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Social Norms and Illicit Behavior: An Evolutionary Model of Compliance

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Abstract

Economists have viewed the presence of externalities and other market failures as leading to a private equilibrium that would not be Pareto optimal. In the exploitation of common pool resources, especially biological resources, this would lead to the much-discussed 'tragedy of the commons'. A challenge to this traditional view has emerged from a careful study of the theory and practice of the exploitation of common property resources. The existence of a social norm may provide an individual with information on the extent of external costs associated with a behavior, and thus provides an imperfect means of internalizing the external costs. In this paper we propose an evolutionary model of compliance that allows for the existence of a social norm. The impact of the social norm on public policy towards externalities is examined.

Keywords: social norms, tragedy of the commons, externalities

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1. Introduction

Economists have tended to view the presence of externalities and other market failures as leading to a private equilibrium that would not be Pareto optimal. In the exploitation of common pool resources, especially biological resources, this would lead to the much-discussed ‘tragedy of the commons’. A challenge to this traditional view has emerged from study of the theory and practice of the exploitation of common property resources. A considerable body of research shows that, for many common pool resources, a private equilibrium embedded in an endogenous institutional structure has resulted in sustainable harvests and biomass. Evidence for these findings appears in numerous places, including Feeney et al., Ostrom (1990), McKay and Acheson, Sethi and Somanathan[1].

The central insight that drives these common property equilibria is the individual’s recognition that individual restraint on behavior can be welfare improving for the individual as well as for the group. From this recognition springs a variety of institutional arrangements that lead to restrained exploitation of resources. Much of the common property literature is devoted to explaining the details of these arrangements.

While the idea of a social norm is intuitively appealing, its real attraction is that it explains some equilibria better than the decentralized equilibria in which decisions are made by individual utility-maximizing individuals. We base our analysis on a study of marine debris discharged from small boats, where the standard utility-maximizing model would predict a great deal less adherence to the rules and regulations about throwing trash overboard than is found in practice. The decline in roadside debris in the US can be explained more easily with a social norm than with the decentralized utility-maximizing model.

Two sorts of mechanisms have been supposed to induce restraint in the absence of collective and legal restrictions—social coercion and social norms. Social coercion occurs when individual behavior appears to violate common accepted restraints. For example, Sethi and Somanathan report that in Bahia, Brazil, the sabotage of equipment effectively restrained fishermen from harvesting outside their socially sanctioned areas. In the Maine lobster fishery, people who fished outside their grounds could expect community censure and possible loss of gear. Many of the cases discussed in the literature involve coercion in some form. In contrast, in an equilibrium induced by a social norm, individuals follow the norm not so much from the external losses caused by the deviation, but the internal loss (in utility) from being different, even if there are no consequences. The idea of a social norm is closely allied with moral considerations. Individuals appear to choose behavior that is morally correct[2]. Externally they appear observationally equivalent. A relevant question is whether one can explain the evolution of either motive.

These mechanisms for equilibria have been chiefly aimed at understanding the allocation of resources, often living resources such as fish or game. Pollution is another class of problem that bears formal similarities to the common property problem. In the case of pollution, economic agents jointly exploit the assimilative capacity of the environment, with returns that vary across agents depending on the cost of pollution control, and with damages that depend on the impact of pollution across agents. While privately negotiated equilibria may be Pareto-optimal with small numbers of agents and clear liability, with large numbers the equilibrium is typically inefficient.

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[1] An extensive literature exists on the relationship between collective action and common property equilibria. Ostrom (2000) provides a comprehensive overview of this literature.

[2] For a discussion of the relationship between social norms and individual rationality see Elster, 1989.

Our purpose in this paper is to use the idea of a social norm to understand some situations in which individuals voluntarily control their own polluting behavior and perhaps achieve an efficient allocation of resources. It is worth emphasizing at the beginning that not all polluting behavior is subject to control by social norms. Indeed, one of the tasks of these modeling exercises is to try to understand what kinds of activities will come under the influence of a social norm.

Consider, for example, two kinds of pollution generated by a common activity, automobile use. One is air pollution, generated by all cars by the act of driving, but which varies considerably across cars in an unobservable way. The other is littering—the illegal or illicit disposal of trash from an auto. This is easily observed, with obvious visual damages. It seems unlikely that the existence of a social norm would help in the reduction of auto emissions. Monitoring violations is costly and the cost of reducing auto emissions is high. Litter, however, is easier to monitor and relative to auto emissions, cheap to reduce. The substantial reductions in littering can be explained quite well by the working of a social norm. First consider the explanation of the standard economic model of individual behavior, where each individual disposes of trash according to his own benefits and costs. A decentralized equilibrium would occur where there would be substantial littering, because it is in no individual's interest to reduce litter, even in the presence of regulations. The private marginal benefits of open access trash disposal would be the foregone private costs of trash disposal. The private marginal cost of such disposal would be the expected fines from detection and conviction plus the almost surely negligible loss of the individual's amenity values for the reduced trash. Calculated in this way, marginal benefits almost surely exceed marginal costs. Yet if we look at individual behavior with regard to littering, most people in the US do not dispose of trash illegally. Further, there has been a rather substantial decline in litter over the past four decades. The standard economic model does not predict well the behavior we observe. This voluntary reduction in littering can be explained with the presence of a social norm. Alternatively, the reduction in auto air emissions has been achieved almost exclusively through technical restrictions on automobile engines and emissions treatment systems.

