The National Council for Crime Prevention Sweden

Econometric Analysis of Crime in Sweden

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Perry Shapiro Harold L. Votey Jr

Stockholm, October 1986 Report 1986:3

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The address is:
Brottsförebyggande rådet
Atlasmuren 1
S-113 21 STOCKHOLM, Sweden
Telephone: (Stockholm) 08-22 97 80

The Council publishes reports in Swedish and English. The Council also issues abstracts on crime and correction in Sweden.
This report can be ordered from
Liber Förlag
Kundtjänst
S-162 89 STOCKHOLM, Sweden

This is a research report.
The views expressed are those of the authors alone.

ISBN 91-38-09510-6
Omslag Förlagsateljén
Produktion AB Allmänna Förlaget
Tryck Gotab, Stockholm 1986

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Preface

Beginning in 1978 the Swedish National Council for Crime Prevention (BRÅ) has provided support to me for econometric research on a number of aspects of Swedish crime. My involvement began as a consequence of a general interest in Scandinavian effectiveness in controlling the consequences of drunken driving. The investigation into these matters in Sweden and in Norway led to a subsequent interest in investigating crime more generally in Sweden. I sought to conduct analyses that involved econometric techniques being perfected in the U.S. and elsewhere to reinvestigate economic models of choice in criminal behavior. Those models, as do those of the classical criminological theory, trace their roots to Bentham, Beccaria and the Utilitarians. I had gained considerable experience in investigating such hypotheses with a variety of data bases in the U.S. and was intrigued with the possibility of conducting similar studies with Swedish data. In particular, I was struck with the similarities in Swedish and American law and treatment of criminals, with sufficient variation to make the studies interesting in their own right. I was also very much impressed with the detail provided in official Swedish crime records and their accessibility through the Swedish National Central Bureau of Statistics.

The primary data collection for the subsequent series of projects began the two summers, 1979 and 1980, in Stockholm, where I was assisted by my wife, using the facilities of BRÅ. The second visit coincided with the 8th International Conference on Alcohol, Drugs and Traffic Safety in which a paper was presented first making use of Swedish data from this project. Econometric analysis was conducted within the facilities of the University of California at Santa Barbara. Visits to BRÅ followed in 1981 and 1984 when seminars were presented with initial results of studies underway using Swedish data.

Santa Barbara, September 1986

Harold L. Votey, Jr

Community and Organization Research Institute
University of California/Santa Barbara

Summary of Research Progress

BRÅ first published the author's econometric analysis of Swedish crime, its causes and control in Kühlhorn & Svensson (1982). That work was extended and published in greater technical detail in Smith & Witte (1983). Subsequently, support for continuation and extension of that research has been provided in part by the US National Institute of Justice, and the US National Science Foundation in connection with studies pursuing those agencies' own research agendas as well as by the University of California in its role of providing research support to its faculty. An extensive list of publications has been the consequence, all of which owe much to the initial interaction with BRÅ. The results are of interest to sweden in that they reveal much about Swedish crime and its control that was previously known. They are of interest to the research community beyond Sweden for the way they provide confirmation of hypotheses tested elsewhere and the opportunity to test further the validity of new research techniques for studying crime and its control.

The papers in this volume were written especially for BRÅ, largely as a consequence of questions arising out of seminar presentations here. The first paper, "The Allocation of Police Manpower Across Counties in Sweden", deals with questions raised about assumptions in earlier modeling of Swedish crime control about the way crime control resources have been allocated across Swedish jurisdictions. The second, "Substance Abuse and Crime in Sweden", makes use of the same econometric framework to evaluate hypotheses regarding the influence of drug and alcohol abusers on crime in Sweden. The third, "Moral Compliance, Private Self-Interest and Exposure to the Law", with Perry Shapiro, draws on joint extensive research conducted to develop and test alternative models for explaining drunken driving behavior and its control. An appendix lists publications that trace their roots to the interaction begun in 1978.

The Allocation of Police Manpower Across Counties in Sweden

Harold L. Votey, Jr

Acknowledgements

This research has benefited by comments provided by attendees to seminars presented to the National Council for Crime Prevention on August 23, 1981 and on July 18, 1984. In particular, comments by Carl-Gunnar Janson, Johannes Knutsson, Eckart Kühlhorn, Ernst Nilsson and Torbjörn Thedéen have been most helpful. Support for this research has been provided by the National Council for Crime Prevention, Stockholm and by the Committee on Research, Academic Senate at the University of California, Santa Barbara. A great number of individuals and organizations in Sweden have contributed generously in helping to put together the data for this research from many official and private sources in Sweden. Of particular help in that connection have been Göran Hedström, Torbjörn Israelson, Eckart Kühlhorn, Ernst Nilsson, Peter Simon and Henrik Tham.

Introduction

This paper examines the allocation of police manpower across Swedish counties and investigates the evidence regarding the criteria used for the allocation.

There are a number of reasons why it might be important to understand the process by which police manpower allocation takes place. One is that in order to conduct credible evalutive research concerning deterrence effects of law enforcement and sanctions against criminals, it may be critical to the evaluation to make appropriate assumptions about how the level of criminal justice manpower is determined. This is one of the issues raised by Blumstein et al. (1978) in their evaluation of deterrence studies in the U.S. Another is that, if evaluative studies are to be pursued to their logical ends with respect to analyzing law enforcement efficiency, one must be able to model the allocation process realistically. The latter concern can be divided into a number of subsidiary concerns. These include whether law enforcement resources are appropriately allocated among sub-components of the criminal justice system, whether appropriate emphasis is placed on the various classes of crime,

whether allocations among communities are appropriately balanced, and whether policymakers spend sufficient resources on crime control as contrasted with other logical targets for the use of public funds.

One might assume that the obvious approach to discovering the criteria used is simply to ask the authorities how they balance expenditures among all of these demands. In a complex bureaucracy it is not that simple, however. For example, there may be political reasons why authorities are reluctant to divulge the process. It may be felt that increased public input into the process may make it more difficult rather than more effective. But more than that, the problem is simply that there is no single point in the system at which all allocative decisions are made, nor should there be. Most often, authority is decentralized in order to place those individuals in close touch with a set of problems in a position to make judgements about how resources should be used. Under such circumstances it may well be that statistical inference can tell us as much or more about the factors influencing a set of decisions as one might learn from extensive questioning of authorities.

In the case of law enforcement manpower, discussion with authorities and cursory investigation suggests that per capita manpower allocations across counties in Sweden are simply based on the population density of respective counties. However, detailed investigation seems to indicate a much more complex process in which marginal adjustments are made systematically to that initial allocation. Such a process could be consistent with optimal planning in which the implicit objective is to minimize social costs of crime. This is not to suggest that what is revealed here is an explicity formalized plan to yield social cost minimization with respect to crime. Rather, the factors seeming to influence the outcome are what one might expect from a conscientious organization with sufficient flexibility to modify decisions to take account of variations in the demand for public safety. It is likely that those demands are expressed through publicly voiced concerns. It is also likely that decisionsmaker are taking account of operational data on successes at dealing with crime loads among the respective counties.

The evidence suggests, in fact, that allocations of manpower are sensitive to the indicators that reflect variation in victim losses across counties. It implies that the authorities **are** sensitive to crimes losses and control costs relative to community income levels, or, in other words, to the perceptions citizens have regarding the costs of crime relative to their ability to pay for public safety.

The approach adopted in this research is to make use of the econometric model of crime generation and control in Sweden developed previously by the author to explain police effectiveness and crime rates. That model has been adapted to the consideration of

the timing and factors influencing decisions about the deployment of police. Data have been obtained detailing that deployment by county (län) for the entire country of Sweden for the years 1975 through 1980.

Background

In earlier papers, Votey (1982, 1984), econometric tests were conducted of a number of hypotheses regarding crime generation and control in Sweden using a simultaneous equation model. As a component part of that analysis, tests were conducted on alternative hypothesis about how the level of police manpower was determined across counties and how it was allocated among offenses. One finding of the more recent study was that allocations of manpower among offense classes were not efficient in an economic sense. That test was based on the fit of a model that allocated police manpower among offense classes on the basis of the relative "value" of types of offenses. The finding of allocative inefficiency should not be surprising for a number of reasons. One is that, for the outcome to have been shown to be efficient would have required police to be allocated on the basis, in this case, of the relative intensity of different classes of personal and property crimes across counties, assuming the same value perceived by the public of preventing those crimes prevailed across all the counties. It could be that the relative perceived values of the offense classes are not considered to be the same for all counties, but more likely the authorities simply do not pay sufficient attention to the relative levels of the crimes classes when making their decisions, so that efficiency along that dimension would be an unlikely occurrence.[1]

Another kind of efficiency also was involved in the analysis, at least implicitly. That is, the total level of expenditures for police should similarly depend upon the value the public places on public safety or freedom from crime. The modeling took account of this problem by testing to see which of two models best explained crime rates and police effectiveness in Sweden over a several year period. One was a model in which total police manpower was assumed to be a function of crime levels and values placed on offenses (i.e., the level of police manpower was assumed to be endogenous to the system). In the alternative model, police manpower levels were assumed unrelated to losses and the values the public placed on crimes (i.e., manpower was assumed to be exogenous).

[1]This same conclusion results from a study of homicide control in the U.S. (Phillips, Votey & Howell, 1976) in which there was a finding of a substantial under-expenditure for control of homicide, based on prevailing estimates of the value of human life.

The presumption in deriving the relationships for estimation is that the chosen objective has been to minimize the social costs of crime, i.e., the sum of victim costs and of the costs of all public efforts to maintain or promote public safety. The idea was simply that the public, if it could place monetary values on crime that took account of psychic as well as more easily evaluated monetary costs would find it equally undersirable either to suffer victim costs or costs of crime prevention. Consequently, the desire would be to minimize the sum of the two.

