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Assessing the deterrent effects of ignition interlock devices

Short title: Deterrent effects of ignition interlock devices

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Abstract

Introduction: Ignition interlock devices installed after conviction for driving under the influence of alcohol (DUI) have been shown to reduce subsequent DUI arrests (specific deterrence).

However, there is little evidence on how interlock-device penalties might affect general deterrence, that is, deterring people from driving after consuming alcohol prior to a DUI conviction.

Methods: A discrete choice experiment was conducted and data were analyzed in 2023 with 583 U.S.-based adults who consume alcohol at least once in the past week to assess the deterrent effects of five different penalties (fine, jail time, interlock device, license suspension, alcohol treatment) for alcohol-impaired driving under randomized sequential scenarios of high (20% chance of being caught) and low (1%) police enforcement. Participants resided in 46 states.

Results: Deterrent effects of an interlock penalty, operationalized as having to install an interlock device for one year, are large and on par with a twentyfold increase in police enforcement activity (from 1% chance of being caught to 20%), or a \$2,000 increase in the DUI fine under the status quo enforcement regime. On average, a 1-year interlock penalty had the same deterrent effect as a 10-day increase in jail time.

Conclusions: Wider use of interlock devices as a DUI penalty could have large deterrent effects, independent of their ability to physically prevent the motor vehicle of an intoxicated driver from starting. The deterrent effect documented here adds to evidence on interlock devices' overall

effectiveness as well as their potential to shift DUI penalties away from criminalization (jail time) and towards immobilization and rehabilitation.

Key words: Alcohol, driving under the influence, public policy, deterrence

Journal Pre-proof

Introduction

Driving under the influence of alcohol (also known as DUI) resulted in 13,424 deaths in 2022, a 23% increase from 2019, with societal costs of up to \$44 billion.^{1,2} Alcohol is involved in about one third of motor vehicle fatalities nationally, a proportion that has been fairly stable over the past two decades. In 2020, as many as 127 million alcohol-impaired driving trips are estimated to have been taken³ with 600,000 DUI arrests.⁴ States have passed a number of laws to reduce DUI, but alcohol-related fatalities varied from 21% of all traffic deaths in 2020 in Utah to 44% in Montana.¹ Driving while intoxicated therefore remains a serious public health threat.

Penalties for DUI vary substantially in their type and severity across U.S. states. Society assigns penalties to violators of DUI laws for a number of purposes: justice, which requires the offender to receive a proportional punishment; general deterrence to prevent DUI by the public at large; specific deterrence, to reduce recidivism among previous DUI offenders; incapacitation to restrain high-risk offenders or their vehicles; and rehabilitation, which assumes an offender has identifiable and treatable problems leading them to commit an offense.⁵

One promising approach to reduce DUI recidivism has been the use of alcohol interlock devices.⁶⁻⁸ These devices prevent a vehicle from starting when they detect alcohol on the driver's breath and continue to require periodic breath samples while the vehicle is moving.

Approximately 350,000 drivers convicted of a DUI had these devices installed in 2017.⁹ The National Transportation Safety Board has repeatedly called for wider use of ignition interlocks and the 2023 Infrastructure Investment and Jobs Act proposed to mandate the installation of such devices in all new cars.¹⁰

Evidence suggests that ignition interlock systems can be effective⁶⁻⁸ and enjoy public support,¹¹ though they are often not installed or used properly or consistently.¹² But nearly all of this evidence is based on studies of repeat DUI offenders after the devices are installed. That is, interlock devices are usually conceived of as reducing DUI only mechanically after someone has a previous arrest or conviction. This paper assesses an additional way in which interlock devices might reduce DUI before they are even installed by measuring the deterrent effects of the devices as components of a state's DUI penalty regime.

