ENFORCEMENT AND COMPLIANCE WITH FISHERIES REGULATIONS IN MALAYSIA, INDONESIA AND THE PHILIPPINES

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ABSTRACT

A study of compliance with fisheries regulations in Malaysia, Indonesia and the Philippines is presented. Compliance models which account for moral obligation and social influence in addition to the conventional expected costs and revenues associated with illegal behavior are developed and tested. The basic deterrence model of regulatory compliance, which focuses on the certainty and severity of sanctions as key determinants of compliance, yields only a partial explanation of compliance behavior and provides poor guidance for policy. To offer a more complete explanation, the models tested herein integrate economic theory with theories from psychology and sociology to account for both intrinsic and extrinsic motivations influencing individuals' decisions whether to comply. Probit, Logit and Tobit econometric estimators are used to examine the compliance behavior of 792 Malaysian, Indonesian and Philippines fishers. The findings are used to draw implications for compliance policy in the context of fishery management regulations.

Introduction

The report presents the results of a study on compliance with fisheries regulations in Malaysia, Indonesia and the Philippines undertaken in 1995. Funds for the study were made available to Universiti Putra Malaysia through the Asian Fisheries Social Science Research Network (AFSSRN) and the Fisheries Co-management Project, both projects being executed by the International Center for Living Aquatic Resources Management (ICLARM). The key objectives of the study are: i) to provide a literature review on enforcement and compliance issues in the fishery sector, ii) to examine compliance levels in the fishery of Malaysia, Indonesia and the Philippines where the fishery management in these countries reflect different levels of centralized control and enforcement of regulations, iii) to empirically test the extended model of compliance developed by Kuperan (1992) in different socioeconomic conditions of Malaysia, Indonesia and the Philippines and finally, iv) to examine ways in which governments and communities can improve their enforcement program and enhance compliance in their respective fisheries through improved institutional arrangements.

The Compliance Problem

Fisheries are regulated to mitigate overexploitation and conflicts among user groups. The overfishing resulting from open access to fish resources is often addressed with regulations that restrict gear and vessel operations, setting of minimum fish-size limits, time and area closures and quotas, and

requirement of licenses to fish (Anderson 1986; Clark 1990). User conflicts are often addressed with gear prohibitions or restrictions and zones to separate user groups. Fishermen, like most regulated economic agents, are typically controlled through monitoring, surveillance, and enforcement. Frequently the most costly element of fishery management programs, enforcement commonly accounts for a quarter to over a half of all expenditures. Also, compliance with regulations is usually far from complete, seriously jeopardizing the effectiveness of management (Sutinen et al. 1990; Sutinen 1993). This raises questions on whether there are ways to improve the cost-effectiveness of traditional enforcement, and whether there are ways to secure compliance without heavy reliance on costly enforcement.

Most modern analysis of compliance behavior centers on deterring rational individuals from violating these rules. The origin of this view in the economics literature dates back to the work of Adam Smith (1759), who notes that individuals acting in the pursuit of self-interest can impose harm on others, and argues that social harmony can be realized only by controlling some aspects of human nature. Accordingly, a key function of the State is to protect members of society from the injustice and oppression of others (Smith 1776).[1] Bentham (1789) adopts Smith's perspective to argue that criminal behavior is entirely rational, and develops the concept of deterrence to reduce crime. Becker (1968), the first to develop a formal theoretical framework for explaining criminal activity, also assumes that criminals behave basically like other individuals in that they attempt to maximize utility subject to a budget constraint. In Becker's model, an individual commits a crime if the expected utility from committing the crime exceeds the utility from engaging in legitimate activity. Becker's framework became the launching pad for a series of studies on the economics of crime.[2]

Sutinen and Andersen (1985), followed by Anderson and Lee (1986) and Milliman (1986), combines Becker's deterrence model with a bioeconomic model to investigate various aspects of fisheries law enforcement. All address the issue of optimal quantities of enforcement services and management policies. The basic deterrence framework used in these studies assumes that the threat of sanctions is the only policy mechanism available to improve compliance with regulations.

The basic deterrence model however, has at least two important shortcomings: first, the model does not explain the available evidence very well and second, the policy prescriptions of the model are impractical. The basic deterrence model assumes that self-interested individuals weigh the potential illegal gain against the severity and certainty of sanctions when deciding whether to comply (Sutinen and Kuperan 1994). Therefore, if the illegal gains are greater than the gains from legal fishing, the expected penalty should be large enough to offset the difference between the legal and illegal gains. Since enforcement is costly, the probability of detection and conviction should be kept low and penalties high (i.e., large enough for the product of their monetary value with the low probability to be larger than the difference between legal and illegal gains). The probability is usually low in practice. The typical odds of being caught violating a fishery regulation are below 1%, and often at or near zero (Sutinen and Gauvin 1989; Bean 1990; Furlong 1991). Penalties on the other hand, are generally not large relative to illegal gains. For example, in the groundfish fishery of the northeast United States, Sutinen et al. (1990) estimates that flagrant violators grossed about US$15 000 per trip from violating closed area and mesh-size regulations, resulting in illegal earnings of US$225 000 for flagrant violators during 1987. When caught and sanctioned for these violations, typical penalties ranged from US$3 000 to US$15 000 in monetary fines.

A similar pattern of potential illegal gains relative to the certainty and severity of sanctions tends to appear in most fisheries. Raising penalties to the point where the expected penalty offsets illegal gain is generally not feasible. The courts are not willing to mete out sanctions perceived as excessively severe. Rather, courts tend to impose sanctions that fit the crime, as measured by the illegal gains realized or the social harm caused by the detected and proven violation. The basic deterrence model predicts that modest sanctions will generally be inadequate to deter illegal fishing. Despite this apparent weakness

[1] Smith also makes the link between crime and economic circumstances, claiming that "nobody will be so mad to expose himself upon the highway, when he can make better bread in an honest and industrious manner" (1763: 155-156).

[2] See Heineke (1978) and Pyle (1983) for an overview of the theoretical models used in the economic literature of criminal behavior.

however, a higher proportion (50-90%) of fishermen normally comply with regulations (Sutinen et al. 1990; Sutinen and Gauvin 1989; Bean 1990).

Asked why they persist to comply when illegal gains are so much larger than the expected penalties, many fishermen refer to the need to 'do the right thing.' That is, they express an obligation to obey a set of rules (either their own or an authority's). The sense of moral obligation is common throughout society and may be a significant motivation that explains much of the evidence on compliance behavior. There is substantial evidence that morality and moral norms influence many economic outcomes.[3] For example, a large number of experiments show that people do not act as free riders when given the opportunity. Instead, many people persist in investing substantial proportions of their resources into public goods despite conditions designed to maximize free riding. In experiments of repeated prisoner dilemma games, over half of the subjects cooperate without being coerced or paid. Other experiments show that many people return lost wallets to their owners with all of the money inside. We also witness anonymous contributions to charity above and beyond what tax incentives can explain. And, it is customary for people to leave tips in restaurants in distant cities which they never expect to visit again. The evidence cited above that many fishermen comply despite the large potential illegal gains and small expected penalties suggests that moral norms also may influence compliance in fisheries.

Smith (1759) explicitly portrays human economic motivation to be multidimensional, arguing that psychic wellbeing is based on acting morally and receiving the approval of others, as well as enhancing one's wealth. For the intrinsic motivation influencing behavior, he imagines an "impartial spectator" within each of us, with which we "scrutinize the propriety of our own conduct."[4]

Recent research in psychology and sociology emphasizes the importance of socialization processes affecting behavior. Compliance with rules and regulations is hypothesized to be related to both the internal capacities of the individual and external influences of the environment, where the socialization process is the linkage between the individual and society. There are two leading psychological theories to explain how socialization processes work with respect to compliance behavior: cognitive and social learning. Cognitive theory focuses primarily on the individual and stages of development (Kohlberg 1969, 1976, 1981; Levine and Tapp 1977; Tapp and Kohlberg 1977). According to cognitive theory, the key variables determining compliance are the individual's personal morality and level of moral development. Social learning theory on the other hand, focuses primarily on the conditioning effects of the environment (Akers 1985; Akers et al. 1979; Aronfreed 1968, 1969; Bandura 1969; Mischel and Mischel 1976). According to social learning theory, the key variables determining compliance include peers' opinions, and the extent of social influence an individual encounters.

