Preliminary Draft
Comments Welcome

One for the Road: Public Transportation, Alcohol Consumption, and Intoxicated Driving

*December 2008**

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Abstract

We exploit temporal and spatial variation in the availability of public transportation in Washington DC to investigate the relationship between public transportation provision, the risky decision to consume alcohol, and the criminal decision to engage in alcohol–impaired driving. We find that each additional hour of late-night operation reduced the total number of DUIs in Washington DC by 9%, and this effect was concentrated in areas where alcohol venders are located close to Metro stations. In contrast, we find evidence that alcohol consumption increased with the service expansion as the number of alcohol-related arrests went up by as much as 14% in certain neighborhoods. Incorporating this moral hazard into our results suggests that each hour of public transportation available reduced the number of "DUIs per drinker" by 35% in neighborhoods with more than one bar within 100 meters of a Metro station.

Keywords: Alcohol Consumption, Drunk Driving, Public Transportation
JEL classification: I18, R49

* * The authors wish to thank Stephanie Cellini, Matthew Freedman, Jordan Matsudaira, Kitt Carpenter, and seminar participants at George Washington University for helpful comments, as well as Charlea Jackson of the Washington Metropolitan Police Department for providing us with access to arrest data. Michael Shores provided valuable research assistance. All errors are our own.

I Introduction:

In 2005, nearly 1.4 million drivers were arrested for driving under the influence of alcohol or narcotics [Department of Justice (2005)] while there are 159 million self-reported episodes of alcohol–impaired driving among U.S. adults each year [Quinlan et al. (2005)]. During 2005, 16,885 people in the U.S. died in alcohol-related motor vehicle crashes, representing 31% of all traffic-related deaths [NHTSA (2006)]. It is estimated that alcohol-related crashes in the United States cost about $51 billion each year [Blincoe et al. (2002)].[1] The Center for Disease Control at the Department of Health and Human Services provides a variety of policy recommendations to reduce the incidence of alcohol-impaired driving.[2] Virtually all these policies involve stricter laws, harsher penalties, and more aggressive enforcement to either increase the penalties associated with drinking while driving or decrease general alcohol consumption among youth. In this paper, we evaluate the impact of public policy aimed at reducing the probability that a drinker gets behind the wheel of a car.

It is a commonly held belief that the provision of accessible public transportation could reduce the incidence of DUIs. For example, the popular press regularly prints articles blaming high DUI incidence on the lack of public transportation.[3] Both public and private organizations provide transportation to drinkers in order to reduce DUIs – for example both the MillerCoors and Anheuser-Busch Brewing Companies operate programs which provide free transportation on popular holidays and from "member" bars.. The slogan of a current Illinois campaign to reduce DUI incidence is "designate a driver - stay overnight - use public transportation."[4] However, there is very little evidence on the relationship between the provision of public transportation and drunk driving, and no studies present empirical quantitative evidence that providing public transportation would actually reduce the incidence of drunk driving. Credible evidence on the relationship between public transportation and DUI incidence is also important for understanding of the benefit of urban transit systems since recent research, based on

[1] http://www.cdc.gov/ncipc/factsheets/drving.htm
[2] The complete list is available on their website. See appendix for webpage.
[3] MARSHA DORGAN (Oct 22, 2008) "CHP DUI checkpoint results" Napa Valey Register , Alan K. Category (Oct 2 2008) The Drunk Driving Situation in Los Angeles , Mutineer Magazine
[4] http://www.cyberdriveillinois.com/publications/pdf_publications/dsd_a1495.pdf

commuting and congestion patterns, argues that fixed-rail transit may actually *reduce* social welfare [Winston and Maheshri (2007)].

The lack of credible evidence about the effect of public transportation on social outcomes is due in large part to the fact that alteration of public transportation, particularly fixed rail service, requires a huge investment in infrastructure. As a result, in recent history, areas have rarely changed from having no public transportation system to having one – in fact, Glaser et. al. (2008) argue that since New York City fixed-rail transportation has been fixed for so long, the location of stops can by considered exogenous. With no variation in public transportation availability within a geographic area, one is forced to compare DUI rates in areas with no public transportation like Los Angeles, to that of areas with public transportation such as New York – clearly this is not satisfactory.[5]

However, while relatively rare, in a few areas there were changes in the hours of public transportation operation that one could use to do a before and after comparison within the same geographic area.[6] In an effort to provide adults reliant on Metro transit the chance to stay at bars until 1:30 am when most bars close[7], in 1999 Washington D.C. Metro decided to extend its hours of operation on Friday and Saturday nights from midnight to 1 am in the morning. In 2000 this was further extended to 2 am[8], and then 3 am in 2003. Since the change in schedule allow us to observe the same geographic area on the same day of the week during the same time of day both with and without public transportation availability, one can use the changes in hours of operation of fixed rail transportation in D.C. to present the first credible investigation into the relationship between public transportation provision and the incidence of alcohol–impaired driving. Since increased public transportation could also affect drinking behaviors, we also

[5] Notable exceptions to this include Baum-Snow and Kahn (2005) who assembles a 30 year panel of data on 13 cities, which allows them to capture variation over time and place, as well as Baum-Snow and Kahn (2000) and Holzer, Quigley and Raphael (2003) who takes advantage of a physical expansion of fixed rail lines. All of these papers look at the effect on commuting behavior of workers, as opposed to public health and safety

[6] In addition to Washington, DC, Boston's Massachusetts Bay Transportation Authority and Austin's Capital Metro Authority introduced late night service with the last ten years.

[7] http://media.www.gwhatchet.com/media/storage/paper332/news/1999/09/20/News/Metro.Considers.Extending.Hours-16550.shtml

[8] http://billonglbt.blogspot.com/2007_07_01_archive.html

investigate the relationship between public transportation provision and alcohol-related crimes.

We identify the effect using a difference in differences in differences approach - comparing the difference in outcomes between the late night (the time of day that the number of hours of Metro availability changed) on Friday and Saturday (the days for which there were schedule changes) and the early evening on Friday and Saturday to the difference in outcomes during the late night and in the early evening on Thursday evenings (when there were no schedule changes). We find that there was a 9% local reduction on average in alcohol-impaired driving arrests for each additional hour of Metro availability after midnight. We also find evidence of moral hazard in the form of increased excessive consumption of alcohol which is substantively large, although these results are not precisely estimated.

The fact that alcohol related arrests and DUI arrests move in the opposite direction is compelling evidence that our effects are not driven by increased police enforcement or secular changes in overall crime.[9] As an empirical test of the validity of our identification strategy, we show that increased Metro availability has little effect on other crimes (non-DUI and non-alcohol-related). We exploit the geographic variation in proximity to bars and Metro stations to test the validity of our strategy further. We find that the reductions in DUI arrests and increase is alcohol-related arrests were larger in areas where there were more licensed alcohol venders, and in areas that were more Metro accessible. When the increase in potential drunk drivers is taken into account, the impact of public transportation on DUIs becomes quite large; we find that the ratio of DUI arrests to alcohol related arrests fell by 2.6% per hour of Metro service per "Metro accessible" bar. While our empirical results are somewhat imprecise, we present the first compelling evidence that cities can reduce DUI arrests by expanding public transportation availability, but we show that such expansion likely comes at the cost of a higher rate of alcohol consumption.

[9] We cannot exclude reallocation of police resources away form drunk driving to what are by and large nuisance crimes, although given the high social cost, and high profile, of drunk driving this seems and unlikely policy decision.

II Alcohol Consumption, Crime, and Public Transportation:

The decision to drive while intoxicated is twofold: the *risky* decision to drink excessively, and the *criminal* decision to drive home once inebriated. Economists have found that alcohol consumption can be reduced by increasing alcohol prices or taxes [Kenkel (1996); Chaloupka et al. (1993); Cook and Moore (1993),(2002); Kenkel and Manning (1996); and Leung and Phelps (1993)] enforcing minimum drinking age laws [Grossman and Saffer (1998); O'Malley and Wagenaar (1991)] and imposing harsher legal penalties on the frequency of alcohol consumption [Kenkel (1993)]. However, the extant literature has not evaluated policies aimed at reducing the social harm associated with alcohol use. We aim to fill this gap in the literature by investigating how the provision of public transportation reduces the rate at which alcohol consumption translates into socially costly DUI incidents.

Conditional on alcohol consumption, individuals evaluate the *criminal* decision to drive home once inebriated. As stated in Becker (1968) "a person commits a crime if the expected utility to him exceeds the utility he could get by using his time and other resources at other activities".[10] Researchers have primarily focused on one side of this equation – reducing the prevalence of crime through policies intended to increase the expected *private* costs of illicit behavior.[11] However, since decisions to commit a crime are also a function of the opportunity cost of illicit behavior, crime could theoretically be reduced by increasing the private benefit of not committing a crime. We will refer to this mechanism as the "safer option" hypothesis.

There is some suggestive evidence that this third method may be effective. For example, Stevenson and Wolfers (2006) find that the introduction of unilateral divorce, which decreased the cost of ending a partnership, lead to a 30 percent decline in domestic

[10] See Doob and Webster (2003) and Levitt (2002) for reviews of the literature on risky behavior and deterrence.