Methods

This paper assesses the deterrent effects of interlocks along with other DUI penalties using a discrete choice experiment (DCE)—a stated preference method based on economic utility theory that systematically measures individual priorities for different aspects of products or services.^{13, 14} DCEs model and measure people's utilities for different alternatives in terms of 'part-worth' utilities for features that together describe a product or choice alternative.¹⁵ These methods can accurately predict actual behavior in many complex settings.¹⁶⁻²⁰

The key strength of DCEs over other preference elicitation methods is their reliance on simple, familiar tasks. Participants are presented scenarios to choose from based on a set of characteristics (attributes) that differ in terms of their experimentally manipulated values (or levels).^{14, 15} These methods have been applied to the design of medical treatments^{21, 22}, public policies,^{23, 24} and job preferences.²⁵ Importantly for the present study, DCEs can capture tradeoffs among penalties that are measured on different scales; e.g. jail time in days versus fines in dollars.²⁶

In this study, respondents are presented a situation and are then asked to choose whether they would or would not drive under the influence of alcohol in that situation. These situations differ in terms of the severity of common DUI penalties (ignition interlocks, monetary fines, imprisonment, license suspension, mandatory alcohol treatment), as well as in police enforcement intensity.

The five types of DUI penalties constitute the “attributes” of the DUI penalty environment. While there is no existing dataset with all state penalties for DUI, the penalty levels used in this study approximate minimum, median and maximum penalty amounts based on previous work.²⁷ See appendix Table A1 for the penalty levels used.

Because the likelihood the respondent would be caught while drinking and driving is a feature of the situation the driver is in, the study experimentally varies this factor within each subject using two levels: low (1% chance of getting caught) and high (20% chance of getting caught). The high enforcement level is deliberately extreme (the likelihood that someone driving under the influence is caught in the U.S. is estimated at 1-2 percent²⁸) so as to feel more intense than the lower level.

Each respondent completes one survey for each enforcement level, administered in random order and separated by a filler task that asks demographic questions. The design for each enforcement level is identical, and consists of multiple-choice tasks isomorphic to the sample task, but different in terms of the DUI penalties and enforcement intensity displayed. See Figure A1 for a sample choice task.

Study sample

Adult (aged 18 and above) participants were recruited from the online digital research platform Connect, which has over 6,000 participants who indicated that they drink at least one unit of alcohol per week.^{29, 30} During three consecutive evenings in July 2023, responses from 661 participants were collected.

Survey response time averaged 19 minutes. Quality checks eliminated 78 (11 percent) of respondents by excluding the fastest 5 percent, those who failed an attention-check task, and respondents who failed to correctly confirm their age and education at the end of the survey, resulting in 583 participants who can be assumed to have been attentive and human. Appendix Table A2 documents participants' demographic profile.

Participants indicated their free and informed consent to participate in the study and received a modest payment. The study protocol was reviewed by the UCLA Institutional Review Board and deemed exempt from full review (45 CFR 46.104 category 3).

Measures

In addition to 11 choices in the main DCE task under each enforcement regime, demographic characteristics (age, birth sex), educational attainment, and race/ethnicity were collected from each respondent. The latter may affect both the likelihood that an individual may be stopped by the police for a suspected DUI and the severity of penalties applied.^{31, 32} Given the relatively small sample, the race/ethnicity measure was simplified to white/non-white respondents in all analyses.

Alcohol dependence was measured using a validated instrument (the Cut, Annoyed, Guilty, and Eye or CAGE tool) that ranges from 0 to 4, where values of 2 or above are considered to be clinically meaningful.³³ Risk aversion was assessed through a widely used scenario resulting in a 4 point scale.³⁴ Low risk aversion may be an independent risk factor for DUI, one's perception of being caught and sentenced, as well as recidivism.³⁵ Prior DUI experience was classified as: "None", "Yes, but not convicted" and "Yes and convicted".

While not strictly a fine, ignition interlocks in nearly every state require an installation and maintenance fee, which is usually not known by the general public. To assess whether these additional fees influence one's deterrent preferences for an interlock device, participants were asked about their beliefs regarding the monthly monetary cost of an interlock device, ranging from \$0 to \$125 or more. Details of the above measures are available in appendix B2.

Statistical analysis

All analyses were performed in 2023. Methodological appendix B provides additional details on the study's main measures described below.

The first analysis characterized individuals who selected the option "I would not drive" every time. These "never DUI" respondents do not provide information about how they trade off different penalties. A logistic regression measures how they differ from the rest of the respondents.