The sociology literature contains two basic perspectives on compliance: instrumental and normative (Tyler 1990a). Similar to Becker, the instrumental perspective assumes individuals are driven purely by self-interest and respond to changes in the tangible, immediate incentives and penalties associated with an act. The key variables determining compliance are the severity and certainty of sanctions. The normative perspective emphasizes what individuals consider just and moral, instead of what is in their self-interest. Individuals tend to comply with the law to the extent that they perceive the law as appropriate and consistent with their internalized norms. The key variables determining compliance in the normative perspective are individuals' perceptions of the fairness and appropriateness of the law and its institutions.

Tyler (1990a and b) argues that compliance with a law or regulation is influenced by the extent to which individuals accord legitimacy to the enforcement agencies. Legitimacy is a normative assessment by individuals of the appropriateness or right of enforcement agencies to restrict their behavior. Tyler's study demonstrates that compliance is higher when individuals accord a high level of legitimacy to the enforcement agencies. Tyler emphasizes outcome and process variables. The outcome

[3] For reviews of the evidence see Etzioni (1988, Chapter 4), Frank (1988), Mansbridge (1990), and Thaler (1991).

[4] Nineteenth century economists commonly account for moral sentiments in their writings. While contemporary economists do not completely ignore morality (see Hausman and McPherson, 1993, for an excellent survey of recent literature), the fact remains that morality is a foreign element to most contemporary economic analysis.

variables are those related to the final result of a regulation and it consists of two criteria, one unrelated to fairness and another related to distributive justice. The process variables are also related to two criteria: efficiency or effectiveness and procedural justice. For example, the conservation objective of a fishery management regulation may lead to an increase in fish stocks, an outcome unrelated to fairness, while the question of who gets more fish as a result of a regulation is an outcome related to the distributive justice criterion. How quickly and frequently violators are detected, arrested and prosecuted is a process variable related to efficiency or effectiveness, while how violators are treated and how consistently is the law enforced is a process variable related to procedural justice. Tyler (1990a) concludes that process variables are more important in maintaining legitimacy than the outcome variables.

In summary, the literature identifies the following factors determining compliance: potential illegal gains, severity and certainty of sanctions, individuals' moral development and their standards of personal morality, individuals' perceptions of how just and moral are rules being enforced, and social environmental influences.[5]

In an attempt to overcome the shortcomings of the basic deterrence model, this study tests an extended model of compliance behavior in which rational individuals are driven by intrinsic and extrinsic motivations (including, but not restricted to, wealth enhancement). Adopting Smith's view of individual behavior, the model integrates economic theory with theories from psychology and sociology to account for both tangible and intangible motivations influencing individuals' decisions whether to comply with a given set of regulations. Specifically, the model accounts for morality, legitimacy, and social influence in addition to the conventional costs and revenues associated with illegal behavior.

The remainder of this paper is organized as follows. The second section explains the econometric framework and data used in the analysis. The results of the econometric estimates are presented in the third section; and the implications of the results and policy are discussed in the fourth section.

Empirical Strategy and Data

Econometric Framework

Our objective is to determine (or test) the relationship between illegal activity and a set of specific intrinsic and extrinsic conditions. The general econometric model underlying the analysis is simply

(1) $$y_i = \beta x_i + \varepsilon$$

where y_i measures the ith individual's noncompliance with the zoning regulation, and x_i is a vector of conditions reflecting the individual's perceived potential illegal gains and risk of detection and arrest, and measures of moral development, institutional legitimacy, and social influence.

Equation (1) can be derived from a model in which a utility maximizing individual decides whether and how frequently to violate a regulation (see Appendix I). The individual's utility is a function of the net income from fishing (legal and illegal), his personal moral standing and his social standing. The individual's personal moral standing is assumed to depend on whether and how much he violates the regulation in conjunction with his moral development and the legitimacy he accords the regulatory institution. The individual's social standing in turn depends on how much he violates the regulation in conjunction with the values and behavior of his peers.

With intrinsic and extrinsic motivations in the model, the total and marginal conditions for utility maximizing behavior are differentiated to generate a set of testable hypotheses.[6] The following hypotheses are derived from the total condition (i.e., an individual will violate if and only if his expected utility from the violation exceeds the utility from not violating) and are stated in the context of a random utility framework. The probability of an individual violating a regulation is less, if

[5] Which of these variables are significant determinants of compliance with regulations is ultimately an empirical issue.

[6] The formal derivation of the comparative statistics on which these hypotheses are based is available from the authors.

1. The probability of detection and sanction (or greater the enforcement inputs) is higher,
2. The penalty if sanctioned is greater,
3. Complying compared to violating is less profitable,
4. The moral development of the individual is higher,
5. The regulation as perceived by the individual is more legitimate, and
6. The regulation as perceived by the community at large is more legitimate.

A similar set of hypotheses, derived from the marginal condition, apply to the extent of violations by violating individuals.[7]

The key dependent variables in this study are the violation decision variable (VIOLT), and the number of days a fisherman has fished in the prohibited zone (NFINS). The violation decision is estimated using a Probit model while the number of days fished inshore (NFINS) is estimated using a Tobit model.

The Study Areas and the Data

The study covered three countries, namely Malaysia, Indonesia and the Philippines. The data for this study was collected using a standardized questionnaire and personal interviews. The questionnaire used in the study (see Kuperan 1992, Appendix B) was developed over a period of five months when it was tested and retested with respondents in the study areas. The fisher association committee members in each study area reviewed the questionnaire and it was tested on at least five fishers in each area. Changes were made to sequences in the questions and wording in the questionnaire to suit the language and cultural requirements in each country to enable smooth implementation by the enumerators. In each country, university undergraduate students were trained to undertake the interviews. The main method used to interview fishers was either through the intercept method at the landing points or through appointments with fishers. Since it is almost impossible to obtain a complete and reliable list of fishers in any of the countries, the sampling had to rely on the intercept method. The total sample size for the study is 792 fishers comprising of 138, 289 and 365 fishers in Malaysia, Indonesia and the Philippines respectively. The locations of the study areas are shown in Figures 1, 2 and 3.

The Philippines

The study area sites in the Philippines are from Panay Island in Central Philippines, which together with Negros Occidental Province, constitutes the administrative region referred to as Region VI. A total of 259 fishers were interviewed for the study on commercial fishing vessels in the following sites: Tigbauan (n=16) and Concepcion (n=100) in Iloilo province, Iloilo City (n=40), and Roxas City (n=103). For small-scale fishers, i.e., those who fish either without a vessel or with vessels displacing less than three gross tonnes, the total number of respondents is 106. The summary statistics of the data for the sample from the Philippines is given in Table 1. The specific regulation of interest in this study is the regulation defining municipal waters. Municipal waters in the Philippines refer to waters within three nautical miles from the shoreline of a municipality. Vessels displacing three gross tonnes or less can operate in the municipal waters. Commercial fisheries in the context of this study in the Philippines refers to fishers operating vessels in offshore waters, i.e., waters further than three nautical miles from the shore.

[7] The only difference is the counter-intuitive result from the marginal condition is the prediction that an increase in the penalty increases the extent of the violation for risk-averse violators.