There are several reasons for modeling and understanding the voluntary control of emissions. As we will demonstrate in our modeling exercise, voluntary reductions in pollution emerge because people gain increases in utility when they restrain their pollution. Consequently pollution reduction will be cheaper when it can be achieved by adherence to a social norm. It requires fewer governmental resources in the control and monitoring, and less coercion of individual activities. The possibility of achieving pollution reductions more cheaply has not been explored, but given the growing recognition of the costs of pollution control, seems worth examining. Over-compliance to pollution standards by industrial enterprises has been observed by Arora and Cason, and by Horowitz and McClelland. One explanation for this over-compliance is the voluntary adherence to a social norm.

Economic ideas for the efficient control of emissions frequently clash with questions about the morality of pollution, the latest clash erupting over proposals for a market for CO_2 emissions. The notion of right and wrong plays no role in the standard economic model of pollution control, but is more relevant in the functioning of a social norm. Since so many activities generate pollution, it is often difficult for economists to understand which ones should be declared 'wrong' or 'immoral'. The idea of a social norm, with its basis in a communal economy with observable pollutants, may help understand the basis for moral distinctions among polluting activities.

In this paper, we derive a model that explains not simply the influence of a social norm on polluting activity, but the evolution of the norm. As Sethi and Somanathan have emphasized and others have observed, the functioning of a social norm is trivial. (See Binmore and Samuelson for a broader discussion of the origin of social norms.) Once a social norm is in place, it works because economic agents get utility from conforming to the norm. The real task, and the one that links theory to policy, is to explain where norms come from. For example in the case of littering from autos, the social norm 40 years ago was for free disposal of trash, quite different from the norm today. Our model explains the evolution of the norm for activities like trash disposal.

2. Evidence of the Internalization of a Social Norm

We begin our analysis with evidence of the operation of a social norm in the context of the disposal of debris in the marine environment. The evidence comes from a study of the costs of reducing marine debris from the recreational boat fleet. The debris results when private individuals and enterprises, chiefly myriad small boats and fewer large ships, throw overboard wastes that persist in the marine environment. Persistent wastes such as plastic from foods, fishing nets, and other wastes with very long lives can have significant social costs. Further the recreational boat fleet may be a potentially large source of debris, such as plastics, fishing line, beverage containers and the like. The potential social cost of debris from recreational boaters may be higher than from the open ocean dumping of ships because the debris is deposited in vicinity of users of the marine environment.

As for many non-point source pollution problems, the costs of controlling debris by conventional methods of pollution control seem high. The very large sources, such as cruise ships and the Navy, are subject to inspection and to a degree, command and control types of regulations. Onshore disposal of trash frequently results from sewage overflow or from runoff from landfills. This source has declined as the control of runoff has improved. But a major source of debris, recreational boating, is effectively unregulated, even though there are legal requirements for disposing of trash.

To study recreational boaters' disposal of and attitudes towards marine debris, Haab and McConnell (1995) surveyed a sample of registered recreational boat owners in Maryland. The focus of the survey was recreational boaters that primarily use marine waters, i.e., the Chesapeake Bay or Maryland coastal waters. The sample frame was registered boat owners in Maryland counties bordering the Chesapeake Bay, whose boats were of length 22 feet or greater. The survey was administered by the Survey Research Center of the University of Maryland.

There is a difficulty in attempting a survey that asks boaters about their trash disposal. People are reluctant to admit that they engage in an activity that may be illegal or illicit. Respondents stated quite emphatically that discarding of debris overboard was wrong. To circumvent this problem, the survey asked respondents if, and how often, trash from their boats has been thrown or blown into the water for a variety of reasons, including: safety reasons, heavy seas, high winds, an accident, children playing, or some other reason. Of 540 total responses to this question, 37.8% admitted that trash was discharged into the water at least once during the past boating season. Similarly, 42.8% of the respondents claimed they had seen other boaters discharge trash into the waters at least once.

