An Economic Theory of College Alcohol and Drug Policies

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ABSTRACT

Colleges employ a wide variety of policies to regulate alcohol and drug use. A model where a regulator monitors the activity of a heterogeneous population of individuals is presented. Engaging in the activity is desired by each, but the aggregate activity exhibits a negative externality. The regulator is unable to observe the quantity or propensity for the activity of any individual, but can establish a maximum acceptable amount of activity and imperfectly monitor compliance with the standard. In this environment the choices made, the need for regulation, and imperfect monitoring are investigated to show that effective policy depends on the goal of the regulator.

I. INTRODUCTION

Institutions of higher education are charged with ensuring the quality of life of their students. Prominent among the factors that affect students' quality of life is the use of alcohol and drugs on campus. It is well documented that abuse of such substances can lead to individual harm such as a lack of academic success and health problems. Also, the use of alcohol and drugs by one student affects the quality of life of other students. Examples of such spillover effects include property damage, sexual assault, violence, and a diminished living environment (Wechsler *et al*, 2000b).

College policies attempting to regulate use vary significantly. Some schools relegate oversight to governments while others self-monitor activity. While some institutions standardize one policy for all substances others set separate policies for alcohol, marijuana, and other illegal drugs. Punishments differ substantially as well. Punishments for a violation of the drug policy range from immediate suspension from the college to only a reprimand. Furthermore, the amount of acceptable activity differs. For example, some schools prohibit all alcohol on campus.[2] Mitchell, Toomey, and Erickson (2005) survey college alcohol policies, Wechsler *et al* (2004) survey college alcohol prevention initiatives, and Wechsler *et al* (2000a) survey college administrators' responses to binge drinking. They find a wide variation of policies and initiatives, which is dependent on factors such as the size of the school, the proportion of students in residence, religious affiliation, and whether it is public or private. With such a wide variety of policies this paper attempts to explain the variation and determine the characteristics of an effective policy.

Alcohol and drug use on college campuses is an example of a negative externality. Students want to engage in the activity. For example, Teter *et al* (2005) document motivations for illicit use of

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prescription stimulants, which include euphoria, concentration, and alertness. The actions of one individual, while beneficial to that person, are harmful to others. Colleges recognize this spillover in their drug policies. As an example, one college states, "these drugs can...cause situations in the setting of a residential college in which individual actions affect all members" (Handbook, 2004) while another points out, "above all else...members of the [community] shall...acknowledge the impact of alcohol on communal living and work to limit its negative effects" (Communications, 2004).

The environment developed in this paper captures three important characteristics of alcohol and drug use on college campuses. First, there is a population of students each of whom decides how much of an activity, which they enjoy, to engage in. Secondly, the extent to which a student enjoys the activity varies across the population. Thus, some students put little weight on the activity while others gain significant happiness from it. Finally, the aggregate amount of activity is harmful to each student. For example, suppose this activity is interpreted as the amount of alcohol consumed. Each student enjoys drinking but each differs in how much they enjoy alcohol. As the total amount of drinking increases on campus the quality of life of each student diminishes.

In this environment the choices made are investigated and the need for regulation is illustrated. Comparing the choice of a student without regulation to the best outcome for the overall student body, regulation is shown to be needed. In practice, the regulator is neither able to observe a student's propensity for the activity nor the actual amount of the activity she selects. An extension to the model is considered where a regulator, unable to perfectly monitor the activity of students, sets a maximum acceptable amount of the activity and observes, with a probability less than one, whether a student has exceeded the standard. If a student is found to exceed the standard the regulator is able to enact a penalty. An effective alcohol and drug policy is shown to depend crucially on the goal of the regulator. Three separate goals are discussed: a reduction in the amount of the activity on campus, an increase in compliance with the policy, and a maximization of the total well-being of the population of students.

Other authors have noted that effective policy implementation is dependent on the goal of the regulator. Caulkins and Reuter (1995, 1997) differentiate between use reduction and harm reduction as the goal of a national drug policy. Which goal is chosen greatly determines how drug use is attacked. As an example they compare a pregnant, recovering addict shooting heroin with an HIV-infected needle to an employed, emotionally stable adult with no dependents using marijuana at home. While both offenses are Schedule I prohibited drugs, the harm of the former is greater. Furthermore, they differentiate between prevalence use reduction and quantity use reduction, which are the first two goals studied here.

The first two goals considered are, as stated, a reduction in aggregate activity and an increase in compliance with the policy. For both more effective monitoring and stiffer sanctions are useful since they increase the expected cost of engaging in an excessive amount of the activity. Policy recommendations differ with regard to the level of acceptable activity. A decrease in the amount tolerated induces some, previously complying, to no longer follow the policy and increase their activity. Others, who continue to follow the rule, reduce the activity to satisfy the lower amount of acceptable use. Thus, such a decrease reduces compliance, but has an ambiguous effect on the aggregate amount of the activity.