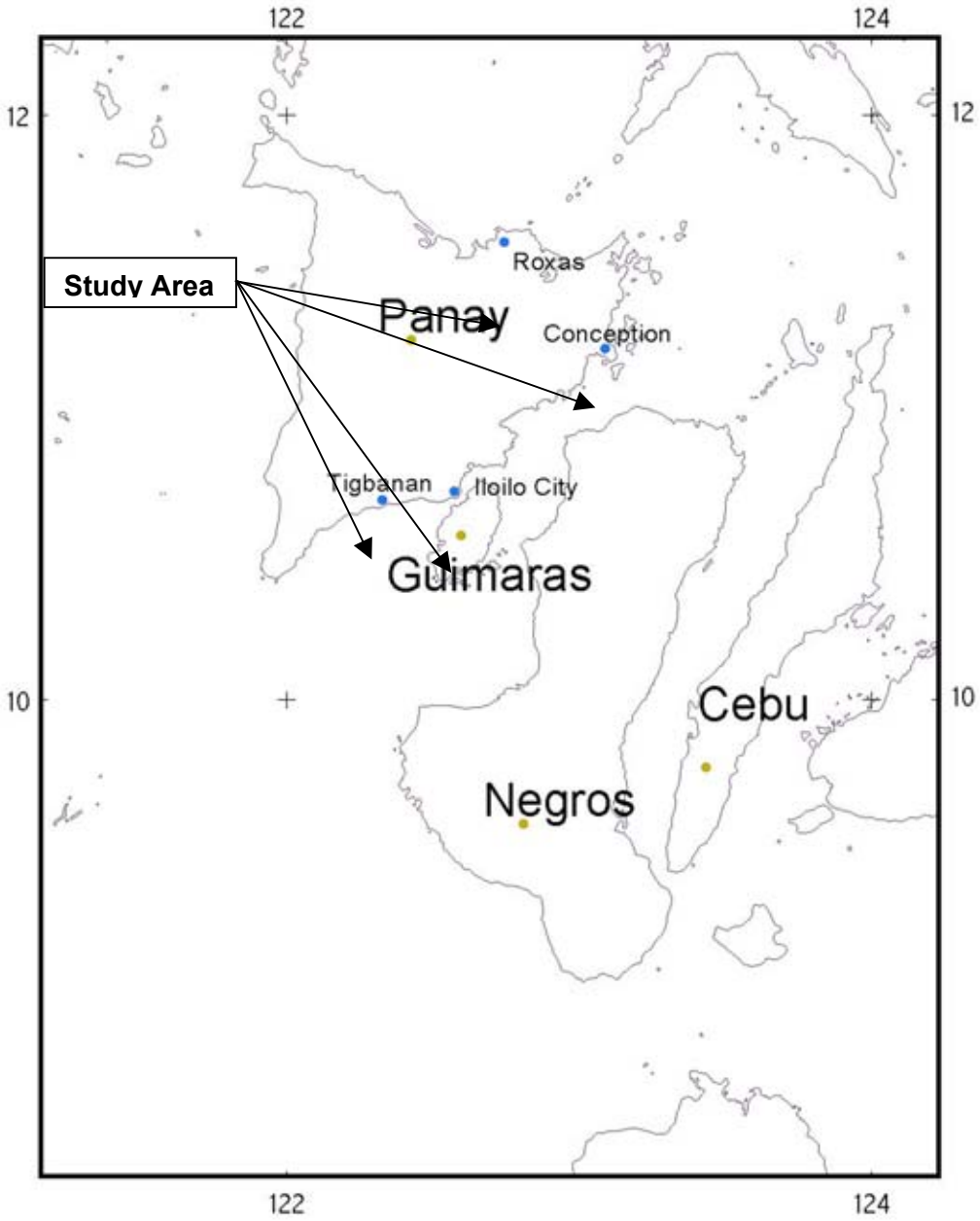

Fig. 1. Map of Panay Island, Philippines showing the study areas

Table 1. Descriptive statistics for Philippines fishers (N=259), Panay Island, 1995

Variable	Average	Standard Deviation
Age of fisher	32.7	10.2
Years in school	6.8	2.49
Household size	6.1	2.64
Children in school	1.9	1.50
Years in fishing	12.9	8.99
Percent income from fishing	98.2	8.22

Boat tonnage	12.0	28.12
Boat horsepower	137.3	102.4
Days fishing/year	242.8	61.16
Days per trip-Peak season	8.2	21.58
Days per trip- Low season	9.2	21.7
Days per trip-Normal season	12.1	25.5
Hours per trip-Peak	11.9	1.8
Hours per trip-Low	10.7	3.3
Hours per trip-Normal	10.9	2.6
Landings (kg)-Peak	3 153.5	9 188.6
Landings (kg)-Low	273.0	636.5
Landings (kg)-Normal	1 133.8	3 063.8
Catch value (P) -Peak	42 492.8	104 299.9
Catch value (P) –Low	5 117.74	10 465.7
Catch value (P) –Norma	17 497.89	40 100.96

Indonesia

The samples for Indonesia were selected from the Island of Java. Fishers from Pekalongan and Juwana were selected as these locations are the main centers of fishing activity in Central Java. About 70% of the medium- and large-scale vessels gather and 90% of the catch are landed in these two areas. A total sample of 187 large-scale operators consisting of 123 respondents form Juwana and 64 respondents from Pekalongan were interviewed. Another 102 respondents for the small-scale samples were interviewed in Pemalang, which is located nearby Pekalongan. The descriptive statistics for the data from Indonesia is given in Table 2. The specific regulation that is the focus in this study in Indonesia is the zoning regulation, which reserves three nautical miles from the shore for boats of five gross tonnes or less. Boats with inboard engines of more than 10 horsepower are also not allowed into the inshore region within three nautical miles from the shore.

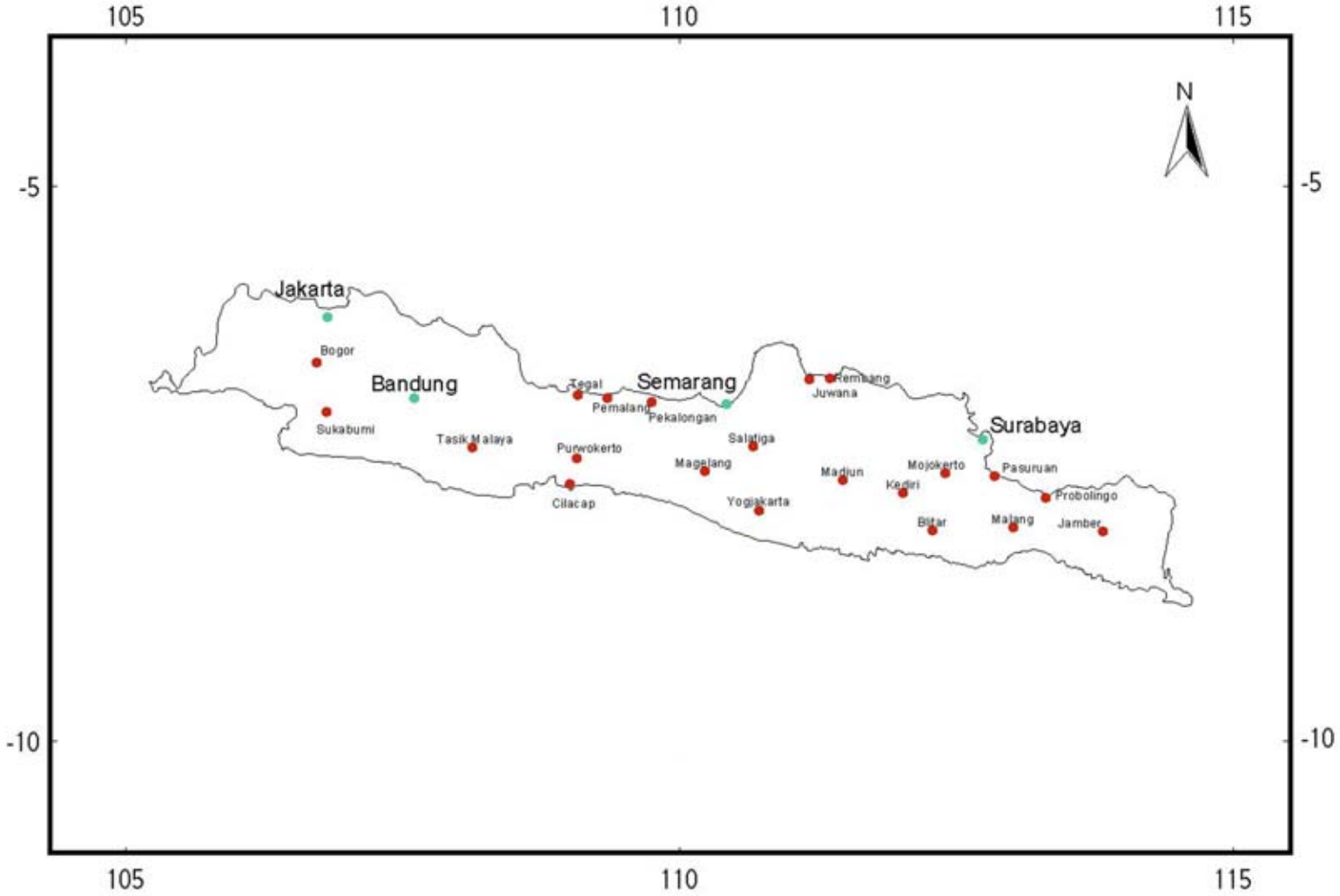

Fig. 2. Map of Java, Indonesia, showing the study areas

Table 2. Descriptive statistics for Indonesian fishers (N =187 for commercial fishers), Central Java, 1995

