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Control activities and compliance behavior—Survey evidence from Norway

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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 monitoring and 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 are concerns that traditional control activities relying on physical inspections, are no longer effective in safeguarding sustainability. Modern control activities, which make use of new technologies, such as camera surveillance on vessels, remote monitoring (drones, planes, satellites) and real-time monitoring of catches with automated data recording, may offer a promising alternative to enforcement officers conducting physical inspections. This paper presents evidence from a large-scale survey among Norwegian fishers, investigating (i) attitudes towards traditional and modern control activities, and (ii) how expectations about and experiences of physical inspections affect compliance behavior. We also investigate the role of individual factors on compliance, such as risk aversion, which we measure with an economic experiment. While we cannot document an effect of risk aversion on compliance behavior, we find that having experienced more controls in the past and perceiving the likelihood of future control as higher, significantly reduce rule violations. We also find that survey respondents appreciate traditional enforcement measures, while they have mixed attitudes towards modern control activities.

1. Introduction

While compliance with rules and regulations is a prerequisite for sustainable fisheries, it also gives rise to an important tension. Under open-access, a fishery is largely unprofitable and there is little gain from violating the rules and regulations that might exist [1]. Effective management and rationalization of fishing fleets, in contrast, has led to the creation of large rents in many modern fisheries [2]. Violating rules and regulations can now yield significant economic profits. Hence, enforcing compliance is hardest when fisheries management is successful. Therefore, it is imperative to ensure that the measures for monitoring and enforcement are effective. Yet, there is a widespread concern that traditional control activities based on physical inspections are no longer effective. In Norway, a country that is widely regarded as a fishing nation that champions compliance and enforcement, less than 1% of all landings are currently being controlled, and the resources allocated to

inspections at sea are decreasing [3]. 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 [4].

Concerns about increasing non-compliance are illustrated by the fact that about 40% of Norwegian cod fishers state that cheating is accepted and about 60% state that they know others who under-report their landings [5]. The Norwegian police authorities, in turn, describe fisheries as an area of concern in their annual threat assessment [6]. Taken together, these facts are serious warning signs about the deterioration of effective resource management. This situation is not specific to Norway, but representative of many fisheries around the world. As a reaction, fisheries managers turn to modern control activities that do not require physical inspections, such as camera surveillance on vessels and

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real-time monitoring of catches with automated data recording [7,8]. However, the acceptability and efficacy of such currently unused, modern control activities, remain to be seen.

In this paper, we study the potential of modern control activities to replace traditional control activities. Specifically, we present a large survey among fishers in Norway asking about the attitudes to control activities, both modern (currently unused) and traditional activities, based on physical inspections onshore and at sea. Eliciting attitudes is important because it tells us something about the perceived legitimacy of the existing or proposed activities. Legitimacy, in turn, is an essential building block for compliance. A large literature documents the role of fishers' intrinsic motivation to comply with rules and regulations, but only if these rules and regulations are deemed to be fair and legitimate [9–13]. Without a reinforcing role of the formal management institution, the motivation of fishers who normally comply may be irreversibly damaged. In the words of Kuperan and Sutinen [9, 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 [14] develops a theoretical model that allows for formal enforcement from regulator and informal enforcement of social norms from peers. She shows that tougher enforcement has 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.

At the same time, regulators rarely rely exclusively on voluntary compliance as there may always be some individuals that take advantage of the situation for their personal profit. Therefore, we ask survey questions about experience and expectations of control and relate this to compliance behavior. The results shed insight on to what extent control activities affect compliance, controlling for personal factors, such as age, tenure, and also fishery-specific questions.

The economic literature on non-compliance is rooted in the work of Becker [15], who states that breaking rules and regulations is not different from any other economic action where the expected benefits are weighed against the expected costs. The expected cost of non-compliance is the product of punishment and the risk of being detected. Hence, the standard economic model of non-compliance predicts an important role of risk preferences [15,16].

Irrespective of whether a model based on intrinsic and social motivations or a model based on economic cost-benefit calculations is more accurate, policy makers ultimately want to know how enforcement efforts affect behavior. To inform the ongoing debate on the adequate choice of control policies, we elicit survey participants' risk preferences and link this to their stated control experiences, their expectations about regulatory enforcement, and compliance behavior.

2. Material and methods

We conducted the survey among Norwegian fishers between September 12 and October 1, 2019. We invited respondents to participate through invitations sent from the Norwegian sales organizations for fish on behalf of the authors. All ex-vessel sales of fish in Norway must be organized through one of six sales organizations, which are mandated by law. This means that all fishers are associated with at least one of these sales organizations. The survey was conducted online, using a survey platform provided by the University of Oslo (*Nettskjema*).