Suppose that there is a causal relationship between a boater seeing others throw trash overboard, and the boater discharging trash himself. In a random utility framework, an individual will discharge trash overboard if the utility of doing so, conditional on whether they have seen others throw trash overboard, is greater than the utility of not discharging trash conditional on the observation of others. Haab and McConnell find that the probability that an individual discharged trash, given that the individual never saw others discharging trash, was .31, while the probability the respondent discharged trash, given that he observed others throwing trash overboard, was .46. The probability that an individual threw trash overboard, given that he saw others throwing trash overboard, was .15 higher than those respondents who did not see anyone discharging trash[3].

This evidence lends support to the hypothesis that in a common property setting individuals may account for the actions of others when choosing their own behavior. This internalization of social action can lead to the partial amelioration of externality costs without external regulation. To understand the policy implications of individuals incorporating social norms into their common property decision process, we propose the following model of compliance/noncompliance behavior.

3. An Evolutionary Model of Compliance Behavior

The essence of a model of a social norm is the interaction among people. If all people are the same this interaction will not be informative. The key is heterogeneity, either for systematic reasons such as education, income, or tastes, or random differences in preferences. The model we construct has limited differences among people, but they are sufficient to make the model work.

Suppose that there are two types of people: noncompliers who violate a legally or socially accepted behavior, and compliers. For individual I the costs of noncompliance are the internal costs of violating the social norm ($\mathbf{G}_i$), and any expected penalty costs for noncompliance: **pF,** where p is the probability of detection, and F is the legal fine associated with noncompliance. The internal costs of noncompliance represent the individual's disutility, measured in dollars, associated with engaging in an illicit behavior. The behavior becomes illicit when a social norm of sufficiently wide standing is established. Standard models of externalities and the tragedy of the commons assume that the individual has no inclination to internalize the external costs. However,

[3] This difference is statistically different from zero at any reasonable level of confidence.

the presence of a social norm may provide the means to assess the extent of external costs, and thus lead to the internalization and hence some attenuation of these costs. To describe the evolutionary behavior of noncompliers versus compliers, and the impact of the social norm on compliance behavior, the internal costs of noncompliance can be thought of as a function of the proportion of the population that are noncompliers (S_d), and the level of awareness of the externality costs of noncompliance (E_i):

(1) $$G_i = G(S_d, E_i) \geq 0.$$

Internal costs are non-increasing in the proportion of noncompliers $(G_1 \leq 0)$, and non-decreasing in the level of awareness of external costs $(G_2 \geq 0)$. If almost everyone follows the norm, the costs of failing to do so are great. If no one follows the norm, it ceases to be a norm and imposes no costs on individuals: $G(1, E_i) = 0$. For example, consider smoking cigarettes. Four decades ago it was the norm in many groups, while today people tend to apologize when they smoke. By assumption, a marginal decrease in the proportionate complying population lessens the marginal internal cost of an increase in awareness of external costs $(G_{12} \leq 0)$. That is, the higher the percentage of the population that violates the norm, the less the impact of an increase in awareness. The individual can comply lawfully for a total cost of k_i.

Now suppose that relative returns explain complying. The total population is N. To understand the evolutionary behavior of compliers and noncompliers, we develop a model to determine how the share of noncompliers changes over time. Let the returns to compliance be

(2) $$\pi_c = A_i - k_i,$$

where A_i represents a reference return level. The expected returns to non-compliance are likewise:

(3) $$\pi_d = A_i - G(S_d, E_i) - pF.$$

For generality, noncompliers can be classified into two categories: socially conscious noncompliers (π_{ds}), and socially irresponsible noncompliers (π_{du}). For the irresponsible, the internal costs of noncompliance are always zero (G_i=0) and the expected returns to noncompliance are:

(4) $$\pi_{du} = A_i - pF.$$

The compliance behavior of this type of individual is only influenced by the imposition of legal penalties.

Consider how this model would work for air emissions from autos. As suggested by Sethi and Somanathan, the phenomenon that needs explaining is the evolution of behavior. Suppose that we were attempting to understand whether there would be voluntary reduction in auto emissions, given that we start at a situation where very few people are complying. This is a reasonable starting point, because for almost all polluting activities, the presumption is that the activity will do no harm to others. The proportion of non-compliers will be quite high at the beginning, by assumption, so that G may be expected to be low. The costs of reducing auto emissions, given the technical standards of autos, come principally from reductions in driving, and are quite high. Consequently, it would be surprising to find voluntary reductions in auto emissions. Even if an exogenous event caused a temporary increase in voluntary reductions in auto emissions, this behavior would not be easily observable by those who did not comply, and so would not increase the long-run compliance rate.