Variable	Average	Standard Deviation
Age of fisher	38.40	8.76
Years in school	1.25	0.82
Household size	3.73	1.92
Children in school	1.54	1.37
Years in fishing	17.75	8.16
Percent income from fishing	100.00	0.00
Boat tonnage	57.14	50.03
Boat horsepower	165.81	100.32
Days fishing/year	265.38	54.11
Hours per trip-Peak	400.80	155.52
Hours per trip-Low	657.74	246.40
Landings (kg)-Peak	33 813.64	34 389.29
Landings (kg)-Low	14 320.86	15 397.69
Landings (kg)-Normal	21 827.54	22 828.02
Catch value (Rp) -Peak	21 573 514	32 686 113
Catch value (Rp) -Low	16 756 351	15 283 635.0
Catch value (Rp) -Norma	18 823 649	20 029 184.7

Malaysia

The samples for Malaysia were selected from the west coast in the state of Kedah in the north of Peninsular Malaysia bordering Thailand. A total of 138 fishers from the fishing town of Kuala Kedah were interviewed. Kuala Kedah is an important fishing town in Kedah and accounts for some 20% of the total fishing landings of the west coast, and some 10% of the total Peninsular Malaysia's landings in 1995. The descriptive statistics for the data from Malaysia is given in Table 3. The regulation of specific interest for the analysis is the zoning regulation for trawlers. The Fisheries Act 1985 and its amendments in 1993 specifies that trawl nets can be used only in waters beyond 5 nautical miles from the coast (Government of Malaysia 1985). The most common violation by domestic fishing vessels in Malaysia is encroachment into the coastal waters that are off-limits to trawlers under the Fisheries Act (Goh 1976). About 90% of all arrests since 1985 were due to violations by trawlers of the 0-5-mile zone reserved for inshore fishers. The number of arrests and severity of sanctions has been on the increase during the past decade. The expenditure on fisheries enforcement increased by over 300% during the 1980s and continued to increase in the 1990s. During the late 1990s, enforcement expenditure accounted for about 16% of all government expenditure on fisheries. The large expenditure on enforcement also reflects a much more developed and organized fisheries enforcement program in Malaysia as compared to Indonesia and the Philippines. The enforcement of fisheries regulations in Indonesia and the Philippines is however limited. The limited government resource for enforcement is the main factor for the much reduced enforcement effort in Indonesia and Philippines. In addition the nature of the geography of these countries where Indonesia and the Philippines are made up of thousands of islands, make it very difficult for the State to enforce property rights over a common property such as the fisheries.

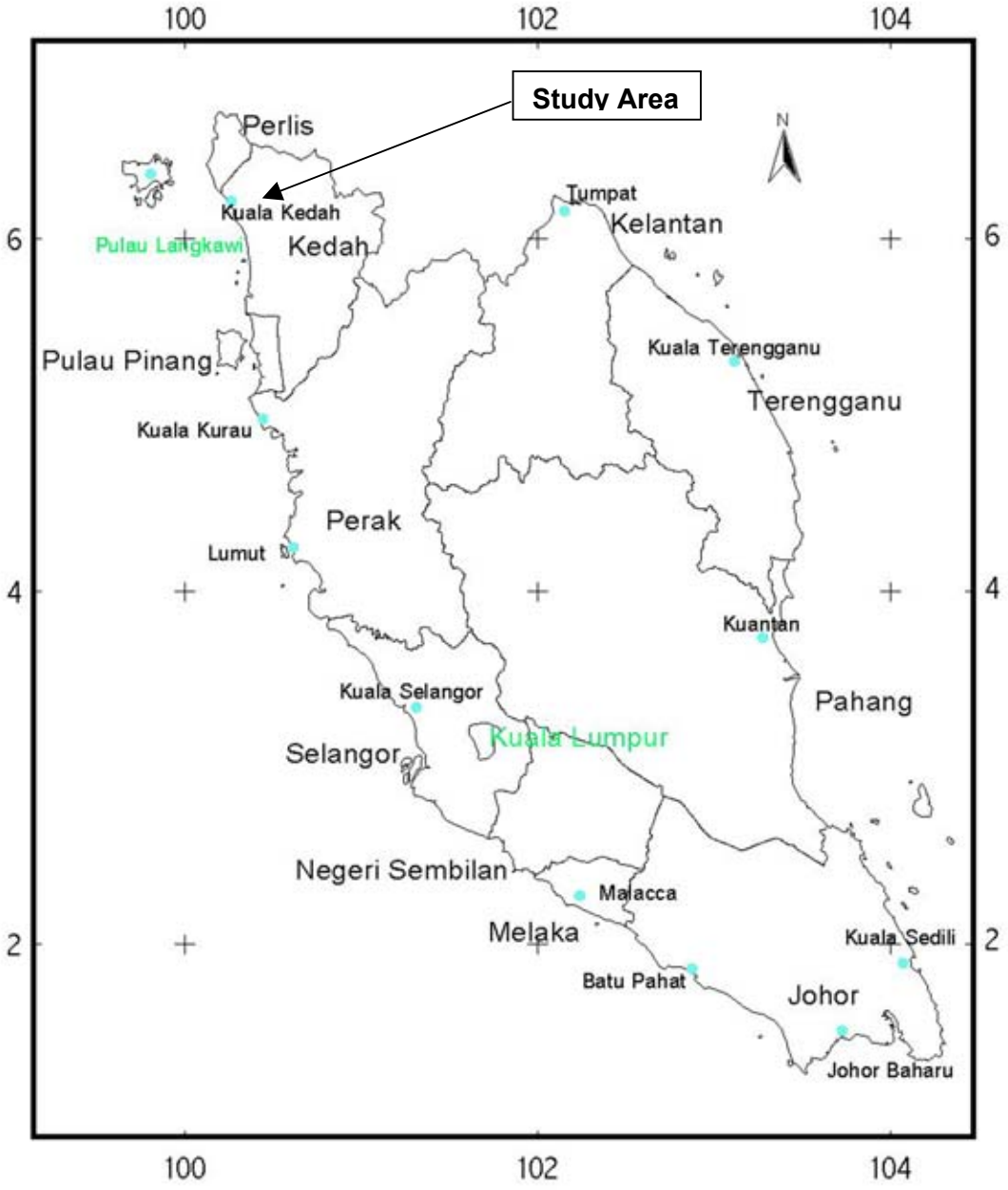

Fig. 3. Map of Peninsular Malaysia showing the study area

Table 3. Descriptive statistics for Malaysian fishers (N=138), Kuala Kedah, 1995

Variable	Average	Standard Deviation
Age of fisher	45.52	8.05
Years in school	5.61	2.54
Household size	6.02	2.33
Children in school	1.96	1.50
Years in fishing	24.38	8.19
Percent income from fishing	97.36	7.95
Boat tonnage	33.40	13.12
Boat horsepower	258.50	102.07
Days fishing/year	229.25	48.65
Hours per trip-Peak	27.82	42.41
Hours per trip-Low	26.58	28.91
Landings (kg)-Peak	1 569.43	2 423.02
Landings (kg)-Low	528.44	615.18
Landings (kg)-Normal	734.82	1 063.41
Catch value (RM) –Peak	1 850.63	2 078.89
Catch value (RM) –Low	788.04	743.12
Catch value (RM) –Norma	932.29	816.44

