Towards a Theory of Dorm Damage

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> It should be noted that, while the subject of this paper is silly, the analysis actually does make sense. This paper, then, is a serious analysis of a ridiculous subject, which is of course the opposite of what is usual in economics.
>
> Paul Krugman, *The Theory of Interstellar Trade*

1 Introduction

Game theory has been used to analyze the efficiency of alternative institutions for the provision of a variety of public goods, ranging from public transportation to environmental protection (see Prize Committee 2007 for an overview). Game-theoretic models have also been used to analyze the performance of different legal liability regimes in accident and contract law (see Benoît and Kornhauser 2002). In all of these applications, the fundamental problem is generating incentive-compatibility in the presence of externalities. The objective of this paper is to analyze the related issue of designing effective liability rules for damage to common areas of a college dormitory. To take advantage of local knowledge, I will focus on the case of Amherst College.

Dorm damage, as the terms is used by the College in its official publications, encompasses a variety of offenses.[1] In particular, it includes accidental, negligent and intentional damage done by students and their guests to

[1] Consult Costache (2007, p. 85) for a statement of the policy

the rooms, furniture and common areas of a dormitory. The College imposes compensatory damages on dormitory residents which cover the cost of repairs. The cost of repairing individual rooms is borne by their occupants. In what is perhaps considered a natural extension of that rule, the cost of repairing common areas is borne by the person responsible for the damage if she steps forward, and divided evenly between the dormitory's residents otherwise. (I will call this policy the *equal division* rule.) Furthermore, in the case of negligent or intentional damage, the College reserves the right to impose punitive damages and other sanctions on the person responsible.

The fines assessed for damage to individual rooms are, to the best of this author's knowledge, not a major source of controversy. However, fines for common area damage are another story. Anecdotal evidence suggests that it is relatively common for the fine to be divided between the dorm's residents, rather than paid by the culprit.[2] This is an intuitively disturbing state of affairs, because the full cost of dorm damage is not always borne by the people responsible. As a result, rational students will not take sufficient precautionary measures to prevent damage due to negligence, and will more readily engage in intentional damage. Furthermore, it is clear that dorm damage has negative externalities. To make matters worse, those who engage in it are not free to choose who suffers from the externality, and who does not. Hence, the externality is nonexcludable, and an efficient amount of dorm damage cannot be ensured by Coasian bargaining. In other words, dorm damage is a form of pollution, and one would expect to see it overproduced relative to the social optimum.[3]

To formalize and test these intuitions about the equal division regime, in section 2 I gradually develop a model of dorm damage. I begin by considering the students as noninteracting utility-maximizers (section 2.1), but later allow students to pressure the person responsible to step forward (section 2.2). In section 3, I consider the alternative regime of *random liability*: should the culprit not step forward, the entirety of the fine is borne by a group of previously-named students, selected using some arbitrary criterion. Possible criteria for selection are briefly discussed, as is the optimal

[2]The College keeps official records of dorm damage incidents, but access to them is restricted. Therefore, a careful analysis of the empirical data is relegated to later work.

[3]For a brief discussion of nonexcludable externalities in the context of environmental policy, see Baliga and Maskin (2003). On Coasian bargaining, see Coase (1960); on its limitations, consult section 3 of Benoît and Kornhauser (2002).

number of students to name under such a scheme. In closing, I consider the conditions under which random liability leads to outcomes superior to the ones achieved presently, discuss its limitations and make suggestions for future research.

2 The Present Policy

I shall assume that the goal of imposing dorm damage fines is to maximize social welfare, which following Polinsky and Shavell (1998) I define as "the benefits parties obtain from their actions, less the costs of precautions, the harm done, and the expenses due to use of the legal system." Since the parties this policy is directed at are the residents of a dormitory, this is equivalent to maximizing

$$U = \sum_{i}^{N} U_i, \tag{1}$$

where U_i's are the utility functions of the N students residing in a dormitory.

Implicit throughout my analysis will be the premise that only a dormitory's residents can be responsible for damage to their building. At first glance, this may seem like a strong assumption: many an act of dorm damage is committed during a party, when both residents and nonresidents are present. Note, however, that the College's present policy makes the resident liable for damage done by any guests of hers. Therefore, the only case in which no dormitory resident is liable for the damage is when it was done by a trespasser.