[11] Economists have found that increases in the size of the police force lead to decreases in crime [Evans and Owens (2007); Levitt (1997) (2002); Klick and Tabarrok (2005); DiTella and Schargrodsky (2004); Corman and Mocan, 2000]. Corman and Mocan (2000) find that increases in arrest rates are associated with decreases in crime and Levitt and Kessler (1999) find that increases in sentence length are associated with decreases in crime that they attribute to deterrence. However, there are notable exceptions to this finding, including Raphael and Ludwig (2000) and McCrary and Lee (2007). In addition, criminologists and sociologists have questioned the basic assumptions of the Becker model; specifically that criminal behavior can be characterized as rational, meaning forward looking with accurate information about costs and benefits (Doob and Webster 2003).

violence for both men and women, and a 10 percent decline in females murdered by their partners. Since part of this effect is likely due to endogenous behavioral changes that take place as a result of the law, this is merely suggestive of the safer option hypothesis. Other suggestive evidence is a documented relationship between crime and poor labor market opportunities [Machin and Meghir (2004); Corman and Mocan (2000)], suggesting that increasing the return to labor force participation may induce people to substitute legitimate work for criminal behavior. Since unemployment and joblessness are also associated with depression [Lee et al (1990] and other social dysfunction [Stankunas and Kalediene (2005)], and since crime may not simply be an income generating endeavor, it is not clear that the safe option effect is driving the results.

This safe option type of policy has rarely been used in crime prevention, but it has been used in public health policy.[12] For example, providing needles to drug addicts and handing out free condoms to teenagers are predicated on the notions that people will be less likely to share needles if they have a limitless supply of fresh needles, and teenagers will be willing to have sexual intercourse with a condom if condoms are available. The provision of late public transportation is very similar in that it allows bar clientele a safe way to get home that does not involve driving while drunk, reducing the social harm associated with consuming alcohol without reducing the expected cost of drinking to the individual. We fill this gap in the crime literature by explicitly testing an important prediction of the notion that crime can be described as a rational decision. Specifically, we test whether policy makers can reduce a person's likelihood to engage in criminal behaviors by improving in their utility gained by not committing a crime.

Policies of this nature have been criticized on the grounds that providing less risky alternatives to certain externally costly actions (i.e. drunk driving) could hurt society overall by increasing the likelihood that persons engage in other undesirable behaviors (i.e. excessive drinking) [Boyum and Reuter (1996)]. These policies may introduce a moral hazard – by providing a safer way to engage in socially undesirable behaviors, one makes socially undesirable behavior more attractive to individuals who do not internalize the full social costs of their actions [Pauly (1974); Holstrom (1979)]. In fact, in severe cases, such well-intentioned solutions could cause more harm than good

[12] A notable exception is job training programs targeted to at-risk populations.

[Hansen and Imrohorglu (1992)]. There is empirical support for this concern. Researchers have linked provision of the contraceptive pill to increased transmission of sexual diseases [Durrance (2007)], abortion availability to increased sexual activity [Klick and Stratmann (2003)] and improvements in the treatment of AIDS/HIV to risky sexual behavior in HIV positive individuals [Sood and Goldman (2006)].

Our paper is closely related to this literature since we look not only at how the availability of late transportation affects DWI arrests, but also its potentially deleterious effects on alcohol consumption. Indeed, alcohol consumption has been shown to be very responsive to price changes [Chaloupka et al. 2002]. Because the first order impact of this policy change can be interpreted as reducing the cost of drinking, *a-priori* we would expect alcohol consumption to increase as Metro service expands. There is a large and growing literature on the relationship between alcohol consumption and crime [Markowitz and Grossman (2000); Joksch and Jones (1993); Carpenter (2008); Dobkin and Carpenter (2008); Cook and Moore (1993)]. Approximately 40% of individuals under criminal justice supervision report being under the influence of alcohol at the time of offense [Greenfeld (1998)], and alcohol is notably the only mood altering substance shown to increase violent behavior in a laboratory setting [Boyum and Keiman (2002)]. Concerns about a moral hazard effect are particularly salient for public transportation policy. Reducing the incidence of intoxicated driving would provide a benefit to society, but if public transportation substantially increases alcohol consumption, on net this may be a social loss. In addition, since drinking is a social activity [Boisjoly et al. 2003, Norton et al (1998)], the reduced costs of alcohol consumption could result in an increase in the number of DUIs, even if the policy reduces the propensity of a given drinker to drive drunk.

III **Analytic Framework**

The first order policy relevant question is whether expanded access to public transportation reduces the incidence of intoxicated driving. Additional interesting questions are whether the availability of the Metro makes individuals more likely to consume alcohol, and if expanded access to public transportation makes it less likely that a given drinker will drive. The economic questions are concerned with the behavioral response of individuals, while the policy question is concerned with the total effect (the combined behavioral response and compositional response). In this section we lay out a simple analytic framework linking public transportation to rates of alcohol consumption, alcohol related crime, and intoxicated driving.

i. The Decision to Drink

On a given night, a population of unknown size P will choose to drink at a bar. Some fraction D of that population will make the risky decision to drink too much, with p_D of them arrested for minor offenses. Holding constant all other criminal activity, the total number of arrests on a given night will be $p_D DP$. Increases in the hours of public transportation M reduce the cost of drinking by reducing the need for an individual to be sober enough to drive home at the end of the night. This will both increase population size P ($\partial P/\partial M > 0$), and for a given drinking population, increase amount each individual drinks, meaning D will increase as well ($\partial D/\partial M > 0$). It is obvious that people who decide to use the newly available public transportation will optimally increase their consumption of alcohol. It may also be the case that the fraction of those who continue to use personal transportation (the population that may drive home) will also increase their alcohol consumption due to what we characterize as “peer effects” and “publicity effects.”

Drinking is a social activity. The amount of alcohol you consume is believed to be a positive function of the amount of alcohol others around you are drinking, although the empirical literature on the subject is not deep [Cook and Moore (2000)]. As the fraction of a bar’s patrons using the Metro increases, the amount of alcohol consumed by any given bar patron’s peers will rise. On the margin, this peer effect will increase alcohol consumption among those who use private transportation.[13]

Promotion of Metro’s expanded hours enhanced public awareness of downtown alcohol venders. The Washington Post characterized the service change as targeted at bar

[13] The Becker (1968) model of criminal behavior implies that some fraction of the drinking population will optimally choose to drive home. Alternately, some drinkers would optimally have chosen to use public transportation, but because of peer effects underestimated the amount of alcohol they eventually consumed. Both optimal and suboptimal behavior would increase the number of DUIs.

patrons, and Metro's publicity campaign highlighted late night activities downtown.[14] By increasing general awareness of DC nightlife, the Metro expansion also increased the return to advertising for bars located downtown. These publicity effects should have increased the number of drivers and non-drivers who drank in bars downtown (P).

Expanded hours of public transportation should result in an increase in the drinking population and the number of people who drink excessively. We therefore predict that each additional hour of Metro service will unambiguously increase the observed number of arrests for alcohol-related crimes $p_D DP$. The size of the effect should be correlated with the likelihood that a given bar patron actually uses the Metro.

ii. The Decision to Drive Once Drunk

An additional theoretically interesting question is whether or not, conditional on drinking, reductions in the private cost of crime lead to reductions in criminal behavior. Concretely, does having public transportation available reduce the fraction of heavy drinkers who drive home? This requires modeling the effect of public transportation access on heavy drinking (moral hazard) in order to determine if that relationship changes with the availability of public transportation (the safer option).

After making the decision to drink at a bar, an additional fraction C of the population DP will choose to drive home, meaning that there will be $p_C(1- p_D)CDP$ people arrested for DUIs. If intoxicated individuals respond rationally to changes in the private cost of crime, then C will be decreasing in Metro availability (e.g. $\frac{\partial C}{\partial M}<0$). Therefore, we predict that as Metro expands its hours of operation, the percentage of drinkers who drive home will fall. However, since the total change in DUI arrests, $\frac{\partial DUI}{\partial M}$, is equal to $p_c(1-p_D)\left(\left(\frac{\partial C}{\partial M}\right)DP + C\left(\frac{\partial D}{\partial M}P + \frac{\partial P}{\partial M}D\right)\right)$, if $\frac{\partial D}{\partial M}>0$ and $\frac{\partial P}{\partial M}>0$, the net effect of increasing Metro access on total DUIs is ambiguous. Even conditional on the number of arrests for alcohol related crime ($p_D DP$) this first order effect of Metro access on DUI arrests may still be positive if $\partial D/\partial M>0$ or $\partial P/\partial M>0$. This seemingly counter-intuitive

[14] The opening scene of the televised ad campaign showed a pair of Metro doors opening onto a crowded bar, and the words 'Metro Opens Doors to Late Night Fun" The commercial can be viewed at http://www.lmo.com/case_studies-change_behavior.html

point is similar to that made in Kenkel (1993), who found that conditional on heavy drinking, policies which increased the cost of drunk driving were associated with increases in drunk driving.

