants had the option to end or continue the survey. In this last part, they had the chance to earn money according to their investment in the Gneezy-Potters risk aversion elicitation task. 462 respondents chose to complete this part of the survey.[2]

Note that we did not elicit participants' gender as our research question does not have a specific gender dimension, nor did we expect to have sufficiently many female respondents to make valid inferences based on gender.

2.1 Participant characteristics

Table 1 shows the average participant characteristics across the five different fishery types. Fishery type refers to the combination of target species, regulatory group, and vessel size. Norwegian fisheries can broadly be divided into those vessels that target pelagic species (such as herring, mackerel, and blue whiting) and those that target demersal species (such as cod, saithe, and haddock, but also crab). Along the dimension of the regulatory group, one can distinguish between those that have individual quotas for their target species, and those that share a common group quota and do not have individual quotas (the "open group"). Finally, there is a large variation in vessel length (and hence catch capacity) ranging from boats that are smaller than 11 meters to large offshore trawlers and purse seiners.

Table 1: Participant characteristics by fishery type

Variable	Pelagic	Cod trawl	Cod conv.	Cod open	Other
Age	45.08	53.65	47.43	53.58	46.72
Tenure	23.88	35.00	24.50	18.78	17.07
Economic situation	1.80	1.82	1.63	0.69	1.19
Risk tolerance	4.13	4.75	4.39	4.31	4.11
Crew member	0.28	0.24	0.09	0.02	0.02
Parents fisher	0.75	0.65	0.63	0.51	0.48
N	123	17	221	226	81

The average age of the full sample of participants is 49 years, and on average, they have been working for about 21 years in their respective fisheries. There is quite some variation in tenure, though, from a maximum of 69 years to several participants who have recently entered the fishery. Tenure is especially high for the demersal trawlers, and lowest for the open demersal group, and the unclassified "other" group.

The variable "economic situation" measures the participants' assessment of their in-

[2]The subset of participants that continued with the survey is not observably different from those who chose to end the survey prior to this question.

come from fishing. The answer options were that "the income [from fishing] was too low to be sustainable in the long run" (coded with a value of 0, chosen by 140 of the 668 participants), that the "income is reasonable" (value of 1, chosen by 243 participants), that the "income is good" (value of 2, chosen by 231 participants) and that the "income is very good" (value of 3, chosen by 53 participants). While we see no difference between the conventional demersal (cod) fishery, the pelagic fishery, or the demersal trawl fishery, the economic situation in the open cod fishery is significantly worse.

Next, the variable "risk tolerance" measures how many out of six possible points the respondents invested in a risky account in the incentivized lottery. A risk neutral person would invest all 6 points in the risky account, but our participants invested on average just over 4 points in the risky account. There are no significant differences across fishery types in this variable.

The variable "Crew member" is a dummy variable that takes a value of 1 when a participant is a crew member, but not a boat owner or a skipper. Several respondents, particularly in the demersal conventional and open groups, selected several roles. We see that about one fourth of the participants in the demersal trawl and the pelagic group work exclusively as crew, while this value is close to zero in the other fisheries.

Finally, the variable "Parents fisher" indicates whether the parents of the participant have been fishers themselves. As is well known, being a fisher is an occupation that is traditionally passed on from one generation to the next. What may be surprising, is that the share of fishers whose parents have been fishers is highest in the pelagic fisheries. Here, three quarters state that also their parents have been fishers. For the open cod group and the remaining "other" group, this is true for only half of the respondents.

2.2 Non-compliance behavior and control

The survey also contains questions to assess participants' non-compliance behavior, and their experiences with and expectations of control activities. One concern with self-reported surveys is that individuals do not honestly state their compliance behavior because they fear negative repercussions or because of image concerns (their image in the eye of the interviewer, or their self-image). To address this challenge, we use the indirect question method to assess compliance behavior.

The indirect question method asks respondents about the behavior (or attitudes) of a typical respondent that is like them, and relies on the fact that most respondents proxy the behavior of others by extrapolating from their own behavior. This type of method is a simple and straightforward way to circumvent potential social desirability bias (Fisher, 1993). It is widely used in surveys that aim to uncover motivational drivers of behavior and attitudes where strong social norms exist (for example, on issues such as racism, prostitution, or environmental concerns).

To assess the magnitude of compliance with a given set of rules and regulations one would need to know both the range of possible behaviors (what would "perfect compli-

ance" look like, and what would "total non-compliance" look like?), and how likely each mode of behavior is along such spectrum. To overcome these difficulties, we ask about the likelihood of breaking a given rule or regulation rather than asking about the extent of compliance. Given that not breaking a rule is the natural reference point, gauging the likelihood of non-compliance is the much easier and more natural task than gauging the extent of compliance. Thus, we focus on *non-compliance*.