In total, we have 668 respondents.² This is the number of

² There are currently 10,491 persons registered with fishing as their primary or secondary occupation in Norway (see: <https://www.fiskeridir.no/Yrkesfiske/Tall-og-analyse/Fiskere-fartoy-og-tillatelse/Fiskermanntallet>), so that more than 5% of all fishers in Norway participated in our survey.

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 [17].

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 lottery-choice task. Participants who continued the survey were on average about four years younger but otherwise not observably different from those who chose to end the survey prior to this question (see Table A-1 in the Appendix for a comparison of the two sub-samples).

The sample is broadly representative of the population of Norwegian fishers in terms of participant's characteristics and location [18]. 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”. The open group comprise smaller coastal vessels; vessels in this group cannot exceed an overall length of 11 m. Finally, there is a large variation in vessel length, and hence catch capacity, ranging from vessels that are smaller than 11 m to large offshore trawlers and purse seiners. Hence, in the table, *Cod passive* refers to vessels using conventional passive gears to target demersal species in individual-quota regulated fisheries, while *Cod trawl* refers to demersal trawlers, also with individual quotas. Participants from idiosyncratic fisheries such as coastal shrimp in Southern Norway, or wrasses to supply aquaculture that do not fall into one of the previous groups are in the *Other* group.

The average age of the full sample of participants is 49 years, and on average, participants have been working for about 21 years in their respective fisheries. There is quite some variation in tenure, ranging 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 income 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

Table 1
Participant characteristics by fishery type.

Variable	Pelagic	Cod trawl	Cod passive	Cod open	Other
Age (avg.)	45.08	53.65	47.43	53.58	46.72
Tenure (avg.)	23.88	35.00	24.50	18.78	17.07
Economic situation (mode)	2	2	2	0	1
Risk tolerance (avg.)	4.13	4.75	4.39	4.31	4.11
Crew member (proportion)	28%	24%	9%	2%	2%
Parents fisher (proportion)	75%	65%	63%	51%	48%
N	123	17	221	226	81

“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 using passive gear, the pelagic fishery, or the demersal trawl fishery, the economic situation in the other group and especially in the open cod fishery is significantly worse.³

Next, the variable “risk tolerance” measures the degree of risk aversion on a six-point scale. To elicit each participant’s level of risk aversion, we used an incentivized lottery-choice task [17]. Each participant who completed this part were given 6 points, where each point was worth 20 Norwegian kroner (NOK). We then asked participants to allocate these points (or NOK 20 coins) between a risky lottery and the safe option of simply keeping the NOK 20 coin (see Appendix A.2 for survey description). In the lottery, there was a 50% chance of winning a payoff three times their bet, and a 50% chance of ending up with nothing. Each participant had to choose how many of the six points she or he would allocate to the lottery and how many they wanted to keep. After respondents completed this task, we randomly selected a subset who received a monetary payout equivalent to the number of points they earned in the experiment. Respondents could choose to take no risk by assigning all six points to the safe option and end up with an outcome of six points regardless of the lottery outcome. About 40% opted for this. Respondents could also put all their points in the lottery, with a 50% chance of ending up with 18 points (3×6) and a 50% chance of ending up with nothing. About 7% allocated their points in this way. The remaining respondents allocated some of their six points to the risky lottery, while holding on to the rest. On average, our participants invested just over four points to the (risky) lottery. There are no significant differences across fishery types in this variable.⁴

Note that a risk neutral person would seek to maximize the expected outcome regardless of risk. Since every point assigned to the lottery has an expected payoff of 1.5, while each point assigned to the safe option gives a payoff of 1, a risk neutral person would assign all six points to the lottery. The respondents’ choices in this lottery task therefore measures their risk aversion, where those allocating all points into the safe option are the most risk averse, while those allocating all points to the lottery are risk neutral.

The variable “Crew member” is an indicator variable that takes a value of one when a participant is a crew member, but not a boat owner or a skipper. Several respondents, particularly in the demersal conventional using passive gears 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, one or both, 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.

³ The p-value of the Kruskal-Wallis rank sum test for the difference between the conventional demersal fishery using passive gear, the pelagic fishery, or the demersal trawl fishery is 0.101. The highest p-value of the pairwise Wilcoxon rank sum tests, accounting for multiple testing by using the Benjamini-Hochberg procedure, is below 0.001 for both the other group and the open cod group.