We use two strategies to pin down the sign $\partial C/\partial M$. First, we focus on areas where C is small (fewer initial drivers), and we expect the sign of $\partial C/\partial M$ to be relatively more important in establishing the net impact of Metro service on DUI arrests. Specifically, we test whether the impact of Metro availability on DUI arrests is larger in neighborhoods with multiple bars located in close proximity to Metro stations. Next we estimate the fraction of DUIs per drinker using the ratio of DUI arrests to arrests for alcohol related crimes. While all crimes are more likely to occur if the victim or offender has been drinking, we argue that certain types of offenses are more likely to be associated with excessive drinking than others [Carpenter (2008)]; specifically, we focus on crimes that we consider most likely to be committed by individuals with an otherwise low criminal propensity, but have engaged in excessive drinking. These offenses include urinating in public, obscene gestures, drinking in public, possession of open alcohol containers, or defacing a building, as well as crimes for which victims may have been at higher risk due to their own excessive drinking (e.g. simple assault, unarmed robbery, rape, indecent exposure, indecent sexual proposal).[15] Finally, to illustrate that our effects are working through the hypothesized channels, we show that these effects are largest in (a) areas with more drinking establishments and (b) areas where drinking establishments are more Metro accessible.[16]

There are multiple mechanisms through which Metro availability could cause arrests for DUIs relative to arrests for disorderly behavior to fall. It could be the case that individuals who used to drive home from bars choose to use public transportation instead. In this case, the identity of the marginal drinker is constant, but the driving behavior of the marginal drinker has changed. It could also be the case that the increase in Metro access induces non-car owners to begin to patronize bars. This is a situation in which the driving behavior of the each drinker is time invariant (this added population always uses

[15] A list of arrests identified as "alcohol related" can be found in the Appendix.
[16] Note that it is possible (and perhaps common) for bar patrons to hire taxi cabs from Metro stations to distant bars, which contaminates our assumed linear relationship between distance and accessibility. This "taxi effect" will bias our estimates of Metro access towards zero.

public transportation) but the identity of the marginal drinker changes. Without information on the size of the drinking population P (alcohol sales data is considered proprietary information under DC law), we cannot distinguish between these two mechanisms. Note, however, that because we observe a measure of excessive drinking, it seems unlikely that our results are driven by changes in the identity of the marginal drinker- this would involve someone who never went to bars now not only going out, but drinking so much that they are arrested.

III Data

We measure the relationship between public transportation, alcohol consumption, and intoxicated driving using detailed arrest data from Washington DC's Metropolitan Police Department (MPD). The data set contains information on all arrests made between 1998 and 2007, and includes information on the primary charge, date and time of the arrest, as well as the location of arrest. Certain assumptions are required to make inferences about changes in criminal behavior using arrest data. While all officially reported crime statistics are based on the sub-sample of crimes that police officers are aware of, arrest records directly reflect police behavior in a way that official crime reports do not. A shift in police priorities from DUI arrests to disorderly conduct arrests, for example, could manifest itself in our data as a reduction in DUIs relative to arrests for other alcohol related crimes. In order for this to be a concern, it must be the case that this shift in priorities not only coincides with the timing of Metro expansion, it *only* occurs on Friday and Saturday nights. We also must assume that the fraction of people arrested for disorderly behavior is a small fraction of the total population at risk (i.e. (1- p_D) is close to one), meaning that an increase in people arrested for disorderly behavior will have a negligible effect on the number of people who drive home drunk.[17] Because of differences in the timing of when most DUIs and most alcohol related arrests occur, it

[17]The probability of being arrested for driving 10 miles with a blood alcohol content of 0.1 has been estimated to be 0.15% (Beital et al. 2000). We are unaware of any estimates of the probability of arrest for minor offenses such as public intoxication, but this assumption seems reasonable. A very small fraction of the general offending population is apprehended, with clearance rates for non-violent offenses roughly 15% in 2006 (see the Sourcebook of Criminal Justice Statistics). Because of differences in the timing of when most DUIs and most Drunk and Disorderly arrests occur (see figure 1) it also is reasonable to assume that changes in police patrol that increase the p_d would also increase p_c.

also is reasonable to assume that changes in police patrol that increase the p_D would also increase p_c.

We define a DUI arrest as an arrest for either a DUI or DWI.[18] These charges make up 3% of all arrests in our sample period. Alcohol related crimes, by comparison, are approximated 34% of all recorded arrests.

< figure 1 >

A few patterns are apparent in our data. First, as shown in figure 1, it is clear that there are many more DUI arrests on Friday and Saturday nights than any other day of the week. Looking at the arrest by hour, one can see that DUI arrests increase over time starting at 8pm and peak between 2am and 3am for all days except Friday and Saturday when they peak between 3am and 4am. Thursday night appears to be the most similar to Friday and Saturday night, which is perhaps not surprising given the large college and federal government employee population.[19] In comparison with DUIs, most arrests for alcohol related crimes occur between 4 and 8 pm, with a second local peak between 11pm and 12 am, which would coincide with late night alcohol consumption (figure 2).

< figure 2 >

To take advantage of the hypothesized spatial variation in patterns of drinking and criminal behavior, we divide DC into neighborhoods based on the 46 Police Service Areas (PSAs). Some advantages of dividing DC into PSAs are worth noting. First, PSA are typically patrolled by the same group of officers, meaning that police officer arresting behavior is likely to be correlated within, rather than across, PSAs. In addition, PSAs are relatively large, a topic of some concern when the boundaries were established,[20] making the assumption that someone arrested for a DUI was drinking in the PSA somewhat tenable, although far from perfect. Finally, PSA boundaries are designed to correspond with generally established neighborhood borders, so the composition of the population is relatively homogenous within a PSA.

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[18] DUI is an acronym for driving under the influence, which is a more serious charge than driving while intoxicated, DWI. We also include per se DUI and DWI arrests- which are violations based only on blood alcohol content, not one's ability to drive a car.

[19] In 2008, the acdting Director of the Office of Personnel Management estimated that roughly half of all federal civilian employees work an alternate work schedule in which ever other Friday is "off." http://www.govexec.com/pdfs/090308b1.pdf

[20] See FAQs about PSA boundaries: http://mpdc.dc.gov/mpdc/cwp/view,a,1239,q,543455.asp

We divide our sample into four time periods corresponding to the different Metro schedules. Each day is parsed into three time blocks: 5 am to 6 pm (day time), 6 pm to 10 pm (early evening), and 10 pm to 5 am (late evening). Note that in our data Friday night technically ends at 5 am on Saturday morning. During each Metro schedule, we then alternately collapse all arrests occurring within a day of the week–time block and PSA-day of the week-time block. This leaves us with two data sets- one where the unit of observation is a day of the week-time block-schedule (e.g.: Friday late nights during schedule 2) and one where the unit of observations is PSA-day of the week-time block-schedule (e.g.: Friday late nights during schedule 2 in PSA 305).

There are four advantages to aggregating the data in this way. Conceptually, we do not expect that arrests for DUIs and alcohol related arrests will be occurring during the same hour. Instead, it is more consistent to assume an increase in alcohol consumption will result in increased arrests throughout the evening, which only at the end of the night are DUIs. In addition, arrests (and particularly arrests for DUIs) are infrequent events. We want to estimate how the *size* of a population changes over time, and aggregating the data across for example, all Friday nights in a time period, allows us to estimate how this size changes based on repeated samples (arrests) from the population. Finally, while arrests for alcohol related offenses are likely to occur where the individual was drinking, this is less likely to be the case for DUI arrests. We therefore expect that the number of DUI arrests within a given PSA to be a noisy signal of the number of DUI arrests resulting from drinking within that PSA and include a DC level analysis.

It is important to note that while it may be tempting to rely on the sharp changes in the hours of operation by comparing arrests right before the Metro is open to those right after the metro is open, such an approach would be misguided. Since people are forward looking, it is clear that their drinking and driving behaviors are made in anticipation of Metro service. (i.e. people leave their cars at home when they leave for the bars at 10pm because the Metro now runs till 2am. People may drink more at 11 pm because they know they can stay out longer now that the Metro is open later). These examples point out that to detect the full effect of the change requires that we use a relatively large time window. Using a large time window also has the added benefit of being much less susceptible to picking up shifting of crime across time. By defining the unit of observation to be the entire evening, we avoid measuring shifting of drinking or driving activity within an evening - and as such measure the true overall effect

< table 1 >

Table 1 provides summary statistics of average DUI and alcohol-related arrests at the PSA-Day of the Week-Time Block. The numbers of DUI and alcohol-related arrests occurring in each PSA during the evening hours are highly correlated with each other (ρ=0.66). Perhaps surprisingly, when we look at evening DUIs and the number of hours Metro is open there is also a positive correlation (ρ=0.32). We argue that this captures a moral hazard effect, because the correlation between alcohol related arrests and Metro hours is also large (ρ=0.50). Also note that, unlike DUI arrests, most alcohol related arrests occur between 5 am and 6 pm, although there is a second spike during the late night hours on Friday and Saturday.