2.1 First Analysis: Individual Welfare Maximizing

As a first approximation to the situation we wish to model, consider the following simplified framework. Each student i chooses an amount of dorm damage to engage in, δ_i. Then, if a student engaged in dorm damage, he chooses whether to step forward. Let $d_i(\delta_i)$ be the utility derived by student i from engaging in dorm damage, $c_i(\delta_i)$ the total disutility from damage δ_i—a measure of how unhappy residents are about seeing holes in walls—and $t_i(\delta_i)$ the total cost of repairing the damage δ_i (all of these are assumed to be nonnegative, increasing and zero for $\delta_i = 0$). If a student i

commits dorm damage and admits to having done so, his utility is given by

$$A_i = d_i - \frac{c_i}{N} - t_i - \sum_{i \neq j}^{N} \frac{c_j}{N}, \tag{2}$$

where c_i/N is the fraction of the total disutility due to dorm damage δ_i borne by the student i,[4] and the last term is the disutility suffered by the student due to dorm damage by other students. If a student does not admit having caused the damage, the fine is divided evenly between the residents, and the culprit's utility is

$$D_i = d_i - \frac{c_i}{N} - \frac{t_i}{N} - \sum_{i \neq j}^{N} \frac{c_j}{N}. \tag{3}$$

A student who does not engage in dorm damage ($\delta_i = 0$) has a utility of D_i, too, but with $d_i = c_i = t_i = 0$. One expected result follows immediately:

Proposition 1. *Under equal division, students never step forward to pay the fine.*

Proof. Observe that, for all $N > 1$,

$$-t_i < -\frac{t_i}{N}, \tag{4}$$

implying that

$$A_i = d_i - c_i - t_i - \sum_{i \neq j}^{N} (c_j + t_j) < d_i - \frac{c_i}{N} - \frac{t_i}{N} - \sum_{i \neq j}^{N} \frac{c_j}{N} = D_i \tag{5}$$

□

[4]Here I assume that the perpetrator suffers equal disutility from dorm damage to that suffered by other students. There are reasons be believe this is not true. Firstly, intentional and negligent dorm damage may to be executed in such a way as to minimize the fraction of the disutility borne by the perpetrator. Secondly, perpetrators may disproportionately be individuals who *don't care* about dorm damage themselves, and therefore don't feel any moral qualms about engaging in it. However, the natural incentive to engage in dorm damage away from one's favorite locations is counteracted by the increased likelihood of being in one of those locations at any given time, including the time when one engages in dorm damage. The second claim is immaterial, as an individual's lack of concern for dorm damage can (without loss of generality) be incorporated into d_i, rather than c_i.

Now, let us make the following intuitive assumptions: doing dorm damage is a source of utility to at least some students, but the utility is diminishing; living in a damaged dorm is a source of *dis*utility; and, the cost of repairing the damage increases with the damage nondiminishingly.[5] It follows that

Proposition 2. *Under equal division, dorm damage is overproduced relative to the social-welfare maximizing amount.*

Proof. By Proposition 1, a student's problem is given by

$$\max_{\delta_i} D_i = d_i - \frac{c_i}{N} - \frac{t_i}{N} - \sum_{i \neq j}^{N} \frac{c_j}{N} \tag{6}$$

leading to the condition

$$\frac{\partial d_i}{\partial \delta_i} = \frac{1}{N} \left(\frac{\partial c_i}{\partial \delta_i} + \frac{\partial t_i}{\partial \delta_i} \right). \tag{7}$$

In contrast, social welfare is given by

$$U = \sum_{i}^{N} U_i = \sum_{i}^{N} d_i - c_i - t_i, \tag{8}$$

which leads to the condition

$$\frac{\partial d_i}{\partial \delta_i} = \left(\frac{\partial c_i}{\partial \delta_i} + \frac{\partial t_i}{\partial \delta_i} \right). \tag{9}$$

But since we have assumed $\frac{\partial^2 t_i}{\partial \delta_i^2} > \frac{\partial^2 d_i}{\partial \delta_i^2} \,\forall\, i$, the condition given by Equation 7 is satisfied for a higher δ_i than the condition given by Equation 9. □

Our simple but plausible model has allowed us to understand why students may be inclined not to step forward, and that inefficiently large amounts of dorm damage result. However, it is hardly a "game": the possibility of student interaction has been entirely ignored. Intuitively, this is a shortcoming. Students burdened with fines may choose to seek out the culprit and pressure him to step forward. To investigate this possibility, in the next section we turn to analyze a model allowing for student interaction.