The compliers subtract the cost of compliance from their base return, A. The noncompliers have the same base utility but do not pay the cost of compliance. Instead, they pay an expected fine (the probability of being caught, p, times the fine F) and in some circumstances incur some opprobrium for violation of the social norm. The returns to noncompliance are A when there is a high proportion of noncompliers because $G(1,E_i) = 0$. But if the number of noncompliers declines, the return to noncompliance declines. The returns to complying are always A - k. The returns to individual j can therefore be defined as:

$$\pi_j = \begin{cases} A_j - G(S_d, E_j) - pF \text{ if } k_j > G(S_d, E_j) + pF \\ A_j - k_j \text{ if } G(S_d, E_j) + pF \geq k_j \end{cases} \tag{6}$$

Defining $I_{(G_i + pF \geq k_i)}$ =1 if $G(S_d, E_i) + pF \geq k_i$, and zero otherwise, the proportion of compliers is the portion of the population for which the internal costs of noncompliance exceed the opportunity costs of complying:

$$S_c = \frac{\sum_{i=1}^{N} I_{(G_i + pF \geq k_i)}}{N} \tag{7}$$

The evolution of the groups over time depends on the relative returns to each group, and the form of any policy aimed at internalizing the externality. We can describe how the proportion of compliers (S_c) changes over time and use $S_c + S_d = 1$ to see how the proportion of noncompliers changes. All else equal, the evolution of compliance behavior will depend on the proportion of current noncompliers that switches to compliance over time. An individual will switch from a noncomplier to a complier if the internal costs increase beyond the reservation price threshold k_i. Denoting the current time period with a superscript 0, and the future time period with a superscript 1, and assuming for the moment that the internal costs of noncompliance are nondecreasing over time, then:

$$\dot{I}_{(G_i+pF>k_i)} = I_{\left(G_i\left(S_d^0,E_i^0\right)+p^0F^0>k_i\right)} - I_{\left(G_i\left(S_d^1,E_i^1\right)+p^1F^1>k_i\right)} = \begin{cases} 1 \text{ if individual i switches from noncompliance to compliance} \\ 0 \text{ otherwise.} \end{cases} \quad (8)$$

The population change in the proportion of compliers over time $\left(\dot{S}_c\right)$ is:

$$\dot{S}_c = \frac{\sum_N \dot{I}_{(G_i+pF>k_i)}}{N} \quad (9)$$

Ignoring the possibility of the deterioration of the social norm over time, the change in the population level of compliance over time is simply equal to the proportion of the population that switches from noncompliance to compliance from one time period to the next. If we allow for the possibility of deterioration (decreasing internal costs) of the social norm over time ($G_i(.,t^0) > G_i(.,t^1)$), then:

$$\dot{I}_{(G_i+pF>k_i)} = I_{\left(G_i\left(S_d^0,E_i^0\right)+p^0F^0>k_i\right)} - I_{\left(G_i\left(S_d^1,E_i^1\right)+p^1F^1>k_i\right)} = \begin{cases} 1 \text{ if individual i switches from noncompliance to compliance} \\ -1 \text{ if individual i switches from compliance to noncompliance} \\ 0 \text{ otherwise.} \end{cases}, \quad (10)$$

and the change in compliance over time equals the net proportionate change in compliers and noncompliers.

4. Dynamic Effects of an Exogenous Shock

To understand the movement of the population behavior over time, suppose we begin in steady state with respect to the change in the proportion of compliance over time: $\dot{S}_c = 0$. This implies that the proportion of compliers, the level of awareness, the probability of detection, and the assessed fine are constant from one period to the next. We will consider two possible exogenous shocks to the steady state: a change in the expected penalty for noncompliance (pF), or a program introduced to increase the level of awareness of the external costs of noncompliance (E).

A Change in the Expected Penalty

A change in the probability of detection and a change in the fine associated with noncompliance will result in similar changes in the proportion of noncompliers. We will therefore focus only on a change in F. To begin, assume a homogeneous population in which all individuals have identical internal costs of noncompliance (G), and identical costs of compliance (k). In such a situation, all individuals must be compliers or all individuals must be noncompliers. Beginning in a state with full noncompliance, an increase in penalty $F^0 \rightarrow F^1$ will result in an increase in the costs of noncompliance from $G(1, E^0) + pF^0$ to $G(1, E^0) + pF^1$. Since the initial steady state occurred with full noncompliance, it must be the case that $G(1, E^0) + pF^0 < k$ for the population. If the increased fine is high enough to cause the costs of noncompliance to exceed the cost of compliance for one individual then it must be high enough to cause all individuals to convert and we will have full compliance. If the shock is not enough to cause compliance to be the less costly option then full noncompliance will continue. In the case of a homogeneous population of noncompliers, an exogenous increase in the expected penalty associated with noncompliance can only result in one of two outcomes: full compliance, or full noncompliance.

As we discussed earlier, the essence of the evolution of a social norm is the interaction among heterogeneous people. However, the result derived here is similar to a result common to the existing literature: an exogenous increase in the costs of noncompliance will cause those individual with costs of noncompliance close to the costs of compliance to convert to compliance, and the remainder of the population will continue noncompliance. In other words, the exogenous shock causes some individuals to convert and others not, and that will be the end of the story. The conversion of some individuals has no subsequent effect on those that do not comply. But when a social norm is at work, individuals are influenced by the proportion of the population that complies, and the effect of an exogenous shock will be worked out over time.