Specifically, we ask "Think about a typical fisher in your vessel group. How likely do you think it is that he or she breaks the following rule: (a) misreporting of size or species, and (b) using illegal gear or fishing outside of mandated seasons or areas."[3]

To answer the two questions (a) and (b), respondents could select one of the following options "100% (certain)", "90% (almost certain)", "70% (likely)", "50% (as likely as not)", "30% (possible)", "10% (nearly impossible)", "0% (impossible)".[4]

Next, to assess the control expectations and experiences of the participants, we first ask whether they (a) have never been controlled this year, (b) have been controlled once this year, or (c) have been controlled several times this year. Second, we ask the participants for the probability that "a typical fisher in their group" is controlled, giving the same options as for the compliance question.

In addition, we asked the participants about their experiences with and expectations about controls at sea and on land, respectively. This makes the control situation that the participants have to think about concrete. Additionally, it allows us to more precisely assess differences in the different violations. Mis-reporting of size or species composition is an act of non-compliance that occurs (and is detected) only when landing the fish, while violation of gear or area restrictions relate to non-compliance behavior at sea.

2.3 Exploring attitudes towards compliance policies

Finally, we explore the attitude towards a range of different policy proposals. We broadly classify the policies as traditional and modern compliance instruments. Traditional policies rely largely on physical inspections involving inspectors controlling vessels on sea or landings on shore. In that category, we list (i) increased surveillance by coast guard at sea, (ii) increased controls of landings, and (iii) observers on board of fishing vessels. While the first two policies refer to augmentation of existing control methods, on board observers are currently not used in Norwegian fisheries. Modern compliance instruments refer to novel methods that make use of emerging technologies. We list in this category (i)

[3] We transformed the answer options to scale with the probabilities they represent to make the coefficients of the statistical model directly interpretable. That is, answer option "0% (impossible)" receives the value 0, answer option "10% (nearly impossible)" receives the value 10, answer option "30% (possible)" receives the value 30, implying linear interpolation of the probabilities that were not offered as options.

[4] Note that while we take the answer to these questions as a proxy for the individuals' own non-compliance behavior, it does not actually matter if one instead more cautiously interprets the respondents' answers to these questions as their assessment of the non-compliance behavior of others who are like them. At the end of the day, we are interested in making a statement about whether the average prevalence of non-compliance is affected by traditional compliance policies.

camera surveillance on vessels (CCTV), (ii) remote monitoring (drones, planes, satellites), and (iii) real time monitoring of catches with automated data recording.

3 Control expectations and experiences differ across groups

In this section, we show that there are significant differences across fleet segments in expectations of being controlled and experiences with having been controlled. Figure 1 shows the overall distribution of answers to these two questions for controls at sea (top) and at land (bottom).

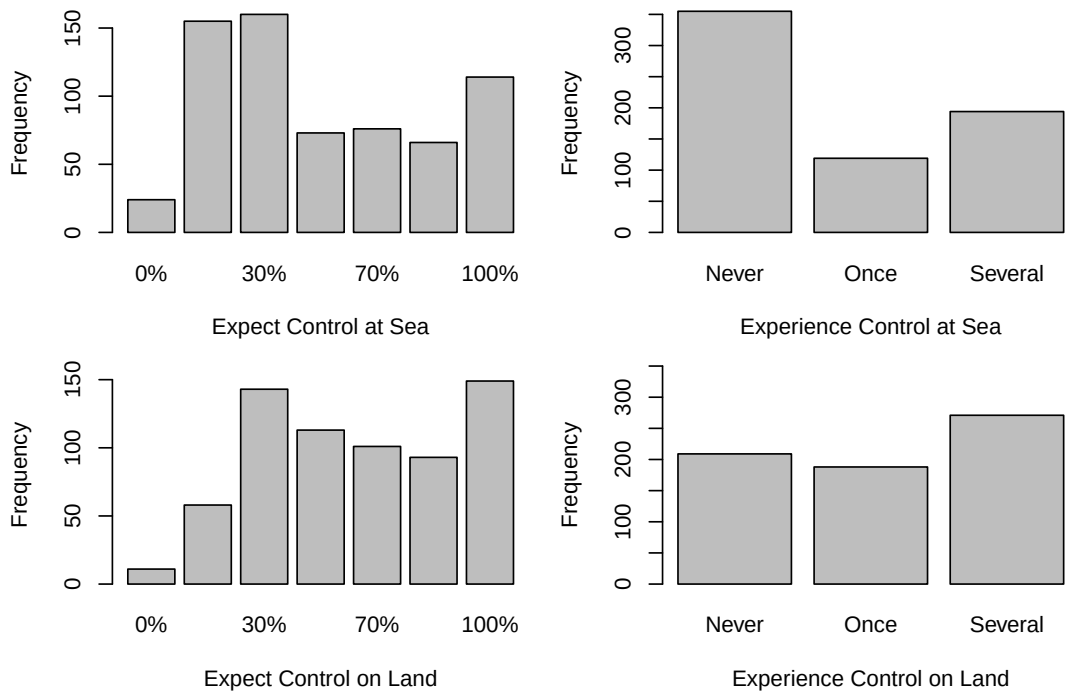

Figure 1: Histogram of Expectations of being controlled at sea and on land (top left and bottom left panel, respectively), and histogram of control experiences at sea and on land (top right and bottom right panel, respectively)

Three observations are noteworthy when comparing controls at sea with controls on land. First, controls on land are more common than controls at sea. The median value of the perceived likelihood of being controlled is 70% for controls on land, and 30% for controls at sea.