⁴ The lowest p-value of the two-sided *t*-tests for the difference in risk tolerance between fishery types, accounting for multiple testing by using the Benjamini-Hochberg procedure, is 0.64.

2.2. Survey questions on non-compliance behavior and control

The survey also contains questions to assess participants’ non-compliance behavior, and their experiences with control activities and expectations about these. One concern with self-reported surveys is that individuals may 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 [19]. 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 compliance” 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 (catch composition), and (b) using illegal gear or fishing outside of mandated seasons or areas.” 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)”. We transformed the answer options to scale with the probabilities they represent to make it possible to interpret the coefficients of the statistical model directly (implying linear interpolation of the probabilities that were not offered as options).

For our empirical analysis, we let $violate_{ij}$ denote the answer of respondent i to the questions about illegal gear/zone/time ($j = 1$) or catch composition ($j = 2$). 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 how the average prevalence of non-compliance is affected by control activities.

Next, to assess the control expectations and experiences of the participants, we first 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 our empirical analysis below, we let $CtrlBel_{ij}$ denote respondent i ’s control expectations (beliefs), at sea ($j = 1$) and on shore ($j = 2$), respectively. Second, we ask how often they have been controlled this year, giving them the following options: never, once, or several times. We create two indicator variable from this: $CtrlExpOnce_{ij}$ takes a value of 1 if respondent i has been controlled at least once at sea ($j = 1$) or on shore ($j = 2$), and zero otherwise. $CtrlExpTwice_{ij}$ takes a value of 1 if respondent i has been controlled at least twice at sea ($j = 1$) or on shore ($j = 2$), and zero otherwise. Doing so allows us to identify the effect from being controlled (at all) and the additional effect of being controlled more than once.

We deliberately related the questions to controls at sea or controls on land. This makes the control situation that the participants have to think about concrete. Additionally, this allows us to more precisely assess differences in the different violations. Misreporting of size or species

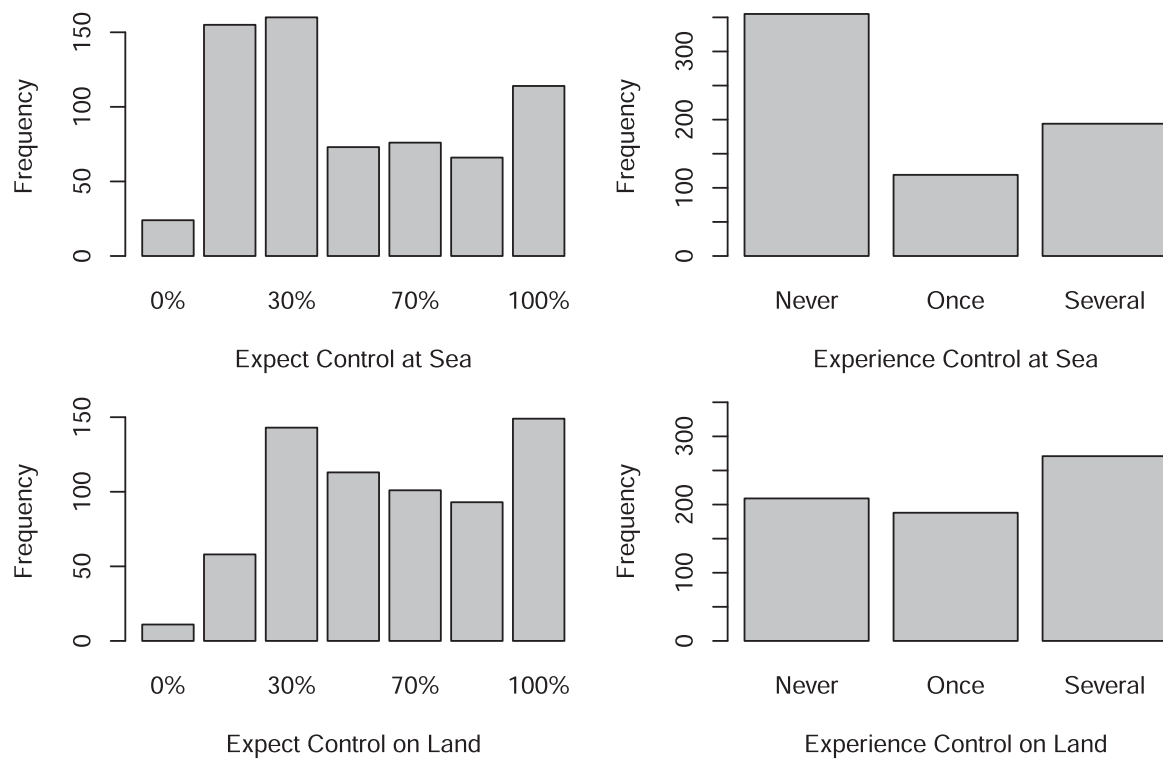


Fig. 1. Bar chart of expectations of being controlled at sea and on land (top left and bottom left panel, respectively), and histogram of control experiences at sea and on land (top right and bottom right panel, respectively).