The underlying theoretical model to generate the functions estimated includes the notion of demand for police, which is a derived demand for each county, and which depends upon the value (loss rate = r_i) associated with a particular level of crime (OF_i), for each crime class, and the ability of the community to afford protection, as measured by the community's median income (Y).[2] The supply of individuals willing to be police officers would logically depend upon the expected wage (w_i) as well as other considerations. The observed level of police manpower thus could be expressed as

$$L = h\ (OF_i,\ r_i,\ w_i,\ Y), \qquad (1)$$

an equation representing the equilibrium between supply and demand.

The data available for estimation did not include measures of the values of expected losses associated with the various classes of crime. This is not surprising, since there is no market in which such a price is determined and there are relatively few studies that even attempt to put values on average loss rates for crimes. What is typically done in econometric studies is to assume that losses are proportional to income.[3] Victimization studies in the U.S. tend to show that this is the case although not perfectly so. A study by Carr-Hill & Stern (1973) for England finds that numbers of offenses are positively associated with income levels, but further, victimization studies in the U.S. tend to show that the level of victimization varies positively with the incomes of victims.

The data also did not provide information on the average wage to police officers in Sweden because these data were simply not available to the extent required for the econometric analysis. Here

[2]This general approach was first used in Phillips & Votey (1975). It has been applied to Scandinavian data in Votey (1982).

[3]An example is Votey (1982).

again, is it probably reasonable, at least over time, to expect that police wages will vary according to the levels of income prevailing in a community. It can easily be shown that average salaries and wages in public sector jobs in Sweden generally move positively with inflation. Across counties in Sweden, it is less likely that average police wages will vary with the counties' income levels because police salaries are presumably set on a national basis and county income is dependent on the state of the local economy. In a regression in which such a proportionality with incomes is assumed, any deviation from that assumption will affect the constant or error term of the regression.

In general, it is not unreasonable to expect that local manpower allocations will be affected by local income levels, because demand will reflect ability to pay, for example, through taxes levied to pay for police protection. In a centrally controlled system, however, this will not likely be the case unless, for example, the authorities have reason to allocate greater numbers of police to higher income areas. They might do so if police authorities respond to the relative levels of losses across counties and wealthier counties have greater losses to crime than poorer ones. Such a policy would be consistent with overall social cost minimization, even though it might seem to be a violation of the notion of an egalitarian distribution of income and governmental services.

It is unlikely that, with the attitudes regarding taxation and the distribution of income and governmental services one finds in Sweden, wealthier communities would be looked upon more favorably than poorer ones because they are wealthy.[4] Nonetheless, if every citizen has an equal say in determining the level of police manpower simply on the basis of majority voting, because wealthy people will be more vocal in demands for public safety, wealthy communities will appear to be more concerned with obtaining increased police manpower than poorer communities and by merely responding to majority concerns seemingly irrespective of wealth, the authorities may modify allocations accordingly.[5]

Thus, there are three factors that are consistent with a positive link between average per capita or per family incomes and police allocations, either across communities or over time.

1. Perceived loss rates per offense will be positively correlated with income levels

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[4]This comment was due to Carl-Gunnar Janson & Ernst Nilsson. Professor Janson suggested further that population density may turn out to be significant as an explanatory variable for offense rates as well, a question tested in other analyses.

[5]This is the prediction of an analysis of the demand for public safety as income varies among communities in Phillips & Votey (1981, Ch. 5).

2. The number of offenses or offense rate will be positively related to family income
3. The ability of the community to pay for, and hence the likelihood that they will demand, public safety will be strongly positively related to income levels

As a countervailing effect, police wages will be closely and positively related to average income levels over time which, however, implies increasing costs for law enforcement and a negative impact on demand. Thus, to the extent that positive factors outweigh this last category of costs, average income levels will be positively related to manpower deployment.

One response of critics of the previous paper was that all of this is very well, but it is well known in Sweden how manpower is allocated. It was asserted that allocation is simply by utilizing a formula whose principle element is local population density. There is, after all, a rule of thumb based on past evidence about the distribution of crime relative to population density. The argument that population density is associated with higher crime rates suggests that it might also be considered as a relevant causal variable for inclusion in the equation to explain offense levels.[6]

A relevant consideration is that of timing. The model is designed to explain offense and police effectiveness levels at a point in time. In fact, as noted, it is likely that this year's manpower levels may actually be determined in a previous period. To expand on this idea, consider that the model might be formulated assuming that manpower allocation decisions are made simultaneously with offense and output levels. Since the data are provided only on an annual basis, this means that any lag between changes in crime levels or other factors and changes in manpower allocated would be less than one year. Alternatively, it may be that manpower levels are set once a year in a budgetary process that provides for the coming year. If this should be the case, then total manpower allocations in any given year might be expected to be exogenously determined. But, does this imply that reallocations among counties would not take place within the year of operation, if relative crime incidence changed? For example, if one area suffered riots because of, say, industrial strife, would the local police be limited by manpower levels set in the previous year? There seems to be good reason to believe that unanticipated factors could affect manpower allocations among counties irrespective of prior overall budgetary determinations. A relevant question, however, is

[6]As noted by Professor Carl-Gunnar Janson, crime has long been observed to be associated with densely populated urban areas. While debate continues as to why crime is associated with crowded urban locations, in general population density can be positively associated with crime. A study discussing previous evidence and presenting additional data is Chilton (1964).

whether published average police manpower assignments recorded in the data reflect periodic short-term adjustments to deal with localized problems.

Investigation of Hypothetical Alternatives

The approach to investigating the determinants of police allocation has been to begin with the premise that the authorities do in fact want to minimize the social costs of crime. Presuming this to be true, as noted previously, theory suggests a number of factors that should relate to the determination of efficiency: costs per unit of law enforcement, average victim costs per offense, and the general level of demand for law enforcement, all of which are expected to be related to per capita income levels. The levels of various classes of offenses will also be relevant in indicating the scope of the problem that yields public concern. The alternative hypothesis is that the authorities simply presume all that is important can be approximated by taking account of variations across counties in the density of local populations.

Testing the alternative hypothesis has required creating a variable representing population density for the years in question. This has been done two ways. The first has been simply to take the series provided by the National Police which they used for their own deliberations (POPD). For the years 1971 to 1975 this appears to have been the 1970 census figure and for the years 1976–1980 this was the value established by the 1975 census. The second was to create a moving series based on intermediate population estimates divided by the constant area served (POPD1). Both have been included as explanatory variables in the relation determining police manpower assignments by county and elsewhere, and as explanatory variables for the determination of offense rates.

Three variables have been used to represent variations in the levels and nature of offenses among counties. These are the aggregate of offenses for crimes against persons expressed in a per capita rate, the aggregate of property crime offenses, similarly expressed, and the per capita level of road traffic offenses that are primarily speeding and drunken driving. As an alternative to using all three measures, a variable has been used that is simply the total of reported offenses per capita including road traffic offenses. To represent income levels, median family income has been used, adjusted for variations due to inflation.

The tests have been run sequentially to attempt to examine a number of separate hypotheses. These can be stated as a set of questions:

1. Is there evidence that police manpower assignments across counties are sensitive to prior year offenses, incomes, and/or population density, i.e., is the relationship recursive?

2. Can it be shown that manpower assignments are sensitive to contemporaneous offenses, incomes, and/or population density?
3. Can it be shown that population density explains manpower assignments to the exclusion of other factors?
4. Does the series on population density provided by the National Police provide as good or better an explanation of manpower assignments as a series adjusted annually for population change?
5. Having standardized for populations density and the load on the system, is the allocation of manpower still sensitive to income levels?

The stepwise investigation of these questions yields a picture of decision-making practice that will be useful for further modeling of crime and its control in Sweden.

Empirical Results

The results have been obtained by estimation using two-stage least squares in order to be consistent with earlier estimation techniques for the full model. The instruments contain the full set of exogenous variables for the crime generation and police effectiveness relationships, as well as the exogenous variables of Eq. (1). An extensive sequence of tests has been conducted in order to evaluate all possible combinations of the proposed set of explanatory variables in both simultaneous and recursive relationships. The dependent variable in every case is the per capita allocation of police manpower by county for the 1975–1980 period. All variables are expressed as natural logarithms so that coefficients are in the form of elasticities.

These results indicate that each of the proposed variables by itself provides a statistically significant explanation for the allocation of police manpower across counties for the years 1975 through 1980. Furthermore, this is true using either prior year values or contemporaneous values. If one uses as a test of fit, the formulation with the least mean square error, combinations of all the contemporaneous values of the explanatory variables lagged one period are superior to any of the variables uses singly.

One clear result is that the measure of population density that the national police publish with their tabulation of manpower by police district and county provides a better fit than one adjusted yearly to account for population growth. An interesting aside is that, with the other explanatory variables for offense rates, including population density fails to improve and, in fact, weakens the fit of the offense equation.

The superior fit with the census tabulation of population density is a rather striking result when one realizes that the basis for establishing the variable used by the National Police is the census year tabulation, so for any given county only the 1975 allocation depends on a different population density value than for the subsequent years of 1976 through 1980. Thus, there seems little doubt that the variable they claim forms the basis for their allocation in fact has a strong influence on the outcome. This observation must be taken as point of departure.

What is still more interesting, however, is that the final allocation appears sensitive to much additional information. In fact, the best fits with the data, in terms of minimizing the mean squared error, are those that include separate measures for personal crimes, property crimes, motoring offenses, and median family income for each of the counties. This turns out to be true whether one uses a model that assumes manpower allocations are endogenous to the system, i.e., are made concurrently with the determination of the levels of offenses and police effectiveness, or with a model that assumes manpower decision use exogenous to the system and, in fact, determined in a budgetary decision process conducted in the previous year.