Specifications and Results

The Basic Deterrence Model

A fisher's decision to violate is modeled as a function of factors that affect his utility from fishing in the prohibited zone (inshore areas). The equation for estimating the violation decision in the basic deterrence model is

(2) $$VIOLT = f^{V}(CONSTANT, CPUEO, CPUEI, OPROB);$$

where VIOLT equals one for a fisher who fishes at least once inshore during the year and zero otherwise. CONSTANT is the intercept in the equation, CPUEO the catch-per-unit-effort in the offshore area, CPUEI the catch-per-unit-effort in the inshore area, and OPROB the overall probability of detection, arrest and conviction if caught violating. The CPUEO and CPUEI variables are the value of landings from offshore and inshore zones, respectively, divided by the number of hours trawled offshore and inshore.
The overall probability of detection and conviction (OPROB) is a subjective probability obtained from fishers directly through interviews. It is a product of a series of conditional probabilities, namely the probability of detection, the probability of arrest given detection, the probability of being brought to court given arrest, and the probability of being found guilty given the fishers is brought to court. The overall probability of detection variable (OPROB) is specified in three different ways for estimating equation (2): (i) as a raw probability obtained directly from the responses from the fishers, (ii) as a function of exogenous determinants of the overall probability of detection, and (iii) as an instrumental variable estimated in the first stage.

Raw Probabilities. Fishers were asked to provide their subjective assessments of the probability of being detected by enforcement officials while fishing in the inshore areas (PROBD), the probability of arrest

given detection (PROBDA), the probability of being taken to court given arrest (PROBDAC) and the probability of being found guilty given the fisherman is taken to court (PROBG). From these subjective probabilities the overall probability of detection and being found guilty for the *i*th individual is given by

(3) $$OPROB_i = PROBD_i*PROBDA_i*PROBDAC_i*PROBG_i$$

Exogenous Determinants of the Probability of Detection

The probability of detection and conviction may simply be determined exogenously by enforcement inputs and fisher's expenditure on evasion activities. In this case the overall probability of detection and conviction (OPROB) itself does not enter equation (2) directly. Instead, the exogenous determinants of OPROB, i.e., enforcement inputs and fisher's expenditure on evasion activities, enter directly to explain the violation decision. These variables are hypothesized to be horsepower (HP) of the engine in the fisher's boat, expenditure on evasion activities (EXPEVA), number of patrol boats in operation (NPBOATS) and the number of times fishers have seen enforcement personnel while at sea (NENFOR).

Estimated probabilities. The overall probability of detection and conviction is expected to be a function of enforcement and evasion inputs. The subjective probabilities of each fisherman may affect his own expenditures on capital inputs (such as larger engines and faster boats, detection evasion equipment such as radar and cellular phones), as well as his assessment of enforcement inputs. The perceived enforcement inputs include the number of patrol boats a respondent thinks are operating in his area, the number of times he has seen enforcement personnel at sea as well as the number of times he has had actual contact with enforcement personnel in terms of boarding or checks by enforcement personnel. The estimated overall probability of detection and conviction is modeled as:

(4) $$HOPROB = f(NPBOATS, NENFOR, EXPEVA, HP,)$$

where,

$HOPROB_I$ is the estimated overall subjective probability of detection and conviction for fisher i,
$NPBOATS_I$ is the number of patrol boats fisher i believes is in operation in his area,
$NENFOR_i$ is the number of times fisher i has seen enforcement personnel at sea,
$EXPEVA_I$ is the expenditure on evasion activity by fisher i, and
HP_I is the horsepower rating of the engine in the *i*th fisher's boat

Alternative specifications for the estimated overall probability of detection and conviction were tried. One specification included a variable for the number of actual contacts fisher had with enforcement personnel via boat boarding and checks, NCONTENF. However, the variable NCONTENF was not significant and did not improve the fit of the model. Another specification included the number of days fished inshore, NFINS, as an explanatory variable for the overall probability since the more a fisher fishes inshore, the probability of detection by enforcement personnel may be higher. The variable NFINS, however, turned out to be insignificant.

The estimated probability is used as an instrumental variable in equation (2). This is done because the decision to violate and the overall subjective probability of detection and conviction may be jointly determined. Two instrumental variables were used for OPROB, one using the ordinary least squares estimator (HOPROB) and another using the Tobit estimator (TOPROB), since the subjective probabilities lie between 0 and 1. The difference between the two is negligible.

Table 4. Probit estimation of violation decision in the basic deterrence model using raw probabilities

Variable	Malaysia	Indonesia	Philippines
CPUEO	0.0000887	0.0000421	-0.00016
	(0.69855)	(0.86946)	(-0.7227)
CPUEI	-0.0000802		0.05579***

	(-0.56946)		(7.4410)
PROBD	0.054789	-0.0087398	-0.00678***
	(0.15616)	(-0.23336)	(-2.7576)
PROBDA	-0.44753	-0.001001	-0.00064
	(-1.2916)	(-0.072065)	(-0.1673)
PROBDAC	0.29785	0.009122	0.00708*
	(0.91980)	(0.89752)	(1.8922)
PROBG	-0.21646	0.004821	
	(-0.77771)	(0.88160)	
PROB12			
PROB34			
CONSTANT	0.54829***	-0.53319***	-0.86351**
	(3.0048)	(-5.0045)	(-2.5049)
Log-likehood	-87.23	-115.33	177.42
Likelihhod Ratio Test	3.8613	12.1542	123.63**
McFadden's R^2	0.0216	0.05005	0.34843
N	138	187	259

Note: *table-ratios in parentheses*
** : significant at 10% level*
*** : significant at 5% level*
**** : significant at 1% level*

Table 5. Probit estimation of violation decision in the basic deterrence mmdel using estimated probabilities

Variable	Malaysia	Indonesia	Philippines
CPUEO	0.0000706	000033503	-0.00031
	(0.54205)	(0.69809)	(-1.3407)
CPUEI	-0.000037		0.05693***
	(-0.26229)		(7.8661)
HPROBD	-0.29348	-0.052043	-0.00970
	(-0.52112)	(-0.53821)	(-0.5209)
HPROBDA	0.60188	-0.14349	0.02484
	(0.81589)	(1.2834)	(1.1575)
PROBDAC	3.5821	0.008442	
	(1.3705)	(1.0899)	
PROBG		0.005401	
		(1.0360)	
PROB34	-3.6980		
	(-1.4552)		
CONSTANT		-0.92526***	-2.1059
		(-4.9172)	(-1.8590)
Log-likehood	-85.095	-111.68	-177.42

Likelihhod Ratio Test	8.1299	19.4604	112.99
McFadden's R^2	0.045	0.0801	0.318
N	138	187	259

Note:

table-ratios in parentheses
** : significant at 10% level*
*** : significant at 5% level*
**** : significant at 1% level*

As shown in Tables 4 and 5, the variables used do not explain the violation decision well in Malaysia and Indonesia for the 1995 data. In the Malaysian case a comparison is made with the results obtained similarly from the catch-per-unit-effort variables CPUEO and CPUEI. It must be emphasized however, that there are fewer ambiguities in the measurement, interpretation and direction of causation with these variables (CPUEO and CPUEI) than with the probability of detection variables. The significance of the CPUEO and CPUEI variables clearly indicates that one of the key factors pushing fisher to violate the zoning regulation is the differential in income potential between the inshore and offshore areas. The positive sign on the CPUEI variable shows that the higher the catch per unit in the inshore areas the higher the probability of a violation by the trawler fisher. The significant probability of detection variables are PROBD, HPROBDA and NENFOR. The positive signs contradict our theory. The reasons for and implications of this finding are discussed below.