[5]Formally, $\exists\, i$ s.t. $\frac{\partial d_i}{\partial \delta_i} > 0$, $\frac{\partial^2 d_i}{\partial \delta_i^2} < 0 \,\forall\, i$, $\frac{\partial c_i}{\partial \delta_j} < 0 \,\forall\, i,\, j$, $\frac{\partial t_i}{\partial \delta_j} < 0 \,\forall\, i,\, j$ and $\frac{\partial^2 t_i}{\partial \delta_i^2} > \frac{\partial^2 d_i}{\partial \delta_i^2} \,\forall\, i$.

2.2 Second Take: A Game Not Worth Playing

We now wish to consider the possibility of students interacting with one another by putting social pressure on the culprit to admit to being responsible for the dorm damage. To have any effect, such social pressure must impose a *contingent cost* on the culprit: should she not step forward, unpleasant consequences must follow.[6] It is reasonable to assume that college students are able to exert social pressure of that kind on one another through the many interactions (linked games) they engage in. Real or perceived threats of ostracism, negative gossip and loss of status are both effective and credible—effective because dormitories are small communities important in the lives of their residents, and credible because these threats are often carried out automatically. For instance, negative gossip about a dorm-damager not paying his fine will have been produced by the time the decision whether to pay the fine is made, and containing this gossip without paying the fine may prove near-impossible.[7]

Exerting social pressure, however, has its costs. Firstly, there is the search cost of finding out who is responsible for the damage. Secondly, there is the social cost: the souring of interpersonal relations resulting from the exercise of social pressure is unpleasant to most people. It also seems that exerting pressure for the sake of avoiding fines may be viewed as petty, and therefore itself an infraction against a community's rules of peaceful coexistence, especially if the amounts involved are small.

The characterization of social pressure in the last two paragraphs is only a sketch—a more thorough treatment of the topic can be found in other works, focusing specifically on such informal enforcement mechanisms. For instance, the enforcement of customs through reputational mechanisms is discussed in Akerlof (1980) and Bernheim (1994), while

[6] In general, the cost in question would be an opportunity cost, so "unpleasant consequences following not stepping forward" would be equivalent to "pleasant consequences following stepping forward." However, rewarding dorm-damagers for stepping forward would have predictably disastrous effects on the incentives to engage in dorm damage, so the latter possibility is ignored.

[7] Informal enforcement between college students (dormitory residents) works similarly to informal enforcement between cattle ranchers in Shasta County described by Ellickson (1986). For a rancher, reputation with the small local community was important because it had consequences for generations of his heirs, who were unlikely to abandon the county. For students, reputation is important because of the common belief that college connections will remain important to them throughout their lives.

a social-custom model of tax evasion is described in Myles and Naylorb (1996). The approach of these studies differs from the one taken here, however, because the aforementioned authors don't consider social pressure as something that can be "exerted." Rather, the only action is on part of the people pressured, who feel compelled to protect their social status by engaging in behavior which conforms to the (ultimately exogenous) preferences of their community. In some sense, their social pressure starts where my "exerting social pressure" ends: exerting social pressure is tantamount to making it known that the culprit has violated a norm, so that the mechanisms of social pressure can compel her to step forward. The problem is worthy of further consideration, but for our present purposes it is sufficient to conclude that the following two claims are at least plausible: (a) social pressure to pay fines can be exerted in a dormitory context, and (b) exerting it is costly.

Consider the following one-shot game between $N \in \mathbb{N}$ students, S_1 through S_N. First, S_1 chooses what amount of dorm damage to engage in. If he chooses $\delta = 0$, the game ends, and each student receives a payoff of zero.[8] If he chooses $\delta > 0$, students S_2 through S_N simultaneously choose whether to exert social pressure on S_1. Exerting social pressure decreases a student's payoff by γ_i and, if and only if S_1 does not step forward, decreases the payoff of S_1 by $s(\sum_i \gamma_i)$.[9] In the last stage, the student S_1 chooses whether to step forward. The extensive form and payoffs of the game are shown in Figure 1.

