Report on:

"An Econometric Technique for Estimating True Offence Rates"

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1. Introduction

It is widely recognized, and well supported empirically by the results of victimization surveys e.g. Congalton and Najman(1973) that not all criminal offences actually committed are recorded in official statistics of "crimes known to the police". This "leakage" of criminal offences from the official statistics may occur for a number of reasons: some offences actually committed may not be recognized as criminal offences by those who observe them; some may not be observed by anyone (other than the offender); some may be observed but not reported to a police officer (hence not recorded, because the police force has the responsibility of collecting basic data on offences committed); and some reported to the police may not be officially recorded because the information contained in the report may be insufficient to ascertain (within reason) that an offence has been committed, or because the report refers to an offence which is too "trivial" for the police to be concerned with.

Whatever the reason why a particular offence committed goes unrecorded though, it is desirable, for a number of reasons, that information on the true offence rate be made available if possible. First, insofar as the quantity of resources devoted to crime prevention is and should be related to the extent of the crime problem - the true offence rate - imperfect data (i.e. official information on "crimes known to the police") may lead to an under-or-over allocation of resources to this purpose. Secondly, monitoring of police force performance is made difficult by the absence of full information: in an extreme case, it would be possible for an apparent increase in police effectiveness (in terms of a reduction in the recorded offence rate) to be solely due to a change in recording practices.[1] And thirdly, imperfect data increases the difficulty of research into the causes of crime, and implies that research results which are based on an investigation of official data must generally be regarded as suspect.

To say that full information is desirable though, ignores the costs and difficulty of obtaining full information. Even in other areas of social and economic activity, where data are easier to measure, official statistics are imperfect, and recognized as such by the inclusion of an error term in summary statistics.[2] In the field of criminal behaviour, the problems are more acute, and the costs of improving the accuracy of information are greater. Even if, for example, the police were required to record all relevant details of all reports received about alleged offences, and presuming that such a rule could be enforced, it would still not be known how many offences went unreported, and it would not be known how many reports related to the same offence (hence over-estimating the true number). In addition, the costs of such a rule, in terms of restricting the ability of the police to perform their primary functions, would be immense, and probably unacceptable.

For decades criminologists and other social scientists have been attempting to measure the true offence rate, mainly by the use of victimization surveys. However, besides the problems of ensuring that the people surveyed give "correct" responses to questions, such surveys are costly if the sample size is to be big enough to be useful in a statistical sense. Nevertheless, victimization surveys are, and probably will remain, the most accurate means of obtaining information on true offence rates.

The procedure explained in this report attempts to provide a complement to, rather than a replacement for, the use of victimization surveys as a means of deriving information on true offence rates. It is based on the assumption that the proportion of offences committed which are finally recorded is not a random variable, nor generally some constant, but is rather a variable whose value can be, to a large extent, explained by changes in other variables. This assumption in turn rests upon the belief that the processes by which offences committed come to be officially recorded are generally the outcome of rational decisions taken by those involved. (A more detailed discussion of these matters is contained in section 2.)

Formally, the theoretical background suggests that it is possible to formulate a model of the recording process, and then estimate the parameters of the model using empirical data, so that the effects of a change in (say) the value of variable x on the "recording ratio" for crime type y, can be ascertained. If this were possible, and if the estimated parameters were shown to be stable over time, then the problem of unrecorded crime could be largely overcome. For any year, we would simply need to know the values of the variables which determine the recording ratio for a given offence, and the number of offences recorded, then apply the estimated parameters to these statistics in order to infer the true number of offences.

The Catch 22 in all this is that it is generally necessary to have data on all relevant variables - including, most importantly, true offence rates - in order to be able to estimate the desired parameters. But, of course, if data on true rates were available, then there would be little point in the estimation procedure.[3] However, depending on the exact specification of the model which we would wish to estimate, it may be possible to infer some information - even a good deal of information - about the determinants of the recording ratio by estimating a "semi-reduced-form" model which does not require (unavailable) data on the true offence rate. If this proves possible, there is, unfortunately, no obvious means of testing the validity of the estimates with any degree of confidence, though the results of victimization surveys may be capable of providing some information in this regard. However, if the estimates appear to be "reasonable", they may be accepted, *pro tem*, as the best available information in a very imperfect world. Moreover, a comparison of the results of victimization surveys with the empirical estimates derived from this model can allow for some cross-checking: major differences between the results of these two methods can suggest reformulations of both, as a means of attempting to resolve ambiguities.