We identify the number of bars within each PSA using address information on establishments with a class CT alcohol license ("taverns") or general alcohol licenses provided by the DC Alcoholic Beverage Regulation Administration. Table 2 provides some sample statistics describing the number of alcohol licenses in each PSA. While this data is a stock of all existing licenses in 2008, most neighborhoods known for late night carousing, such as Adams Morgan (PSA 303) and Georgetown (PSA 206), have been under liquor license moratoriums since the late 1990s (District of Columbia Municipal Regulations Title 23 Chapter 3). Two neighborhoods, U Street (PSA 305) and H Street (PSA 102), have large numbers of licenses in our database, due to highly visible neighborhood revitalization efforts in the early 2000s. We therefore exclude these two neighborhoods from the part of our analysis dependent on the location and prevalence of alcohol vendors. Figure 3 below shows the PSA boundaries for Washington D.C. along with the location of licensed alcohol venders (gray dots) and Metro Stations (blues squares). The PSAs in our sample have on average 30 alcohol venders in their borders (sd= 44.3). Only one neighborhood, PSA 702, does not contain any bars and 23 neighborhoods have at least one alcohol vender within 400 meters of a Metro station. We use the geographical variation in (a) the number of alcohol venders in a given PSA and (b) the accessibility of alcohol venders each PSA to a Metro station to see if those area that should be “more treated” by the change in Metro schedule based on *ex ante* characteristics actually experiencing larger treatment effects.

IV Empirical Strategy

In principle there are two sources of variation in public transportation that can be exploited: (1) the temporal difference in provision by comparing outcomes when public transportation is provided to times when it is not; (2) the spatial variation by comparing outcomes in areas where there are many bars close to Metro stations to those of areas where Metro stations are not located near any bars.

When there is a set public transportation schedule (i.e. trains always run at 10 pm and never run at 5am), it is impossible to separate a time of day effect from a public transportation effect. For example, if the trains stop running at midnight, one might try to compare outcomes between 11 pm and midnight, to outcomes between midnight and 1 am. If the underlying outcomes (in the absence of any difference if public transportation availability) are the same between 11 pm and midnight and midnight and 1 am, this temporal comparison would yield the effect of public transportation availability on crime. However, this necessary precondition is unlikely since people are more likely to be drunk at 1 am then at 11 pm. Therefore, a comparison of outcomes across different times of day is unlikely to uncover a causal relationship. To avoid confounding time of day effects with Metro availability effects, one would want to compare the outcomes during the same time of day (and day of the week) when Metro was available to when Metro is not available.

The second potential source of variation is spatial in nature. It is reasonable to expect that neighborhoods close to Metro stations will be more greatly affected by the availability of Metro service than areas that are farther away from Metro stations. If the underlying outcomes (in the absence of any difference if public transportation availability) were the same in areas close to Metro stations and those far away from Metro stations, one could uncover the causal effect of public transportation availability on outcomes by comparing outcomes in areas close to Metros to the outcomes in areas far away from Metros. However, proximity to a Metro station may be associated with crime for reasons unrelated to the availability of public transportation. Areas close to Metro stations may, on average, be more commercial and may serve different residential populations - both of which could exert an independent effect on crime. To avoid confounding geography effects with Metro availability effects, one would want to compare the outcomes in the same geographic location when Metro was available to when Metro is not available.

The changes in the Metro schedule changed the times during which public transportation was provided – allowing one to compare outcomes during the same time of day (and day of the week) both with and without public transportation. Since the schedule changes break the perfect mutli-colinearity between hours of Metro availability and time of day for a given day of the week, we can control for time-of-day-by-day-of-week effects and use the change in the number of hours of Metro availability that occurs across the different schedules.

Using only the temporal variation, we can isolate the effect of changing Metro availability on crime using a differences-in-difference-in-differences (DIDID) strategy. A simple difference strategy would only use data from Friday and Saturday evening and compare outcomes before and after the schedule change. Such a simple difference strategy would provide a consistent estimate as long as there were no changes over time that affected crimes during the schedule changes (i.e., 1999 was a low crime year and 2002 was a high crime year). To account for possible confounding time effects one can use a difference in difference strategy that only uses data from Friday and Saturday, but also has outcomes for the late afternoon of these days. With crime data for Friday and Saturday afternoon one can implement a DID approach – compare the difference between outcomes before and after the schedule change on Friday and Saturday afternoons to temporal differences in outcomes on Friday and Saturday late evenings. As long as any unobserved factor that affects crime over time has the same effect on daytime crimes and late evening crimes, this DID approach should allow one to isolate the effect of Metro availability on outcomes. Since most DUI arrests occur at night, one may worry that time effect may differentially affect DUI arrests and drinking behaviors differently at night vs. during the afternoon. To address this concern, we propose introducing another round of differencing, using the difference between outcomes in the late evening to those in the afternoon before and after the schedule changes as the counterfactual change in outcomes.

In other words this DIDID approach would identify the effect of Metro availably by comparing the difference in DID for Friday and Saturday to the DID on Thursday.

This DIDID methodology can be implemented by estimating the following equation by Ordinary Least Squares (OLS).

$$Y_{tds} = \alpha + \beta \cdot M_{tds} + \theta_{sd} + \theta_{td} + \theta_{st} + \varepsilon_{tds} \qquad [1]$$

Y_{tds} is the natural log of DUI attests outcome at time of day *t*, on day of the week *d* during schedule *s*, M_{tds} is the number of hours of Metro operation during the time of the day. This variable is identified off the three-way interaction between day-of-week, time of day, and schedule. Since M_{tds} is defined by the three-way interaction, we need to control for all the two-way and one-way interactions. θ_{sd} θ_{td} and θ_{st} are effects for the two-way interactions between schedule and day of the week, time of day and day if the week, and schedule and time of the day, respectively.

V **Does Public Transportation Reduce Intoxicated Driving?**

i. Aggregate Estimates:

Table 3 presents the results of these DIDID regressions, using only the time variation. As such, there is one observation for each time of day, during each day of the week during each schedule period. Using all four schedules, 7 day of the week, and 3 times of the day we have a total of 84 observations. To address the possibility that secular changes in crime may be correlated with the schedule changes, we also include results in which we include arrests for crimes that seem less directly related to alcohol consumption.[21] The logic of this test is straightforward – if other confounding factors are correlated with the schedule changes, such as increased police enforcement or demographic changes, these factors should also affect other arrests and not just DUI or alcohol related arrests. As such, the lack of any substantively significant effect on other

[21] These arrests are essentially all crimes that are not DUIs, our definition of "alcohol related", or involve distributing alcohol to minors.

crimes would give us confidence that our effects on DUI and alcohol arrests are not driven by confounding factors and reflect a credible causal relationship.

< Table 3 >

Column 1 presents the naïve model using all the available data. If one interprets this regression causally, the estimates indicate that increasing the number of hours of Metro availability has a small imprecisely estimated negative effect on the number of DUI arrests and a statistically significant increase in arrests for "other" crimes. The fact that there is a statistically significant 14 percent increase in other arrests should give one pause in trusting the results from these specifications. However, recall from figure 1 that the temporal pattern of DUI arrests varies over days of the week, implying that arrests on Monday and Wednesday may not provide appropriate comparison groups for Friday and Saturday. In columns 3 and 4 we present the DIDID model using only Thursday night (the best candidate evening) as the comparison night, as opposed to the entire week. In these models, each hour of Metro availability is associated with a statistically insignificant 18 percent reduction in DUI arrests.[22] While the effect on other arrests is no longer statistically significant, the estimated coefficient is economically significant.

There is an important potentially confounding effect of the final schedule change. Just under two-thirds of alcohol vendors in DC are licensed to serve alcohol until 3 am on Friday and Saturday nights. We hypothesize that the final Metro schedule change, which increased hours of Metro operation from 2 am until 3 am, may have been less relevant for the decision making of the late night bar crowd, biasing our estimated effect towards zero. Two other major events, the establishment of the Washington Nationals, a new major league baseball franchise, in April of 2005 and the opening of the new Washington Convention Center in March of 2003, also may have resulted in an increase in intoxicated driving and alcohol consumption in DC. In addition, media coverage of the Metro service expansion indicated that growth in late night ridership slowed after 2003, and eventually began to decline. Finally, the final schedule change included expanded morning hours on Saturday and Sunday, which we would not expect to have any effect on late night DUIs

[22] Note that this approach will overstate the impact of Metro service on alcohol consumption and behavior if there is displacement in drinking from Thursday to Friday and Saturday nights. Focusing only on Fridays and Saturdays yields point estimates of equation one corresponding to a 25% reduction in DUIs per hour, and a 3% increase in alcohol related arrests, suggesting that this is not the case.

or alcohol consumption. Because of these concerns, in columns 5 and 6 we focus on the schedule changes that took place within a narrow time window (between 1999 and 2002). Focusing on this narrower time window, which should be less susceptible to bias due to secular reduction in crime, leaves us with the first two schedule changes. Column 3 presents the DIDID model using only data from Thursday through Saturday night and throwing out data after 2003. In these models, increasing the number of hours of Metro availability has an imprecisely estimated 22 percent reduction in DUI arrests. The coefficient for other crimes is reduced to 0.15 and is no longer statistically significant. This makes us more confident that focusing on the Thursday through Friday sample, and only the first two schedule changes will yield plausible causal effects that are not confounded with time of day effect, day of week effects, or secular changes in crime.

ii. Geographic Variation:

As discussed above, there is expected variation in the effect of Metro availability due to geography. In particular, if our proposed mechanisms are correct, one would expect that the marginal effects of greater Metro availability would be greatest in areas with a large number of drinking establishments, and in particular areas where those establishments are closer to Metro stations. For example, the Dupont Circle neighborhood has a centrally located Metro station (Dupont Circle) as well as an additional station within a ½ mile on pedestrian friendly city streets (Farragut North). In contrast, the Georgetown neighborhood is notoriously under-served by Metro, with the closest Metro station (Foggy Bottom) approximately mile away and on the opposite side of two highways (the Whitehurst Freeway and Rock Creek Parkway).