In terms of minimizing the mean squared error of the regression, it would be difficult to distinguish between the simultaneous and recursive models, although the models assuming allocative decisions are primarily made in the prior year fits very slightly better. Furthermore, the equations for estimating offense relationships and law enforcement effectiveness provide slightly better fits to the data when based on a set of instruments that assume budgeted allocations depend in part on prior year judgments.

The fact that both of the alternative hypothesis about the timing of the allocation decision seems to fit the data well argues for a decision process that is more complex. That is, it appears likely that initial allocations are made on the basis of information available in the prior year but that adjustments to that allocation are made to account for demands upon law enforcement that vary from year to year and that cannot be fully anticipated in advance. To test this hypothesis, an estimation model is tested in which the final allocation is based on weighted average of both prior year and contemporaneous values for all of the variables thought to be relevant: personal crime rates, property crime rates, road traffic offenses, income levels, and population density.

The estimation process for achieving this result is complicated because of the high degree of collinearity among variables when all ten explanatory variables (prior year and current values) are included

in the estimating relationship.[7] As a consequence, an iterative process is used to determine the weights that reflect the decision process. The criterion for the best fit throughout has been the lowest sum of squared residuals for the regression, still estimated in the two-stage least-squares or instrumental variables framework. In the final result it becomes clear that a weighted model fits best, but it is not possible to get separate statistically significant estimates for relations that include both contemporary and prior years levels for personal and property crimes in the same estimation, although it is possible to get significant estimates based on weighted sum for the two years. In estimates that include only prior year weights for personal and property offenses or current year weights, with both prior and current weights for road traffic offenses, income and population density, the sum of squared residuals is 2.45 % lower for the estimates bases on using only contemporary weights on personal and property offenses, suggesting that current values are definitely taken into account in the decision process. The individual coefficients for all variables have t-values ranging from 2.85 to 6.90, indicating statistical significance at better than an .01 level based on a two-tailed

[7]The Farrar & Glauber (1967) test for multi-collinearity was used at this stage of the estimation to confirm that the estimation problem was in fact collinearity among the personal and property crime lagged and contemporaneous values.

Table 1. Alternative estimates of the law enforcement manpower allocation relationship

Variable	Combined Model			Contemporaneous Model			Lagged Model		
	Weights	Coeff.	t	Weights	Coeff	t	Weights	Coeff.	t
OFPER(t)	.104	*1.145	3.63	1.0	.1680	3.30			
OFPER(t-1)	.046						1.0	.1632	3.94
OFPRO(t)	.118	*0.662	2.84	1.0	.1413	2.85			
OFPRO(t-1)	.078						1.0	.1214	3.01
DWI(t)	.082	1.017	6.66	.082	.986	6.50	0.82	1,038	6.90
DWI(t-1)	.089			.089			.089		
MFI(t)	.219	0.990	3.11	.219	.942	2.89	.219	1.072	3.32
MFI(t-1)	.287			.283			.287		
POPD(t)	.470	0.991	6.07	.470	.992	5.95	.470	1.035	6.27
POPD(t-1)	.079			.079			.079		
SSR			0.8729			0.8795			0.9010
F(5,138)			128.89			127.71			124.00

* Weights estimated individually to deal with collinearity.

test. The F-statistic is 127.71 for the best fit with 3.15 required for significance at the .01 level. The estimated weights for all the variables and coefficients for the two "best" models are presented in Table 1.

Conclusions

The results are gratifying in the following sense. They show clearly that, despite the apparent evidence from the statistics provided by the National Police indicating that the basis for per capita police manpower allocations across counties is simply population density from the five year census, there is strong evidence that other factors that should be relevant to the final decision play an important but perhaps elusive role in the allocation process. In fact, all of the variables that should be relevant, if the objective is to minimize the social cost of crime, are statistically significant, and they all have the signs one might hope they would have. This result does not contradict the position that population density is used as a rule of thumb, only that population density does not appear to be an exclusive measure on which allocations are based.

These results do not contradict the previous inference that the allocation of manpower among offense classes is inefficient, nor do they confirm in any way that the right amount of resources is going into the criminal justice system relative to expenditures on other publicly supported activities. To make that determination would require sound estimates of the values the public places on avoidance of the various kinds of offenses relative to other outlets for expenditure.[8] The estimates, however, indicate a high degree of sensitivity among policymakers to crime losses and the costs of public safety as it varies across jurisdictions.

In fairness to the authorities at the various levels who make the decisions regarding the extent to which public efforts are devoted to crime control, the ability to achieve economic efficiency cannot be anything but elusive. There is no built-in process in public decision-making to yield efficiency as there is in a competitive market system. And the process of achieving efficiency in a guided system is even more complex with publicly provided goods than is the case for privately consumed goods. Until techniques for planning become much more sophisticated with regard to crime control, the achievement of efficiency can only be a hoped for outcome with a high probability of error. Still, it should be gratifying to observe that, in such an imperfect process, variables that should be relevant appear in Sweden to be influencing the outcome in the direction one would hope they would for minimizing the social costs of crime.

[8]This is not a question that is easily answered. Most studies merely rank crimes by seriousness without attempting to place cardinal values on offenses. A first effort in this direction is in Phillips & Votey (1981, Ch. 4).

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Substance Abuse and Crime in Sweden: Econometric Estimates of Linkages

Harold L. Votey, Jr

Acknowledgements

This research has been supported by a grant from the National Council for Crime Prevention and by the Academic Senate Committee on Research, University of California, Santa Barbara. Johannes Knutsson, Torbjörn Thedéen and others who participated in a seminar at the National Council for Crime Prevention have provided useful comments on this paper.

Introduction

Substance abuse has long been a subject of concern because of its adverse impacts on those who indulge in the practice. It has become increasingly a matter of concern, as well, for the alleged damages to others who are indirect victims. The most recognized damages from such behavior are those relating to road accidents caused by misuse of alcohol and drugs.[1] Less frequently one hears the allegation that such misuse leads to other kinds of offenses.[2] This paper investigates one kind of evidence regarding possible linkages between alcohol and drug use and felony crime. The framework for the analysis is an already established econometric model of crime among counties in Sweden that measures inferentially the influence of observed drug user populations in Swedish counties.

Background

Maintaining laws against substance abuse is costly in Sweden as is the case in most countries in which such laws are maintained. A reason that laws against such abuse are numerous among countries is, in part, for the threat that substance abuse poses in contributing to

[1]Sweden has long been among the nations leading in research on this topic and, for example, was the June 1980 sponsor of the 8th International Conference on Alcohol, Drugs and Traffic Safety held in Stockholm.

[2]Such data for Sweden are presented in Bejerot (1975), pp. 172–196.

behavior and life styles that are inimical to those felt to be desirable by many of the rest of the population. An alternative concern, often alleged but not self evident, is that substance abusers are more likely to be involved in felony crime than non-abusers. Arguments regarding the appropriateness of policies to deal with substance abuse tend to depend to some extent on whether one or the other of these concerns is felt to be the overriding one.

Two theoretical possibilities could yield an apparent link between substance abuse and crime. One is that substance abuse is simply an antisocial form of behavior in which some small subset of the population will be likely to indulge simply to exhibit disdain for the law. Following this line of reasoning, however, substance abuse will not be the only form of illicit behavior for those individuals. They will also likely be involved in personal and property crimes and a wide variety of lesser abuses of social norms simply because it is a part of their nature. In this line of reasoning, there is no causality that runs from substance abuse to the commission of felony crime.

An alternative possibility is that drug and alcohol use are causal factors in other kinds of crime. Continued use of drugs and alcohol may have pathological effects on users, altering their behavior toward more antisocial ways. Or, almost a separate line of argument, the abuse may form the basis for felony crime simply because drugs and alcohol are costly and property crime is a way to obtain the resources to acquire them. And in the execution of those crimes, personal crimes may be committed as well.

With respect to drugs, there is substantial evidence in the U.S. that this latter argument is supported by fact. This is not to argue that the first hypothesis is not also true. Rather, it can be shown that persons who perceive an urgent need for drugs will be inclined to commit felony crimes to obtain those drugs. The result is that substantial amounts of property crime can be causally linked to drug use. At the same time, drug users in the U.S. are often among a subset of the population that commonly commits a wide range of offenses.

This is supported by an extensive study of drugs in the U.S. by Wald & Hutt (1972), a report to the Ford Foundation of the Drug Abuse Survey Project. In that volume considerable space is devoted to evidence that heroin users are motivated to steal, rob, shoplift, engage in prostitution and commit other crimes to obtain costly hard drugs. This evidence with respect to property crime is extended by Brown & Silverman (1974) and Silverman & Spruill (1977) who find that, as illicit prices for heroin increase, property crimes tend to increase substantially. That large amounts of property crime are attributable to hard drug users in supported by an experiment conducted by the police in Santa Barbara, California in which it was found that jailing heroin addicts under the influence of opiates led to

a measurable decline in burglaries and larcenies (Votey, 1979).[3] An entirely different approach is Carter (1977) in which a sample of the Santa Barbara addict population is examined in detail for characteristics that would support one or both of the hypotheses about drug use and other felony crime.[4] That study tends to suggest both that addicts are, at the outset, a non-conforming population subset and inclined to be more involved with property crimes as a consequence of drug abuse, and that property and other crimes are committed to obtain drugs. This evidence is discussed in Phillips & Votey (1981) in which options for control are modeled and evaluated.