Assume that it's possible to exert sufficient pressure for S_1 to step forward, i.e. $\exists\, \gamma*$ s.t. $s(\gamma*) > t - t/N$. Even then, if the cost of exerting that pressure is greater than the fractional fine avoided ($\gamma* > t/N$), then the unique subgame perfect equilibrium of the game is for S_2 through S_N to exert no pressure at all ($\gamma_i = 0 \forall\, i$) and for S_1 to maximize D_1 (Equation 3). By Proposition 2, this leads to a socially inefficient outcome, the overproduction of dorm damage. The result comes about because S_2 through S_N cannot credibly commit to pressuring S_1. Once the dorm damage has been done, their utility functions are

$$U_i = \begin{cases} -\frac{c}{N} - \frac{t}{N} - \gamma_i & \text{for } \gamma < \gamma* \\ -\frac{c}{N} - \gamma_i & \text{for } \gamma \geq \gamma* \end{cases} \tag{10}$$

[8] I drop the subscripts on δ, c and t now, since it is assumed that S_1 does the damage.

[9] The function $s(\sum_i \gamma_i)$ is assumed to be increasing in each γ_i.

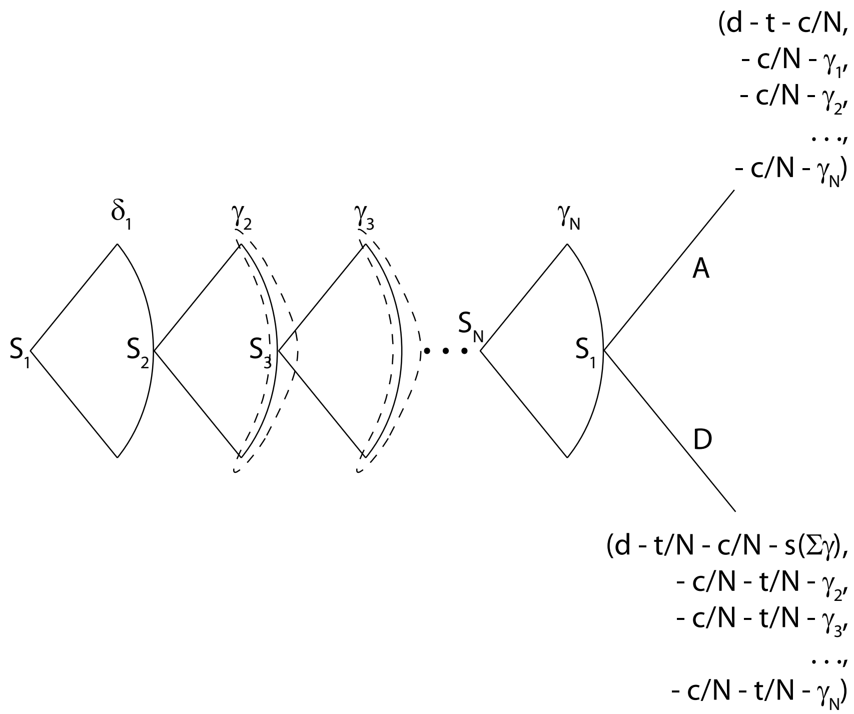

Figure 1: The game of dorm damage with social pressure, equal division regime. The dashed lines indicate information sets. Students S_2 through S_N all choose their γ_i simultaneously, as indicated by the ellipsis $(\cdots)$. While c and t are functions of δ, I have suppressed this dependence for clarity.

Since we have assumed $\gamma* > t/N$, these utility functions are maximized for $\gamma_i = 0$.