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. Empirical model on non-compliance behavior and control

To measure how traditional control activities relate to non-compliance behavior, we need variation in the exposure to control activities. However, rules and regulations are the same for everyone. To overcome this challenge, we exploit the fact that exposure varies at 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 due to objective differences in monitoring probabilities across fishery type and subjective differences in perceptions.

More specifically, to assess whether traditional control activities have an effect on compliance behavior, we run the following linear regressions using ordinary least squares (OLS):

$$Violate_{ij} = \alpha_j + \gamma_j \cdot Ctrl_{ij} + \beta_{1j} Type_i + \beta_{2j} Age_i + \beta_{3j} Tenure_i + \beta_{4j} Risk_i + \epsilon_{ij} \tag{1}$$

where i denotes respondent and j denotes whether we analyze compliance behavior with control activities taking place at sea ($j = 1$) or on shore ($j = 2$). As introduced in Section 2.2, the variable $Violate_{ij}$ is respondent i 's assessment of the extent of non-compliance with respect to gear/zone/time restrictions (detected at sea, $j = 1$) and misreporting of catch composition (detected on shore, $j = 2$). $Ctrl_{ij}$ is a vector consisting of the respondent's control beliefs and experiences, $CtrlBel_{ij}$ and $CtrlExp_{ij}$, respectively.

The key parameter of interest is γ_j . To analyze whether there is a significant relationship between the experience with and expectation of being inspected and compliance behavior, we test whether the coefficient γ is significantly different from zero in the two cases (at sea and on shore).

In addition to these variables of interest, we include a number of control variables in our analysis. First and foremost, we need to control for the participant's fishery type to account for the heterogeneity in Norwegian fisheries. The variable $Type_i$ is an indicator variable for whether the respondent belongs to the open group (fishery type). In addition to fishery type, we control for the respondent's age because age may be correlated with attitudes to authority and the importance of following rules (Age_i). Moreover, we control for the participant's experience in a given fishery type (her or his tenure) as experiences with non-compliance and norms relating to this may differ across fisheries ($Tenure_i$). Finally, we explore the role of participant's risk tolerance, $Risk_i$.

2.4. Exploring attitudes towards control activities

Finally, we explore the participant's attitude towards a range of different policy proposals. We broadly classify the policies as traditional and modern instruments for monitoring and enforcement. 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 policies