Both of these goals aim for improvements in a specific variable, either aggregate amount of the activity or number complying. The third goal for the regulator is to maximize the total well-being of the population of students. It is shown that the optimal sanction must be greater for larger populations of students and activities that have a stronger spillover onto other students. Both affect the size of the negative externality and, thus, must be accompanied by stiffer penalties. This is similar to the goal of harm reduction discussed by Castro and Foy (2002) and Caulkins and Reuter (1997). Since the expected cost of violating the rule is the product of the probability of apprehension and the sanction there is an inverse relationship between the probability of catching a student who has exceeded the tolerated amount of activity and the optimal sanction. The greater this probability the greater the marginal cost to the activity, thus, to remain at the level that maximizes the well-being of the population, the sanction must decrease. This result contrasts that of the previous two goals. Similarly, the maximum amount of acceptable activity must be lower for larger student populations and more detrimental activities. Furthermore, in this environment a policy of abstinence is never best for the student body.

Others have used economic theory to describe the use of alcohol and drugs and the enforcement of laws. Benson and Rasmussen (1998) use economic theory to explain the determination of drug laws and monitoring by law enforcement agencies. Krebs, Costelloe, and Jenks (2003) model a game between the government and drug smugglers. Miron and Zwiebel (1995) and Miron (1998) investigate the effects of prohibition of alcohol in the 1920s to discuss the impact of current policies of prohibition of drugs. Here, a standard model of negative externalities is applied to a new application, college alcohol and drug policies, to generate policy recommendations and explain observed differences in policies.

This work is also related to the literature on optimal deterrence in the field of Law and Economics. Following from Becker's (1968) seminal work it has been shown that since sanctions and enforcement both add to the expected cost of violating a policy they are substitutes. It is possible to decrease one and increase the other and maintain the same amount of compliance. Since enforcement tends to be more costly than implementing stiffer sanctions, his work predicts that full compliance with the law occurs using maximal sanctions. Neither of which occur in practice. A sizeable literature has developed to explain the lack of full compliance and the use of nonmaximal sanctions (see Garoupa (1997) and Polinsky and Shavell (2000) for more detailed literature reviews). The literature can be organized along three lines of explanation. First, some have argued that imposing more severe sanctions comes at a cost that balances the cost of enforcement. Examples include direct costs to the legal system (Polinsky and Shavell, 1992), the costly avoidance activities more severe sanctions encourage (Malik, 1990), and the imposition of socially inefficient nonmonetary sanctions (Shavell, 1987). A second line of explanations focuses on various forms of regulation. Examples include the *ex ante* vs. *ex post* regulation of the production of harm (Wittman, 1977; Kolstad, Ulen, and Johnson, 1990), general vs. specific enforcement (Shavell, 1991), and the tradeoff between monitoring and investigation (Mookherjee and Png, 1992). Finally, frictions in the enforcement activities may lead to reduced sanctions and incomplete enforcement. Examples include imperfect information about the magnitude of the sanctions (Craswell and Calfee, 1986; Bebchuk and Kaplow, 1992) or rate of apprehension (Bebchuk and Kaplow, 1993), heterogeneous wealth constraints of the population restricting the severity of the sanction (Polinsky and Shavell, 1991), and the problem of marginal deterrence where an increased sanction for one offense encourages violation of another (Shavell, 1992; Wilde, 1992; Friedman and Sjostrom, 1993). The model presented here adds to the literature of friction-based explanations. Individuals select an amount of activity and the regulator is only able to observe whether an activity has exceeded a set threshold. This is a new, specific informational friction in enforcement that is particularly applicable to the use of alcohol and drugs.

The work presented here is novel in two aspects. First, it applies a rather standard model of negative externalities to an important application generating policy recommendations. The model is used to rationalize the variation in policies observed among colleges and universities. There has been no prior theoretical, economic inquiry into this application. Second, it adds to the literature on optimal deterrence of law breaking and policy violation by considering an environment not before considered in the literature. The work provides new explanations for the fact that maximal sanctions are rarely used and full compliance is not achieved. Section II presents the base model and illustrates the need for regulation. Section III presents an extension to the model considering the imperfect monitoring of the regulator, which provides the results stated. Section IV concludes. Proofs of the results are given in the appendix.

II. THE NEED FOR REGULATION

Consider a population of N students. Each student selects an amount of activity in which to engage. Let y_i denote the amount of the activity student i selects where $0 \leq y_i \leq y^+ < \infty$ where y^+ is the upper bound to y_i. The activity can be interpreted as the consumption of a good such as a quantity of alcohol or another drug. Define Y to be the aggregate amount of activity of the students. Thus, $Y = \sum_{i=1}^{N} y_i$. Let $u_i(y_i, Y)$ denote the utility to student i engaging in y_i activity if the aggregate activity is Y. Each student benefits from the activity she does but is hurt by the total amount of activity, or rather, utility is increasing in y_i and decreasing in Y. To provide an analytical solution let

(1) $u_i(y_i, Y) = a_i \ln y_i - bY$

where $0 \leq a_i \leq a^+ < \infty$ and $0 < b < \infty$ where a^+ is the upper bound to a_i. The amount of satisfaction students receive from engaging in the activity varies across the population. For simplicity, the marginal impact the aggregate activity has on each student, b, is the same for each student.

Consider, first, the outcome with no regulation where every student selects the amount of the activity in which to engage. From standard optimizing behavior each student chooses y_i at the level where her marginal benefit exactly equals her marginal cost. In this model the marginal benefit is the direct gain to the activity, while the marginal cost is the lost utility due to the increase in Y. From (1),

(2) $a_i / y_i = b$.