Second, a large share of respondents (36%) are certain or near certain that they are being controlled on land, while there are considerably lower expectations for controls at sea. In fact, the majority states that they have not been controlled at sea in 2019, while 17% state that they have been controlled once, and 29% that they have been controlled several times. In contrast, only 31% state that they have not been controlled on land in 2019 (28% state that they have been controlled once, and 41% that they have been

controlled several times).

Finally, and not surprisingly, there is a significant correlation between control expectations and experiences in both cases. For controls on land the Kendall's τ rank correlation coefficient is 0.50 ($p < 0.001$). For controls at sea, the correlation is even stronger: Here, Kendall's τ rank correlation coefficient is 0.63 ($p < 0.001$).

Table 2 shows how control expectations and experiences differ by fleet segment (fishery type). We see that there are significant differences among the various fleet types. Compared to the conventional cod fishers, those who participate in the open cod group think that it is 16% less likely that they are being controlled at sea and 15% less likely that they are being controlled on land. The respective values for control experiences match this pattern.[5]

Participants from the demersal trawler group and pelagic fisheries, in contrast, think that it is more likely that they are controlled at sea. They also state that it is more likely that they are controlled on land, but this difference is less pronounced, and actually not significant for cod trawlers. Again, the picture from control experiences matches that of control expectations.

Table 2: Control expectations and experiences by fleet segment (fishery type). Conventional cod is the baseline category

	Dependent variable:			
	Ctrl Expect Sea	Ctrl Expect Land	Ctrl Exper Sea	Ctrl Exper Land
	(1)	(2)	(3)	(4)
Cod open	-16.182^{***}	-14.977^{***}	-0.504^{***}	-0.640^{***}
	(2.810)	(2.794)	(0.071)	(0.071)
Cod trawl	34.344^{***}	8.552	0.575^{***}	-0.448^{**}
	(7.477)	(7.433)	(0.188)	(0.188)
Pelagic	32.417^{***}	13.722^{***}	0.783^{***}	0.353^{***}
	(3.342)	(3.322)	(0.084)	(0.084)
Other	0.851	-12.261^{***}	-0.062	-0.614^{***}
	(3.858)	(3.836)	(0.097)	(0.097)
Constant	47.421^{***}	64.977^{***}	0.778^{***}	1.330^{***}
	(1.998)	(1.987)	(0.050)	(0.050)
Observations	668	668	668	668
Adjusted R^2	0.257	0.113	0.267	0.215
Note:	*p<0.1; **p<0.05; ***p<0.01			

[5]Note that the dependent variable is categorical ("never", "once", or "several times") and interpretation is hence not straightforward in this case.

4 Attitudes towards modern compliance policies

In this section, we explore respondents attitude towards a range of different policy proposals, where the top three items can be classified as traditional instruments and the bottom three items as modern control instruments. Figure 2 shows to what extent respondents rank these proposals on a spectrum between "fully OK" (dark green) and "unacceptable" (red).