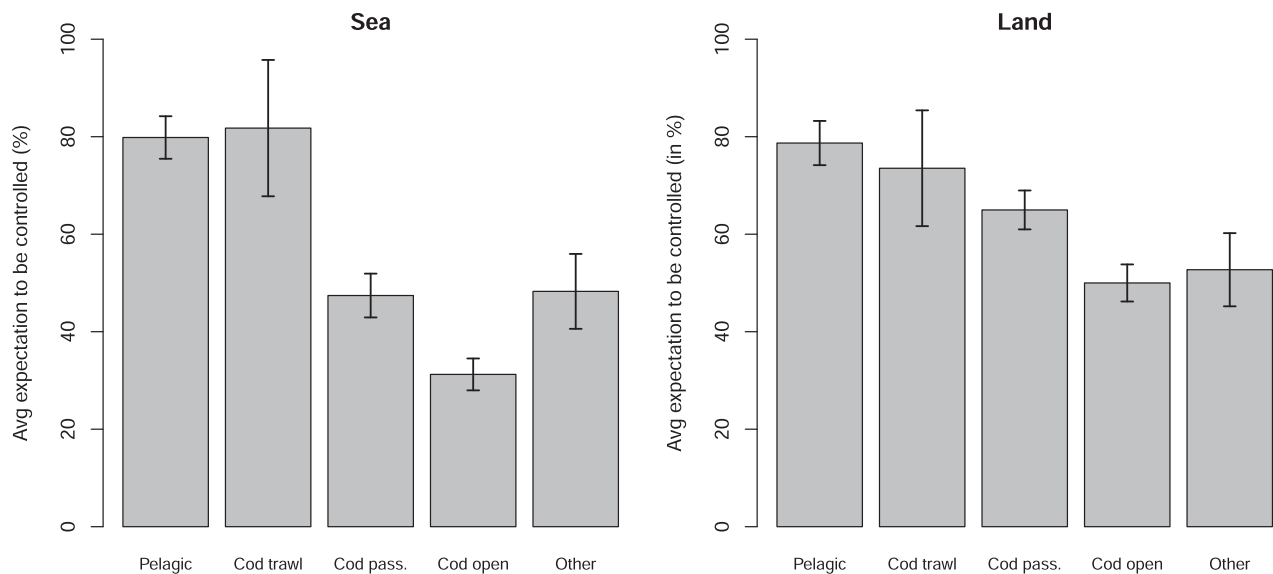


Fig. 2. Average expectations of being controlled at sea (left panel) and on land (right panel) by fishery type. Whiskers show 95% confidence interval.

refer to novel methods that make use of emerging technologies and do not require physical presence of enforcement officers. In this category, we include (i) camera surveillance on vessels (CCTV), (ii) remote monitoring (drones, planes, satellites), and (iii) real-time monitoring of catches with automated data recording.⁵ The key difference in our definition of modern and traditional control activities is that traditional activities require physical inspections by enforcement authorities, while modern activities only use remote monitoring. Traditional activities can still use modern technology. For example, many fisheries authorities use vessel monitoring systems, such as VMS or AIS to detect unusual activity and inform which vessels to inspect.

For more details on how we phrased the questions about the different policy proposals, we refer to the survey questions in [Appendix A.2](#).

3. Results

3.1. Control expectations and experiences differ across groups

In this section, we present participants' expectations of being controlled and experiences with having been controlled, pointing out that there are significant differences across fleet segments. [Fig. 1](#) shows the overall distribution participants' expectations of being controlled and experiences with having been controlled for controls at sea (top) and on land (bottom).

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 large majority of participants states that they have not been controlled at sea in 2019, 17% state that they have been controlled once, and 29% state that they have been controlled several times. In contrast, only 31% state that they have not been controlled on land in 2019 (28% state they have been controlled once, and 41% that they have been controlled several times). Second, a large share of

⁵ Policy proposals that are discussed in this regard are both the automatic and secure transmission of relevant information from the ship to the official registers (ranging from the location of a vessel to the recorded weight of the catch on board of a vessel to the quota registry) and the automated collection and presentation of relevant information from various registers to interested stakeholders. A prototype of the latter application is the website <https://www.barentswatch.no> where fishers, citizens, scientists, and regulators can get an overview of the real-time fishing effort (at varying degrees of detail as the information is partly confidential and accessible only to state authorities).

respondents (36%) are certain or almost certain that they are being controlled on land, while there are considerably lower expectations for 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. 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 -b rank correlation coefficient is 0.50 ($p < 0.001$), and for controls at sea, the correlation is even stronger with a Kendall's τ -b rank correlation coefficient of 0.63 ($p < 0.001$).

[Fig. 2](#) then shows that there are significant differences among the various fishing fleets (see [Table A-2](#) in the Appendix for formal pairwise tests). Compared to cod fishers using passive gear (the middle bar), we see that those who participate in the open cod group think that it is 16% less likely that they are being controlled at sea (left panel) and 15% less likely that they are being controlled on land (right panel). Participants from the demersal trawler group and pelagic fisheries, in contrast, think that it is more likely that they are being controlled at sea. These fishers also state that it is more likely that they are controlled on land, but this difference is less pronounced. The picture from control experiences is parallel to the differences of control expectations by fishery type and is not presented additionally here (but see [Table A-3](#) for formal statistical tests).

Based on the data in the recent Norwegian Official Report on Fisheries Control [[3](#)], chapter 7.2.2., about 1% of all landings has been controlled in recent years, but between 6.5% and 9% of the landed quantity has been controlled. The reason is that the regulator prioritizes large landings, in line with our findings that respondents from the pelagic fishery or from demersal trawlers state a higher probability of being controlled. If one takes the probability that a given landing is controlled in one out of hundred cases and assumes that a vessel makes one hundred landings in a year, one arrives at a cumulative probability of being controlled at least once in a year of 63%, which is very close to the average control expectation given by respondents in the conventional cod fishery using passive gear of 65%. The open group is seasonally concentrated and has fewer landings, hence a lower chance of being controlled in a given year, which is also in line with the reported control expectations.