If we assume $\gamma* < t/N$ (pressuring the culprit to step forward costs a student less than paying the fractional fine), there are $N-1$ equilibria in which different students pressure S_1; in all of these equilibria, S_1 will choose A in the last stage, and so the amount of dorm damage done is chosen to maximize

$$U_1 = d(\delta) - t(\delta) - \frac{1}{N}c(\delta). \tag{11}$$

Meanwhile, the socially optimal δ would maximize

$$U = \sum_i U_i = d(\delta) - t(\delta) - c(\delta) - \sum_i \gamma_i. \tag{12}$$

There are two noteworthy differences between Equations 11 and 12. Firstly, in Equation 11 there is a factor of $1/N$ in front of c. Secondly, the culprit's utility function ignores the costs of social pressure, $\sum \gamma_i$. The result is that the full costs of dorm damage are still not borne by the person responsible, so damage will still be overproduced, though by a lesser amount that in the $\gamma* > t/N$ case (since we have t instead of t/N in Equation 11). How much of an improvement takes place from one case to the other depends on the two ignored factors mentioned above.

The importance of the first of these (the $1/N$ before the c) depends on the ratio t/c. If no expense is spared in removing damage briskly, and the residents aren't much bothered by it, this ratio will be high and the maximization of U_1 will entail near-maximization of social welfare. On the other hand, if repairs take place only when convenient and the residents can't sleep at night for the horror of gaping holes in hallway walls, broken sinks and massacred furniture, the t/c ratio will be low and inefficient amounts of dorm damage will continue to take place. It seems reasonable to assume that, at Amherst College at least, this ratio is rather high.[10]

How much the omitted pressure-cost term ($\sum \gamma_i$) matters depends on the socially optimal amount of dorm damage. For note that $\sum \gamma_i = 0$ if no dorm damage takes place (no pressuring is called for, so there is no cost due to it). If very little (or no) dorm damage is socially optimal,

[10] While this possibility is not investigated here, note that t/c can be artificially elevated by charging punitive fines.

then the pressure-cost term will be zero in most iterations of the game as played around campus, and Equations 11 and 12 will both be maximized for $\delta \approx 0$. If the socially optimal amount of dorm damage is considerable, however, the costs of exerting social pressure become a source of inefficiency. The magnitude of these losses is limited, of course, by the assumption characterizing of this case ($\gamma * < t/N$).

Note that the condition $\gamma * < t/N$ becomes more stringent as we increase N. Therefore, we would expect to see more damage done in larger dormitories. In general, it seems plausible to believe that pressuring someone to hand over an amount t should not cost significantly less than t is worth: certainly not more than an order of magnitude less. But few dormitories boast occupancies on the order of $N = 10$,[11] suggesting that most students will experience the $\gamma * > t/N$ regime in which dorm damage is significantly overproduced.

2.3 The Coordination Objection

An objection may be raised against the model presented in section 2.2, along the following lines. The students in the model are allowed to interact with S_1, so it is only fair to assume that they can also interact with one another. Why, then, don't they coordinate, for instance so that each of the $N-1$ students devotes only $\gamma * /(N-1)$ of social-pressuring effort to making S_1 step forward? This objection, I believe, is more to my naïve interpretation of the model than to the model itself. For if the students are to coordinate, one of them has to take upon herself the cost of organizing their cooperation. Students will not organize themselves spontaneously, without a ringleader, because there are no institutions in place to produce such coordination. A college dormitory, due to its extremely high turnover, is not conducive to the development of such institutions. (To the extent that they develop nonetheless, we observe that Proposition 1 is violated and some students do, in fact, pay fines.)

The ringleader has to learn who is responsible for the damage and convince fellow students to admonish the perpetrator. But then, it is the ringleader who is paying the cost of pressuring S_1: the search cost, the bulk of the social cost (against whom will the resentment of the perpetra-

[11] The average at the College is $N = 46$: thirty-five dormitories for slightly more than sixteen hundred students.

tor be targeted, once the game is over?) and the cost of convincing other students to participate in the enterprise. Therefore, the ringleader bears the cost $\gamma*$, while the other students participate essentially for free.

In some sense, the Coordination Objection demands that we consider a model in which the interactions between the students are repeated multiple times. In the limiting case of an infinitely-repeated game, a broad array of equilibria should be possible under the Folk Theorem.[12] I claim that incidents of dorm damage take place sufficiently rarely in the year-long lifetime of a dormitory community that they are better approximated by a series of one-shot games than by an infinitely-repeated one. Future empirical research will hopefully shed more light on how often these incidents take place, allowing for a more informed modelling choice.