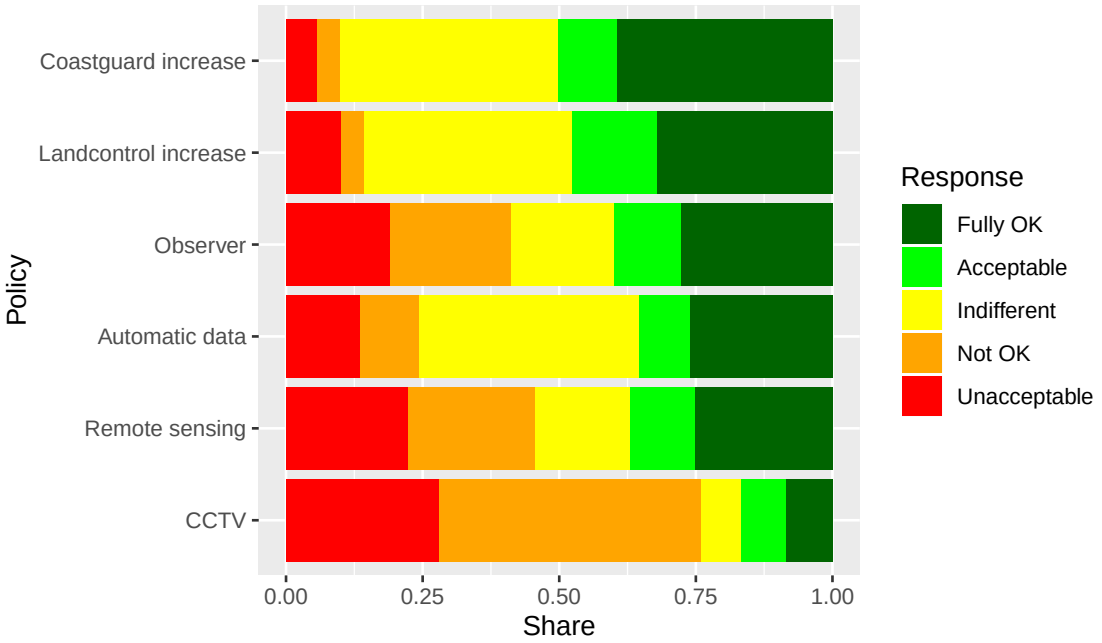

Figure 2: Acceptance of various compliance policies

First, we see that respondents find traditional compliance policies – increasing physical inspections either on land or at sea – the most acceptable. Only 9.8% (sea) and 14.4% (land) are negative to these policies (by responding either "not OK" or "unacceptable"). Having on-board observers is much less accepted, with 41.3% giving negative responses.

Then come a range of modern compliance policies, where automatic transmission of data meets the least resistance. Only 24.4% of the respondents are negative to this policy. At the same time, there is also a large fraction being indifferent (40.3%), implying that there is not wide support either – only 35.3% of the respondents are positive to automatic data transmission (by responding either "fully OK" or "acceptable"). When it comes to remote monitoring (using drones, planes and satellites), 45.7% of the respondents are negative to such policy, while 37% of respondents are positive. Finally, camera monitoring (CCTV) meets by far the most resistance, with 75.9% of participants being negative towards this.

When exploring whether attitudes to modern compliance policies correlate with observable characteristics of the participants, such as their age, fishery type, risk preferences etc., we do not find any systematic relationship.

Two main reasons for the low acceptance rate of modern compliance policies come to mind. First, modern compliance policies are new and do not exist in the Norwegian compliance context yet.[6] The lower acceptance rates could hence be due to a general tendency to resist new and unknown policy proposals. Second, modern compliance policies are more remote and less salient. In particular, they lack the direct human contact. Especially in light of the high regard that fishers hold for the coast-guard and the appreciation for competent fisheries inspectors, this factor could also contribute to explain their low acceptance.

5 The effect of traditional compliance policies

In this section, we move beyond descriptive statistics and try to explain compliance behavior with the attributes of the regulatory environment and personal characteristics in an econometric regression model. First, we establish the empirical model and the underlying assumptions, before presenting the results.

5.1 Empirical model

We assess whether traditional compliance policies have an effect on compliance behavior by estimating the regression equation (1) and testing whether the coefficients in the vector γ are significantly different from zero. In this equation, the outcome variable y_i is the "compliance behavior" of individual fisher i, the vector C_i is the compliance policy that the fisher is exposed to and X_i is a vector of control variables.

$$y_i = \alpha + C_i\gamma + X_i\beta + \varepsilon_i \tag{1}$$

To measure how traditional compliance policies C_i are related to non-compliance behavior y_i, we need variation in the exposure to compliance policies. However, rules and regulations are the same for everyone. To overcome this challenge, we exploit the fact that exposure varies on an individual level: We have variation in both the individual experience of being controlled (since not everyone is controlled), and the expectation about being controlled (objective differences in monitoring probabilities across fishery type and subjective differences in assessments).

The vector of control variables X_i that we include in our analysis contains first and foremost a factor for the participant's fishery type to account for the heterogeneity in Norwegian fisheries. In addition to fishery type, it is important to control for individual characteristics that are likely to play a role in determining compliance behavior. We con-

[6] Also on-boat observers do not exist in the Norwegian compliance context; this, incidentally, is also the least accepted policy among the class of traditional policies.

trol for the participant's age because age may be correlated with attitudes to authority and the importance of following rules.[7] In addition, we control for the participant's experience in a given fishery type (her or his tenure) as specific norms about non-compliance may be culturally transmitted and learned over time in the different groups. Finally, we explore the role of risk aversion. Table 1 shows regression results for the specification with the full set of explanatory variables. We report the results from exploring potential interaction effects in the Appendix.

Our approach is then to test the null hypothesis that traditional compliance policies have no effect on compliance behavior by estimating the specific models (2) and (3).

$$\textit{violate-gear}_i = \alpha + \gamma \cdot \textit{Ctrl-sea}_i + \beta_1 age_i + \beta_2 tenure_i + \beta_3 open_i + \beta_4 risk_i + \varepsilon_i \qquad (2)$$

$$\textit{violate-size}_i = \alpha + \gamma \cdot \textit{Ctrl-land}_i + \beta_1 age_i + \beta_2 tenure_i + \beta_3 open_i + \beta_4 risk_i + \varepsilon_i \qquad (3)$$

We regress the stated probability of (i) violating gear / zone regulation (*violate-gear*; model (2)) and (ii) misreporting size or species (*violate-size*; model (3)) on the variables *Ctrl-sea* and *Ctrl-land*, which are either the experience of control efforts at sea or on land, respectively, or the expectation about control efforts at sea or on land, or the combination of experience and expectation.

