A Perverse Effect of Lowering the Threshold Blood Alcohol Content

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Recent legislation in the U.S. encourages states to lower the legal threshold for drunk driving blood alcohol content. The intention of such legislation is to reduce the number of accidents and fatalities associated with drunk driving. This note shows that lowering the threshold blood alcohol content has an ambiguous impact on the incidence of drunk driving accidents and will not reduce the number of drunk drivers with blood alcohol content above a previous threshold (.1). The formal analysis serves to encourage further empirical research in this area.

1 Introduction

In 2000 U.S. President Clinton signed into law the Transportation and Related Agencies Appropriations Act which broadly encouraged states to set the threshold blood alcohol content (BAC) for drunk driving at .08. Policy makers clearly anticipated that in response to changes in the law, some people would alter their behavior. The presumptive change in behavior is that people would drive with lower BAC levels, and this would in turn reduce the number of fatalities related to drunk driving. In this note I demonstrate that, in fact, reductions in legal limits on BAC give a perverse incentive for some drinker drivers to drive with higher BAC.

The National Highway Traffic Safety Administration (2004) offers a point and counterpoint style discussion concerning the .08 BAC laws and suggests that some contend that "legislation will not affect problem drinker drivers who have high BAC levels" (page 2). However, it is also the case that laws *will* affect some drinker drivers with BACs near the legal limits and that the effect on some of these drinker drivers will be adverse. That is, some drinker drivers will drive with higher BACs. The purposes of this note then include: to highlight the fact that there is no clear theoretical conclusion concerning BAC laws and social outcomes such as reduced fatalities; to note that empirical research, not intuitive reasoning about the behavior of drinker-drivers, should guide public policy in this area; noting that intuition may be wrong, to provide a more formal demonstration that BAC laws may have a perverse effect; and to note that given

this perverse effect heterogeneity among states may mean that for some states a .1 BAC law will result in fewer fatalities than a .08 BAC law.

Various studies examine the problem of drunk driving without any explicit concern for the impact of a .08 versus .1 BAC limit as a *per se* legal violation (see for example: Wilkinson, 1987; Mullahy and Sindelar, 1994; Ruhm, 1996; Benson, Mast, and Rasmussen, 2000). Some more recent studies have focused on the issue of the .08 *per se* BAC limit. Apsler, Char, Harding and Klein (1999) and Hingson, Heeren and Winter (1996) find some evidence that the .08 limit reduces fatalities relative to the .1 limit; however, not all states in their studies support this conclusion. In fact, Einsberg (2003) notes that previous research has given mixed results. Still, Dee (2001) and Einsberg (2003) provide considerable empirical support for the argument that .08 *per se* limit laws reduce drunk driving related fatalities. Accordingly, my purpose is not to suggest that the .08 BAC limit is an example of "bad" public policy. Rather, I hope that the formal analysis below highlights the importance of examining the empirical research offered by others in enough detail that some subtle implications are not overlooked in guiding policy makers.

2 Model and Result

There are N drivers. Let Θ denote the set of all possible measurable BAC levels; e.g., $\Theta = \{0, 0.01, 0.02, \ldots\}$. Let $V_i : \Theta \to \mathbb{R}$ be the *drunk driving utility function* of driver $i = 1, 2, \ldots, N$. The argument of V is t which is the BAC while driving. Define a driver's type as

$$\theta_i = \arg\max_{t \in \Theta} V_i(t).$$

In words θ_i is driver i's desired BAC when there are no legal restrictions. Let F denote the distribution of types. Additionally, assume that driver types are well ordered; for any two drivers i and j if $V_i(t) > V_j(t)$ then $V_i(t') - V_i(t) > V_j(t') - V_j(t)$ for any $t' > t > 0$. In other words, drivers with greater utility from drunk driving also have greater marginal utility from drunk driving.

Now consider a legal limit $\bar{t}$ for BAC such that any driver with $t \geq \bar{t}$ faces legal action and cost with some positive probability. Let $C(t)$ denote the expected cost of driving with BAC of t. I assume that $C(t)$ is 0 for all $t < \bar{t}$, then C has a jump at $\bar{t}$ and is strictly increasing for $t \geq \bar{t}$. The monotonicity assumption is for consistency with the fact that higher BAC impairs driver ability, increases the probability that a driver will commit a driving infraction, be pulled over, and ultimately face legal action. The existence of legal restrictions alters the driver's objective function so that his *limit type* is defined as

$$\overline{\theta_i} = \arg\max_{t \in \Theta} (V_i(t) - C(t)).$$

The distribution of limit types is G. Observing that some drivers drive drunk we can safely state that for some drivers $\overline{\theta} \geq \bar{t}$. Noting the assumption concerning drivers' marginal utility for drinking we can show the following.