One could test for this type of response heterogeneity by including interactions of the main three-way effect with measures of geographic distance and the prevalence of alcohol venders. A more flexible approach would be to estimate the marginal effect of increased Metro hours for each PSA, and then to use the estimated marginal effects as data. This auxiliary regression approach is similar in sprit to Card and Krueger (1992), who estimate returns to schooling for each state and then regress the returns on state level characteristics. Specifically, we estimate equation [1] for each of the 46 PSAs in our sample and then regress the marginal effect on PSA level characteristics. Figure 4 shows the distribution of these PSA level estimates.

< *figure 4* >

The average across PSAs is -0.09 with a standard error or 0.06, reflecting the fact that increased Metro hours is associated with a reduction in DUI arrests on average. The density plot makes clear that the change on average is not driven by any one particular PSA, and that the center of the distribution is below zero. In contrast, the distribution of arrests for non-alcohol related offenses (figure 5) is centered at 0.04, with a standard error of 0.04.

Using 44 of the PSA level estimates as data, we test whether (1) areas with several drinking establishments experience greater reductions in DUI arrests and (2) areas where drinking establishments are farther away from Metro stations in general experience smaller reductions in DUI arrests. First, we do a series of simple t-tests to compare the marginal effects across neighborhoods. In the 15 neighborhoods with at least one bar located within 100 meters of a Metro station, the average reduction in DUIs is 21%, compared to 2.7% reduction in the other 29 PSAs. In neighborhoods with fewer than 6 alcohol venders (the 25% percentile) the average change in DUIs is a 5% *increase* compared to a 16% decrease for neighborhoods with more than 6 alcohol venders. PSAs with a Metro station within its boundaries have an average reduction of 18%, compared with the 23 other PSAs with a reduction of 0.5%. While none of these differences are statistically significant at the 5% level of confidence, the consistency of the direction is striking. Comparing the marginal effects for non-alcohol related crimes produces opposite conclusions; there are small reductions in arrests for non-alcohol related crime in PSAs with at least one Metro accessible bar (-6%), where there are more than 6 bars (-2%), and when there is a Metro in the PSA (-0.2), and increases of between 8% and 17% in the complimentary PSAs.

To examine the geographic variation in Metro effects more formally, we take the PSA marginal effects and estimate the following equation by OLS.

$$\beta_P = \alpha + \pi_1 MetroAccess_P + \pi_2 AlcoholAccess_P + \theta Youth_P + \varepsilon_P \qquad [2]$$

In equation [2], β_p is the estimated DIDID coefficient on Metro from equation [1] estimated for PSA p. $MetroAccess_P$ is a vector of measures of general neighborhood access to Metro, including an indicator variable equal to 1 if PSA p has a Metro station located within its boundaries and the natural log of the distance from the center of the PSA to the closest Metro station. $AlcoholAccess_P$ is a vector characterizing the number and proximity of alcohol venders to Metro stations in PSA p. We also include a (time invariant) control for the fraction of the PSA population that is under 18, $Youth_p$, typically positively correlated with crime rates.

< *table 4* >

As the results in table 4 show, the regression results are consistent with our proposed causal mechanisms. First, in column 1, we present the mean of the DIDID estimates across PSAs. As one can see, the coefficient is -0.09, the average neighborhood reduction in DUIs per additional hour of Metro service. Columns 2 and 3 test if this effect is larger in areas with more alcohol venders. As one can see, the effect of additional bars is primarily due to areas with *no* bars not being affected by Metro service. The coefficient on more than 6 licenses is -0.24- while marginally significant this is three times the average effect. Column 4 includes variables that proxy for proximity to Metro stations, as well as a control for the age of residents. The estimates suggest that the effect of distance is highly non-linear such that areas with a Metro station in its borders have fewer DUIs, while areas that are farther away from Metros on average also have larger reductions in DUIs. These somewhat inconsistent results for distance may be due to the fact that it is the distance from bars to the Metro station that is the relevant distance. In column 5, we include variables indicating the number of bars in the PSA within 100, 400, and 800 meters of a Metro station. As one can see, the results indicate that the number of licenses within 100 meters of a Metro station is strongly associated with larger reductions in DUI arrests, and that conditional on this measure, the number within 400 meters or 800 meters is irrelevant. Column 6 includes all these predictors- what emerges as the strongest predictor of the effect of Metro service on drunk driving is the number of "Metro accessible" bars. In fact, conditional on the number of bars located within short walking distance to Metro stations, bars located more than a 5 minute walk from a Metro station are actually associated with smaller reductions in DUIS (recall this is consistent with a publicity effect).

In sum, the geographic results are consistent with our *a priori* notions, and they suggest that our effects work through the hypothesized channels. Specifically, areas with more than 6 licenses experience greater reductions in DUIS, PSAs that have a Metro station within their borders also experience larger reductions in DUIs ,and PSAs that have more Metro accessible bars experience greater reductions in DUIs.

iii. Controlling for Moral Hazard:

Our results in Tables 3 and 4 suggest that as Metro expanded its service there was a decrease in the number of DUI arrests and that this effect varied with availability of "Metro accessible" alcohol. This suggests that the increased availability of Metro service could have created a moral hazard leading to increased alcohol consumption. This moral hazard would imply that the change in total DUI arrests *understates* the behavioral change caused by reducing the private cost of criminal behavior.

We predict that public transportation availability will be negatively related to the number of drinkers who drive home. We empirically test this argument by repeating the above analysis with the dependant variable replaced, alternately, with the marginal DIDID effects on the natural log of alcohol related arrests and the linear difference in the natural logs of DUIs and alcohol related arrests.

The distribution of PSA-specific marginal effects for alcohol-related arrests and DUI arrests per alcohol related arrest are shown in figures 6 and 7. Unlike DUIs and non-alcohol related arrests, there does appear to be an outlier pulling the average marginal effect downward. The full sample mean effect of Metro service is a 1% increase in alcohol related arrests per hour- eliminating PSA 201, a neighborhood with no Metro station, increases this effect to 3% (se=0.04). The distribution of DUIs per drinker (figure 7) is noticeably tighter around a 10% reduction in drinkers who drive home. PSAs with at least one bar within 100 meters of a Metro station have an average increase in arrests of 14% (se=0.7), compared with a 6% reduction in the other PSAs (se=0.06). PSAs with more than six venders or a Metro station have a 12 percentage point larger increase than PSAs without, but these differences are less precise than the differences in drunk driving.

Combining the DUI and alcohol related arrests generates statistically and substantively significant variation in the effect of Metro service. Neighborhoods with at least one Metro accessible bar have an average reduction in DUIs per alcohol related arrest of 35% per hour (se=0.12), compared to an average 4% increase where there are no Metro accessible bars. PSAs with more than six bars have an average reduction of 20% per hour (se=0.09), and PSAs with a Metro station see DUIs per drinker fall by 25% per hour. There is no statistically significant change in any of the complimentary neighborhoods, and the difference across neighborhood categories is statistically significant at the 5% level.

< *table 5* >

In Table 5 we present the geographic variation in arrests for alcohol-related offenses with Metro service. In contrast to drunk driving, each alcohol vender in a neighborhood is associated with a 0.2 percentage point *larger* increase in arrests per hour of service. The relationship between having a Metro station is not in our hypothesized direction, but the more "remote the PSA is from a Metro, the smaller the increase in arrests. In addition, there is a 1 to 2 percentage point increase in the effect of Metro service on alcohol-related arrests for every bar within 100 meters of a Metro (there is an average 7.8 if there is at least one). Bars located further away have a smaller, and perhaps even negative, effect on the change in our proxy for alcohol consumption.