For respondents who indicate they would drive at least once, a Mixed Logit Model with a Multivariate Normal population distribution of individual-level utility parameters was used to model the choice among the alternatives in each task.³⁶ The model was estimated using what Sawtooth Software refers to as a Hierarchical-Bayes Multinomial Logit Model (HB-MNL).^{37, 38} Appendix B presents the exact mathematical definitions used here. Appendix C shows that this model fits the data better than common alternatives.

To facilitate interpretation, utilities were transformed into importance weights, deterrence probabilities, and exchange rates. Importance weights reflect how important each penalty type is for each respondent. Simulated deterrence probability is defined as the predicted proportion of respondents who choose the “Not drive” option instead of a single driving scenario. Finally, exchange rates among penalties capture how a 1-year interlock penalty compares with other penalties, especially monetary fines and imprisonment. See Appendix B3 for definitions of all three constructs.

All reported population or subgroup averages of importance weights or deterrence probabilities are weighted (see appendix B4) to make them representative of the US population in terms of education, age, sex, and educational attainment.^{39, 40}

Results

About 39 percent (N=222) of the total of 583 respondents selected never to drive after drinking under the low enforcement condition, and 53 percent under the high enforcement condition (Appendix Table A2). Analyses of respondent characteristics correlated with never driving under

the influence are presented in Appendix Table A3. Regardless of enforcement intensity, being female and being more risk averse increase the chance of being a “never DUI” respondent. When enforcement intensity is low, higher CAGE scores lower that likelihood. Under high enforcement, being non-white also reduces the likelihood. Other coefficients were not statistically significant predictors of being a “never DUI” respondent.

For the 61 percent ($N=361$) of respondents who chose to drive under the influence at least once during the survey, all 11 DCE tasks from each respondent were used in the estimation, resulting in 3,971 observations. Table 1 presents weighted population average importance weights of each penalty type under each enforcement regime among these respondents. The raw utility parameters of the model are not directly interpretable. See Appendix C for further estimates.

None of the differences in importance between enforcement levels are statistically significant at the 5% level based on a between-subject analysis, but one (license suspension) is significantly more important based on a (preferred and more powerful) within-subject test. Increased enforcement does not significantly affect the relative importance of ignition interlocks based on either test.

Focusing on ignition interlock in Table 1, the range of interlock penalties considered (0 to 1 year) is slightly more important than the length of mandatory alcohol treatment (0 to 6 months), slightly less important than the length of license suspensions (0 to 6 months), and less than half as important as the lengths of prison and magnitude of monetary penalties considered.

Table 2 presents regression analysis of the individual average importance of interlock on individual characteristics. Individual characteristics correlated with the importance of interlocks depend on the level of enforcement intensity: at low enforcement, no statistically significant effects are detected, while under high enforcement age and alcohol dependence increase the importance weight of an interlock. While statistically significant, none of these effects is particularly large in magnitude.

Table 3 presents weighted population average deterrence probabilities for the three levels of ignition interlock penalty severity while keeping the remaining penalties at their lowest levels (no prison time, no license suspension, no alcohol treatment, and \$400 fine). All differences are statistically significant ($p < 0.001$). Starting from the \$400-fine low-enforcement baseline, adding a one-year ignition interlock has nearly the same increase in the probability of deterrence as increasing enforcement to the high (20%) level. The effect size is statistically significant ($p < 0.001$) and large in magnitude, effectively doubling the percentage of deterred DUI trips.

Figure 1 plots the deterrence probability of adding an ignition interlock to a \$400 fine as a function of interlock duration, by enforcement level and DUI experience. The figure shows adding one month of interlock to a standard fine increases deterrence regardless of prior DUI experience. Longer interlock durations have an even stronger effect. Focusing on the DUI but no conviction group under low enforcement, the deterrence probability increases from 22% with just the fine to 34% with 1-month of interlock to 44% with 1-year of interlock.

When the individual-level increase in deterrence is regressed on the same explanatory variables as in Table 2, no additional explanatory variables significant at the 5 percent level emerge.