Solving (2), student i selects a_i / b. Suppose a regulator is interested in the well-being of the entire population. Such a regulator wants to maximize the sum of the utilities of all students, $\sum_{i=1}^{N} u(y_i, Y)$.

Selecting y_i to maximize this expression it follows that the amount of activity of student i solves[3]

(3) $a_i / y_i = Nb$.

Figure 1: The Need for Regulation

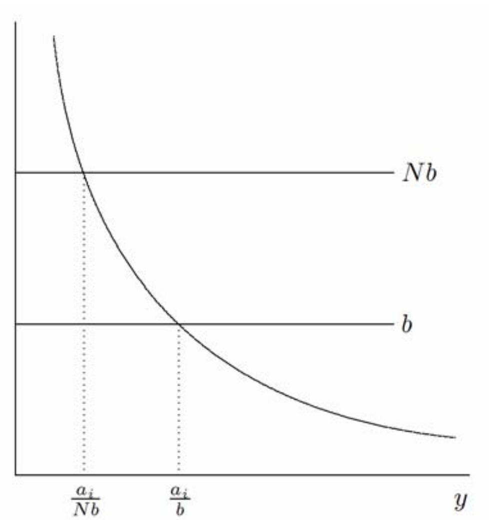


Figure 1 depicts the marginal benefit and marginal cost of both (2) and (3). Whereas student i would select a_i / b it would be best for the population if she only selected a_i / Nb. This is the standard negative externality result. Since the individual does not take into account the full cost of her activity too much is done. Notice that the amount of activity that is best for the population is less with a larger population or a more harmful activity because in either case the externality is greater. Finally, the amount of activity that achieves the greatest well-being for the population prescribes that each student does not engage in the same amount of activity. Those valuing the activity more do more of it. With full information the regulator can construct penalties that induce the socially optimal amount of activity.

Now consider an extension of the model where the regulator lacks the information needed to do so and can only imperfectly observe whether or not a violation of a set policy has occurred.

III. IMPERFECT MONITORING

The previous analysis studied the straightforward but unrealistic case where the regulator is able to observe both the amount of activity each student engages in and each student's propensity for the activity. In practice, neither is perfectly observable. How should a regulator act if it is unable to perfectly monitor the activity?

Suppose that the a_is are privately known. Since a_i represents student *i*'s taste for the activity it is likely that this is not observable to the other students or the regulator. As a consequence, the regulator is unable to condition a penalty on a student's willingness to act. Also, assume that neither the set of y_is nor Y is observable to any student or the regulator. Furthermore, suppose the only available option for the regulator is to set a maximum acceptable amount of activity (i.e. "one size fits all"), y^*, which is referred to as the *standard*, and imperfectly observe whether or not a student complies with this standard. Assume that if a student exceeds y^* then with a probability less than one the regulator observes that $y_i > y^*$ and can levy a punishment. A student engaging in more of the activity has a greater probability of getting caught. Let the probability that a student selecting $y_i > y^*$ is caught be py_i where $p \geq 0$ and $py^+ \leq 1$. The regulator who has caught a student exceeding the standard knows that the policy has been violated, but is not able to determine the extent of the violation. In this model a student selecting less activity than the tolerated amount is never wrongfully punished. A penalty imposed on a student exceeding the standard with the informational constraints is a lump-sum sanction dependent only on being caught. Denote this punishment as *f*.

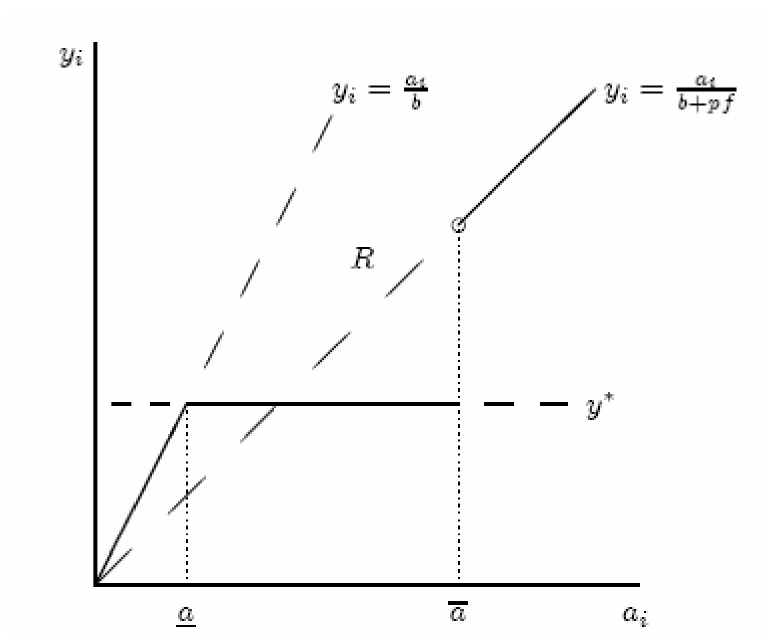
For many illegal activities this is a reasonable, accurate setup. A college administrator is unlikely to know exactly how much or how often a student engages in alcohol or drug misuse and is even less likely to know the aggregate amount of such activity on the campus. The institution is able to set limits to the activity and learn (imperfectly) whether or not this standard has been violated. Alternatively, if the regulator is able to observe either y_i or Y perfectly other enforcement mechanisms would be available.[4] Thus, this model focuses on activities, like alcohol and drug use on college campuses, that exhibit these characteristics and informational constraints.