In all of this evidence, the drug primarily involved is heroin. Heroin is an addicting drug that is typically used by individuals with low or non-existing legitimate economic opportunities. Users tend to be minorities, concentrated in urban central city populations. Although it has been alleged, there is little evidence to support a causal link between marijuana and other non-addicting drug use and the use of heroin. Nor does there appear to be evidence that particularly links use of other drugs to crimes to obtain resources to purchase them.

This study investigates similar linkages for Sweden. In Sweden, hypotheses expressed regarding linkages between drug and alcohol use and crime appear to focus less on the economic incentives associated with their use as it related to felony crime and more on the possibilities that pathological and physiological effects of drugs and alcohol may be causally linked to the commission of felony crimes. This is not to suggest that economic motives linking felony crimes and drug use have not been heard in Sweden. It should be noted, however, that in Sweden drugs classed as central stimulants may be more prevalently in use among persons who commit other crimes than are the opiates, which were in widespread use in the U.S. at the time of the studies cited here.[5] A volume that surveys some of the literature and one that presents a broad discussion of the issues for Sweden similar to the Wald & Hutt report in the U.S. is Bejerot (1975). His presentation of data on individuals with substance abuse and crime goes a long way toward supporting a picture for Sweden similar to that observed in the U.S.

Data on alcohol consumption have been readily available for a very long time in Sweden. Data on drug use appropriate for analysis similar to the aforementioned U.S. studies are far less accessible and

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[3]Tests of a policy to incarcerate drug users apprehended under the influence of opiates for 90 days found the policy to be cost effective in terms of the value of property crimes prevented; Phillips & Votey (1977).

[4]In this study, 100 addicts, resident in Santa Barbara, were studied in considerable depth, including reviewing complete details of their criminal records and using individual interviews.

[5]This is a point that is made emphatically in Bejerot (1975).

only because of a recent study on the subject has it been possible to conduct tests of a range of hypotheses linking drug use and crime. These tests are conducted within a framework that takes account of other causal forces for crime as well as the deterrence impacts of apprehension and sanctions. The next section discusses the nature of the statistical tests conducted.

The Link Between Drug and Alcohol Use and Other Crime in Sweden

To begin to evaluate whether a link exists between drug use, alcohol use and felony crime in Sweden, the econometric model of crime across Swedish counties is used to conduct some basic tests. Combined with it are data from **Tungt Narkotikamissbruk** (1980) on the distribution of known drug users by county.

The approach has been simply to use the model to investigate the impact of the presence of drug users on the incidence of felony crimes. To do so requires a baseline result for the model that includes the years for which it is assumed that the drug users population is in place. Those results are displayed in Table 2. Variable definitions are in Table 1. Results are essentially as with previous estimates using data from 1975 through 1980.

Table 1. Definition of variables (all variables are expressed as the natural logarithms of the measure in question)

Label	Definition
LOPERP	Crimes against persons, per capita
LOPROP	Property crimes, per capita
LCR	Convictions/Offenses specific to the crime class of the dependent variable (personal, property)
LATS	Average time served (months) for the relevant crime class
LDVIP	Divorce and legal separations, per capita
LALENP	Proportion of non-Swedish (alien) population
LUPM	Proportion of unemployed males in the labor force
LALCP	Per capita consumption of alcohol for persons over 15 years of age
LNARCP	The population of all drug users relative to the county population
LCANAP	The population of users known to have been using cannabis relative to the county population
LOPIAP	The population of opiate users relative to county population
LCSTIM	The population of users of central stimulants relative to county population
CON	The constant term of the regression

Table 2. Baseline results for the econometric model, years 1975-1980

Dependent Variables	Explanatory variables							
	LCR	LATS	LDVIP	LALENP	LUPM	LALCP	CON	F/DF
LOPERP	−1.31	0.14	0.39	−0.29	0.16	0.09	−4.70	34.3
	(10.75)*	(0.26)	(4.98)*	(0.69)	(4.49)*	(2.51)*	(7.47)*	6,125
LOPROP	−0.95	0.005	0.73	0.10	0.26	0.17	−0.97	21.66
	(8.31)*	(0.04)	(8.25)*	(2.13)*	(4.95)*	(3.67)*	(1.34)	6,125

* Significant at the .01 level or greater (1-tailed test).
Student's t-statistics are in parentheses (absolute value).

If drug use is strongly associated with other felony crime because of the first hypothesis that drug crimes are simply another form of antisocial behavior, one would expect that personal crimes and property crimes would be equally correlated with the incidence of drug users. Furthermore, one would not expect to find a great deal of difference between the associations for drug users in total and those using opiates or central stimulants, since all these are illegal in Sweden.

If, on the other hand, there is a causal link from drug use to other kinds of crime, the relationships with other types of crimes might be expected to differ. Most drugs tend to create a sense of euphoria, pleasure, relaxation. Thus, it seems unlikely that their use will lead to greater violence against persons. Acquiring them, however, is costly so that a need to obtain drugs can be expected to be translated into an increase in crimes against property. This is not to say that violent personal crimes may not be a result of efforts to acquire property where success is threatened by individuals defending their property. However, even though this may be occassionally true, one might still expect a disproportionately stronger association between property crime and the presence of drug users.

The exception to the expectation of drugs moderating personal behavior is with central stimulants. Here, is contrast to the euphoria created by other drugs, these drugs tend to make individuals hyperactive and, it is thought, more inclined to violence. Thus, with an increased use of stimulants, in addiction to the violence associated with theft and strong arm robbery, one might hypothesize an increase in personal crimes of violence as a consequence of the drug's physiological or pathological effects.

An effect that might be expected is that users of opiates would be more strongly involved with crime in general than users of other

drugs. There are two reasons for this. First, opiates tend to be addictive. The compulsive need of drugs is an overriding force for acquisition that is not so likely to be present with users of marijuana and barbituates. Second, opiates tend to be considerably more costly than other drugs.[6] Thus, the need to commit crime to obtain drugs can be expected to be the greatest with users of opiates, one would expect it to be less for central stimulant users and still less for marijuana users.

In terms of its effects on behavior, alcohol can be expected to fall somewhere between the observed effects of marijuana and central stimulants. For some, alcohol leads to silliness progressing to very passive behavior and in the extreme to passing out. Little violence should be expected to accompany such a sequence. At the other extreme, some inebriates become excessively or hyper-active and tend toward belligerence. Such individuals tend to pick fights and indulge in assault. Since assaults can culminate in homicides, one must view excessive alcohol consumption as potentially life threatening, even when not associated with driving or operating machinery.

Alcohol, too, could provide an incentive for committing property crime simply to pay the cost of acquisition. The incentive effect, however, is likely to be much less than with drugs simply because alcohol tends to be less expensive. In fact, alcohol may be the relatively moderately priced substitute for other illegal substances that allows consumption without the need for theft to acquire a drug high.

To summarize, the net effect of this theorizing is that a crude test of the hypothesis that alcohol and drug use simply lead to greater irresponsibility and hence crime in general would simply be a finding of a positive relationship between drug and alcohol abuse and crime in general. If the observed outcome of substance abuse is the result of physiological and pathological inclinations toward violence, one would expect a relatively stronger association between alcohol use and central stimulant use and violent crime. If crime is simply a means to pay for increased drug and alcohol dependence, one would expect strong links between substance abuse levels and the commission of felony property crimes. Furthermore, one would expect stronger effects for users of higher cost drugs who need to raise greater amounts of money to support their addiction.

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[6]This assertion is based on data for the U.S. and other countries, rather than for Sweden. Those data are discussed in Walt & Hutt (1972) and in Phillips & Votey (1981).

Empirical Tests

The test of the effect of alcohol on both personal and property crime rates is established quite effectively by the original model using the full data period from 1975 to 1980. As reported in an earlier study (Votey, 1984), these results indicate that apprehension and conviction are highly significant in deterring crime, based on the coefficients on LCR, but that, as reported previously, it was not possible to show a separate effect for severity of sentence (based on the coefficient LATS). With the exception of the coefficient on alien population (LALENP) for personal crimes, all causal variables are highly significant.[7] From Table 2, it can be observed that the coefficient on per capita consumption of alcohol is almost twice as great for property as for personal crimes (0.17 vs 0.09). Since coefficients are estimated using logarithmic forms for all variables, the estimates can be interpreted as elasticities, i.e., they reflect percentage changes in the dependent variables associated with a one percent change in the explanatory variable. This can be interpreted to mean that a one percent increase in alcohol consumption is associated with a .09 percent increase in violent crime and a .17 percent increase in property crime, after having standardized for the deterrence effects of conviction and the other causal factors. Both estimates are highly significant.

The relative weights appear to reflect a stronger relationship between property crime and alcohol consumption than between personal crimes and alcohol use. This uneven emphasis is consistent with the hypothesis that thefts facilitate a higher level of alcohol consumption rather than one that alcohol consumption merely reduces inhibitions against committing all crimes.

Because the data on the distribution of known drug users is restricted to a much briefer time period, tests regarding drugs and crime must be conducted in a somewhat different format. What has been done has been to reestimate the model, restricted to a two year period: the years 1978 and 1979. Recall that the data on the distribution of drug users covered a part of each of those two years. The estimates have been conducted for both personal crimes and property crimes as before, but alternately including variables for all drug users taken together (LNARCP), for users of marijuana or cannabis only (LCANAP), for users primarily of opiates (LOPIAP) and for users primarily of central stimulants (LCSTIM). These results are shown in Table 3.

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[7] These results differ slightly from earlier published results because they cover a longer time period than for those reported in Votey (1984) and because, to eliminate anomalies in some of the data for the counties of Gävleborgs län and Jämtlands län, both counties were excluded for the entire six years. This reduces the underlying population for the study approximately 5.2 % based on the 1975 census.