Consider a situation where there is a heterogeneous population of 10 individuals (labeled A through J) with initial costs of noncompliance uniformly distributed between 10 and 1, so:

(11)
$$\begin{aligned} &G_A(S_d, E_A) + pF = 10 \\ &G_B(S_d, E_B) + pF = 9 \\ &\ldots \\ &G_J(S_d, E_J) + pF = 1 \end{aligned}$$

For the moment, assume the compliance costs are constant across the population at \$15, so in the initial steady state there is full noncompliance. Additionally suppose there is an exogenous increase in the assessed fine from F^0 to F^1 such that the expected penalty increases by \$5 for all individuals. In period 1, the \$5 increase in expected penalty is enough to cause individual A to convert from noncompliance to compliance. The costs of noncompliance in period 1 are:

(12)
$$\begin{aligned} &G_A(S_d^0 = 1, E_A) + pF^1 = 15 \\ &G_B(S_d^0 = 1, E_B) + pF^1 = 14 \\ &\ldots \\ &G_J(S_d^0 = 1, E_J) + pF^1 = 6 \end{aligned}$$

If the internal costs of noncompliance do not depend on the proportion of compliers then the dynamics would end in period 1 with 10% compliance (S_c=.1). But, the increase in the proportion of compliers in period 1 will result in an increase in the costs of noncompliance in period 2 $\left(G(S_d^0 = .9, E) > G(S_d^0 = 1, E)\right)$. For simplicity suppose that a 10% increase in the proportion of compliers leads to a \$1 increase in the internal costs of noncompliance. Further, suppose the marginal cost of an increase in the proportion of compliers is constant (G_{11}=0). This assumption will be relaxed subsequently. For individuals B through J, the conversion of A results in an internal cost increase of $1 in period 2. This additional $1 leads to a total noncompliance cost of $15 for B in period 2 and B will convert. B's conversion increases the internal cost of noncompliance for A and C-J by $1 in period 3. The $1 increase will cause C to convert which increases the cost of noncompliance for A,B, and D-J. Given the simple assumptions we have made here, this process will continue until the entire population fully complies.

Figure 1 illustrates this example. Individuals A-J are indexed on the horizontal axis, and the costs of compliance and noncompliance are measured vertically. The constant compliance cost of $15 (represented by the dark horizontal line) represents the switching point from noncompliance to compliance. If the costs of noncompliance are below this line then the individual will not comply, and if the noncompliance costs rise above the compliance cost the individual will convert. The initial costs of noncompliance in period 0 are labeled T0 and are illustrated to uniformly decrease from $10 to $1 for A through J. The $5 increase in expected penalty increases all individuals' noncompliance cost by $5 (labeled shock cost and T1). This causes individual A to convert in period 1 and sets in motion the dynamics of the internalization of the social norm. A's conversion increases the noncompliance costs of B-J and leads to B's conversion in period 2 (T2), which in turn leads to C's conversion in period 3 (T3) and so on. Although the initial shock was not enough to convert everyone (as in the case of a homogeneous population), the internalization of the social norm leads to a dynamic model with full compliance.

Stopping the Dynamic Process

This example assumes uniformly distributed initial noncompliance costs, constant costs of compliance and constant marginal social norm costs. If in addition we assume a large enough population to allow for a continuous distribution of initial costs across the population then the following generalization can be made: the evolutionary process set in motion by an exogenous increase in noncompliance costs will always result in full compliance once at least one individual has converted. Obviously, this model does not coincide with casual real world observations: Some portion of the population litters; some portion of the population dumps marine debris; some proportion smokes. One possible explanation that is consistent with the above example is that the dynamic process has been set in motion but we have yet to reach the terminal steady state. So, the proportion of compliers should continue to decrease until we observe full compliance. A second, perhaps more satisfying possibility, is that by relaxing some of the restrictive assumption from the previous example, we may observe a steady state with less than full compliance.

Continuing with the previous example, suppose instead of an initial uniform distribution for noncompliance costs, suppose the distribution is bimodal so that half of the population (A-E) have a noncompliance cost equal to $10, and the remainder have costs equal to $1 (see figure 2). In this case, the exogenous shock of period 1 is enough to convert A-E from noncompliance to compliance, but the subsequent $5 increase in social norm costs for F-J from the conversion of A-E is not enough to cause F-J to convert in period 2. In figure 2, the additional cost of noncompliance in period 2 due to internalization of the social norm does not increase the costs of F-J enough to put them over the conversion threshold. The steady state will consist of half of the population complying and half remaining noncompliers. The distribution of costs of noncompliance across the population can therefore affect the proportion of compliers in steady state, and the evolution of compliance behavior due to exogenous shocks.