5.2 Regression results

We report results on non-compliance behavior of gear and area restrictions in Table 3, and in Table 4 we report on stated misreporting of size and species when landing. Column (1) in Table 3 and 4 shows the effect of control expectations, column (2) shows the effect of control experiences, and column (3) combines the two. Column (4) shows the results of the model that includes the risk tolerance variable (with a smaller sample).

In the following, we shall first comment on the main results for these two regressions, and then discuss the role of the control variables. In particular, we controll for whether a participant was in the small-scale open fishery for cod, her or his age, her or his tenure in the respective group, and the participant's risk tolerance (measured by how many tokens were invested in the risky account in the lottery choice). We provide results on the additional co-variates that were excluded in the model selection process, on the (insignificant) interaction between experiences and expectations, and the full set of fleet segment variables in the Appendix Tables A-1 and A-2.

For non-compliance with gear and spatial regulations (Table 3), we see that higher expectations about being controlled are related to a lower probability of non-compliance (column 1). The size of the effect is small: A 10% increase in the expected probability of being controlled at sea leads to a reduction in the likelihood of non-compliance by less

[7] Already Socrates complained about the youth that would no longer respect the rules...

Table 3: Non-compliance with gear regulations – OLS results

	Dependent variable:			
	violate-gear			
	(1)	(2)	(3)	(4)
Ctrl Expectation	-0.087^{***}		-0.088^{***}	-0.090^{***}
	(0.023)		(0.032)	(0.030)
Ctrl Experience		-2.361^{**}	0.053	
		(0.927)	(1.264)	
Open group	5.000^{***}	5.453^{***}	5.011^{***}	4.555^{**}
	(1.731)	(1.755)	(1.753)	(2.168)
Age	-0.221^{***}	-0.206^{***}	-0.221^{***}	-0.172^{*}
	(0.071)	(0.072)	(0.071)	(0.090)
Tenure	0.081	0.072	0.080	-0.011
	(0.061)	(0.061)	(0.061)	(0.077)
Risk Tolerance				0.441
				(0.500)
Constant	23.144^{***}	19.979^{***}	23.135^{***}	21.785^{***}
	(3.255)	(3.078)	(3.264)	(4.607)
Observations	668	668	668	462
Adjusted R^2	0.044	0.032	0.042	0.041
Note:				*p<0.1; **p<0.05; ***p<0.01

than a percent. However, the effect is highly significant ($p < 0.001$), which highlights the behavioral importance of the formal enforcement mechanism.

Turning to control experiences (column 2), we see that also more experiences with controls at sea are significantly related to lower compliance. Increasing this variable by one unit (i.e. from not being controlled in 2019 to once, or from once to several times) decreases the probability of violating gear or spatial regulations by 2.3%.

When we include both experiences and expectations as explanatory variables, we see that the effect of experiences loses significance both economically and statistically, and is no longer related to a decrease in non-compliance behavior. In contrast, the effect of expectations is virtually unchanged. In the Table A-1 in the Appendix, we show that there is also no interaction effect between these two variables. Hence, for non-compliance behavior at sea, it is mainly the expectation about being controlled that has an impact.

Interestingly, we find the opposite for violations of size or species regulations. Misreporting is usually detected when landing the fish and here we find that expectations about control activities have no effect on non-compliance behavior (column 1 in Table 4). In contrast, experiences of control have a significant negative effect on non-compliance behavior. The effect is significant at the 5% level and of similar magnitude as for the non-compliance behavior with respect to gear and spatial regulations (also here, the effect is almost entirely driven by the difference between having being controlled once or several

times). We see that the effect remains the same in magnitude, but loses significance when also including control expectations (column 3).

Before we discuss the effect of the other co-variates such as age and the participant's fishery group, we emphasize our finding on risk tolerance (column 4 in Table 3 and 4). Surprisingly, we see that they are not related to non-compliance behavior. Note that we have substantially lower power (about a third of our sample did not participate in the risk elicitation task), which explains why the effect of experience on violations of size- and species-reporting requirements loses significance. The estimate for the effect of experiences on gear and spatial regulations is not affected.

The fact that risk preferences are not related to compliance behavior even though expectations and experiences with control clearly have an effect may appear surprising at first sight. This result goes counter to the "rational criminal" story that would predict that participants that are more willing to invest in the risky account are also more likely to violate. However, the fact that there is no relation between risk preferences and non-compliance behavior is well in line with a situation where the primary role of the control policies is to signal which norm one ought to follow.