The exchange rate calculations present the increase in monetary fines from the base \$400 level that would leave the median respondent indifferent between a 1-year interlock and the increased fine (see Appendix B5). The deterrent effect of a 1-year interlock is on par with an approximately \$2,200 increase in the DUI fine irrespective of the enforcement regime. An analogous calculation for prison time shows that a 1-year interlock penalty has approximately the same deterrent effect as a 10-day increase in imprisonment to the median respondent in the sample.

Discussion

Prior research has shown that ignition interlock devices can be effective when they are deployed to DUI offenders, at least when they are actually installed in the vehicle.⁴¹ This study shows that interlocks also have promise to work prospectively as a general deterrent for driving under the influence, both among people who have never before been penalized for this behavior as well as among people with prior DUI convictions.

Compared to a monetary fine of \$400, the addition of a mandatory ignition interlock penalty of one year has the same deterrent effect as increasing police enforcement (arguably a more costly alternative), adding a mandatory sentence of 10 days in jail (also likely more costly), or increasing the fine amount by about \$2000. Notably, interlock's deterrent effect was significant regardless of the level of alcohol dependence, prior DUI experience, or other demographic and psychographic variables. It thus appears that interlock's deterrent potential is broadly applicable.

Interestingly, at the low level of enforcement, most of an ignition interlock's deterrent effect can be obtained from a brief (1-month) interlock penalty. Thus, having to install an interlock device even for a short period of time may have a significant deterrent effect.

The importance respondents give to the ignition interlock device as a deterrent increases with the additional monetary fees associated with installing the device. This finding contrasts with a recent qualitative study that examined why a small portion of those convicted of a DUI chose a suspended license rather than install an ignition interlock, identifying the cost of the device as the main reason for non-compliance.⁴² One explanation for this discrepancy is that the previous study focused on convicted DUI offenders who chose not to drive instead of incurring the cost of installing an interlock device. In contrast, this study focuses on deterrence among people not currently adjudicating an offense.

This study also finds a systematic relationship between DUI and gender and risk-aversion: women and more risk-averse respondents are more likely to indicate that they would never drive under the influence, all else equal. In contrast, respondents with higher levels of alcohol dependence are more likely to drive under the influence, as consistent with previous literature.⁴³

To date, there is little research on what the general population believes will deter them from drinking and driving. Several previous studies, using similar methods on much smaller, non-representative samples are largely consistent with the present findings. Yao et al⁴⁴ conducted a DCE assessing several combinations of DUI penalties with 121 US undergraduate students finding that enhanced police enforcement was the strongest deterrent, closely followed by jail

time, license points, and the availability of alternative means to get home. Monetary fines, different Blood Alcohol Content (BAC) levels, and delayed punishment due to judicial processing had relatively little effect on participant preferences. Similar results were found in China,⁴⁵ Switzerland,⁴⁶ and Austria.⁴⁷ None of these studies examined interlock devices.

Currently, seven states (California, Indiana, Nevada, North Dakota, Montana, South Dakota, Wisconsin) have no interlock penalty requirement, five states (Georgia, Ohio, Massachusetts, Maine, Missouri) only require interlocks for repeat offenders, and seven states (Florida, Michigan, Minnesota, North Carolina, Pennsylvania, Rhode Island, Wyoming) only apply interlock penalties to high Blood Alcohol Content (BAC) or repeat offenders.⁴⁸ This suggests there is considerable room for strengthening interlock penalties across many states.

Given evidence of unequal probabilities of arrests and convictions among non-white populations,^{31, 49-52} moving towards interlocks as standard DUI penalties may also yield an equity benefit to the extent that they could reduce prison sentences among overpoliced minoritized communities.