< *table 6* >

Across DC neighborhoods, there was a weak reduction in DUIs per drinker with each additional hour of late night public transportation. When we allow this effect to be heterogeneous with respect to alcohol venders and Metro accessibility, displayed in table 6, we see evidence of a reduction in criminal behavior that is concentrated in particular neighborhoods. PSAs with more than six bars have a 30 percentage point larger reduction in DUIs per drinker (column 2), and each 10% reduction in the distance from the center of a PSA to the closest Metro station reduces the number of DUIs per drinker by 0.09 percentage points (column 4). Each additional bar corresponds to an additional 0.6 percentage point reduction in the effect of Metro, and each Metro accessible bar is associated with an additional 2 percentage point reduction in the impact of Metro service on DUIs per drinker (column 6). The behavior of patrons drinking at bars more than 100 meters from a Metro station, however, is not affected by public transit. As a final robustness test, in Table 7 we repeat this analysis for less alcohol related arrests, and find not substantial geographical variation.

VI. **Conclusion**

Excessive alcohol consumption imposes large costs on society as well as the individual drinker. In particular, driving under the influence of alcohol is estimated to cost society $51 billion a year. Governments and social groups also attempt to reduce the social cost of drinking by lowering the private cost of driving under the influence of alcohol, or providing a "safer option". These policies range from providing free or subsidized taxi service on New Year's Eve to temporary expansions of public transportation services during major athletic events. These well-intentioned services also generate the potential for moral hazard, since the safe ride home reduces the personal cost of alcohol consumption. The primary mechanism through which public transportation should affect DUIs is by allowing people who drink at bars to ride, as opposed to drive, home. We identify the impact of a change in public transportation availability using a triple-difference approach that compares arrests for DUIs and other alcohol related crimes over time, during different days of the week, and across neighborhoods in Washington DC. As the DC Metro expanded its late night hours of operation, the number of DUIs fell by approximately 9% per hour of service. This increase in DUIs was larger in areas with more alcohol selling establishments, and areas which were better serviced by Metro.

We also find evidence that the reduction in DUIs may have been associated with an increase in out-of-home alcohol consumption. As Metro service expanded the number of arrests for alcohol-related crimes increased by as much as 14% in "Metro accessible" neighborhoods, suggesting that late-night Metro service caused large increase in the drinking population. Using arrests for these crimes as a proxy for changes in the size of this typically non-measurable population, we estimate that expanding Metro's hours of operation from midnight to 2 am reduced the number of drinkers who drove home by

35% per hour in these neighborhoods. The magnitude of the effect warrants attention. At the same time, the benefit of reduced DUIs per drinker dissipates rapidly as alcohol venders become more remote to Metro stations.

Does expanding late night public transportation increase social welfare? Because our measure of alcohol consumption is likely a coarse measure of actual behavior, a back of the envelope cost benefit calculation is suggestive at best. If each hour of late night Metro service did reduce DUIs by 9% between 1998 and 2003, then 452 DUIs were avoided by Metro operating between 12 am and 2 am. How much is this reduction worth? Miller, Cohen and Wiersema (1996) estimate that each drunk driving incident imposes an average cost of approximately $21,500 (in 2003 dollars) on society, meaning a savings of $9.72 million.[23] If the external cost of consuming an ounce of ethanol is 25.5¢ [Manning et al 1991], then an additional 297,732 gallons of ethanol would have to have been consumed between 12 and 5 am on Fridays and Saturdays during 1999 and 2003 to negate this positive benefit. In 1998, 1.676 million gallons of ethanol were sold in DC, and between 1999 and 2003 this increased at an average rate of 2.7%, or 38,000 gallons per year.[24] As this figure includes all alcohol sales made in the District, it suggests that an increase in consumption in bars of over 297,320 gallons over the course of four years is perhaps implausible. Providing drinkers with a safer way home does appear to reduce the incidence of intoxicated driving, reducing the total external cost of alcohol consumption. This social benefit should be weighed cautiously against the corresponding increase in risky alcohol consumption.

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[23] A total of 2,236 arrests were on made Friday and Saturday nights during schedules 2 and 3. The 452 estimate is generated by assuming that DUI arrests were 9% lower than they could have been during schedule 2 and 18% lower than they could have been during schedule 3.

[24] Estimate taken from the National Institute Alcohol Abuse and Alcoholism http://www.niaaa.nih.gov/Resources/DatabaseResources/QuickFacts/AlcoholSales/consum02.htm

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Figures:

Figure 1

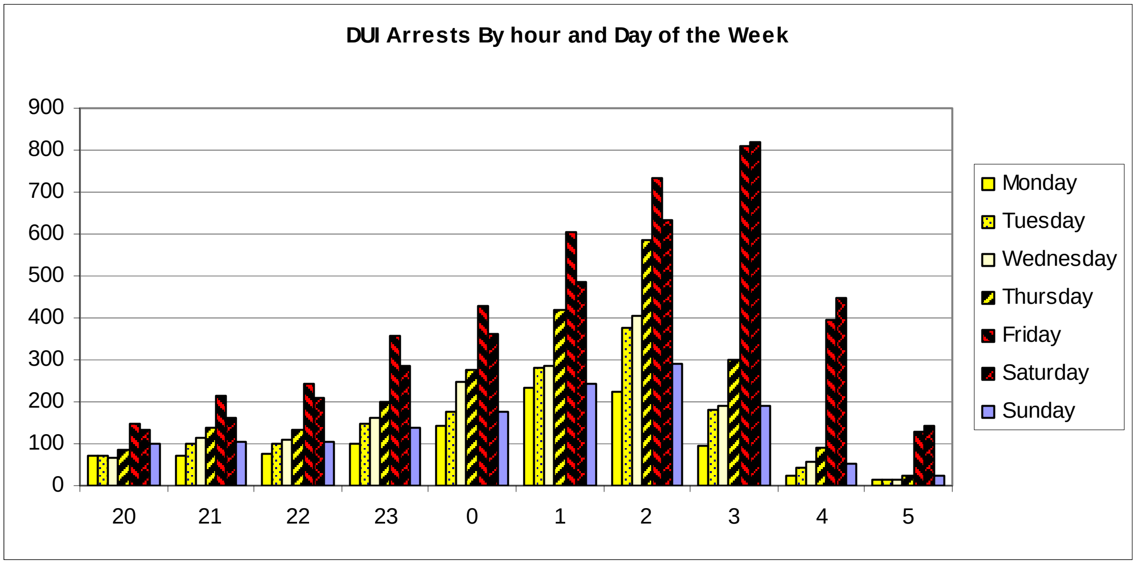


Figure 2

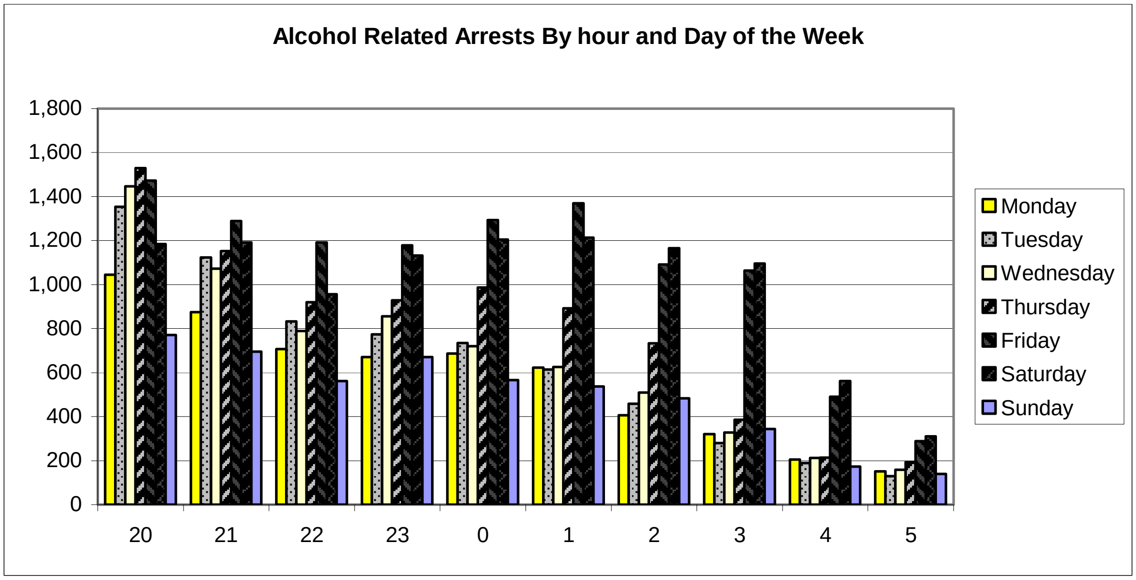
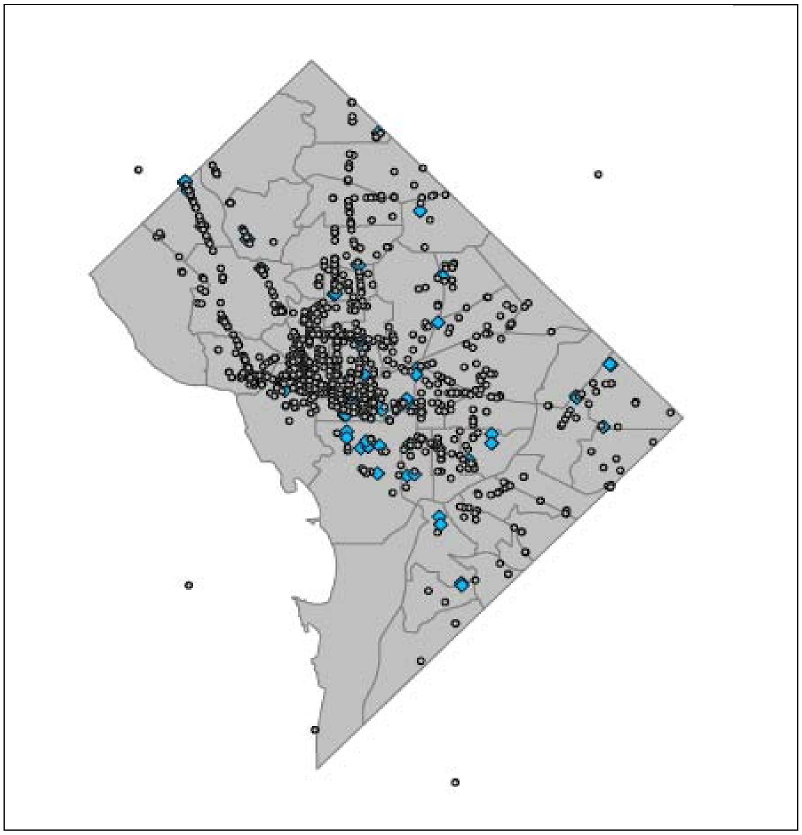