The Extended Model of Compliance[8]

The compliance model is extended to include the effects of moral obligation and social influence on compliance behavior. The moral obligation to comply is assumed to depend on the individual's moral development and on the perceived legitimacy of the regulatory institution. The Kohlberg Standard Issue Moral Judgment Interview and Scoring System (Cobly and Kohlberg et al. 1987a) was used to rank fishers according to their level of moral development. The variable MCODE provides a one to three ranking of individual fishers on the Kohlberg scale of moral development. Fishers were placed in three categories: preconventionalist, conventionalist, and postconventionalist. The preconventionalist was given a rank of 1, the conventionalist a rank of 2, and the postconventionalist a rank of 3. The placement of fishers on each of the ranks was based on their responses to a set of moral dilemma questions regarding the fishery regulation. Kohlberg's theory of moral development asserts that the preconventionalist and conventionalist are more likely to violate a regulation than the postconventionalist (Colby et al. 1987a and b, p.16). This hypothesis is tested below.

The legitimacy accorded to the regulatory authorities by a fisher is measured by 12 variables reflecting the individual fisher's assessment of the outcomes and procedures associated with the regulation. The outcome variables are CONSERVE, CONFLICT, JUST, EVERYONE, INSHORE and OFFSHORE. For each of these variables the respondent ranked his level of agreement with each statement (Table 6) on a scale of one to five, where a higher score indicates stronger agreement. The theory is that individuals that agree with these outcome variables are also likely to accord a higher level of legitimacy for the enforcement agency and thus exhibit greater compliance with the regulations (Tyler 1990a). The six process variables are RIGHT, VIEWS, NONCONST, NODETECT, PENALFIT and ENFORADQ. Respondents ranked their level of agreement or disagreement with the statement on a scale of one to five. Tyler finds that individuals who disagree strongly with statements similar to those used here tend to accord a lower level of legitimacy to the enforcement agency and exhibit a lower compliance rate. Tyler also concludes that the process variables are more important than the outcome variables in influencing legitimacy and that procedural justice is more important than procedural efficiency in influencing legitimacy and compliance.

[8] A formal specification of this model is given in Appendix I.

Table 6. Legitimacy variables

Variable	Question
CONSERVE	The principal reason for the 5-mile restriction on trawlers is to conserve and protect the fishery resource.
CONFLICT	The principal reason for the 5-mile restriction on trawlers is to avoid conflict between inshore and offshore fishers.
JUST	The 5-mile offshore zoning regulation is a just regulation.
EVERYONE	The 5-mile offshore zoning regulation improves the long-term wellbeing of all fishers.
INSHORE	The 5-mile offshore zoning regulation improves the long-term wellbeing of inshore fishers.
OFFSHORE	The 5-mile offshore zoning regulation improves the long-term wellbeing of offshore fishers.
RIGHT	The government is doing the right thing imposing regulations with regards to fishing in certain areas of the sea.
VIEWS	The views of fishers are taken into account in the formulation of fisheries regulations.
NONCONST	The 5-mile offshore regulation is not enforced consistently.
NODETECT	Many trawler fishers who fish in the inshore areas are getting away with it (i.e., not detected or penalized).
PENALFIT	The penalties given to trawler fishers who are caught violating the 5-mile offshore zoning regulation "fit the offense."
ENFORADQ	Enforcement in inshore fishing areas is adequate.

As indicated above, the behavior of others is expected to influence the behavior of individual fishers. In particular, fishers are faced with competition for fish resources that are migratory, i.e., moving from inshore to offshore. If a large proportion of fishermen are violating the regulation, nonviolators lose out to violators in the competition for fishery resources. Also, the social reputation of a fisherman is not as likely to be affected if he violates in a community where a large proportion of the fishermen are violating. To capture the effect of what others are doing, the variable PERTVIOL, which indicates the percent of fishers perceived to be violating the regulation, is used. The variable is each fisher's subjective assessment of the percent of fishers in his area violating the regulation prohibiting trawling in the inshore areas.

Table 7 shows the results of including the nonmonetary intrinsic and extrinsic variables in the model for explaining violation decision. As in the basic deterrence model, the variables reflecting the differential in income potential from fishing offshore and inshore, CPUEO and CPUEI, are significant and have the expected signs. The raw overall probability is insignificant while the estimated overall probability, HOPROB, is significant and positive, a sign that contradicts theory. The moral development variable, MCODE, and the social influence variable, PERTVIOL, are significant and have the expected signs. Two of the outcome variables, CONFLICT and EVERYONE, are significant at the 1% level in both specifications of the model. The negative signs for CONFLICT and EVERYONE imply that fishers are less likely to violate if they agreed with the statement that the objective of the regulation is to reduce conflict and benefits to all fishers, suggesting that fishers favor the regulation if it reduces conflicts or benefits everyone. Two other outcome variables, JUST and OFFSHORE, are significant only at the 10% level and in alternative specifications of the model. None of the process variables were significant, implying that the decision to violate or not to violate does not seem to depend on the process variables, the opposite of the conclusion of Tyler (1990a) that process variables are more important.[9]

[9] The statistical model used by Tyler for assessing the effect of these normative variables is different from the model used here in that he used a ranking variable of 1 to 5 for measuring compliance. Also, he used the inappropriate OLS statistical model.

Table 7. Probit estimates of the extended compliance model

Variable	Model with Raw Probabilities	Model with Estimated Probabilities
CONSTANT	1.754*	1.242
	(3.542)	(1.493)
CPUEO	-0.00411*	-0.00440*
	(-2.683)	(-2.757)
CPUEI	0.00872*	0.00896*
	(6.529)	(6.698)
OPROB	-0.648	
	(-1.160)	
HOPROB		4.650*
		(6.710)
MCODE	-0.773*	-0.781*
	(-4.940)	(-4.992)
PERTVIOL	0.0124*	0.0122*
	(2.332)	(2.286)
CONSERVE[1]	0.0573	0.0475
	(0.454)	(0.376)
CONFLICT[1]	-0.307*	-0.305*
	(-2.312)	(-2.328)
JUST[1]	0.194	0.212**
	(0.121)	(1.758)
EVERYONE[1]	-0.374*	-0.405*
	(-2.459)	(-2.630)
INSHORE[1]	-0.0873	-0.947
	(-0.688)	(-0.748)
OFFSHORE[1]	-0.206**	-0.191
	(-1.734)	(-1.568)
RIGHT[2]	0.142	0.139
	(1.180)	(1.150)
VIEWS[2]	-0.0268	-0.0146
	(-0.284)	(-0.156)
NONCONST[2]	0.110	0.106
	(1.398)	(1.353)
NODETECT[2]	0.0125	0.0244
	(0.130)	(0.251)
PENALFIT[2]	0.079	0.0785
	(0.825)	(0.822)
ENFORADQ[2]	0.081	0.0691
	(0.962)	(0.764)
Log-likelihood	-99.733	-100.19
Likelihood-rtest	161.44*	160.52*
Mcfadden's R^2	0.41599	0.412

1-outcome variable (t-ratios in parentheses)
*2-process variable **significant at 1% level* ***significant at 5% level*

Number of Days Fished Inshore

We turn now to look at another aspect of compliance behavior, i.e. the number of days fishers fish in the prohibited zones (i.e., the extent of violation). The number of days a fisher violates is important since it is the frequent or flagrant violators that threaten the success of a regulation. The decision whether to comply provides only a partial picture of the compliance problem since all fishers who violate one or more times fall into one category. In practice, an occasional infraction may not be considered serious by fishers or by enforcement authorities, while the frequent and flagrant violator may be sanctioned socially by other fishers and/or targeted by enforcement agencies.

The number of days fished inshore has a minimum value of 0 for those who report not fishing inshore and a maximum value equal to the total number of days fished during the year. In the data collected the maximum number of days fished inshore is 300 days. This means that the dependent variable (NFINS) is truncated in the sense that the lowest value is zero and the highest value is 300. A Tobit model is used to estimate the number of days fished inshore for the sample of 792 observations. The first two columns of Table 8 present the results of the estimation.