Lemma 1 *there exists a* θ *such that for any* $\theta_i \geq \theta$, $1 - F(\theta_i) = 1 - G(\theta_i)$.

To prove this, simply note that there is a type, θ', for which breaking the law is optimal. Then for any type $\theta \geq \theta'$ breaking the law will also be optimal.

Now we simply want to compare two different legal limits $\overline{t}$ and $\hat{t}$ and observe what impact this will have on drunk driving. Let $\overline{t} > \hat{t}$. We want to demonstrate that under $\hat{t}$ there will be at least as many drivers with $t > \overline{t}$ than under $\overline{t}$. In other words, when the legal BAC limit is .08 there will be at least as many drivers with BAC at or above .10 as when the legal limit is .10. Below let $\hat{C}$ and $\hat{G}$ denote the cost function and distribution of limit types when the legal limit is $\hat{t}$.

Lemma 2 $1 - \hat{G}(\overline{t}) \geq 1 - G(\overline{t})$ *for* $\overline{t} > \hat{t}$.

Proof: to prove the result we need only show that $1 - \hat{G}(\overline{t}) < 1 - G(\overline{t})$ cannot be the case and *a fortiori* we provide an example where $1 - \hat{G}(\overline{t}) > 1 - G(\overline{t})$ is the case. Suppose then that $1 - \hat{G}(\overline{t}) < 1 - G(\overline{t})$ is true. Consider a drinker driver i such that $\overline{\theta}_i = \overline{t}$. This is the lowest type for which the drinker driver breaks the law. (One could easily object that if V is smooth then no driver will choose $t = \overline{t}$ when C takes a jump at $\overline{t}$. If one has such an objection then one can simply change the above to be the lowest type that breaks the law and continue). Then under the law $\hat{t}$ we observe that $\hat{C}(t') > C(t')$ so that $V_i(t') - C(t') > V_i(t') - \hat{C}(t')$ for any $t' \in [\hat{t}, \overline{t})$. We know though that $\overline{\theta}_i = \overline{t}$ maximizes $V_i(t) - C(t)$ so that it must similarly maximize $V_i(t') - \hat{C}(t')$. Then by employing the previous lemma we arrive at a contradiction. This concludes the proof.

A simple example establishes the possibility of inequality. Suppose that C is simply defined by $.1t$ for any t at or above the legal limit for a *per se* violation and 0 otherwise. Suppose a drinker driver has utility function $V(t) = t^{.15} - t$. Additionally, suppose that t is chosen from the set $\{\ldots, .08, .09, .1, \ldots\}$. In this case the driver will choose $t = .09$ when $\overline{t} = .1$ and $t = .1$ when $\overline{t} = .08$. In other words, a drinker driver who was willing to limit his drinking to stay below .1 BAC may "give up" trying to stay below the limit when the more rigorous standard of .08 is applied, and end up driving with a higher BAC.

3 Discussion of Implications

Whether or not there is an actual increase in drivers with a BAC above $\overline{t}$ depends on the marginal utility of BAC for driver types "near" the legal limit. The result does not make a clear prediction about fatalities. The end impact of a change in BAC legal limits depends critically on the probabilities of fatal crashes at the various BAC levels. Ultimately, the question of optimal BAC limit laws cannot be settled theoretically or intuitively. The issue is best addressed empirically, and this note should serve to encourage further empirical research on that front.

An additional implication is that a uniform BAC limit across states may result in more fatalities relative to the situation where some states have a .08

limit and others have a .1 limit. The studies of Apsler, Char, Harding and Klein (1999) and Hingson, Heeren, and Winter (1996) suggest that some states do not benefit from a reduction in the legal BAC limit while, Dee (2001) and Einsberg (2003) find benefits from a .08 BAC limit at the aggregate level. Because states differ in terms of numerous laws regarding alcohol, including incidence of "dry" counties, their demographic makeup, and the average distance of bars from residences, for some states the perverse effect may outweigh the positive effects of a lower BAC limit. This suggests that a better policy in terms of minimizing fatalities is to allow for variation in state laws concerning legal BAC limits.

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