3.2. Attitudes towards modern control activities

In this section, we explore participants' attitude towards a range of different policy proposals, summarized in [Fig. 3](#), where the top three

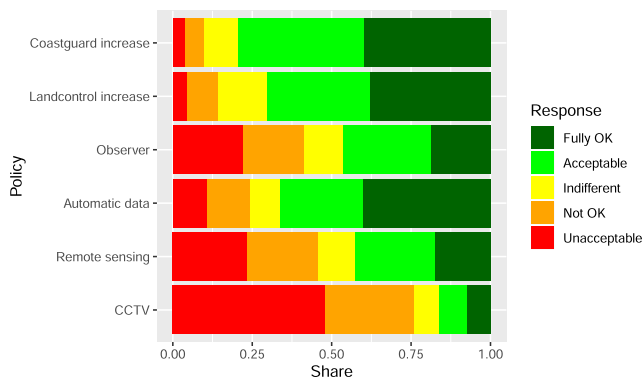


Fig. 3. Acceptance of various compliance measures. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

items can be classified as traditional control activities and the bottom three items as modern control activities. The figure reports to what extent respondents rank the policy proposals on a 5-scale spectrum between “fully OK” (dark green, on the right) and “Unacceptable” (red, on the left).

First, we see that respondents find traditional control activities – more physical inspections either on land or at sea – the most acceptable. Only 9.9% (sea) and 14.4% (land) are negative to these policies (by responding either “Not OK” or “Unacceptable”). Views regarding on-board observers are more polarized: While 41.3% state this is “Unacceptable” or “Not OK”, 46.6% state that such measure would be “acceptable” or “fully OK”.

Of the three modern control activities, automatic transmission of data meets the least resistance. Only 24.4% of the respondents are negative to this policy. When it comes to remote monitoring with drones, planes or satellites, 45.7% of the respondents are negative to such policy, while 43% of respondents are positive. Finally, camera monitoring (CCTV) meets by far the most resistance, with 75.9% of participants being negative towards this policy.

Several reasons for the low acceptance rate of modern control activities come to mind. First, modern control activities are new and do not exist in the Norwegian compliance context yet. This is also true for on-boat observers, which, incidentally, is also the least accepted policy among the class of traditional policies. The lower acceptance rates could therefore be due to a general tendency to resist new and unknown policy proposals. Second, respondents may find modern control activities less acceptable because they are likely to be more effective, and hence render non-compliance more difficult (or simply more effectively constrain an activity that has traditionally been seen as “free” and unregulated). Third, modern control activities 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.

That said, participants have generally positive views on fisheries control: The statements “It is OK to be controlled to secure sustainable stocks”, “It is OK to be controlled to ensure a level playing field”, and “It is OK to be controlled because laws and rules must be enforced”, meet approval rates of 95%, 91%, and 92%, respectively. In contrast, more ambiguous statements like “Control activities involve too much red tape” or “Control agencies do not understand the situation of the fishers” have lower approval rates of 76% and 64%, respectively. Finally, only 33% of the respondents agree with the statement that “control agencies fail to uncover criminal activities”.

When exploring whether attitudes to control activities correlate with observable characteristics of the participants, such as their age, tenure, risk preferences etc., we do not find any systematic relationship (results not shown). In particular, we do not find differences between fishery

types, despite the fact that control experiences and expectations (Section 3.1 above) and compliance behavior (Section 3.3 below) differ significantly. Similarly, the extent to which participants have been controlled at land or at sea neither correlate with their acceptance of increasing controls at land nor at sea.

3.3. The effect of traditional control activities

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; see Eq. (1).

We first present results with regard to non-compliance with gear, spatial and seasonal regulations in Table 2, before turning to violations with size and species regulations in Table 3. In the Appendix, in Tables A-4 and A-5, we present results using alternative model specifications. In these model specifications, we introduce additional covariates, including the full set of indicator variables for fleet segment. As those results confirm, there are no significant differences across fleet segments other than the open group. In our main model specifications, we therefore control only for whether the respondent reports that her or his main fishery is the open group.

For non-compliance with gear and spatial regulations (Table 2), we see that higher beliefs about being controlled are related to a lower probability of non-compliance (column 1). The size of the effect is small: The estimated coefficient of -0.087 , implies that a 10% point increase in the expected probability of being controlled at sea, leads to a reduction in the likelihood of non-compliance by less than one percent ($-0.087 \cdot 10\% = -0.87\%$). 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 of Table 2), we find that more experience with controls at sea is also related to lower non-compliance: Both the coefficient on the indicator whether a respondent has been controlled at least once, and the coefficient on the indicator whether a respondent has been controlled twice or more are negative and the two coefficients are jointly significant (F -test of joint significance, $p = 0.04$). We do not find that the indicator variable for being controlled twice or more is significant on its own.