Discontinuity in the distribution of the initial costs is not the only explanation for a termination of the dynamics prior to full compliance. Suppose the population is homogeneous with regard to their noncompliance costs, but have heterogeneous compliance costs (it is more costly for some portion of the population to comply than others). We will further maintain the assumption of a constant marginal social norm cost. As seen in figure 3, heterogeneous compliance costs can cause a termination of the evolution of compliers prior to full compliance. If the increases in costs due to either the exogenous initial shock, or the increased costs due to internalization of the social norm are not sufficient to surpass the compliance costs for some part of the population in any time period, then the dynamics will stop and we observe a steady state with partial compliance.

Figure 4 relaxes the assumption of constant marginal social norm cost and allows for the possibility that the increment to the internal cost of noncompliance due to a marginal change in the proportion of compliers may decrease as the proportion of compliers increases. In other words, part of the population is easily swayed by the actions of other, and they will incur large internal costs as the proportion of compliers increases initially, but as that proportion increases, the remaining noncompliers incur lower increases in internal costs due to additional changes in the proportion of compliers. As seen in figure 4, decreasing marginal social norm costs can lead to a partial compliance steady state. In the extreme, some portion of the population may ignore the actions of others, in which case the marginal social norm costs are always zero. The only way to convert these individuals is through the initial exogenous shock.

Changes in the Level of Awareness (E).

Advertising, moral suasion, modest fines with low probabilities of enforcement are typical devices to increase the awareness of pollution and its consequences. Policies to change the level of awareness of the external costs of noncompliance will result in similar outcomes to changes in the expected penalty if all individuals are affected similarly by the policy change: i.e.

$\frac{\partial G(S_c, E_i)}{\partial E_i} = \frac{\partial G(S_c, E_j)}{\partial E_j} \quad \forall i, j$. For example, if an education program aimed at making illegal dumpers aware of the social costs of dumping increases the cost of noncompliance equally across the population, then figures 1-4 can be used to illustrate the possible effects of the education program. In this case, an increase in the level of awareness is equivalent to an exogenous increase in the expected penalty.

If, however, the marginal effect of a change in the level of awareness differs across individuals, then a policy aimed at increasing the level of awareness will alter the distribution of noncompliance costs across the population. A uniform distribution of noncompliance costs before the policy may be transformed to one with discontinuities after the policy. These discontinuities may then cause a steady state with less than full compliance. On the other hand, an initial distribution with discontinuities may become closer to continuous with the redistribution of noncompliance costs due to the change in awareness. So a dynamic process that would lead to less than full compliance if the expected penalty were changed might result in full compliance if the level of awareness changes.

An important implication of this model is that due to heterogeneity among individuals it is possible to observe a steady state proportion of compliers less than unity. In other words, differences across individuals result in the possibility of observing a positive proportion of noncompliance even in the presence of social consciousness. Differences in the distribution of initial noncompliance costs, the distribution of compliance costs, or the decay rate of marginal social norm costs can result in steady state outcomes less than full compliance. In addition, different types of policies can result in different steady state outcomes. The same set of circumstances that might result in full compliance if the expected penalty is changed, might lead to less than full compliance if instead a policy aimed at changing the level of awareness is implemented. Or, circumstances that might result in full compliance if the level of awareness were changed might result in less than full compliance if the expected penalty is changed.

Conclusions

In a number of settings, households seem to abate some of their pollution activity voluntarily, contrary to what one would expect of polluting activities from a model of utility maximizing individuals. When the pollution activity is observable, and there is consensus on the consequences of pollution, this voluntary activity may be a result of the workings of a social norm. While the idea of a social norm does not preclude optimizing behavior, joining optimization and a social norm does not explain where the social norm has come from. As part of a model to explain the emergence of voluntary behavior, we have developed an evolutionary model of a social norm. This model is helpful in explaining the kinds of activities that are likely to be subject to the workings of a social norm, as well as the evolution of the norm.

Despite the uncertainty regarding the ultimate steady state outcome, a number of stylized conclusions can be drawn from the model presented.

1) Policies aimed at increasing the level of compliance can result in dynamic as well as static adjustment to the level of compliance if individuals react to social norms.
2) Future research aimed at understanding the distribution of noncompliance, compliance and social norm costs could be fruitful in designing least cost policies for maximizing compliance.
3) Collective action can result in amelioration of externalities if social action is incorporated into individual decision-making.