How effective is the regulator? The expected utility of a student is

$$(4) \quad = \begin{cases} u_i(y_i, Y) - py_i f & \text{if } y_i > y^* \\ u_i(y_i, Y) & \text{if } y_i \leq y^* \end{cases}$$

First, a student who does not put much weight on the activity would select an amount less than the standard. Such a student is not affected by the regulation. Hence, for a given standard y^* there exists a value of a_i, denoted $\underline{a}(y^*)$, such that students with lower values of a_i select the same amount of activity as without regulation, a_i / b. A student with a large weight on the activity chooses to violate the policy. Again, such a student selects the amount that equates her marginal benefit with her marginal cost, which now includes the potential punishment. From (1) and (4) the optimal level of the activity is $y_i = a_i / (b + pf)$. Thus, for a given amount tolerated by the college administration there exists a second value of a_i, denoted $\overline{a}(y^*)$, and students with greater values select $a_i / (b + pf)$. Finally, a student with an intermediate value of a_i would exceed the standard if there were no regulation, but does not find it worth the potential cost to select that amount of activity. This student exactly complies with the amount tolerated selecting $y_i = y^*$. Figure 2 depicts the expected utility maximizing choice of y_i for students with various values of a_i. The derivation of $\overline{a}(y^*)$ and $\overline{a}(y^*)$ along with the proofs of the results are given in the appendix. The area above the line and below the $y_i = a_i / b$ dashed line, denoted R in Figure 2, is a measure of the reduction in activity due to the regulation.

Figure 2: Activity with Imperfect Monitoring



Consider, as an illustration, a policy of tolerating no more than $y^* = 4$ drinks, a fine of $f = 100$, a probability of $p = 0.01$ of catching a violation, and the aggregate activity has a $b = 1$ weight. Student 1 has a weight $a_1 = 20$ on the alcoholic drinks. For her breaking the rule with $a_1 / (b + pf) = 10$ generates a greater payoff, $20 ln 10 - bY - (.01x10x100) \cong 36 - bY$, than complying, $20 ln 4 - bY \cong 28 - bY$. Student 2 has a weight $a_2 = 10$. For him breaking the policy, with $a_2 / (b + pf) = 5$, results in a payoff of $10 ln 5 - bY - (.01x5x100) \cong 11 - bY$, which is less than the payoff from complying, $10 ln 4 - bY \cong 14 - bY$. Student 3 has a weight $a_3 = 1$ and, as a result, is only interested in having $a_3 / b = 1$ drink. Since this is an acceptable amount Student 3 consumes one drink. Hence, on Figure 2, Student 1 is beyond $\bar{a}$, Student 2 falls between $\underline{a}$ and $\bar{a}$, and Student 3 is less than $\underline{a}$.

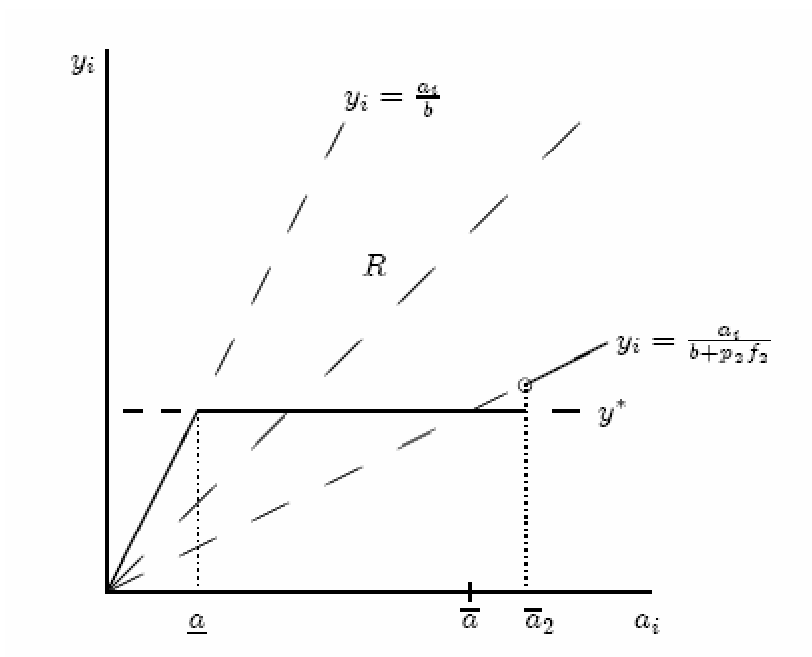
Result 1: *There is less activity with regulation than without.*

The regulator may be able to adjust its enforcement. Two possible goals of the regulator are to (1) reduce the aggregate amount of activity and (2) induce more compliance. The first would come from an increase in *R* while the second would be achieved by increasing $\bar{a}$.