Limitations

This study has several limitations. The absolute level of a deterrence probability is subject to various biases that may cause a divergence between the predicted probability and what the respondents would actually do in the situation they must imagine during the survey. To the extent that the biases distort only the levels of the response, estimates of the effect of changes in attribute levels on changes in response remain externally valid in direction, and can remain unbiased in terms of magnitude (see Appendix B6 for details). Due to a lack of data regarding

every state's DUI penalty regime, another limitation of this study is a lack of link between the scenarios presented and the full DUI penalty regime within each respondents' state. Finally, participants were not randomly selected from the US population, so weighted averaging was necessary to strengthen external validity of population and sub-population level predictions. However, the participants are quite diverse, hailing from 46 states, and seem attentive in that they did not skip any questions (thus reducing the potential for biases). The online survey provider also uses a number of procedures to assure high quality responses.^{29, 30}

Conclusions

Discrete choice experiments can provide evidence for policymakers seeking to reduce drinking and driving. This study finds that adding an ignition interlock device to a state's DUI penalty regime could have a substantial general psychological deterrent effect even before any such devices are installed. This deterrent effect is large, broadly applicable to people with varied alcohol dependence and prior DUI experiences, and comparable to increasing the monetary fine penalty by \$2200, increasing the jail time penalty by 10 days, or increasing police enforcement activity twentyfold from 1% chance of getting caught to 20%. A final implication of this study is that states already authorizing interlock penalties may wish to publicize this fact to the public to benefit from the general deterrence effect documented here.

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Declaration of interests

No financial disclosures have been reported by the authors of this paper.

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Title and footnotes for figures

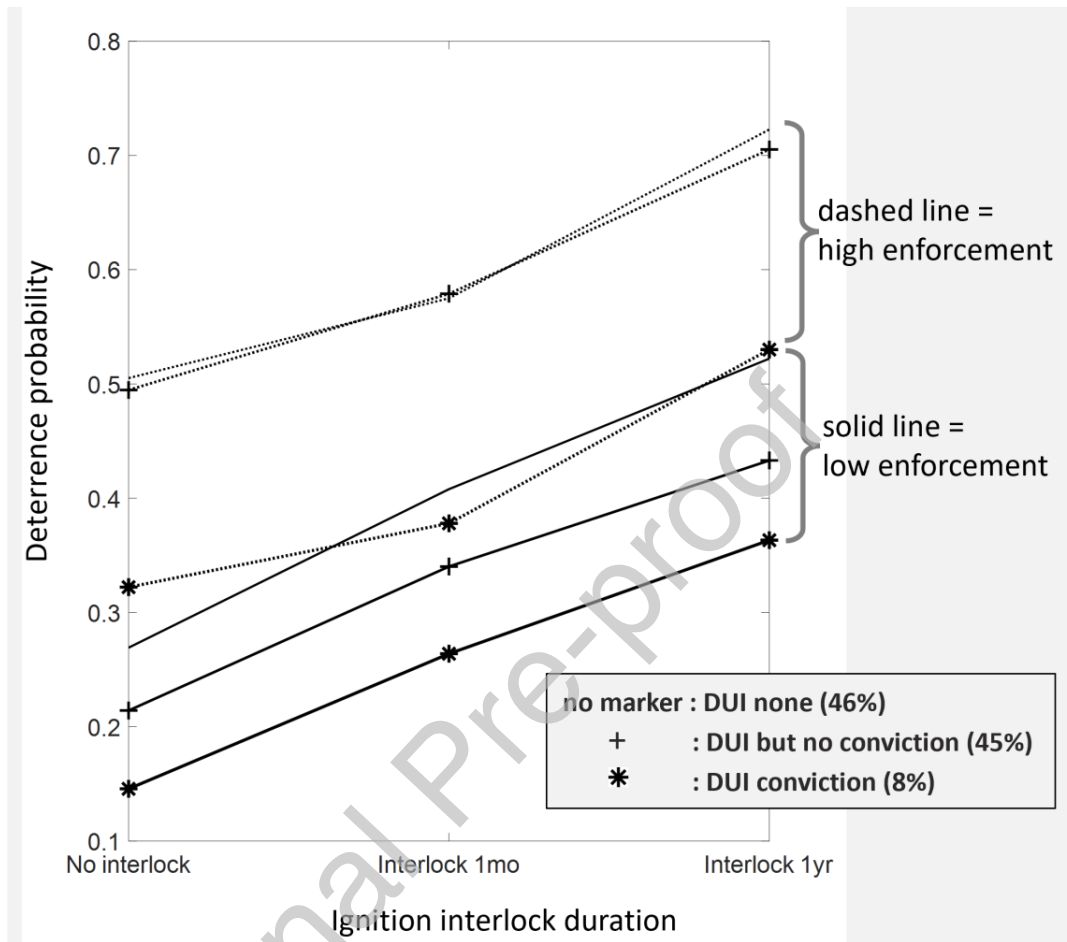


Figure 1: Deterrence probability of adding an ignition interlock penalty to a \$400 fine as a function of interlock duration, by enforcement level and DUI experience