Table 4: Non-compliance with size and species regulations – OLS results

	Dependent variable:			
	violation-size			
	(1)	(2)	(3)	(4)
Ctrl Expectation	−0.028		0.0003	
	(0.025)		(0.030)	
Ctrl Experience		−2.038**	−2.045*	−1.321
		(0.956)	(1.129)	(1.164)
Open group	6.094***	5.415***	5.415***	7.070***
	(1.744)	(1.780)	(1.781)	(2.138)
Age	−0.243***	−0.247***	−0.247***	−0.253***
	(0.073)	(0.072)	(0.073)	(0.088)
Tenure	0.165***	0.178***	0.178***	0.134*
	(0.063)	(0.063)	(0.063)	(0.077)
Risk tolerance				−0.118
				(0.495)
Constant	23.309***	23.941***	23.924***	25.067***
	(3.508)	(3.151)	(3.519)	(4.291)
Observations	668	668	668	462
Adjusted R^2	0.022	0.026	0.025	0.027
Note:				*p<0.1; **p<0.05; ***p<0.01

An analysis of the co-variates age, tenure, and fishery type reveals interesting patterns. First, we see that the indicator variable of whether a participant belongs to the small-scale open fishery for cod is large and highly significant. An average participant in the

open fishery for cod is about 5% more likely to violate both gear/spatial or size/species regulations than participants from other fishery groups.[8]

Tables 3 and 4 furthermore show that participants' age has a significant negative relationship with non-compliance. The younger a participant is, the more likely it is that she or he does not comply with rules and regulations. This observation is particularly worrisome in light of the finding that non-compliance increases with tenure, at least for misreporting of species or size categories. Taken together, these results indicate that non-compliance behavior is group specific and learned over time. Policies must thus pay attention, especially in the small-scale fisheries for cod, to avoid that a culture of non-compliance forms and that it becomes acceptable behavior to violate rules and regulations.

6 Discussion

The standard economic model of criminal behavior developed by Becker (1968) establishes that non-compliance with rules is the rational choice if the expected benefit of doing so outweighs the costs. This theoretical finding has been repeatedly challenged for its lack of explaining empirical evidence (Jolls et al., 1998; Levitt, 2017). For example, Nøstbakken et al. (2015) asked respondents in a survey among Norwegian fishers why they do not comply (more) with a given regulation. For discarding, only 6% gave "fear of formal punishment" as the main reason, while the vast majority selected "one should follow the law" (35%) or "stock development and future income" (48%).[9] While the findings by Nøstbakken et al. (2015) suggest that wider intrinsic or social motivational factors explain why individuals comply with rules, this does not necessarily imply that formal enforcement is unimportant.

That relatively few fishers report "fear of formal punishment" as the most important reason for complying, might reflect weak monitoring and a high chance to sail safely under the radar of surveillance. In the survey presented here, we show that higher expectations about being controlled is related to a lower probability of violating rules. These insights nuance the importance of social and personal factors of complying with regulation, suggesting that strong enforcement remains important. However, trading off expected benefits with expected costs is not necessarily the key determinant of non-compliance. The difference between not being controlled in 2019 and being controlled once lowers the probability of violating gear or spatial regulations by only 2.3%. Such low elasticity of non-compliance behavior to changes in the monitoring probability is well in line with

[8] Tables A-1 and A-2 in the appendix show that there is no significant difference in non-compliance behavior across the other fishery groups.

[9] With respect to breaking gear/season/spatial restrictions, the answers are almost identical, only that the stock development is relatively less important, which is of course not surprising. 10% gave "fear of formal punishment" as the main reason, 51% selected "one should follow the law," and 27% selected "stock development and future income."

earlier findings (Telle, 2013).

Given that fishers are intrinsically or socially motivated to comply with regulations regardless of formal sanctions, one may conjecture that lower enforcement would be optimal. In such case, regulators may be tempted to save costs by either reducing enforcement or relying on modern technologies (e.g. satellite monitoring) which can be cheaper than human observers on sea or shore. We would like to make a cautionary note here, as there is increasing evidence that compliance is not only the result of economic and moral calculus, but also depends on the salience of enforcement (Dur and Vollaard, 2019). In a field experiment with household waste, Dur and Vollaard (2019) found that dumping waste illegally goes down if a fine is combined with a bright orange warning label to highlight salience. In fisheries, control vessels and human inspectors are more salient than modern technologies, such as satellite images or drones, which could be an eye in the sky that is largely invisible.

The strong conviction that "one should follow the law," that was also documented in the survey of Nøstbakken et al. (2015) as the main reason to comply with regulations, must be upheld by a confirmation from the regulator via effective formal enforcement. Salience is important because it sets a clear injunctive norm about what is appropriate behavior, and its visibility tends to create strong peer effects, which are important for two reasons. First, (Rincke and Traxler, 2011) documented that compliance with TV licence fees increases significantly if controls have taken place in the neighborhood. In fisheries, similar spillover effects can be expected as fishers tend to be well informed about control activities at sea and shore. Second, violating regulations may damage one's reputation among fellow fishers, as they perceive it as creating an unfair advantage Gezelius (2006, 2002).