EXPECTED COST

Suppose, first, that the regulator is able to stiffen its enforcement by either catching violations at a higher rate (increase *p*) or imposing a more severe sanction (increase *f*). Figure 3 illustrates the effect of an increase in either *p* to p_2 or *f* to f_2.

Figure 3: Activity with $p_2 > p$ or $f_3 > f$



Increasing *p* or *f* has the effect of increasing the expected cost when violating the standard. Such an increase would have two effects. First, it would reduce the activity of those continuing to violate the policy (rotation out of the a_i / $(b + pf)$ line). They reduce their activity to balance out the additional cost.

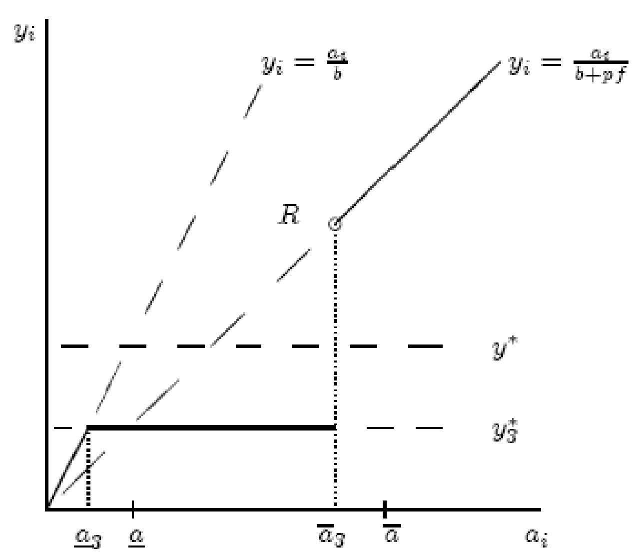
Second, it would encourage some students previously violating the policy to comply. The additional cost makes it no longer worthwhile to engage in the excessive activity (increase from $\bar{a}$ to $\bar{a}_2$).

Result 2: *An increase in enforcement (either p or f) reduces the amount of activity (increases R) and increases compliance (increases* $\bar{a}$*).*

STANDARD

Alternatively, the regulator may be able to adjust the standard, y^*. For simplicity, assume that the standard can be changed freely without affecting the ability to enforce it. In some situations technological constraints may preclude this. Alcohol and drug use can often be quantified; blood-alcohol levels, container size, and weights are examples of such measurements. Therefore, the assumption is used both because it seems realistic and it is useful to know what would be the preferred adjustments to the change in the standard. Consider a decrease in the amount tolerated by college officials from y^* to y_3^* so that less activity is acceptable as depicted in Figure 4. Again, there are two effects from such an adjustment. First, the amount of activity of those who continue to comply is reduced. Those previously choosing to exactly meet the standard are forced to reduce their activity, while some students, selecting an amount just less than the previous amount allowed (a_i in [$\underline{a}_3$, $\underline{a}$]), must now reduce their activity to comply with the new one. The second effect of the adjustment is that some students who were previously complying no longer find it worthwhile to do so because the marginal benefit at y_3^* now exceeds the marginal cost (a_i in [$\bar{a}_3$, $\bar{a}$]). Since their activity had been reduced to comply with the standard they now conduct more activity than before.

Figure 4: Activity with $y_3^* < y^*$



The two effects from the lowering of the acceptable level of activity (from y^* to y_3^*) have opposing impacts on the change in the aggregate amount of activity. Those complying with a_i between $\underline{a}_3$ and $\overline{a}_3$ reduce the amount of activity. Students with a_i between $\overline{a}_3$ and $\overline{a}$ no longer abide by the rule. A number of factors determine which of the two effects is stronger. One is the number of individuals complying. If many students are complying then a lowering of the tolerated amount would act to reduce the activity of much of the population. Thus, R would increase. The high rate of compliance could be due to a lenient, high standard (large y^*) or from a population that consists of many students with low values of a_i. Another factor that would effect which of the two effects dominate is the stringency of the enforcement. If the enforcement is tough (large p and/or f) then the increase in activity of those that now choose to comply is mitigated. Thus, the gain in activity would be less. Furthermore, a high level of enforcement induces more to comply, which enhances the reduction in the activity.

Result 3: *A decrease in y* decreases compliance, but has an ambiguous effect of the reduction of the activity. If compliance and/or enforcement is high then a decrease in y* diminishes the aggregate activity.*

As a consequence of Results 2 and 3 it is important to identify the goal of the regulator. If the regulator is interested in reducing the aggregate activity lowering the acceptable amount of activity is effective only when it is coupled with strict enforcement. If few are complying then it is likely that the number of students who refuse to comply and increase their activity will exceed the number reducing their activity. In contrast, if the goal of the regulator is to increase compliance the lowering of the amount tolerated works against this goal.

WELFARE

As discussed in the previous section the regulator may instead be interested in the total well-being of the population of students. With the imperfect monitoring of students' activity the socially optimal outcome cannot be achieved, but given the constraints on the regulator's information, what policies can the regulator use to most enhance the well-being of the students?