When we include both control experiences and expectations as explanatory variables in the regression model (column 3 of Table 2), we see that the effect of experiences becomes smaller, and is no longer significantly related to a decrease in non-compliance behavior (F -test of joint significance, $p = 0.98$). In contrast, the effect of expectations is virtually unchanged. In the Table A-4 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. Note though, that our control expectation variables are strongly correlated with the corresponding control experience variables.⁶

Surprisingly, our results indicate that risk tolerance is not correlated with non-compliance behavior (column 4 in Table 2). The estimate for the effect of experiences on gear and spatial regulations is unaffected when controlling for risk tolerance.

When we compare those results to the violations of size or species regulation, some interesting differences come to light (Table 3). Misreporting is usually detected when landing the fish, and here we find that beliefs about control activities have no effect on non-compliance behavior (column 1 in Table 3). In contrast, experiences of control is significantly related to lower non-compliance behavior (F -test of joint significance, p -value = 0.08). By comparing columns 2 and 3 in the table, we see that the estimated coefficients for *Ctrl Experience* remain

⁶ Kendall's τ coefficients are respectively 0.50 and 0.63 between the expectations and experience variables for the two types of violations we consider.

Table 2

Non-compliance with gear, spatial and seasonal regulations. OLS coefficient estimates with standard errors in parentheses. Columns (1)–(4) refer to model specifications that differ in which explanatory variables are being included.

	Dependent variable Violate-gear			
	(1)	(2)	(3)	(4)
Ctrl Beliefs	−0.087***(0.023)		−0.088***(0.032)	−0.090***(0.030)
Ctrl Experience(once or more)		−2.387(2.037)	−0.202(2.172)	
Ctrl Experience(twice or more)		−2.331(2.217)	0.349(2.405)	
Open group	5.000***(1.731)	5.452***(1.758)	4.999***(1.757)	4.555***(2.168)
Age	−0.221***(0.071)	−0.206***(0.072)	−0.221***(0.072)	−0.172*(0.090)
Tenure	0.081(0.061)	0.072(0.061)	0.080(0.061)	−0.011(0.077)
Risk tolerance				0.441(0.500)
Constant	23.144***(3.255)	19.982***(3.088)	23.173***(3.277)	21.785***(4.607)
Observations	668	668	668	462
Adjusted R ²	0.044	0.031	0.041	0.041

Note: ***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively.

Table 3

Non-compliance with size and species regulations. OLS coefficient estimates with standard errors in parentheses. Columns (1)–(4) refer to model specifications that differ in which explanatory variables are being included.

	Dependent variable violate-size			
	(1)	(2)	(3)	(4)
Ctrl Beliefs	−0.028(0.025)		0.001(0.030)	
Ctrl Experience(once or more)		−0.963(1.956)	−0.982(2.029)	−1.317(2.343)
Ctrl Experience(twice or more)		−3.060(1.883)	−3.084(1.998)	−1.324(2.311)
Open group	6.094***(1.744)	5.321***(1.787)	5.322***(1.788)	7.070****(2.144)
Age	−0.243***(0.073)	−0.247***(0.072)	−0.246***(0.073)	−0.253***(0.089)
Tenure	0.165***(0.063)	0.176***(0.063)	0.176***(0.063)	0.134*(0.078)
Risk tolerance				−0.118(0.496)
Constant	23.309***(3.508)	23.674***(3.181)	23.617***(3.554)	25.066***(4.310)
Observations	668	668	668	462
Adjusted R ²	0.022	0.025	0.024	0.025

Note: ***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively.

the same in magnitude when we also include control expectations in the model, although it loses significance (*F*-test of joint significance, *p*-value = 0.16).

As before, our results indicate that risk tolerance is not correlated with non-compliance behavior (column 4 in Table 3). The effect of experience on violations of size- and species-reporting requirements loses significance. This may be a consequence of having substantially lower power in this regression as about a third of our sample did not participate in the risk elicitation task.

We find no correlation between risk preferences and compliance behavior even though expectations and experiences with control clearly have an effect on compliance. This may seem surprising, as the rational choice model of crime [15] would predict that participants who are more risk tolerant are also more likely to violate. However, the fact that we do not find a relationship between risk preferences and non-compliance behavior is well in line with a situation where the primary role of the control measures is to signal which norm one ought to

follow. In addition, we measure the risk preferences of individuals working in fisheries, while many vessels are owned by firms who may have policies around compliance.

Analysis of the co-variates age, tenure, and fishery type reveals interesting patterns. First, we see that the effect 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. Tables A-4 and A-5 in the Appendix show that there is no significant difference in non-compliance behavior across the other fishery groups.