Table 8.Tobit estimates of the number of days fished inshore (NFINS)

Variable	**All Fishers** (Model with raw probabilities)	**All Fishers** (Model with estimated probabilities)	**Violators Only** (Model with raw probability)	**Violators Only** (Model with estimated probability)
CONSTANT	26.392*	56.436*	16.346	49.776*
	(2.001)	(2.870)	(1.143)	(2.458)
CPUEO	-0.0953*	-0.0731*	-0.0844*	-0.0585***
	(-3.010)	(-2.321)	(-2.528)	(-1.771)
CPUEI	0.0217*	0.0208*	0.0146*	0.0132*
	(4.103)	(3.964)	(2.759)	(2.530)
OPROB	-44.155*		-31.309	
	(-2.647)		(-1.589)	
HOPROB		-342.581*		-398.811*
		(-2.262)		(-2.570)
MCODE	-20.538*	-19.892*	-10.784*	-9.023***
	(-4.601)	(-4.469)	(-2.143)	(-1.804)
PERTVIOL	0.874*	0.857*	0.823*	0.840*
	(6.810)	(6.740)	(6.156)	(6.327)
CONSERVE[1]	-5.605	-4.542	-5.385	-3.940
	(-1.609)	(-1.307)	(-1.465)	(-1.068)
CONFLICT[1]	-6.334**	-5.257	-2.428	-1.549
	(-1.836)	(-1.539)	(-0.683)	(-0.446)
JUST[1]	0.629	1.253	-1.586	-1.152
	(0.173)	(0.347)	(-0.404)	(-0.300)
EVERYONE[1]	-7.875**	-8.630*	-4.448	-5.010
	(-1.928)	(-2.128)	(-1.041)	(-1.189)
INSHORE[1]	5.278	4.468	9.324*	8.634*
	(1.567)	(1.326)	(2.710)	(2.523)
OFFSHORE[1]	-6.162**	-7.212*	-4.323	-4.871

	(-1.808)	(-2.138)	(-1.165)	(-1.335)
$RIGHT^2$	8.062*	9.241*	3.9366	5.238
	(2.240)	(2.558)	(1.008)	(1.346)
$VIEWS^2$	-4.976**	-4.846**	-6.824*	-6.902*
	(-1.949)	(-1.913)	(-2.565)	(-2.631)
$NONCONST^2$	3.001	2.605	3.138	2.685
	(1.254)	(1.089)	(1.238)	(1.066)
$NODETECT^2$	-3.167	-3.690	-2.877	-4.014
	(-1.139)	(-1.312)	(-0.993)	(-1.374)
$PENALFIT^2$	-2.071	-1.539	-1.522	-0.932
	(-0.789)	(-0.591)	(-0.543)	(-0.337)
$ENFORADQ^2$	8.745*	8.818*	7.529*	7.867*
	(3.298)	(3.338)	(2.612)	(2.750)
σ	47.742	47.634	45.621	45.228
	(21.316)	(21.316)	(21.480)	(21.479)
Log-likelihood	-1297.2	-1293.2	-1220.7	-1218.7

1-outcome variable *(t-ratios in parentheses)*
2-process variable ** significant at 1% level*
*** significant at 5% level*
**** significant at 10% level*

The catch-per-unit-effort variables for inshore and offshore (CPUEO and CPUEI) continue to be significant and have the expected signs. Unlike above, the overall probability of detection has the expected sign and is statistically significant whether used in a raw or estimated form. The moral development variable is also significant at the 1% level of significance while the negative sign is consistent with Kohlberg's theory of moral development. The PERTVIOL variable, reflecting the fisherman's subjective assessment of the proportion of fishermen who are violating the regulation, is significant and exhibits the expected positive sign.

The performance of the legitimacy variables is marginally better in this model than in the model of the violation decision. Six of the 12 variables used to measure legitimacy, three outcome and three process variables, are statistically significant. As above, the outcome variables CONFLICT, EVERYONE and OFFSHORE are statistically significant (though not consistently) and exhibit the expected signs. The interpretation is the same as above. In addition, the process variables RIGHT, VIEWS and ENFORADQ are statistically significant. The positive signs for the RIGHT and ENFORADQ variables indicate that if fishers agree that the government is right in imposing the regulation or that the enforcement of the regulation is adequate, then the fishermen's violation rates are higher. This appears contrary to theory but may be plausible because it is rational for violators to support tough regulations, especially if enforcement is relatively weak and compliance due to moral and other reasons is high. The exclusion of voluntary compliers from the regulated or prohibited zone increases the marginal value product of fishing for the violators in the regulated zone. The other significant process variable is VIEWS, exhibiting the expected negative sign. The sign implies that the more a fishers agrees that the views of fishermen were taken into account in the formulation of fisheries regulations the lower is the violation rate.

For further comparison, a Tobit estimate for violators only was made. The second two columns of Table 8 present the results of the Tobit estimate of the number of days fished inshore by the violators only. The results on the variables CPUEO, CPUEI, MCODE, and PERTVIOL are the same as for the whole sample (violators and nonviolators). The estimated overall probability, HOPROB, is statistically significant and of the expected sign, though the raw overall probability, OPROB, is not statistically significant. The

performance of the legitimacy variables is not as strong as for the whole sample. Only one outcome variable, INSHORE, is statistically significant. Its positive sign indicates that violators violate more if they believe that the regulation is benefiting inshore fishers only. This makes sense as the outcome of the regulation which benefits one group, which in essence is in competition for the same resource with the other group, will attract noncompliance from the other group which feels that it is not benefiting from the regulation. When groups feel that the outcome of the regulation favors one against the other, it erodes the legitimacy the individuals in that group have for the institutions enforcing the regulation, thus increasing noncompliance.

Two process variables that are also significant in the violators' only model are the VIEWS and ENFORADQ. Whether the management authority considers their views in formulating regulations will influence legitimacy and compliance levels or not is clear for violators, as for the whole sample. As before, the positive sign for the ENFORADQ variable implies that violators who believe that there is adequate enforcement are also likely to violate more. Fishers who fish more days inshore stand to lose more from increases in enforcement; therefore, it is rational for them to oppose strengthening enforcement by indicating it is adequate.

Discussion

The variables CPUEO and CPUEI are consistently significant with the expected signs in all of our estimates of the violation decision and the number of days fished in the prohibited zone. These variables, reflecting the relative stock abundance and income potential in the two zones, play a major role in the compliance decisions of fishers. The variables MCODE and PERTVIOL also are consistently significant with the expected signs, providing strong support to the theory in the compliance literature that moral development and social influence are important determinants of compliance behavior.

The normative perspective on compliance behavior, which emphasizes the role of legitimacy of enforcement institutions and agencies in securing compliance, is not as strongly supported by our estimates. No set of legitimacy variables is consistently significant with the sign predicted by legitimacy theory. To the extent our results have merit, they contrast with Tyler (1990a) and Tyler et al. (1989) who conclude that process variables are more important. Our results indicate outcome variables play a more consistent and significant role.

Issues of Theory and Estimation

An important area of concern is the inconsistent performance of the variables measuring the probability of detection and conviction. The first explanation of the poor performance is related to the subjective probabilities used in this study. Subjective probabilities are difficult to analyze because we do not know how these subjective probabilities are generated, and what biases may be inherent in them. Tversky and Kahneman (1974) describe some of the biases in judgment about probabilities. They show that people rely on a limited number of heuristic principles, which reduce the complex tasks of assessing probabilities and predicting values to simple judgmental operations. They conclude that in general these heuristics are quite useful, but sometimes lead to severe and systematic errors of thinking under uncertainty.

A second explanation is that respondents may not understand the concept of probabilities. This points to the need for better ways or instruments for eliciting and assessing subjective probabilities. The issue of not understanding probabilities is also plausible as the average educational level of the fishers in the survey areas was just six years of schooling. It is possible that the fishers are not able to give good probability estimates for the overall probability of detection and arrest but are able to give fairly good estimates of the probability of detection (PROBD) and the probability of arrest given detection (PROBDA). These two subjective probabilities did make sense in the estimation.