Table 3. Results of testing for effects of presence of drug users

Dependent Variables	Explanatory variables: LCR	LATS	LDIVP	LALENP	LUPM	LALCP	LNARCP/ LCANAP/ LOPIAP/ LCSTIM	CON	F/DF
					ALL DRUG USERS				
LOPER	−0.93	0.08	0.47	−0.04	0.23	0.12	0.10	−2.83	21.12
	(5.43)*	(1.07)	(2.91)*	(0.70)	(3.78)*	(2.41)*	(1.43)	(2.44)*	7,36
LOPROP	−0.62	0.08	0.98	−0.03	0.17	0.08	0.04	3.09	30.14
	(2.90)*	(0.78)	(8.36)*	(0.04)	(2.08)*	(1.36)	(2.01)*	(4.29)*	7,36
					MARIJUANA USERS				
LOPERP	−0.89	0.07	0.53	−0.002	0.23	0.11	0.07	−2.46	21.21
	(5.27)*	(0.95)	(3.53)*	(0.02)	(3.76)*	(2.20)*	(1.13)	(2.16)*	7,36
LOPROP	−0.62	0.08	1.01	−0.003	0.18	0.06	0.13	3.30	30.54
	(2.88)*	(0.83)	(9.22)*	(0.05)	(2.15)*	(1.08)	(2.11)*	(4.62)*	7,36
					OPIATE USERS				
LOPERP	−0.94	0.07	0.42	0.004	0.24	0.13	0.04	−3.10	20.22
	(4.97)*	(0.89)	(2.28)*	(0.07)	(3.86)*	(2.61)*	(0.93)	(2.58)*	7,36
LOPROP	−0.56	0.06	0.79	0.07	0.18	0.10	0.09	2.47	32.93
	(2.84)*	(0.66)	(5.33)*	(1.40)	(2.20)*	(1.80)	(2.66)*	(3.33)*	7,36
					CENTRAL STIMULANT USERS				
LOPERP	−0.91	0.08	0.43	−0.05	0.23	0.11	0.11	−2.91	22.55
	(5.46)*	(1.03)	(2.74)*	(0.84)	(3.81)*	(2.41)*	(1.94)	(2.57)*	7,36
LOPROP	−0.76	0.05	0.88	−0.01	0.21	0.09	0.18	2.63	33.57
	(3.50)*	(0.52)	(7.20)*	(0.25)	(2.54)*	(1.70)	(2.98)*	(3.68)*	7,36

* Significant at the .01 level or greater (1-tailed test).
Student's t-statistics are in parentheses (absolute value).

A number of effects can be noted from this table. One is that the coefficients on all variables differ very little between the estimates based on six years of data (Table 2) and that based on only two years. Overall significance based on the F-statistics is actually greater and the significance for individual variables very similar despite the degrees of freedom falling to approximately one-third of what they were for the longer period estimates. Consider too, that this is in spite of adding another explanatory variable which might be expected to weaken results on some of the others. The only case where the latter turned out to be true is observed to be for alcohol. A possible explanation for this is the fact that substance abusers frequently are known to use alcohol in combination with other substances, in which case the drug and alcohol variables would, in part, be measuring the same phenomenon.

Perhaps the most striking result is that the presence of drug users, for the most part, appears to have an insignificant effect on personal crimes but a highly significant impact on property crime, even when all the other causal factors are taken into account. The one exception to the lack of support between drug user presence and personal crimes is associated with central stimulants. This does tend to support the allegation that central stimulants use leads to more violent behavior in contrast to a lack of such a finding for the other classes of drug users. The hypothesis that a partial motivation for property crime is to obtain costly drugs is supported by the greater degree of significance for presence of opiate and central stimulant users than for cannabis users (which range from 26 % to 43 % greater for opiate and central stimulants users, respectively), as well as the differential in significance between drug user presence with respect to property versus personal crimes.

Summary, Conclusions and Comments

How does one summarize these findings? Any conclusion must be drawn with care, since results are inferential, from aggregate data, and one would want assurance that they are consistent with observed individual behavior.[8] Having said that, one can conclude that there appears to be more than simply a revelation of substance abuse being common among offenders in general, since the results show a definite twist in favor of a stronger association between economically motivated crimes and substance abuse, suggesting that there may be a causal link between substance abuse and property crime to pay for the cost of drugs and alcohol.

Insights about the physiological and pathological effects of alternative forms of substance abuse are supported as well. Alcohol, cannabis and opiates, all of which can be found to have depressant effects, seem to be less strongly related to both general classes of crime in the aggregate than are central stimulants. Certainly the hypothesis that there is a causal link between central stimulant use and crime in general, including violent crime, is supported by these results.

There is a potential danger in using these results as a basis for imposing more severe enforcement policies against drug and alcohol abuse. The fact of damage to the individual and the inferred link to other crime certainly suggests that reduced drug use would produce social improvements. The catch is likely to be that the costs of such policies tend to outweight the benefits. One need only examine the

[8]The data on criminal behavior of abusers in Bejerot (1975) does not distinguish among classes of drug abusers.

U.S. experience in continually mounting enforcement costs with little evidence of reductions in the magnitude of substance abuse. Decriminalization and attempts at treatment, while not eliminating the problem, may be socially superior, in part, because, they tend to reduce the incentive for a black market in abused substances. The history of England's experience since 1967 with its Dangerous Drug Act bears serious consideration. The one catch to all of this is that central stimulants may pose a problem in their own right that requires a more strenuous effort toward elimination of use rather than containment. For such abuse there may be no viable and appealing alternative to law enforcement measures.

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Moral Compliance, Private Self Interest and Exposure to the Law: the Response of Swedish Drivers to Drunken Driving Controls

Perry Shapiro & Harold L. Votey, Jr

Acknowledgements

This research has been made possible by support from the Swedish National Council for Crime Prevention, the (U.S.) National Institute of Justice and the (U.S.) National Science Foundation's Law and Social Science Program. In addition, a large number of individuals and organizations have helped in the acquisition of Swedish data. Of particular help in that connection have been Göran Hedström, Torbjörn Israelson, Eckart Kühlhorn, Ernst Nilsson, Peter Simon and Henrik Tham.

Introduction

The focus of this work is on deterrence. Crime control by the public, if it is to work, depends critically on the effect of laws and their enforcement in reducing tendencies for illegal behavior in response to the threat of punishment and the incapacitating effects of punishment itself. Past efforts to establish the effectiveness of deterrence measures have all been subject to extensive criticism.[1] Thus, the extent of deterrence effectiveness has remained in doubt. This work represents a radically different theoretical and methodological approach to the evaluation of deterrence effects. It should be of interest to the people of Sweden because Sweden has perhaps greater than average concern with such matters. It should be doubly of interest there because the data for empirical testing represent observation of a four year period for the entire country of Sweden.

The primary aim of this research has been to determine the effects to alternative sanctions on the decision to drink while intoxicated. To do so, ideally, we would wish to select people randomly out of the

[1] Perhaps the best known critique of deterrence studies in general has been that of Blumstein, Cohen & Nagin (1978), commissioned by the (U.S.) National Academy of Sciences which dealt almost exclusively with the studies generated primarily in the U.S. based on a reinvestigation of the classical criminological theory or utilitarian approach. Typical of the criticism of deterrence research on drunken driving is Ross (1981).

population and apply various sanctions, or treatments, to them, examining the effects on driving while intoxicated. Unfortunately, the problem that plagues every investigation of crime affects this study as well. Not only are we unable to make random assignments to individuals, there is not even an expedient way to study the phenomenon in the aggregate. With certain criminal activity we can have a good idea of the level of crime in the aggregate because the crimes have identifiable victims and they are reported to the authorities. Drunken driving, unless there is an accident or an arrest, is not detected and so we cannot even have clear measures of the aggregate level of this activity.

We do have an excellent data set from which to study the problem. Our data are the complete file of drunken driving arrests and convictions in Sweden 1976 through 1979. These files, while they do not reveal names or otherwise identify arrestees, do provide important information. For instance, the records tell the age, sex, and previous arrest and conviction record of the subject. They also tell the sanction for the recorded conviction as well as the sanctions on previous convictions since 1970. We use these data to estimate the effects of various sanctions on the probability that a person will drive while intoxicated.

In order to evaluate the effects of social policy on this antisocial behavior, we first need a model of individual behavior. For this purpose we use the model of the rational actor. In that context, people are viewed as making choices in their own best interest.[2] They view the alternatives and choose the one that maximizes their level of satisfaction. In the case of drunken driving, the alternatives are to behave legally, not driving while intoxicated, or to behave illegally, driving while intoxicated and risking the chance of suffering legal consequences.

It is important to understand what assumptions need to be made to invoke the behavioral model we use. It is not necessary to assume that the decision to drive while intoxicated is made with the same degree of rationality as is the decision of a banker to make a loan. We do take the position that it is credible that rationality may prevail during much of the sequence of events that lead to the drunken driving opportunity. For instance, if two people are going to a party where alcohol is being served, a rational decision would be for one to abstain from drinking.[3] If this decision is influenced by the potential sanctions and the perceived probability of arrest, then it fits our model of rationality. For this model to yield socially useful results, it is not

[2]Thus, our theory is seen to be rooted in the Utilitarian perspective going back to Jeremy Bentham (1948) and others whose writings have been the antecedents for both classical criminological theory and modern decision theory that forms the basis for much economic analysis.

necessary to assume that all drivers act with even this degree of rationality. For the result to be useful, it is only necessary that enough individuals do so that the effect can be detected with statistical analysis and that the discovered effects potentially lead to social benefits in terms of reduction of loss of life, personal injury, and property damage to offset the cost of policy implementation.