3 Random Liability

In the previous section, I have discussed the dorm-damage fine system as it operates presently. Now, I wish to turn my attention to the possible alternative of random liability. Under this system, should the culprit not step forward, the fine t is divided evenly not between all of the dormitory's residents, but between a previously-named subset of them. (The subset may, of course, contain only one student.) The idea behind this policy is that the students who now bear a lion's share of the costs of damage will be more motivated to find the culprit and pressure her to pay the fine. The policy of random liability can be analyzed using the model introduced in section 2.2.

Consider the same game as in section 2.2, with the following modification. After dorm damage has taken place, but before the game of "social pressure" is resolved, a subset $F \subset \{S_i | i \in [2, N]\}$ numbering n students is arbitrarily selected to bear the fine t. This modification is really a generalization, as a random liability regime with $n = N$ is tantamount to the equal division regime. With no essential loss of generality, we may let the subset F consist of students S_2 through S_{1+n}.[13] The payoffs of the modified game are as shown in Figure 2.

[12] For a discussion of the Folk Theorem see, for instance, section 2.3.B in Gibbons (1992).

[13] We lose generality only insofar as we assume that S_1, the perpetrator, is never selected as one of the n students—this simplifies the model, but has little bearing on the results.

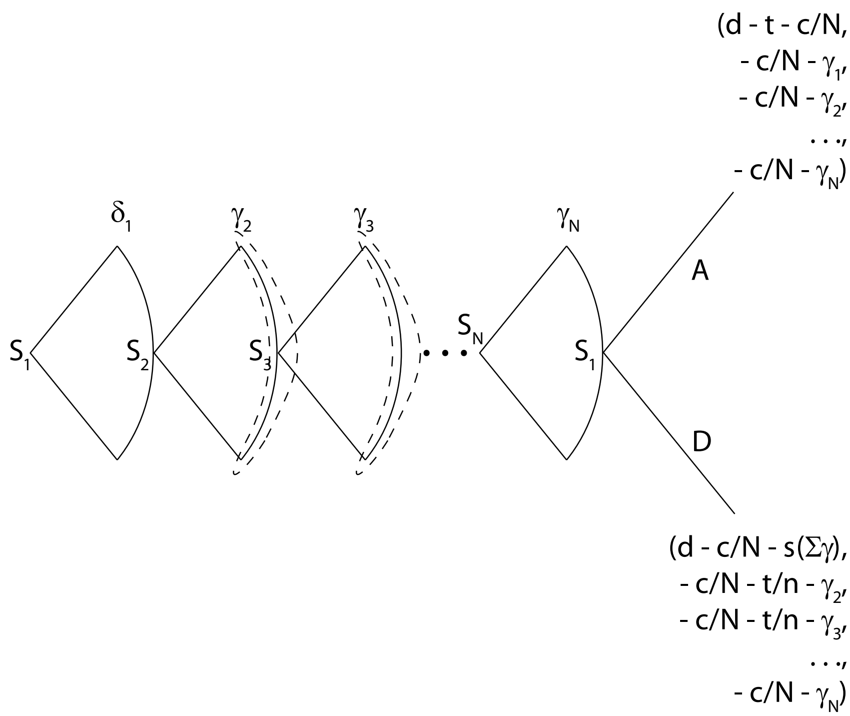

Figure 2: The game of dorm damage with social pressure, random liability regime.

Let us assume, as in section 2.2, that the culprit *can* be pressured to step forward ($\exists\, \gamma*$ s.t. $s(\gamma*) > t$). Let us again consider two cases, $\gamma* < t/n$ and $\gamma* > t/n$. If it's cheaper to exert social pressure than to pay one's fraction of the fine ($\gamma* < t/n$), we get $n-1$ equilibria in which one of the students $S_i \in F$ pressures the culprit to step forward, analogously to the equal-division case. Again, S_1 maximizes

$$U_1 = d(\delta) - t(\delta) - \frac{1}{N}c(\delta), \tag{13}$$

while social welfare is given by Equation 12, to wit

$$U = \sum_i U_i = d(\delta) - t(\delta) - c(\delta) - \sum_i \gamma_i. \tag{14}$$

The efficiency of this scheme is limited by the—already discussed—omission of $\frac{N-1}{N}c$ and $\sum_i \gamma_i$ terms. The case $\gamma* > t/n$ is exactly analogous to the $\gamma* > t/N$ case of the equal division regime, with residents S_2 through S_{n+1} exerting no pressure at all and S_1 overproducing dorm damage.