Figure 3: Alcohol Venders and Metro Stations in Washington, DC



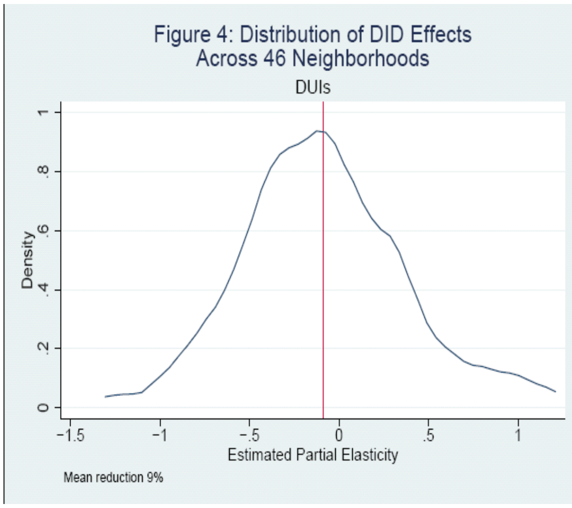


Figure 4: Distribution of DID Effects
Across 46 Neighborhoods
DUIs
Density
0
.2
.4
.6
.8
1
−1.5
−1
−.5
0
.5
1
Estimated Partial Elasticity
Mean reduction 9%

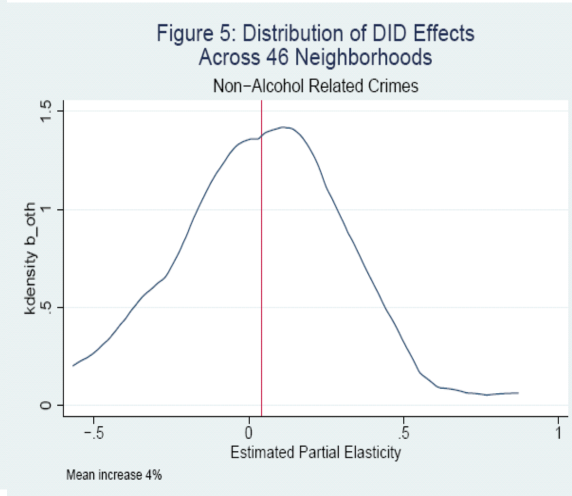


Figure 5: Distribution of DID Effects
Across 46 Neighborhoods
Non−Alcohol Related Crimes
kdensity b_oth
0
.5
1
1.5
−.5
0
.5
1
Estimated Partial Elasticity
Mean increase 4%

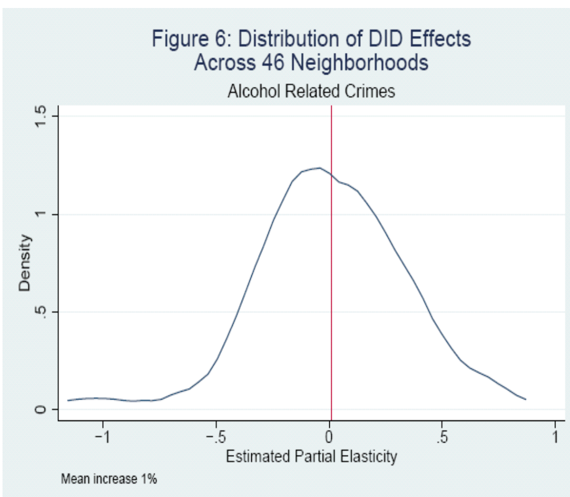


Figure 6: Distribution of DID Effects
Across 46 Neighborhoods
Alcohol Related Crimes
Density
0
.5
1
1.5
−1
−.5
0
.5
1
Estimated Partial Elasticity
Mean increase 1%

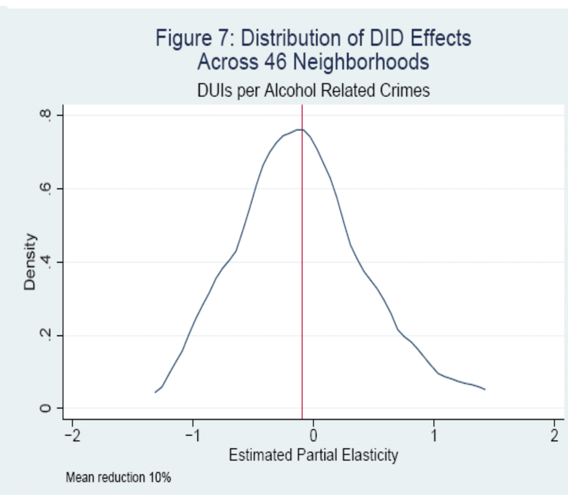


Figure 7: Distribution of DID Effects
Across 46 Neighborhoods
DUIs per Alcohol Related Crimes
Density
0
.2
.4
.6
.8
−2
−1
0
1
2
Estimated Partial Elasticity
Mean reduction 10%

Tables:

Table 1: Mean Arrests by Day of the Week and Time of Day

		Morning	Evening	Late Night
Weekly	DUIs	1.23	1.60	9.00
		(2.32)	(2.44)	(20.131)
	Alcohol - Related	59.11	30.77	28.18
		(93.73)	(37.30)	(41.32)
Sunday	DUIs	2.30	1.76	6.26
		(3.40)	(2.66)	(10.14)
	Alcohol - Related	45.36	21.59	21.63
		(48.95)	(22.41)	(24.76)
Monday	DUIs	0.93	1.24	4.69
		(1.72)	(1.88)	(7.68)
	Alcohol - Related	66.68	28.97	23.42
		(119.04)	(34.06)	(23.14)
Tuesday	DUIs	1.07	1.43	6.81
		(1.66)	(1.90)	(12.86)
	Alcohol - Related	76.41	39.61	25.47
		(108.45)	(42.89)	(26.20)
Wednesday	DUIs	0.91	1.51	7.71
		(1.49)	(2.00)	(13.67)
	Alcohol - Related	77.54	41.24	26.45
		(114.80)	(41.51)	(28.60)
Thursday	DUIs	0.95	1.74	10.57
		(1.61)	(2.06)	(19.94)
	Alcohol - Related	77.61	41.12	32.67
		(109.50)	(41.48)	(39.63)
Friday	DUIs	1.15	2.69	18.82
		(1.78)	(3.50)	(33.30)
	Alcohol - Related	66.51	40.55	49.11
		(83.96)	(41.34)	(64.65)
Saturday	DUIs	2.55	2.44	17.13
		(3.66)	(2.91)	(30.94)
	Alcohol - Related	62.80	33.10	46.65
		(72.52)	(33.02)	(60.40)

Standard deviations in parentheses

Table 2: Alcohol Venders in Police Service Areas

	Full Sample	U and H Street corridors Excluded
N	46	44
# Venders	29.5	28.1
	(44.0)	(44.3)
Minimum	0	0
Maximum	215	215
# Venders within 100m of Metro	2.84	2.66
	(7.16)	(7.11)
# Venders within 400m of Metro	13.5	12.6
	(35.5)	(35.4)
# Venders within 800m of Metro	20.0	19.0
	(41.3)	(41.4)
Mean Distance from Venders to Metro (meters)	891.9	904.9
	(566.8)	(571.3)
Minimum	187	187
Maximum	2439.5	2439.5
Minimum Distance from Venders to Metro (meters)	486	500.9
	(558.7)	(566.8)
Minimum	14	17.2
Maximum	2204.2	2204.2

Standard deviations in parentheses

Table 3 : OLS estimates of Log(DUI) Log(Other) and Metro Availability

	(1)	(2)	(3)	(4)	(5)	(6)
	log DUI	Log Other	log DUI	Log Other	log DUI	Log Other
Metro Hours	-0.017	0.140	-0.184	0.254	-0.223	0.146
	[0.118]	[0.058]	[0.229]	[0.095]	[0.509]	[0.152]
	{-0.148}	{2.408}	{-0.806}	{2.675}	{-0.437}	{0.961}
Observations	84	84	36	36	27	27
R-squared	0.966	0.993	0.973	0.994	0.965	0.993
Days of the week	All	All	Thurs, Fri & Sat	Thurs, Fri & Sat	Thurs, Fri & Sat	Thurs, Fri & Sat
Schedules	All	All	All	All	1,2,3	1,2,3

Robust t statistics in brackets
All regressions include day of week x time of day x schedule effects.