There are two variables which the regulator might have control over: the penalty and the acceptable level of activity. For example, consider a college attempting to regulate alcohol and drug use on campus. It is able to set a policy that outlines the acceptable and unacceptable amounts of each activity. Violations of the standard may be difficult to observe but once the violation is caught assessing whether or not it exceeded the acceptable level should be straightforward. The size of the sanction for the violation is also within the control of the college.

Consider, first, a change in the size of the punishment, *f*, handed down to a student caught exceeding the standard. An increase in *f* affects the well-being of the population in the same two ways as mentioned before. First, the increase causes some students to alter their activity, which reduces their utility. Students continuing to exceed the tolerated amount reduce their activity due to the greater potential cost while others now decide to comply with the standard. Secondly, from Result 2, the increase in *f* reduces *Y*. This increases the well-being of all students.

What, then, can be said about the optimal penalty that maximizes the total well-being of the population? First, the optimal penalty is increasing in both the size of the population, *N*, and the magnitude of the disutility from aggregate activity, *b*. Both *N* and *b* affect the magnitude of the negative externality; either by affecting more individuals or by having a more severe impact on each person. By controlling the penalty the regulator is able to control the expected cost to a student engaging in excess activity. An increase in the probability of being caught also increases the expected cost. Since the optimal penalty sets the marginal benefit equal to the marginal cost the penalty is less when the probability of apprehension is greater.

Result 4: *The larger the population of students or the more harmful the activity (greater N or b) the higher the optimal penalty, while a greater probability of apprehension (p) reduces it.*

Next, consider a decrease in the amount allowed, *y**. The optimal standard balances the benefit from the reduced aggregate activity felt by the entire student population with the lost utility of those meeting or exceeding the standard. As before, a greater value of *N* or *b* increases the benefit of a lower acceptable amount of activity.

Result 5: *The larger the population of students or the more harmful the activity (greater N or b) the lower the optimal standard.*

Furthermore, the optimal level of acceptable activity is always greater than zero. Because of the inability to perfectly monitor the students' activities every student, who generates a positive utility from the activity, would violate the policy and be subject to the potential punishment. An increase in the acceptable level, which from Result 3 would increase the amount of activity, would allow students to engage in small amounts of it without punishment. Such an increase would also increase compliance and would result in the students caught exceeding the rule being the ones who engage in the most activity.

Result 6: *A policy of abstinence is never best.*

It should be pointed out that by using the functional form given in (1) it is assumed that for every student with $a_i > 0$ the marginal benefit of engaging in the activity is infinitely large if she does not engage in the activity. If this assumption is relaxed so that the marginal benefit is finite, for large populations and sufficiently harmful substances it may then be best to prohibit the activity (see Miron and Zwiebel (1995) and Miron (1998) for detailed discussions of prohibition of alcohol and drugs).[5] Furthermore, the only harm the activity is assumed to cause is the externality generated by the aggregated activity. This setup does not include direct harm that the activity might cause, such as sexual assault.

IV. CONCLUSION

The goal of this paper is to address effective college alcohol and drug policy. A theoretical model of the effects and use of alcohol and drugs as an activity where there is a personal preference for the activity, there is variation in the intensity of this preference across the student body, and the aggregate quantity of the activity has harmful externalities is developed. It should be pointed out that the activity is interpreted as the use of alcohol and drugs on college campuses, but the analysis could be applied to any activity that has these three characteristics.

Effective policy is shown to be determined by the goal of the regulator. Three goals were analyzed. The following table summarizes the results.

Table 1: Policy Recommendations

Goal 1: Reduce Aggregate Activity	
1. Regulate activity	Result 1
2. Increase sanction	Result 2
3. Catch violations with a greater probability	Result 2
4. Decrease acceptable amount of activity if compliance is high and enforcement is effective, otherwise increase the tolerated level	Result 3
Goal 2: Increase Compliance	
1. Regulate activity	Result 1
2. Increase sanction	Result 2
3. Catch violations with a greater probability	Result 2
4. Increase acceptable amount of activity	Result 3
Goal 3: Maximize Student Well-Being	
1. Regulate activity	Result 1
2. Larger populations need a stiffer sanction and a lower acceptable standard	Results 4 & 5
3. Detrimental activities need a stiffer sanction and a lower acceptable standard	Results 4 & 5
4. Stiffer sanction with a lower probability of catching violations	Result 4
5. No abstinence policy	Result 6

This paper can explain much of the variation in college alcohol and drug policies. Larger schools need stronger sanctions and lower acceptable levels of activity. More harmful activities require lower amounts of acceptable activity and stiffer penalties. Thus, separate policies for alcohol, possession of illegal drugs, and distribution of illegal drugs are in order. It also calls for policies to discriminate based on the size of the externality. For example, off-campus activity might be punished differently than on-campus violations. Furthermore, the abandonment of policies of abstinence is in accordance with this goal. Consequently, colleges with abstinence policies or those that do not differentiate between activities must have some other goal besides improving the well-being of the student population.