What is the difference between the two regimes, then? In both, there is a critical value of $\gamma*$ below which the perpetrator would pay the fine, and therefore engages in less (though possibly still too much) dorm damage. In the case of equal division, this critical value was given by $\gamma* = t/N$. Under random liability, it is $\gamma* = t/n$. Since $n < N$, the random liability regime reduces inefficient dorm damage for a broader range of the parameter $\gamma*$. If n is chosen to be small, the gain in welfare may be dramatic.

This gain, of course, comes at a cost. As I have argued on page 9, if the optimal quantity of dorm damage is large, the pressure costs (ignored by the culprit, but borne by the students) will become a source of inefficiency. Furthermore, if the repair costs captured by the fine represent a small fraction of the total cost (t/c low), the incidence of the fine will have little effect on the volume of dorm damage, and by extension—the shift from one liability regime to another will have little effect, other than burdening some students with the cost of exerting social pressure.[14]

A few words are in order on the optimal value of n. If we stay within the confines of the model, the optimal value of n is the one that maximizes

[14] It should be noted, however, that if the fine matters little to the culprit, then forcing her to pay it should not be particularly strenuous. In other words, a low t implies a low $\gamma*$.

social welfare. If, as seems likely, the optimal amount of dorm damage is very small (or even zero), the welfare-maximizing value may be $n = 1$. However, there are considerations outside the model which may motivate a policymaker to increase n. It seems risky to burden only one student with the liability, since he may happen to be particularly isolated from the community, and thus unable to exert social pressure effectively. This fact is not captured by the framework used in this paper, because the function $s(\gamma_i)$ was assumed to be the same for all students. In reality, the ease with which students can influence their peers varies, and s is a function of some weighed average (rather than sum) of the γ_i, with the weights not distributed uniformly within the population. The shape of the influence distribution in small groups, such as a dormitory, has presumably been studied (although this author is not aware of any literature on the subject). If this distribution is not close to uniform, it may maximize expected social welfare to select a larger number of students to share the liability. Furthermore, it may be advisable to design a selection criterion such that the n students will be likely to enjoy considerable influence.

4 Conclusion

The study of dorm damage is its infancy, and it is too early to expect any firm policy prescriptions. The chief preliminary finding is that using a random liability rule may, under some circumstances, be welfare-maximizing. In particular, such a regime will be beneficial if the optimal amount of dorm damage is low, and the dorm damage fine captures a large portion of the cost of the damage. The primary cost of a random liability regime is the pressuring cost it imposes on some students. This cost could presumably be minimized by an appropriate choice of the number of students charged under the scheme (n), or perhaps by an intelligent criterion for selecting them. For instance, Resident Councillors may find it easier to pressure culprits than other students do—perhaps charging them, rather than a random student, would be efficient? An additional benefit of such an arrangement is that the RCs can be easily compensated for the cost of exerting pressure, since they are already salaried employees of the College.

Before any policy changes are undertaken, however, a more thorough study of the topic is recommended. Firstly, empirical studies of dorm damage trends would be extremely useful. Knowing the sheer number of incidents would allow us to more confidently reject (or perhaps reluctantly embrace) an infinitely-repeated model of dorm damage interaction. Studies estimating c, the disutility of living in a damaged dorm, would allow for the determination of the t/c ratio, and lead to an estimation of the optimal amount of dorm damage. Secondly, a more thorough theoretical treatment would be of use. In particular, the mechanism behind exerting social pressure should be fleshed out in greater detail. Other ways to modify the liability regime could also be considered. Examples include punitive fines (overcharging for repairs) and sorting schemes (channeling students with high d and low c to the same few dorms). Finally, a public-choice perspective on optimal punishment described in Friedman (1999) should be entertained: how are the policy prescriptions modified if we take a more symmetric perspective and consider not only the students, but also the enforcement apparatus of the Dorm Damage Office, as rational self-interested actors?

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