Table 4 : Geographic Variation Associated with Metro Effect – Drunk Driving

	(1)	(2)	(3)	(4)	(5)	(6)
Constant	-0.090	-0.082	0.054	0.456	-0.087	0.668
	[0.069]	[0.086]	[0.129]	[0.411]	[0.090]	[0.470]
	{-1.311}	{-0.950}	{0.416}	{1.110}	{-0.960}	{1.422}
Venders		0.000	0.001			-0.002
		[0.001]	[0.001]			[0.003]
		{-0.280}	{0.658}			{-0.673}
Venders > 6			-0.240			-0.247
			[0.168]			[0.199]
			{-1.424}			{-1.243}
Metro Station in PSA				-0.377		-0.366
				[0.402]		[0.410]
				{-0.939}		{-0.894}
Ln(Distance from				-0.029		-0.038
PSA center to Metro)				[0.070]		[0.081]
				{-0.410}		{-0.462}
Venders < 100m					-0.017	-0.011
					[0.005]	[0.006]
					{-3.799}	{-1.789}
Venders < 400m					-0.001	-0.008
					[0.007]	[0.005]
					{-0.074}	{-1.519}
Venders < 800m					0.003	0.010
					[0.006]	[0.005]
					{0.420}	{1.971}
Pop < 18 y.o.				0.000		0.000
				[0.000]		[0.000]
				{-3.055}		{-3.130}
Observations	44	44	44	44	44	44
R-squared	0.000	0.001	0.053	0.159	0.028	0.242

The dependent variable in each regression consists of neighborhood specific estimates of β from Table 3, column 5. Robust standard errors in brackets, t-statistics in braces

Table 5 : Geographic Variation Associated with Metro Effect – Alcohol Related Arrests

	(1)	(2)	(3)	(4)	(5)	(6)
Constant	0.006	-0.046	-0.080	0.703	-0.064	0.611
	[0.050]	[0.060]	[0.071]	[0.340]	[0.066]	[0.444]
	{0.123}	{-0.765}	{-1.132}	{2.071}	{-0.977}	{1.377}
Venders		0.002	0.002			0.005
		[0.001]	[0.001]			[0.002]
		{2.030}	{1.542}			{2.336}
Venders > 6			0.061			-0.067
			[0.111]			[0.153]
			{0.549}			{-0.438}
Metro Station in PSA				-0.597		-0.559
				[0.317]		[0.353]
				{-1.882}		{-1.582}
Ln(Distance from				-0.124		-0.121
PSA center to Metro)				[0.056]		[0.067]
				{-2.224}		{-1.797}
Venders < 100m					0.017	0.011
					[0.010]	[0.009]
					{1.740}	{1.137}
Venders < 400m					-0.013	-0.008
					[0.005]	[0.005]
					{-2.798}	{-1.448}
Venders < 800m					0.010	0.001
					[0.004]	[0.005]
					{2.471}	{0.288}
Pop < 18 y.o.				0.000		0.000
				[0.000]		[0.000]
				{-0.601}		{-0.194}
Observations	44	44	44	44	44	44
R-squared	0.000	0.062	0.068	0.128	0.116	0.239

The dependent variable in each regression consists of neighborhood specific estimates of β analogous to Table 3, column 5, with logged alcohol related arrests on the left hand side. Robust standard errors in brackets, t-statistics in braces

Table 6: Geographic Variation Associated with Metro Effect –
Drunk Driving per Alcohol Related Arrest

	(1)	(2)	(3)	(4)	(5)	(6)
Constant	-0.096	-0.036	0.134	-0.248	-0.022	0.057
	[0.081]	[0.098]	[0.141]	[0.367]	[0.104]	[0.476]
	{-1.190}	{-0.371}	{0.951}	{-0.675}	{-0.216}	{0.120}
Venders		-0.002	-0.001			-0.006
		[0.001]	[0.001]			[0.003]
		{-1.438}	{-0.643}			{-2.229}
Venders > 6			-0.301			-0.180
			[0.188]			[0.214]
			{-1.600}			{-0.841}
Metro Station in PSA				0.220		0.193
				[0.344]		[0.422]
				{0.638}		{0.456}
Ln(Distance from				0.095		0.083
PSA center to Metro)				[0.062]		[0.080]
				{1.542}		{1.045}
Venders < 100m					-0.034	-0.021
					[0.013]	[0.012]
					{-2.637}	{-1.761}
Venders < 400m					0.013	0.000
					[0.008]	[0.007]
					{1.564}	{-0.002}
Venders < 800m					-0.007	0.009
					[0.007]	[0.007]
					{-1.057}	{1.250}
Pop < 18 y.o.				0.000		0.000
				[0.000]		[0.000]
				{-1.859}		{-2.189}
Observations	44	44	44	44	44	44
R-squared	0.000	0.031	0.091	0.178	0.086	0.303

The dependent variable in each regression consists of neighborhood specific estimates of β analogous to Table 3, column 5, with logged DUI arrests minus logged alcohol related arrests on the left hand side. Robust standard errors in brackets, t-statistics in braces

Table 7 : Geographic Variation Associated with Metro Effect – Non-Alcohol Related Arrests

	(1)	(2)	(3)	(4)	(5)	(6)
Constant	0.040	0.054	0.173	0.038	0.070	0.282
	[0.042]	[0.051]	[0.077]	[0.390]	[0.050]	[0.347]
	{0.960}	{1.058}	{2.245}	{0.097}	{1.400}	{0.814}
Venders		0.000	0.000			0.003
		[0.001]	[0.001]			[0.003]
		{-0.648}	{0.390}			{1.161}
Venders > 6			-0.209			-0.225
			[0.098]			[0.141]
			{-2.133}			{-1.587}
Metro Station in PSA				-0.076		-0.118
				[0.371]		[0.300]
				{-0.205}		{-0.395}
Ln(Distance from				0.000		-0.025
PSA center to Metro)				[0.059]		[0.051]
				{0.004}		{-0.498}
Venders < 100m					0.000	0.000
					[0.009]	[0.009]
					{-0.041}	{-0.029}
Venders < 400m					0.005	0.003
					[0.006]	[0.006]
					{0.786}	{0.551}
Venders < 800m					-0.005	-0.006
					[0.005]	[0.006]
				0.000		0.000
Pop < 18 y.o.				[0.000]		[0.000]
				{0.679}		{0.394}
				{-1.859}		{-2.189}
Observations	44	44	44	44	44	44
R-squared	0.000	0.006	0.112	0.028	0.027	0.148

The dependent variable in each regression consists of neighborhood specific estimates of β from Table 3, column 6. Robust standard errors in brackets, t-statistics in braces

Appendix:

Alcohol-Related Crimes
excluding crimes consisting of less than 0.1% of total

Offense	Percent
Affrays	1.38
Assault Simple in Menacing Manner	**21.93**
Assault Threatened in Menacing Manner/T	0.98
Assault w/Intent to Commit Any Other Of	0.18
Attempt Theft	0.27
Conspiracy/Threats (Felony)	1.13
Destroying or Defacing Buildings/Other	0.1
Disorderly (Craps)	1.21
Disorderly (Jostling)/Other Disorderly	**4.57**
Disorderly Conduct (Incommoding)	0.46
Disorderly Conduct (Loud & Boisterous)	**5.65**
Disorderly Conduct (Obscene Gestures)	0.04
Disorderly Conduct in Public Building	0.1
Drinking in Public	**2.18**
Indecent Exposure	0.17
Indecent Sexual Proposal	0.16
Metro Misconduct	0.51
Other Felony Offense	6.71
Other Misdemeanor Offense	**17.89**
Other Non-Aggravated Assault	0.48
Possession Open Container of Alcohol	**19.07**
Robbery -- Force & Violence	1.01
Robbery -- Pursesnatch (Force)	0.23
Robbery/Attempt to Commit Robbery	0.58
Shoplifting	1.19
Theft 1st Degree	**1.99**
Theft 2nd Degree	**2.89**
Theft from Auto I	0.24
Unlawful Assembly	0.4
Unlawful Entry on Property	**3.22**
Urinating in Public	**2.2**