Without a reinforcing role of the formal management institution, the motivation of fishers that normally comply may be irreversibly damaged. In the words of Kuperan and Sutinen (1998, p. 330): "As moral obligation and social influence are weakened, compliance begins to erode among those who normally would have complied with the regulations. Their subsequent noncompliant behavior influences others not to comply with the regulations, and ultimately compliance breaks down." This mechanism also works in the other direction: Nøstbakken (2013) develops a theoretical model that allows for formal enforcement from regulator and informal enforcement of social norms from peers. She shows that tougher policies have an indirect effect in addition to the intended direct effect. A policy change, such as an increased probability of detection, which makes actors more compliant, can gradually strengthen the social norm of compliance, which in turn induces more compliant behavior.

In addition, there is a growing literature that explores the social aspects of rule compliance (see, for example: Kuperan and Sutinen, 1998; Eggert and Ellegård, 2003; Hatcher and Gordon, 2005; Viteri and Chàvez, 2007; Eggert and Lokina, 2010; Gezelius, 2006, 2002; Acheson and Gardner, 2010; Dresdner et al., 2015; Boonstra et al., 2016). When moral considerations depend on the surrounding social environment, the relevant reference

group is an important yardstick to what extent rules and regulations can be stretched. Clearly, whether or not it is justified to violate a given rule or regulation depends both on what the relevant peers do (descriptive social norm) and on what they think one ought to do (injunctive social norm). The more specific the rule in question, the smaller is the relevant peer group. For example, in the survey of Nøstbakken et al. (2015), 91% of the Norwegian fishers say that it can "never" be justified to employ black labor. The attitude towards this rule that applies to all sectors of the economy is broadly representative of the attitude in the society at large – Norwegian fishers are not *per se* more willing to violate rules and regulations than other Norwegians. In contrast, only 53% say that discarding – a fishery-specific rule – can "never" be justified.

Kocher et al. (2018) allow further insights into the micro-economics of peer pressure using an experiment. Their study confirms prior evidence that many individuals do not lie when they are asked to report the outcome of a dice roll, even though it is in their financial interest to do so. When the same individuals are placed in groups, however, a "dishonesty shift" occurs almost instantly. All groups in the relevant treatment misreported the outcome of the dice roll. This is well in line with prior research that shows that groups act more selfishly than individuals (see e.g. the survey of Charness and Sutter, 2012). Kocher et al. (2018) go on to show that this dishonesty shift occurs because the individuals exchange arguments about why it is legitimate to lie in the given situation.

In general, compliance with norms and regulations is often highly context dependent. For example, Nøstbakken et al. (2015) document that 91% of the respondents in a survey among Norwegian fishers say that it can "never" be justified to violate gear, time, spatial catch restrictions, while for discarding, only 53% say that this can "never" be justified.[10] In that light, it is noteworthy that expectations about controls at land have no effect on the probability to misreport, perhaps because it is easy to conceal once it is known that the inspectors will be there. Disentangling and dissecting the roles of moral considerations, legitimacy, and peer effects is obviously difficult, if not impossible.[11]

The policy lesson to take away from this study is that (a) social norms of non-compliance may spread rapidly in small groups, such as crews on a fishing vessel, and that (b) there is a role in public policies to provide salient rules that do not offer wiggle room, and to support compliant behavior and discredit non-compliance.

Of course, the evidence from behavioral studies almost exclusively comes from individual decision makers, while in real life fishery policy deals with firms. Firms are economic actors in the market and are not expected to be subject to the same behavioral forces that individuals are. The study of Eggert and Ellegård (2003), for example, underlines this point. The authors find a clear difference in the importance of social/moral considerations versus economic consideration depending on the scale of operation in the

[10] 43% of the respondents say that discarding can "sometimes" and 4% say that it can "usually" be justified.

[11] For a strong argument that the discipline of economics stands to gain by looking beyond choices as the result of preference orderings over outcomes see Binmore (2010), and for a broad and accessible treatment of the concept of social norms see Bicchieri (2017).

survey of Swedish fishers: The operators of large, highly capitalized vessels are much less confident that co-management approaches will help to regulate fisheries and put their trust on formal punishment and official monitoring to deter violations. This is also in line with findings from Hatcher and Gordon (2005) who survey UK fishers about quota violations and find that non-economic considerations are relatively unimportant in this industrialized fishery.

7 Conclusion

In this paper, we carried out a large survey among Norwegian fishers (N=668) asking about their past experience and expectation of being monitored, and how likely they consider "a typical fisher" to (i) violate gear/seasons/zone or (ii) misreport size / species. In contrast to the widespread sentiment that traditional compliance policies based on physical controls are not effective, we find that expectations about and experiences of control activities do affect compliance behavior. In particular, we find that the expectation of being controlled and experience of having been controlled decrease the likelihood of non-compliance. We conjecture that some of this may be attributed to the salience of formal enforcement with human inspectors.

Moreover, we asked respondents about their attitude towards various compliance measures. We find that fishers have a mixed attitude towards modern compliance policies based on remote monitoring and automated data transmission, at the same time as they show appreciation for competent fisheries inspectors. Fishers may disapprove of modern compliance policies because they are not established yet and it is possible that this resistance will disappear once fishers are used to them. Still, modern compliance tends to lack salience, and and at least for now, also legitimacy. Thus, our findings suggest that modern compliance policies are a promising complement, but no substitute, to physical inspections.