A third reason for the lack of significance of the overall probability variable is that fines or penalty are not included as arguments in the model. This could not be done because a large proportion of respondents (38%) did not respond to the question of amount of fine paid for violation activities. It is possible that

probabilities may not make a difference,[10] but fines may make a difference in the deterrence model. In terms of a fisher's decision, it may not be probabilities but fines that really matter and thus support the hypothesis of the basic deterrence model that it is the value of the expected penalties compared with the value of expected benefits that really determines whether a fishers will violate a regulation.

A fourth reason for the insignificance of the probabilities of detection and conviction in the violation decision is that the simultaneity problem in the estimations has only been partially handled by using a two-stage estimate of the probabilities of detection and conviction. The identification problem with the probabilities of detection and conviction has however not been solved. The system has not been fully identified. Fishers who have higher probabilities of detection are also the fishers who are fishing more in the inshore areas and also those who spend more on evasion activities and more powerful boats. This itself makes them targets for greater enforcement action. Thus enforcement inputs such as NPBOATS, NENFOR and evasion activities such as EXPEVA and HP are likely to be endogenous variables. There is not enough information on other variables linked to these endogenous variables to identify all of them for estimation.

Finally, a fifth reason for the failure of probabilities of detection and conviction to be significant is that there may be other influences in the study areas that are not captured in the model but important enough to reduce the impact of the probabilities on the violation decision. An example of such influences may include syndicates that may be able to influence enforcement personnel or obtain early information on surveillance activities. Stories regarding this have been reported by fishers, and even the head of the enforcement section of the Malaysian Fisheries Department has voiced concern that there are insiders who warn fishers of the planned surveillance activities of the Department so that they can avoid detection and arrest. Fishers have also reported that those trawler-owners who have arrangements with enforcement personnel have methods of signaling this through the way they store their nets in their boats and thus avoiding arrest. It must be emphasized however that we have no empirical evidence on these other influences.

As noted above, our estimates do not lend much consistent support to Tyler's theory of legitimacy. There are at least two possible explanations for our findings. One, obviously, is that the theory is wrong. The other explanation relates to the measurement of the legitimacy variables. We attempted to develop measures analogous to those used by Tyler; however, instruments for measuring legitimacy are not nearly as well-developed and refined as, for example, those for measuring moral development. Given the theory's great intuitive appeal and ability to explain casual empirical evidence, we suspect our measures of legitimacy are imperfect and require further testing, development and refinement. Only then can we be confident of a sound empirical test of the theory.

Summary and Conclusions

This analysis of fisher's compliance demonstrates that the extension of the basic deterrence model to include moral, legitimacy, and social influence variables results in a richer and superior model of compliance behavior. The analysis provides empirical support for the argument that morals, legitimacy and the behavior of others are important determinants of compliance in addition to self-interest.[11] These variables are important both for the study of compliance behavior and for the design and implementation of regulatory policy.

Implications for Policy

The results of our analysis provide modest support for traditional enforcement policy. Our estimates indicate that the number of violations by those violating can be reduced by strengthening enforcement (i.e., by increasing the probability of detection and conviction). However, the estimates of the deterrent effect of the probability of detection and conviction imply that adding enforcement resources will not likely reduce

[10] Furlong's (1991) study of regulatory enforcement in the Quebec fishery found the deterrent effects of penalties on violation rates statistically insignificant.

[11] Frank (1988) however has argued that moral behavior is in the long term self-interest of an individual.

the number of violators. As indicated above, these results are weakened by the problems associated with measuring the appropriate probabilities.

The significance of the catch-per-unit-effort variable both in the decision to violate and the extent of violation pose some serious problems for policymakers. If enforcement becomes more successful in keeping trawlers out of inshore areas, the difference in the catch-per-unit-effort between the zones will become more pronounced, increasing the incentive to violate. The ability to obtain high levels of compliance will to a large extent depend on whether zoning regulations can also result in higher catch-per-unit-effort in the offshore regions. If this does not happen the pressure on enforcement resources will increase as trawler-fishers attempt to violate the regulations to make up for the difference in the stock between the two zones.

According to compliance theory, the willingness to comply stemming from moral obligation and social influence is based on the perceived legitimacy of the authorities charged with implementing the regulations. Other evidence (Tyler 1990a, b) suggests that a key determinant of perceived legitimacy is the fairness built into the procedures used to develop and implement regulatory policy. To the extent that this is valid, enforcement authorities should determine what policies and practices are judged fair by segments of the population subject to regulations. This may mean, for example that civil penalties and other sanctions should be comparable in value to the larger of the harm done or gains realized. This may mean that fishers subject to surveillance and monitoring be treated with dignity and respect. This may mean that the boundaries of the closed zone be both reasonable and appropriate as perceived by fishers.

If a high degree of compliance can be realized via the twin forces of moral obligation and social influence, the question that arises then is whether enforcement is necessary. We argue that it is, that enforcement is an essential element of compliance policy. In almost any group of individuals subject to regulation there is often a core subgroup (usually small) of chronic, flagrant violators[12]. Chronic, flagrant violators tend to be motivated only by the direct tangible consequences of their actions. Moral obligation and social influence have little or no effect on their behavior. Only changing the economic incentives, by reducing the illegal gain or by increasing the expected penalty, can there be control in the amount of violations by this subgroup. In the absence of a tangible incentive mechanism (e.g., monetary rewards for compliance), the only means of controlling this subgroup is left to enforcement. Even if the subgroup of chronic, flagrant violators is small and the amount of their violations is minor, there is still a need to control their illegal activity. Eliminating enforcement would allow chronic, flagrant violators to flaunt their violation of the law. Being seemingly immune to the regulations sends two signals to the larger group who normally comply. One is that regulatory procedures are unfair, having no effect on flagrant violations of fishing regulations. The other is that the regulatory program is not effectively protecting the fishery resources and inshore fishers. Each of these signals weakens the moral obligation to comply and the moral basis on which social influence is exercised. As moral obligation and social influence are weakened, compliance begins to erode among those who would normally comply with the regulations. Their subsequent noncompliant behavior influences others not to comply with the regulations, and ultimately compliance breaks down.[13] Only effective enforcement can prevent this deterioration.

[12] Gauvin (1988) and Bean (1990) estimate roughly 10% of the fishermen in the Massachusetts lobster and Rhode Island clam fisheries frequently and flagrantly violate major regulations. The other 90% of fishermen normally comply, exhibiting much lower violation rates. These estimates are similar to the results reported in numerous other studies (see Feldman 1993 for a review).

[13] This process of deteriorating compliance is believed to have occurred in Northeast U.S. fisheries in the late 1980s (Sutinen, Rieser, and Gauvin 1990).

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Definitions of the Variables

AGE	Age of fisherman
YEARS	Years as a fisherman
TYEARS	Years as a trawler fisherman
TON	Gross registered tonnage of boat
HP	Horsepower rating of engine in the boat
DFISH	Total number of days fished in a year
CPUEI	Catch-per-unit-effort in inshore area in value terms
CPUEO	Catch-per-unit-effort in offshore area in value terms
DCPUE	Difference in catch-per-unit-effort between inshore and offshore in value terms
PERTVIOL	Percent of fishermen who are perceived to be violating the zoning regulation
MLOSS	Trawler fishermen's estimate of monthly loss due to the zoning regulation
NENFOR	Number of times fisherman has seen enforcement officers at sea during the study period of one year
NPBOATS	Number of patrol boats operating in the fisherman's fishing area during the study period of one year
NCONTENF	Number of times fisherman has been stopped and checked by enforcement officers during the study period of one year
TNINSP	Total number of inspections made by enforcement officers on the fishermen's boat during the study period of one year
PROBD	Fisherman's perceived probability of detection by enforcement authorities if he undertakes a

	violation activity
PROBG	Fisherman's perceived probability of being found guilty if he is arrested and brought to the court
NFINS	Number of days the fisherman has fished in the inshore areas during the study period of one year