Tables 2 and 3 furthermore show that participants' age has a significant negative relationship with non-compliance. The younger is a participant, the more likely that she or he violates rules and regulations. At the same time, we find that non-compliance increases with tenure, at least for misreporting of species and size categories. Policies must thus pay attention, especially in the small-scale fisheries for cod, to avoid that

a culture of non-compliance forms, and that violating rules and regulations becomes acceptable behavior.

4. Discussion

Our survey among Norwegian fishers highlights three important points in the discussion about monitoring and enforcement policies. First, we find that control expectations and experiences are significantly related to non-compliance, while risk aversion plays no role. Second, we find that there are significant differences in control expectations and experiences across different fisheries, and that it is especially the small-scale "open group" fishery for cod that stands out with respect to non-compliance. Finally, we find that Norwegian fishers generally have a positive attitude towards traditional control activities based on physical inspections but appear to be more skeptical towards modern control activities, such as camera surveillance, remote monitoring, and automated data recording.

The finding that risk aversion is not an important determinant for non-compliance behavior is well in line with earlier challenges to the standard economic model of criminal behavior [20,21]. For example, Nøstbakken et al. [22] asked respondents in a survey among Norwegian fishers why they do not violate a given regulation (more). For discarding, only 6% gave "fear of formal punishment" as the main reason, while the vast majority selected either "one should follow the law" (35%) or "stock development and future income" (48%) as main reason for their compliance decision.

The fact that so few fishers report "fear of formal punishment" as the most important reason for complying, could reflect weak monitoring and a high chance to sail safely under the radar of surveillance. However, in the current study, we do show that higher expectations about being controlled are significantly related to a lower probability of violating rules among the fishers. These insights suggest that strong enforcement remains important. Nevertheless, trading off expected benefits with expected costs is not necessarily the key determinant of non-compliance. According to our econometric analysis, a 10% point increase in the probability of being controlled at sea, only raises compliance with gear, seasonal and zone regulations by 0.87%. Such low elasticity of non-compliance behavior to changes in the monitoring probability is well in line with earlier findings [23]. 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 land.

However, there is increasing evidence that compliance is not only the result of economic and moral calculus, but also depends on the salience of enforcement. For example, Dur and Vollaard [24] find that dumping waste illegally goes down if a fine is combined with a bright orange warning label to highlight salience in a field experiment. 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" as the main reason to comply with regulations as documented in Nøstbakken et al. [22], 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, there may be spillover effects. For example, Rincke and Traxler [25] document 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 [11,26]. The importance of

this aspect can be seen from the fact that 91% of the participants in our survey agree to the statement that "it is OK to be controlled to ensure a level playing field."

There is a growing literature that explores the social aspects of rule compliance [see, for example: [9,10,12,13,27–30]]. 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 the perception of what one ought to do (injunctive social norm) and on what the relevant peers do (descriptive social norm).

Our results indeed uncover significant differences between fisheries when it comes to control expectations and experiences. In this regard, the small-scale open fishery for cod, which is different from the other commercial fisheries along several dimensions, stands out in terms of non-compliance. Differences in regulatory groups may be caused by either group-specific differences in economic factors or social norms. While identifying the relative importance of social norms is outside the scope of this paper, our results suggest that social factors do play a role. After all, we do find that non-compliance depends on age and increases with tenure, so it may seem plausible that group-specific social norms form. This leads us to the first policy conclusion: Enforcement agencies need to monitor the situation closely and take decisive measures to avoid that social norms of non-compliance take a hold and spread among (sub-)groups of the population. The recent efforts of the Norwegian government to reform and improve fisheries control institutions are an important step in the right direction.

However, the second policy lesson from our survey is that enforcement agencies should not only aim for modern control activities. We document that fishers have a mixed attitude towards modern control activities based on remote monitoring and automated data transmission, while they acknowledge the importance of enforcement and showing appreciation for fisheries inspectors. Fishers may disapprove of modern control activities because they do not have sufficient experience with them yet. It is therefore possible that this resistance will disappear as fishers become more accustomed to them. Still, modern control activities tend to lack salience, and at least for now in the Norwegian context, they also lack legitimacy. Our research is therefore only a very first step towards understanding whether and how physical inspections can be complemented or substituted by modern technologies relying on remote monitoring.

Data availability

The data used in this research is documented and curated by the Norwegian Center for Research Data and freely available for download at <https://doi.org/10.18712/NSD-NSD2847-V3>.

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Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at [doi:10.1016/j.marpol.2020.104381](https://doi.org/10.1016/j.marpol.2020.104381).

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