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Appendix

We show additional regression results for compliance behavior with respect to gear regulations (Table A-1) and (mis-)reporting of size/species (Table A-2). Column (1) of both tables shows results for all fishery types instead of the dummy for the open group used in the tables of the main text. Column (2) of both tables shows that the interaction of control experiences and expectation is not significant. Column (3) of both tables shows that adding the economic situation, whether respondent's parents have already been fishers, and whether respondents are crew as co-variates does not change the results. Finally, in column (4) of Table A-2 we use control experience as a categorial variable, showing that there is a difference whether respondents have been controlled once or several times.

Table A-1: Non-compliance with gear regulations – Additional OLS results

	Dependent variable:		
	NoC.gear		
	(1)	(2)	(3)
Ctrl.Expect	-0.077^{***}	-0.093^{**}	-0.073^{***}
	(0.025)	(0.041)	(0.025)
Ctrl.Experience		−0.545	
		(2.354)	
Ctrl.Expect×Exper.		0.015	
		(0.033)	
TypeCod open	5.533^{***}	5.603^{***}	4.419^{**}
	(1.918)	(1.935)	(2.079)
TypeCod trawl	−1.385	−1.454	−1.486
	(4.784)	(4.792)	(4.799)
TypeOther	3.404	3.429	2.962
	(2.455)	(2.459)	(2.499)
TypePelagic	−1.729	−1.888	−1.958
	(2.238)	(2.271)	(2.273)
Age	-0.234^{***}	-0.233^{***}	-0.233^{***}
	(0.071)	(0.072)	(0.072)
Tenure	0.099	0.098	0.101
	(0.062)	(0.062)	(0.064)
Econ			−1.442
			(0.979)
Parents.Not.Fisher			−0.514
			(1.578)
CrewD			1.630
			(2.678)
Constant	22.608^{***}	22.982^{***}	24.781^{***}
	(3.304)	(3.448)	(3.779)
Observations	668	668	668
Adjusted R^2	0.044	0.042	0.043
Note:			*p<0.1; **p<0.05; ***p<0.01

Table A-2: Non-compliance with size and species regulations – Additional OLS results

	Dependent variable:			
	NoC.size			
	(1)	(2)	(3)	(4)
Ctrl.Expect		0.025		
		(0.048)		
Ctrl.Experience	−2.061**	−0.812	−2.003*	
	(1.011)	(2.255)	(1.022)	
Ctrl.Expect × Exper.		−0.022		
		(0.033)		
Control.Experience.Once				−1.148
				(1.977)
Control.Experience.Several				−4.106**
				(2.023)
TypeCod open	4.501**	4.464**	5.409**	4.460**
	(2.038)	(2.041)	(2.205)	(2.040)
TypeCod trawl	1.179	1.092	0.466	1.208
	(4.891)	(4.928)	(4.917)	(4.894)
TypeOther	−2.299	−2.179	−1.728	−2.273
	(2.594)	(2.604)	(2.630)	(2.596)
TypePelagic	−1.684	−1.516	−2.319	−1.519
	(2.195)	(2.220)	(2.260)	(2.218)
Age	−0.245***	−0.240***	−0.229***	−0.244***
	(0.073)	(0.074)	(0.074)	(0.073)
Tenure	0.169***	0.167***	0.172***	0.167***
	(0.064)	(0.064)	(0.066)	(0.064)
Econ			0.863	
			(1.001)	
Parents.FisherNei			0.556	
			(1.640)	
CrewD			3.083	
			(2.739)	
Constant	24.919***	23.610***	22.112***	24.641***
	(3.317)	(4.132)	(3.965)	(3.359)
Observations	668	668	668	668
Adjusted R^2	0.024	0.022	0.023	0.023
Note:				*p<0.1; **p<0.05; ***p<0.01

Successful fisheries management relies on compliance. Compliance in turn relies on the perceived legitimacy of the existing rules and regulations, the effectiveness of enforcement, and on the positive feedback loop between legitimacy and effectiveness. Against the backdrop of increasing incentives to violate rules and regulations in modern fisheries, there is a widespread view that traditional control policies are no longer effective in guaranteeing sustainable fisheries management. This paper presents evidence from large-scale survey among Norwegian fishers, showing that expectations about and experiences of control activities affect compliance behavior. Moreover, survey respondents have a mixed attitude towards modern compliance policies based on remote sensing and open data, while appreciating competent fisheries inspectors. Thus, modern compliance policies are a promising complement, but no substitute, to physical inspections.

SNF

Samfunns- og næringslivsforskning AS
Centre for Applied Research at NHH

Helleveien 30
NO-5045 Bergen
Norway

P +47 55 95 95 00
E snf@snf.no
W snf.no

Trykk: Allkopi Bergen