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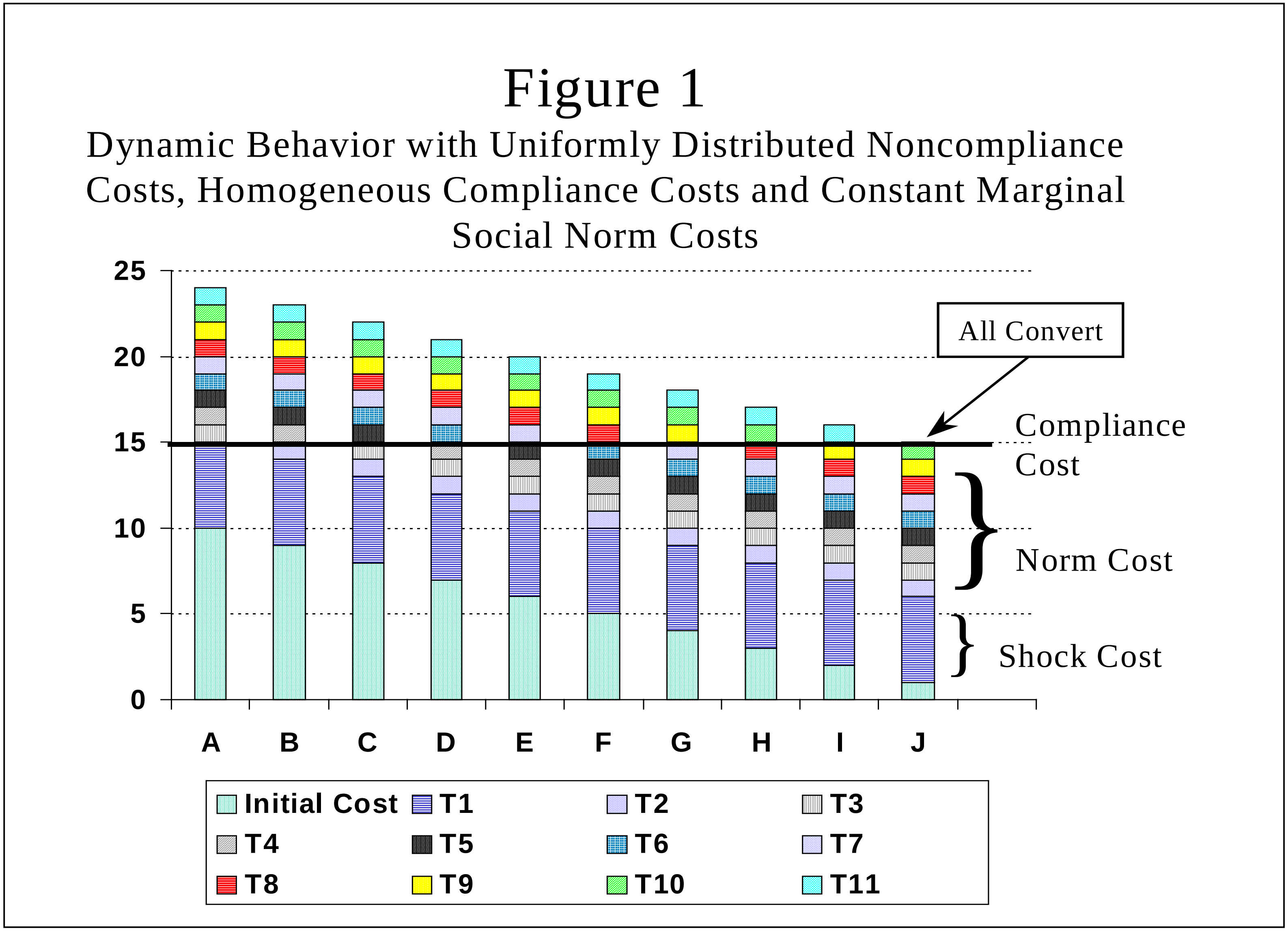
Figure 1
Dynamic Behavior with Uniformly Distributed Noncompliance Costs, Homogeneous Compliance Costs and Constant Marginal Social Norm Costs
25
20
15
10
5
0
A
B
C
D
E
F
G
H
I
J
All Convert
Compliance Cost
Norm Cost
Shock Cost
Initial Cost
T1
T2
T3
T4
T5
T6
T7
T8
T9
T10
T11

Figure 2

Dynamic Behavior with Bimodal Noncompliance Costs, Homogeneous Compliance Costs and Constant Marginal Social Norm Costs