Individual decisionmaking is a personalized process and outcomes are known to depend on individual characteristics. We know, for instance, that patterns of accidents and violation of drinking and driving laws vary by age and sex. It is believed that individuals with prior convictions are more likely to be arrested and convicted of drunken driving than individuals without prior arrest records. It is known that a large fraction of both accident and convicted drivers are people with alcohol problems. One would thus infer that individuals arrested with prior convictions are more likely to be heavily involved with alcohol.

There are a number of extant studies on sanctions and drunken driving. There are even ones that show that control efforts have had a favorable impact.[4] But these studies provide few insights as to the effects of increasing the severity of sanctions as contrasted with their certainty. Because they are unable to reveal much about behavior, there are many important questions left unanswered. For instance, do anticipated sanctions have a greater impact on persons who have experienced arrest and sanctions than on those who have not? Are fines a viable alternative to jail? Can we believe driver's license withdrawal will deter further violations in the face of our knowing that a substantial proportion of violators continue to drive even though their licenses have been revoked?

The theory of deterrence depends upon perceptions of risk of arrest and sanctioning. Compliance with the law also depends upon "moral attachment" the notion that individuals with a strong commitment to social order will be less liable to violate the law, deterrence effects aside.[5] The past record of law violations for other offenses would be a measure of an individual's law abidingness. It has been suggested that the propensity to obey the law is related to age. Individual data, such as the Swedish data we use, is required to evaluate such possible linkages.

It is possible to sort out effects related to prior violations as distinct from age effects, enforcement intensity and sanctions strength. To

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[3] As logical as this behavior may seem, it is probably considerably more prevalent behavior in Scandinavia than elsewhere that people are tempted to drink and drive.

[4] Examples are Phillips et al. (1984), Votey (1982), and Votey & Shapiro (1983).

[5] A recent volume that makes a strong case for this position is Norström (1981).

separate these effects, even with detailed data, requires a carefully worked out evaluation strategy and careful hypothesis testing. For that, a behavioral model is required that permits a test of the deterrence hypothesis within a framework accounting for the multidimensionality of individual differences. Our research starts with a model of rational individual behavior. That model is then applied to the Swedish data with surprising conclusions about the effects of sanctions on people's behavior.[6]

Choice and the Decision to Drive While Intoxicated

For the purpose of this study people are viewed as having four choices, three of them legal and the forth illegal. The legal choices are

1. to refrain from both drinking and driving
2. to drive but refrain from drinking
3. to drink but refrain from driving

A person taking any one of these alternatives would be under no risk of arrest and would not appear in our sample of arrested drivers. The final alternative is illegal, namely

4. to both drink and drive

It is the person choosing this option who is likely to appear in our statistics, since choosing the illegal alternative means that a person runs the risk of arrest and sanctions. In the process of making the final decision to act illegally, the benefits of the illegal act will be weighed against the potential costs of being caught.

There is, however, a great deal of uncertainty about the outcome of the illegal act. If a person drives while intoxicated there is a chance that he will be arrested, along with the possibility that no arrest will result. In the narrative to follow, we label the individually perceived chance of arrest – the subjective probability – P*. That probability is a function of an individual's own perceptions and it must be contrasted with the underlying real probability of arrest. The real probability, P, depends on a number of environmental factors, for instance, the number of police patrolling the highways, the time of day, the number of drivers on the roads. Most of these factors are external to the individual decision maker, i.e., the real chance of arrest may depend to some extent on individual behavior while intoxicated, but it also depends to a large extent on the intensity of police effort. In the study we report, we have treated these individual differences as purely random effects.

[6]A more technical version of the model is presented in Shapiro & Votey (1984). That paper forms the basis for the statistical analysis presented here.

In this model of behavior, individuals make comparisons between the certain outcome of legal behavior and the uncertain outcome of driving while intoxicated. There is a benefit to the individual for acting legally, which we assume is known to him. In what follows, we label this benefit BL. There is a chance of arrest which bears a cost we label CA, the perceived cost of being arrested. There is also a chance that no arrest will result; in this case we label the perceived benefit BN. The expected net benefit from the illegal act is just the difference between the chance (probability) of not being arrested times the benefit of not being arrested and the chance (probability) of being arrested times associated arrest costs. In definitional terms, expected net benefits are a weighted sum in which the weights are the subjective probability of arrest, P*, and the subjective probability of not being arrested, $1-P^*$. Thus, in symbols, the expected net benefit from acting illegally is

$$(1-P^*)\ BN-P^*CA.$$

What this means is that the expected benefit of acting illegally depends upon what people believe are the costs of an arrest (e.g., the pain they associate with fines, jail, loss of license, stigma, etc.) and on their perceptions of the probability they will be arrested. This is the classical model of deterrence, simply stated.

In the spirit of this model of behavior, the choice to act illegally is taken if its expected benefit is greater than the benefit of making the legal choice. In symbols, a person chooses to drink and drive if

$$(1-P^*)\ BN-P^*CA>BL.$$

Manipulation of the inequality implies that a person will drink and drive if and only if the individually perceived chance of being caught is sufficiently small relative to the individually perceived benefits. In other words, if and only if

$$P^*<(BN-BL)/(BN+CA).$$

The criterion can be better understood with the use of two variables defined as follows:

$$MCI = BL/BN$$

and

$$PSI = CA/BN,$$

where MCI is a measure of **moral compliance**. It is the ratio of the benefit of taking the legal choice to the benefit of succesfully acting illegally. The perfectly moral man would always pick the legal choice

no matter what the benefits of illegal behavior because, for him, the value of BL is always sufficiently greater than that of BN. More generally, people with large values of MCI are likely to be law abiding since they share society's values. Others who may have no compulsion to be law abiding may be so nonetheless because they place a high value on the benefits of being favorably regarded by those who do. The latter would be the "rotten kids" in Becker's "Theory of Social Interactions."[7] Note that for our purposes it does not matter why individuals act as if they place a high values on moral behavior; it only matters that they do. PSI is a measure of **private self interest**. It is the ratio of the personal cost associated with arrest to the benefit of making the illegal choice and not being arrested. People with large values of PSI are likely to be law abiding since they find the potential costs of arrest high relative to the perceived benefits of a successful illegal act. In terms of these values the choice criterion becomes

$$P^* < (1-MCI)/(1+PSI).$$

The implications of this choice rule are very sensible. It implies that the more morally motivated is a person, the higher is MCI, hence the lower must be the perceived arrest probability for the person to be tempted to drive while intoxicated. Furthermore, the higher a person perceives the cost of arrest to be, hence the higher is his PSI, the lower the subjective probability of arrest will have to be for him to take the illegal action.

The development of this inequality condition helps to point up the complexity of the individual's decision process. On the left hand side we have P^*, the individual's **perception** of the probability of being arrested if he acts illegally. On the rights hand side, the factors are included that reflect how he behaves **in response** to the perceived probability. To be able to work out from the data the logic of the revealed outcomes requires a careful modeling of both the process of perception and the logic of the response. We begin with the response side.

The Right Hand Side

The right hand side of the inequality depending on the values of MCI and PSI, in turn, depends upon the values of BL, BN and CA. It is these relationships that suggest the statistical test of this model. The

[7]Gary Becker (1976) in his theory of social interaction, discusses at length the possibility that an individual may behave in a socially desirable way, not because he is motivated by moral compliance, but rather out of need for approval of elders or peers, which need may be motivated by expected financial reward.

benefits from being law abiding and successfully breaking the law, BL and BN, might very well be related to observable personal characteristics. In particular a person's criminal and drunken driving record gives us a clue as to his degree of moral compliance. A person with a record of drunken driving arrests might have either a very low regard for the law and thus a small BL, or he might have an alcohol addiction and thus a high BN. In either case one would expect his value of MCI to be very low. A person's age might have some bearing on his MCI. Younger drivers are apt to be more reckless and perhaps worry less about the potential dangers of driving while intoxicated. Or they may not have reached a degree of maturity or social responsibility that would yield a high BL. Their BN values could be higher than older, more cautious people. Either could lead to a low index of moral compliance. With the middle aged population, it is well known that alcoholism is more prevalent than with other ages, which would cause that group to have larger values of BN and make them appear less morally motivated. From these effects, we should expect the young **and** middle aged to drive while intoxicated for larger values of P^* than would older drivers. Individuals with histories of drunken driving arrests will likely have achieved their status because of relatively low values of MCI and could thus be expected to have driven while intoxicated at higher levels of P^* than would be the case for individuals with no record of prior offenses.

The denominator of the choice inequality depends upon private calculations of PSI which in turn depend upon the values of CA and BN. We have already discussed how observable personal characteristics might affect the value of BN. These same characteristics might also affect CA as well. For instance a person's earning power tends to increase with age through the middle years, therefore a middle aged person is likely to have a larger value of CA than is a younger person. However, recall that he is also likely to have a larger value of BN, therefore the net affect on the ratio PSI is ambiguous. Similarly, consider the affect on PSI of previous arrests for drunken driving. As noted, a past record may be an indication of an alcohol problem and a consequent high BN. But a previous arrest also is an indication that person fully understands how unpleasant an arrest can be: it will result in time spent in legal proceedings, fine and jail. A person who has not experienced this process might not appreciate how unpleasant it can be while someone who has been arrested will know fully well how bad the experience is. Both the CA and the BN effects leave the effect of a previous drunken driving arrest ambiguous. If the cost effects outweigh the BN effects, a previous arrest will cause people to require higher probabilities of success to act illegally. However, if the BN outweights the CA effect, the threshold probability will be higher.