These results fit reasonably well with the limited empirical evidence. Mitchell, Toomey, and Erickson (2005) survey college alcohol policies. They report that larger schools more frequently prohibit alcohol use in Greek houses, ban beer kegs, and provide on-campus, alcohol-free activities than smaller schools. Furthermore, colleges with a higher percentage of students living on campus more frequently prohibit the use, possession, advertising, and sale of alcohol. Thus, their results support the prediction that larger populations with spillovers affecting more people need lower levels of acceptable activity

As with any theoretical model assumptions are made to simplify the analysis and focus the discussion on the important aspects of the interaction. The work could be expanded to take into consideration many factors not included in the analysis. First, student preferences are assumed to be static. Many initiatives in place on college campuses specifically attempt to influence student's preferences. For example, marketing campaigns are used to affect the social norms of drinking and drug use. (Mitchell, Toomey, and Erickson, 2005). Kacapyr and Choudhury (2006) illustrate, though, that student perception of drinking on a college campus does not significantly affect the quantity of drinks consumed or the prevalence of binge drinking. Another important aspect to regulating alcohol and drug use on campus is the costs of regulation. Monitoring student activity is time consuming and costly. Also, overregulation by the college reduces the students' quality of life, which may have detrimental impacts on students not violating the policy. For example, room searches affect not only the accused, but also those living with the accused. Thirdly, the model looks at three potential goals of the regulator. Many more goals are possible. For example, a regulator interested in the well-being of the student body prior to penalties is considered, but not the well-being net of the penalties. Presumably, optimal penalties would be lessened and the optimal level of acceptable activity would be higher. Other policy goals include harm reduction, reducing legal liability, and expenditure reduction. None of these are studied in this model. Additionally, enforcement is modeled simply as a sanction and a probability of apprehension. The work does not differentiate between various forms of sanctions (monetary fines and restrictions on student life activities are two examples of potential punishments) or modes of enforcement (investigations based on reports and the monitoring of activities are two examples). A useful avenue would be to identify the effective forms of enforcement. Finally, the environment might be expanded to allow for interaction over time. The punishment of multiple offenses is not modeled and distinguishing between users and experimenters is not done. Also, the probability of being caught is assumed to be a function of the quantity of activity. A more elaborate model explicitly modeling the oversight by the college might add some important results.

ENDNOTES

1. I would like to thank Jonathan Caulkins, Maureen Donohue-Smith, Amihai Glazer, Patrick Meister, and Jim Mullen for their helpful comments. Suggestions made by William P. O'Dea and an anonymous referee also proved quite valuable.
2. An example of relegating oversight to legal authorities see the stated policy of the University of Kansas (www.vpss.ku.edu/alcoholbrochure.pdf). Ripon College is an example of a school laying out separate policies for many substances (www.ripon.edu/administration/Plant/ drugs.htm). Elmira College suspends students for a first time violation of its drug policy (www.elmira.edu/pdfs/campuslife/0405handbook.pdf) while Monmouth University uses fines and probation for a first offense (www.monmouth.edu/student/ policies/student.asp). Finally, Houghton College bans alcohol on campus (campus.houghton.edu/orgs/student_life/ comm_res_policies.htm#Drugs%20and%20Alcohol). It should be emphasized that these schools are just examples; for each there exists multiple examples.
3. From (1) $\sum_{i=1}^{N} u(y_i, Y) = \sum_{i=1}^{N} a_i \ln y_i - \sum_{i=1}^{N} bY = \sum_{i=1}^{N} a_i \ln y_i - NbY$. Since $Y = \sum_{i=1}^{N} y_i$ this simplifies to $\sum_{i=1}^{N} (a_i \ln y_i - Nby_i)$. Therefore, setting the derivative of this expression equal to zero yields equation (3).
4. If *Y* is observable an example of another mechanism would be to target an optimal level of *Y* and indiscriminately punish all students if it is not achieved.
5. If the functional form is altered to have a finite marginal cost a policy mandating *y** = 0 would be socially optimal if $\partial u_i / \partial y_i \big|_{y_{8i}=0} \in (b, Nb)$.

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APPENDIX

The goal of this appendix is to formally prove the results presented in the text. First is the derivation of $\overline{a}(y^*)$ and $\underline{a}(y^*)$. Without regulation a student selects $y_i = a_i / b$. When this is less than y^* it is preferred if

(5) $a_i \ln(a_i / b) - b(Y_{-i} + a_i / b) \geq a_i \ln y^* - b(Y_{-i} + y^*)$

where Y_{-i} is the total activity of all students except i. Define $\underline{a}(y^*)$ as the value of a_i that equates (5). It follows immediately that

(6) $\underline{a}(y^*) = y^*/b$.

If a student violates the policy and is subject to a potential punishment a selection of $y_i = a_i / (b + pf)$ maximizes her expected utility. This is preferred to exactly complying with the policy if

(7) $a_i \ln(a_i/(b+pf)) - b[Y_{-i} + a_i/(b+pf)] - pf[a_i/(b+pf)] \geq a_i \ln y^* - b(Y_{-i} + y^*)$, or rather, if

$$a_i \ln(a_i/(b+pf)) - a_i \geq a_i \ln y^* - by^* \ .$$

Define $\overline{a}(y^*)$ as the value of a_i that equates (7). Notice that the left-hand-side of (7) increases at a rate of ln (a_i / (b + pf)) + 1 when a_i increases while the right-hand-side increases at a rate of ln y^*. Since the threshold a_i / (b + pf) is of interest only when it is greater than y^* the left-hand-side of (7) increases at a faster rate. Thus, if either p or f increases then $\overline{a}$ must increase as well to maintain the equality. Also, if y^* increases then the right-hand-side of (7) increases as well since the condition matters only if y^* is below a / b. Since, as established, the left-hand-side increases with a_i at a faster rate, if y^* increases so to does $\overline{a}$ to maintain the equality.