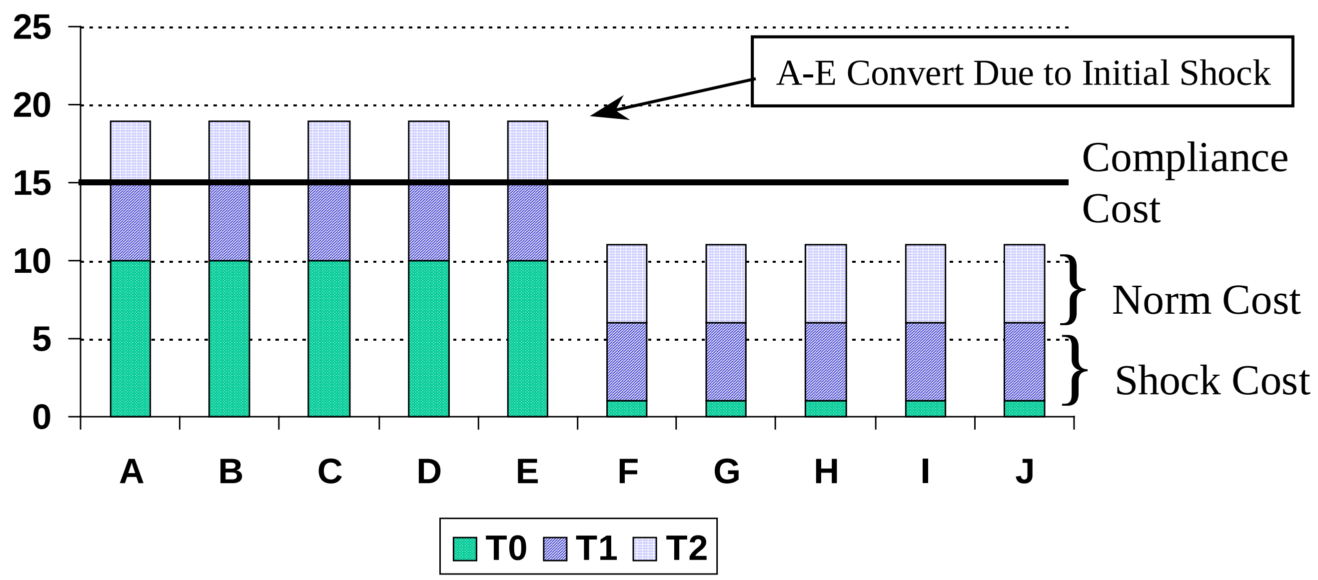

Figure 3

Dynamic Behavior with Homogeneous Noncompliance Costs, Heterogeneous Compliance Costs and Constant Marginal Social Norm Costs

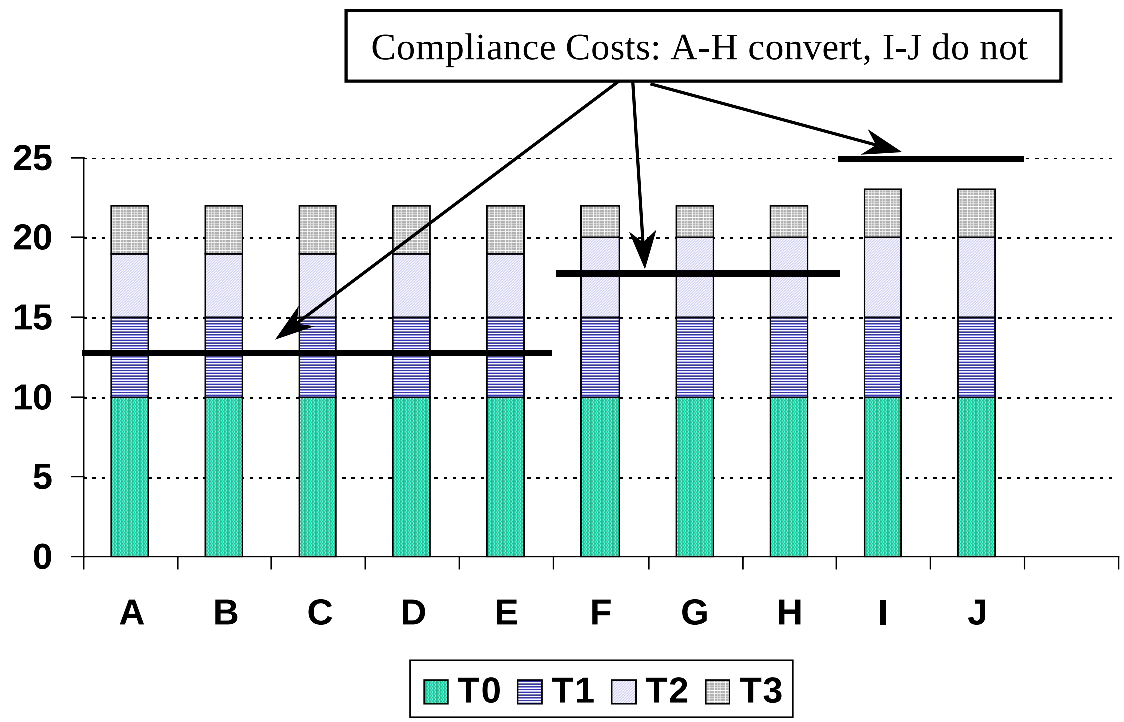

Figure 4

Dynamic Behavior with Uniformly Distributed Noncompliance Costs, Homogeneous Compliance Costs and Decreasing Marginal Social Norm Costs