Finally, the value of PSI should be affected by the actual level of costs. For instance we know that the penalties for drunken driving

increase with the number of drunken driving arrest so a person with a record of drunken driving will necessarily have a higher cost and that should cause him to be more cautious. Furthermore, if the arrest costs are increased for everyone, as they would be if the level of fines, the length of time licenses are suspended or the length of jail terms are increased, then individual CA's should increase. This will lead to increased values of PSI and cause people to be more cautious, i.e., to require lower values of P* before choosing to drive while intoxicated.

This discussion indicates that is it difficult to separate the cost effects from the benefit effects. Unless we can experimentally determine a person's BN and CA functions, it is impossible to tell whether a personal characteristic has a greater affect on perceived benefits or perceived costs. Unfortunately, the data we use are not sufficiently detailed to allow us to separate the two effects. Therefore, we will consider the right hand side of the inequality as a single index reflecting the degree of legal compliance. It incorporates a persons moral feeling about obeying the law relative to his feeling about the cost of unsuccessfully breaking the law.

The Left Hand Side

There is another part of the story that is as important as moral compliance, namely, what a person thinks is the chance of being unsuccessful, i.e., getting arrested. One would think an arrest record would indicate that the person feels that the chance of arrest is remote. The previously arrested group might have naturally been selected because the members of the group systematically underestimate the probability of arrest. However, if one thinks about how personal assessments of probabilities might be formed, it is less clear that the previously arrested would assign lower probabilities to arrest. If a person drives while intoxicated and is not arrested, it is certainly reasonable that he lower his assessment of the arrest chances. Conversely, if a person is arrested, then it is reasonable that he increase his estimates of the chance of arrest. Therefore, the effect of a previous arrest is ambiguous.

Model of Decision and Arrest

We have argued that the model of behavioral choice depends upon personal beliefs about the chance of arrest and about what we label public and private concerns. To a large extent the variables we choose to represent the ratio of private to public concerns are arbitrary and some of the same variables that affect this ratio will also affect the perceived probability of arrest. At this stage of the research program we can only propose a set of variables that explain both sides of the decision inequality.

The right side of the inequality, namely the ratio of public to private concerns might well be a function of the age of the individual. As for the numerator of that ratio, which is 1-MCI, we might reasonably expect it to decline with the age of the individual. Younger people have less experience with the importance of their public responsibility and might be expected to act more selfishly than their adult counterparts. If this is were the only consideration, then we would expect the value of MCI to increase with age. However, one must remember that MCI is the ratio of BL, the benefit of acting legally, to BN, the benefit of acting illegally and not being arrested. This ratio will surely be affected by a person's need for alcohol. One could reasonably expect that this affinity would increase with age and, if so, the value of BN would grow as well. This would lead the MCI variable to decline with age. The presence of these two countervailing tendencies indicates that we cannot predict the effect of age on MCI, nonetheless it is clear that such a variable ought to be included in any model that attempts to explain the decision to act illegally.

A person's past history of drunken driving should give a hint as to his sense of moral responsibility. If a man has a long history of drunken driving arrests, it is very likely that he is either very antisocial, thus has a low value of MCI, or he has a serious alcohol problem, and has a low value of PSI. In either case, a record of drunken driving arrests should be an indication that the right hand side of the decision inequality is low. This means that a person with a drunken driving history will be more likely to decide to act illegally even if he believes the chance of arrest, P*, is high.

Environmental factors, especially those that affect the cost of arrest, should affect the right side of the decision inequality. As the community increases the severity of its sanctions, people are likely to increase the value they assign to the cost of being arrested, CA. Therefore, if a community systematically increases its imposition of jail time, fines or time that licenses are withdrawn in the event of a drunken driving conviction, it is rational for people to become more cautious about acting illegally. In terms of the decision calculus given here, for them to continue to drive while intoxicated, people will need to believe the chance of arrest is smaller as the severity of penalties increases.

The left side of the decision function, the subjective probability of arrest, can be affected by some of the same factors that determine MCI and PSI. A person's arrest record will affect his perception of the chance of arrest. As explained before, an arrest might reasonably lead people to increase their subjective judgment about the chance of arrest. This subjective judgement should, in some way, be affected by the actual chance of arrest, which is a function of the effort put in by society to apprehend intoxicated drivers. It is reasonable to believe that, as the police effort in arresting drunken driving increases,

people's subjective probability of arrest increases as well. In the analysis that follows, we use a measure of police manpower devoted to drunken driving as the measure of societal effort.

We now have a model for testing hypotheses about the decision to drive while intoxicated. This model would be fine for statistical analysis if we had a random sample of the population and we were confident that those sampled would truthfully report whether they had driven under the influence. We do not have a random sample of the population. Instead, we have a universal sample of every person arrested. It is necessary, in order to complete our investigation of the decision process, to describe how a decision to act illegally gets translated into an arrest.

Two things must happen before a person is recorded as a drunken driving arrest statistic. First, he must drive while intoxicated and second, he must be arrested while he is doing so. In symbols, if the probability of deciding to act illegally is P(DD) and the probability of an arrest if a person drives while intoxicated is P(AR/DD) then the probability of an arrest is

$$P(AR) = P(DD)\ P(AR/DD).$$

In the modelling that follows, for mathematical convenience we will be using the logarithmic transformation of all variables and equations and for that reason it will be useful to adopt the convention that lower case letters in equations represent the logarithm of the corresponding upper case variables. With this convention the probability expression becomes

$$p(AR) = p(DD)+p(AR/DD).$$

It is convenient to work in logarithms because the direction of all the inequalities remain the same and the equations are translated into linear relationships.

The arrest process is very simply modeled as being directly related to the intensity of police effort. The real probability of arrest cannot be measured directly, but we expect it to be directly related to the law enforcement resources devoted to traffic control. Because of data limitations, we represent intercommunity differences in law enforcement resources by the hours of police manpower deployed for patrol, as a fraction of total population. Our model of law enforcement effectiveness in determining the arrest probability can be summarized as

$$p(AR/DD) = a0+a1\ police+u1,$$

where police is the logarithm of the manpower variable and u1 is a random error distributed independently of police.

The next step is to describe the probability of driving while intoxicated. An examination of the decision function indicates that this probability is the probability that a persons subjective chance of arrest is no greater than the ratio (1-MCI)/(1+PSI). If this ratio is labeled

$$R(MCI/PSI),$$

it can be shown that the probability that a person drives while intoxicated is

$$p(DD) = r(MCI/PSI)-p^*,$$

(remembering that P^* is the subjective probability of arrest and lower case letters are used to indicate logarithms).

From our previous discussion, there is reason to believe that r(MCI/PSI) depends both on private characteristics and environmental ones. Among the things we can know about every person in our sample are his age and his drunken driving arrest history. Both of these are reasonable indicators of public versus private concerns. Among the environmental characteristics are those that affect the real costs of arrest – the denominator of the decision ratio r(MCI/PSI). These environmental characteristics are the average jail sentence in recent and previous periods, the level of monetary fines and the average length of license withdrawals. We also allow for there to be environmental differences that cannot be directly measured but that are accounted for by the location of the arrest. For this reason we include dummy variables indicating the city or region in which the arrest was made.

In explaining r(MCI/PSI) we use the following linear specification

$$\begin{aligned} r(MCI/PSI) = {} & b0 + b1\,AG2 + b2\,AG3 + b3\,O + b4\,M + \\ & b5\,lw0 + b6\,lw1 + b7\,lw2 + b8\,fn0 + b9\,fn1 \\ & + b10\,fn2 + b11\,jl0 + b12\,jl1 + b13\,jl2 + \\ & b\,STOCK + b\,MAL + b\,GOTE + u2. \end{aligned}$$

The variables AG2 and AG3 are dummy variables taking on the value of 1 when the age of the arrestee is between 26 and 55 and 56 or over, respectively, and 0 otherwise. Similarly, O and M are dummy variables indicating (O)ne or (M)ore previous arrests for drunken driving while STOCK, MAL, and GOTE are dummy variables for the city of the arrest. Notice that all the dummy variables are indicated by upper case letters because they are not expressed in logarithms. The remaining variables for which the logarithms are taken are continuous for the average length of license suspension, zero in the current month, 1, in the month before the arrest, and 2, in the month before that. Similarly, fn and jl indicate the average monetary fine and length of jail sentence during the month of the arrest, the previous month, and the month before that. The lagged

variables for the severity of penalties were included on the belief that it may take people some time to become aware of change in the level of penalties and therefore there would be a lag in the time it takes them to modify their behavior after a change in sentencing severity.

There is, finally, the question of the subjective judgment of the arrest probability. As our previous discussion indicates we want to choose a functional specification that allows for the possibility that people learn, or at least change their judgments, about the chance of arrest on the basis of their experience. It is a reasonable conjecture that an arrest experience will cause people to increase their subjective belief about the chance of arrest. Furthermore, peoples' beliefs should conform to some degree to reality so that subjective probabilities should positively related to the real chance of arrest. A specification that captures all these possibilities is as follows:

$$p^* = C0 + c1\,0 + c2\,M + c3\,\text{police} + c4\,O^*\text{police} + c5\,M^*\text{police} + u3.$$

On **a priori** grounds, a positive value of c3 is expected, since it would indicate that the more numerous the resources devoted to traffic control and drunken driving detection, the greater people believe the chance of arrest to be. We have no **a priori** notion about the sign of the other coefficients in this equation. The coefficients on O and M indicate how people with arrest records evaluate the chance of arrest relative to the population without arrest experience. Positive values would indicate that the previously arrested assign larger values to the chance of arrest than do those with no arrest. The coefficients on O*police and M*police suggest how changes in actual arrest probabilities (changes in police intensity) are evaluated by individuals. These coefficients, since they are associated with the logarithm of the respective variables, represent the effect of a one percent change in the level of police activity on the percentage change in the subjective probability of arrest. For example, a value of c3 and/or c4 greater than one indicates that a one percent change in police activity will change the subjective probability of arrest by more than one percent, independently of interaction effects depending on the individual's prior record. Conversely, values smaller than one indicates that a one percent change in police activity will lead to less than a one percent change in subjective probabilities.