Furthermore, $\overline{a}$ requires that $a_i / (b + pf) \geq y^*$, or rather, that $a_i \geq (b + pf)y^*$, while $\underline{a}$ requires that $a_i / b \leq y^*$, or rather, $a_i \leq by^*$. Therefore, $\overline{a} \geq (b + pf)y^* > by^* \geq \underline{a}$ so that an interval where $y_i = y^*$ is the expected utility maximizing choice exists. It follows immediately that since both y^* and b are nonnegative there exists an interval $[0, \underline{a}(y^*)]$ where $y_i = a_i / b$ is the expected utility maximizing selection. Finally, there exist students with values of a_i where the choice $y_i = a_i / (b + pf)$ is the optimal selection when $\overline{a}(y^+) \leq a^+$. If the upper bounds satisfy (7) when $a_i = a^+$ and $y_i = y^+$ this inequality holds and students make such a choice.

Now consider the results presented in the text.

Proof of Result 1: R is the sum of the difference between a_i / b and y^* for students with a_i in $[\underline{a}(y^*), \overline{a}(y^*)]$ and y^* and a_i /(b + pf)) for students with $a_i > \overline{a}(y^*)$. Since $a_i / b \geq y^*$ for $a_i \geq \underline{a}(y^*)$ and $pf > 0$, $R > 0$.

Proof of Result 2: As shown previously, $d\overline{a}/dp > 0$ and $d\overline{a}/df > 0$. Since students with $a_i \leq \overline{a}(y^*)$ are complying with the policy then an increase in p or f increases compliance. For students with $a_i > \overline{a}(y^*)$ an increase in p or f increases the difference between a_i / (b + pf)) and a_i / b.

Furthermore, the increase in $\bar{a}(y^*)$ shifts some from $y_i = a_i/(b + pf)$ to $y_i = y^*$, which is a reduction in their activity. Thus, R increases.

Proof of Result 3: As previously shown, $d\bar{a}/dy^* > 0$. Hence, a decrease in y^* decreases compliance. A decrease in y^* has three effects on R. It increases the difference between a_i / b and y^* for students with a_i in $[\underline{a}(y^*), \bar{a}(y^*)]$, increasing R. Second, since $d\bar{a}/dy^* > 0$, some students shift from $y_i = y^*$ to $y_i = a_i / (b + pf)$, which decreases R. Finally, since $d\underline{a}/dy^* > 0$, other students shift from $y_i = a_i / b$ to $y_i = y^*$, which increases R. Thus, a decrease in y^* reduces activity if the number of students between $\bar{a}(y^*)$ and $\underline{a}(y^*)$ is large. Also, such an adjustment reduces activity if the jump from y^* to $a_i / (b + pf)$ for those near $\bar{a}(y^*)$ is small, which occurs when pf is larger.

Proof of Result 4: Consider an increase in the penalty f. Students with $a_i > \bar{a}(y^*)$ decrease their activity. Since these students select $a_i / (b + pf)$ the rate of decrease is $pa_i / (b + pf)^2$. The regulator selects f at the point where the marginal benefit equals the marginal cost. The benefit is the gain in utility to all students when the aggregate activity is reduced. Since the change in Y with an increase in f is $\sum_{i \in E} pa_i/(b + pf)^2 df$ where E is the set of students exceeding y^*, the marginal benefit is $Nb\sum_{i \in E} pa_i/(b + pf)^2 df$. The cost is the lost utility to those who reduce their activity. Therefore, the marginal cost is $\sum_{i \in E}(a_i / y_i)pa_i/(b + pf)^2 df = \sum_{i \in E} pa_i/(b + pf)df$. The optimal penalty, f^*, is the one that satisfies

(8) $Nb\sum_{i \in E} pa_i/(b + pf)^2 df = \sum_{i \in E} pa_i/(b + pf)df$.

This simplifies to

(9) $f^* = b(N - 1) / p$.

Consequently, $df^* / dN = b / p > 0$, $df^* / db = (N - 1)/ p > 0$, and $df^* / dp = - b(N - 1) / p^2 < 0$. Hence, Result 4 holds.

Proof of Results 5 and 6: For a small decrease in y^* the students exactly complying with the standard reduce their activity. The optimal penalty sets the marginal benefit equal to the marginal cost. The benefit is the gain in utility to all students when the aggregate activity is reduced. Thus, the marginal benefit is $Nb\sum_{i\in C} dy*$ where *C* is the set of students exactly complying with the standard. The cost is the lost utility to those in *C*. The marginal cost is $\sum_{i\in C} a_i / y * dy *$. The optimal level of acceptable activity, y**, is the one that equates the two. This simplifies to

(11) $y^{**} = \sum_{i\in C} a_i / Nb$.

Since *y*** > 0, Results 5 and 6 hold.