Note to Figure 1: Solid lines interpolate between simulated values under the low police enforcement scenario. Dashed lines interpolate between simulated values under the high police enforcement scenario. Markers indicate the respondent's DUI experience, with location corresponding to the (weighted) average deterrence probability within each group.

Tables

Table 1: Average importance of each penalty, by enforcement intensity

Penalty types	Low enforcement	High enforcement	Difference (High – Low)	SE diff (between)	SE diff (within)
Monetary fine	33.19 (1.22)	31.76 (1.84)	-1.43*	2.21	0.82
Prison	29.10 (1.10)	27.93 (1.42)	-1.17	1.80	0.78
License suspension	15.15 (0.84)	17.70 (1.20)	2.55**	1.46	0.59
Ignition interlock	12.07 (0.75)	12.43 (0.92)	0.36	1.19	0.54
Alcohol treatment	10.49 (0.78)	10.18 (0.87)	-0.31	1.17	0.51

Note: Numbers are importance weights with standard errors in parentheses.

Boldface indicates statistical significance from within-subject tests (* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$, **** $p < 0.001$).

Table 2: Linear regression of the individual importance of the interlock penalty on personal characteristics

Variable names	Low Enforcement				High Enforcement			
	Coeff	SE	t	p	Coeff	SE	t	p
(Intercept)	9.38***	1.06	8.84	0.00	8.63***	1.11	7.79	0.00
Non-white (versus white)	-0.16	0.36	-0.45	0.66	-0.20	0.37	-0.55	0.59
Female (versus male)	0.65*	0.33	1.95	0.05	0.51	0.34	1.48	0.14
College+ (versus less)	0.20	0.32	0.62	0.54	0.25	0.34	0.75	0.46
Age (years)	0.02*	0.01	1.71	0.09	0.04**	0.01	2.72	0.01
Currently intoxicated	0.77	0.64	1.19	0.23	0.83	0.67	1.23	0.22
Alcohol dependence (0-4)	0.13	0.13	0.98	0.33	0.39**	0.14	2.83	0.00
Never drove drunk	0.59	0.68	0.87	0.38	1.02	0.71	1.44	0.15
Prior DUI but no conviction	0.03	0.63	0.04	0.97	0.99	0.66	1.50	0.13
Risk Aversion (1-4)	0.08	0.14	0.55	0.58	-0.11	0.15	-0.71	0.48
High Enforcement first	0.14	0.31	0.45	0.65	0.33	0.33	1.00	0.32
Expected interlock cost (1-6)	0.12	0.09	1.29	0.20	0.15	0.10	1.53	0.13
R^2	0.038				0.081			

Note: All explanatory variables are dummies unless otherwise indicated. The dependent variable is each individual's posterior average importance weight of the interlock penalty, scaled as 100=100%. N=361 respondents.

Boldface indicates statistical significance (* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$, **** $p < 0.001$).

Table 3: Average deterrence probability of ignition interlock in addition to a \$400 fine, by enforcement intensity and interlock duration

Enforcement level	Ignition Interlock Duration						Difference in duration	
	None	SE	1 month	SE	1 year	SE	Year- None	SE of diff
Low	23.5%	2.7%	36.6%	2.5%	47.0%	2.6%	23.5%**	3.8%
High	49.3%	3.0%	56.8%	2.8%	69.9%	2.3%	20.7%**	3.8%
High - Low	25.8%**	4.1%	20.2%**	3.8%	23.0%**	3.5%		

Boldface indicates statistical significance (*p<0.10, **p<0.05, ***p<0.01, ****p<0.001).

Author Credit statement

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