With the specification of these equations, it is now possible to write the equation that describes what we observe, namely, the probability of an arrest for drunken driving. This equation is

$$p(AR) = (a0 + b0 + c0) + b1\,AG2 + b2\,AG3 + (b3 - c1)\,O + (b4 - c2)\,M + (a1 - c3)\,\text{police} - c4\,O^*\text{police} - c5\,M^*\text{police} + b5\,lw0 + b6\,lw1 + b7\,lw2 + b8\,fn0 + b9\,fn1 + b10\,fn2 + b11\,jl0 + b12\,jl1 + b13\,jl2 + b14\,STOCK + b\,15\,MAL + b16\,GOTE + v,$$

where v is a random error. A regression of arrest probabilities on the set of right hand variables will give us unbiased estimates of the coefficients as written. The formulation follows directly from preceding equations. The coefficients on O and M need some further elaboration.

The coefficients on O and M (b3 – c1 and b4 – c2) represent the difference between how a person with an arrest record evaluates public responsibility and private interest, r(MCI/PSI), and how an arrest affects the personal evaluation of the chance of arrest. We might reasonably expect that there is something about a person with a drunken driving history, particularly the chance that he is an alcoholic, that would lead us to expect b3 and b4 to be positive. Such a person, if he has driven while intoxicated and put lives of others in danger, had demonstrated little regard for the public welfare. Furthermore, if the person is an alcoholic, he has shown little regard for his own welfare. We do not have a strong feeling about the signs of c1 and c2. In fact there are two distinct, and plausible, possibilities. The first is that a person with an arrest record strongly underestimates the chance of arrest and that is why he has an arrest record. He has driven while intoxicated at times when others would not because of fear of arrest. The second is that what people feel to be the chance of arrest is based on their experience. If a person has driven while intoxicated and escaped detection, he might have felt that the chance of arrest was quite small. However, if a person is arrested for drunken driving, he is likely to revise upward his estimate of the probability of arrest. If the first possibility dominates, then c1 and c2 would be negative indicating that a person with an arrest record assigns a smaller chance to being arrested than does a person without a record. If the second possibility dominates and there is a learning effect, then c1 and c2 would be positive. These observations provide us the possibility of a test for the presence of a learning effect. Since we can be reasonably certain that b3 and b4 are positive, if the coefficients of O and M are negative this could only happen if c1 and c2 are positive. Therefore negative coefficients on these variables provide strong indication of a learning effect.

Empirical Application and Results

The model as specified explains the probability of a person being arrested for drunken driving given his age, history of arrests and environmental characteristics. The natural choice for a dependent variable is the proportion of people of a given age and arrest history that were arrested for drunken driving in a given times period. The only way we could know this would be to know the number of people in the population of a given age and arrest record and from this information to calculate the proportion of those arrested. From our

data we do know how many people were arrested by age and arrest history, but we do not know the extent of these characteristic in the population. It was therefore necessary to estimate the population totals. The details of this estimation are given in Shapiro & Votey (1984). The estimation technique involved uses published data on the age distribution of the population, and our data on arrests, to calculate the number of people in particular age group who had been arrested previously.

The data indicated that less than 5 % of the those arrested for drunken driving were females. Given this fact, it is clear that if gender were included as an explanatory variable in the regression, it would be statistically significant. We felt, however, that it would tell us very little about the drunken driving decision. Females might be such a small part of the sample because they are more rational then men, because they drink less, because if two people in a car are intoxicated, the driver is likely to be male or because the police systematically choose to believe that a female driver cannot be intoxicated. The inclusion of gender in the regression would not allow us to sort out these possibilities and, in fact, might cause some confusion. We decided, therefore, to study only the results for the males, and we excluded female arrestees from the sample.

The regression results were as follows:

VARIABLE	COEFFICIENT	VALUE	t STATISTIC
	a0+b0+c0	8.476	1.004
AG2	b1	1.237	4.650
AG3	b2	−4.671	17.560
O	b3−c1	−6.754	2.362
M	b4−c2	−16.436	5.749
police	a1−c3	1.662	2.246
O*police	−c4	−1.683	2.613
M*police	−c5	−3.762	5.842
lw0	b5	−0.591	1.337
lw1	b6	−0.283	0.611
lw2	b7	−0.881	2.007
fn0	b8	−0.140	0.183
fn1	b9	0.019	0.025
fn2	b10	0.085	0.117
jl0	b11	−0.457	0.964
jl1	b12	0.182	0.349
jl2	b13	−0.588	1.176
STOCK	b14	−1.371	1.959
MAL	b15	−2.628	7.008
GOTE	b16	−2.715	4.062
	R2 = 0.353		

The coefficients on the dummy variables for age indicate that the decision to drive while intoxicated is age dependent. Men in the middle age group, between the ages of 26 and 55, are more likely to drive while under the influence of alcohol than are either younger or older drivers. In fact, these results indicate that the difference are quite large. An estimate of that difference is the ratio of probability of drunken driving for the two oldest groups relative to the youngest. These ratios are

$$\text{AGE2:AGE1 } \exp(\ 1.237) = 3.32$$
$$\text{AGE3:AGE1 } \exp(-4.671) = 0.01$$

This indicates that the men in the middle age group 3 are three times as likely to drive while intoxicated as the youngest men, while the older men are only one one hundredth as likely to do so. It is clear from these results that men in the middle years present the largest social problem.

One can hardly expect to explain fully as complicated a phenomenon as this. However, in terms of our model, the coefficients b1 and b2 indicate how age is correlated with the ratio of public moral behavior to private self interest. A man in the middle years might be expected to be somewhat more public spirited than a younger man but he is also more likely to have a drinking problem. It appears that the propensity to drink and perhaps the opportunity to do so outweigh any increase in social responsibility that comes with age. Older men appear to be very unlikely to drive while intoxicated. This might indicate an increase in public responsibility, a lessening in the desire for alcohol, fewer opportunities to drink and drive or something unaccounted for in our data. For instance, the dependent variable in this study is the number of people arrested in a particular age and arrest category divided by the **estimated** number of such people in the population as a whole. Since it is likely that people with drinking problems have a higher mortality rate than do other men, the older population may simply contain a smaller fraction of alcoholics than does the younger group.

The estimated coefficients on the O, M, O*police, and M*police variables are particularly interesting. The obvious indications from the coefficients on O and M are that people with previous arrests are less likely to drive while intoxicated than are men with no arrest history. This may seem a surprise and it may indicate that the data do not capture all important aspects of the drunken driving phenomenon. We have estimated the population with a history of drunken driving arrests to form the ratio that is the dependent variable. The number of such people is a smaller part of the population and we have assumed that as high a proportion of those people are "at risk" of arrest as are those without record. But, it is possible that a significant number of these people were in jail or had their licenses suspended

during the period of the study. If that is the case then we have overestimated the number of people with arrest histories that were at risk of being arrested and, as a consequence, have underestimated the value of the dependent variable for these people. This would have led to a downward bias in the value of the relevant coefficients.

A second explanation, and one that we are currently exploring, has profund policy implications. Namely, an arrest for drunken driving significantly reduces the probability that a person will drive while intoxicated in the future. This is the issue that has to do with deterrence versus incapacitation. In terms of the decision model, an arrest has an impact on the ratio R(MCI/PSI) in that it raises the cost of an additional arrest. In Sweden the penalties for drunken driving increase with the number of arrests. This will lead to an increase in the value of the denominator and a subsequent reduction in the ratio. The implication of this reduction is that a person will reduce the value of the chance of arrest, P*, at which he will act illegally, and subsequently will drive while intoxicated less frequently than before an arrest.

The coefficients on O*police and M*police support the notion that a person with an arrest experience also increases his subjective evaluation of the chance of arrest. Clearly an increase in police activity increases the actual probability of arrest. The significantly negative coefficients -c4 and -c5 indicate that an increase in the real probability translates into a significantly larger increase in the perceived probability for a person with an arrest than for one without. This will lead a person to increase his caution about driving illegally.

Each of these explanations leads to a similar conclusion about the effectiveness of arresting drunken driving. Whether the arrested are deterred because they are incapacitated, are subject to larger costs if arrested again, or are more aware of the chance of arrest, the result is the same: they act illegally less often than they otherwise would.

Summary of Results

We believe the results presented here, and in the more technically detailed paper on which this one is based, indicate important advances on two levels. The first is in the advancement of theory and statistical methodology relating to the understanding of the determination of perceptions of arrest and sanctioning probabilities on the one hand and the individual's responses to them on the other. These advances are general in nature and can contribute to the evaluation of deterrence effects for a variety of illegal behaviors.

The second level deals with the evidence of a learning effect associated with arrest experience for drunken driving that clearly exists in the face of the well established evidence that there is a subset

of drivers who persist in illegal (drunken) driving and who contribute substantially to arrests in the aggregate. The evidence of this learning effect is consistent with other evidence that arrests and sanctions are cost effective in Sweden in reducing the costly loss of life and serious injuries associated with drunken driving.[8]

[8] Cost effectiveness is evaluated for Sweden in Shapiro & Votey (1983), using estimates of deterrence effects from a number of studies.

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Appendix

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