When this research was begun, there was perhaps, too great a degree of confidence in its potential. Major problems arose both with the nature of available data and its interpretation, and more importantly with the specification of the model. It is unclear at present which set of problems are the more significant. If, for example, data were of better quality - more uniform, more disaggregated - there would be more degrees of freedom available for model specification, and perhaps this could lead to more reasonable estimates. On the other hand, it may be that even with the best possible data, no reasonable estimates will be obtainable, because the procedure itself is flawed. Judgement on this question must be suspended though the conclusion of this paper is pessimistic. Perhaps acceptable model specifications, different from those utilized here, will be capable of performing better. Perhaps better data will facilitate more useful specifications. Some suggestions for further development are contained in section 5, but in this writer's view, optimism is not justified. The paper is organized as follows: Section two examines the theoretical background to the procedure. Section three considers some of the estimation possibilities of the model. In section four, data are discussed and specific models outlined. Section five presents some results, while in section six some conclusions are discussed.

2. Theoretical Background

The principle of the method of estimating true offence rates, which is discussed in section three, follows the normal Economic approach of being based on an underlying theoretical model of behaviour of the principal "agents" involved in the system. The particular Economic focus of the model - what differentiates this approach from other (e.g. sociological) approaches - is the basic assumption that all relevant agents in the system react prodictably to changes in incentives. In loose terms, if the costs of taking a particular action increase, an agent will be less likely to take that action.

To implement an "Economic" approach to the analysis of crime and the crime recording process, some content needs to be given to the notion of costs and benefits facing the various agents in relation to the relevant decisions. Considerable guidance in this matter is given by various areas of Economic Analysis, including the area described as "the Economics of Crime". The theoretical model outlined here follows standard conventions in specifying the relevant costs and benefits of agents.

Empirical implementation of the specific model of the crime recording process requires simultaneous specification of models describing (some of) the causes of crime, (equivalently, a "supply of offences" function), the control of crime (a "police production function") and a model of the recording process itself (a "recorded crime function"). The reasons for this will be discussed in section three. In this section, an outline is given of these basic theoretical models, followed by a brief evaluation of them.

2.1 The Supply of Offences

The "economic" approach to the analysis of criminal behaviour began with G. Becker's (1968) largely theoretical work, "Crime and Punishment: an Economic Approach".[4] It was subsequently refined by I. Ehrlich (1973), and has since led to a large number of empirical studies of criminal activity.[5]

The economic approach to the analysis of criminal behaviour begins with the assumption that offenders react to changes in incentives in the same sort of way that consumers or workers react to changes in the incentives facing them. That is, if the expected costs of any action increase, or the expected benefits decrease, the individual concerned is less likely to take the relevant action. On an aggregate level, the number of the relevant class of actions (e.g. criminal offences, purchases of particular commodities) will decrease if the expected costs of the action (to the individual) increase.

The basic assumption - which does not require us to view individual agents as clones of "economic man" - lies at the heart of "the economic method." The assumption is generally not justified in terms of "realism". Rather, it is justified because by using the assumption, interesting insights into behaviour and impirically testable predictions can be derived.[6]

In applying the economic approach to criminal behaviour, it is first necessary to specify the relevant components of expected costs and benefits. Using insights derived from the economic analysis of behaviour in the face of risk, it is assumed that the likelihood of apprehension and conviction, and the size of "punishment" received (if convicted) are the major components of the expected cost of committing an offence. Thus, if the probability of conviction or severity of punishment increases, the incentive to commit a given offence will be lower.

On the benefits side, it is easiest to conceive of measuring benefits in relation to property offences: the expected benefits of theft can be approximated by the expected value of property stolen. For other offences (against the person, for example) "benefits" are more amorphous, and can generally be summarized as "psychic". To find an empirical correlate for such benefits may be difficult in the case of many types of crime. For example, while some measure of the wealth of a community may be correlated with expected benefits of theft, it is difficult to think of an empirical correlate of the expected benefits of murder. However, this is largely an empirical problem for which reasonable answers can often be suggested.

Besides the conviction elements of expected cost, and the benefits associated with various offences, a number of other "taste" and "opportunity" influences may be suggested (and placed in the "costs" or "benefits" side of the equation, as convenient). For example, if a person is unemployed, the value of time required to commit an offence is lower, hence we might expect a high unemployment rate to be an incentive to commit offences. Similarly, if, other things equal, young males have a greater "taste" for mischief (including criminal mischief) than others in the population, we might expect the number of young males in the population to be an influence on the rate of crime.

In its most general form, the theory can be summarized in a "supply-of-offences" function of the form:

$$C_i = f_i \; (\overset{(-)}{P_i}, \overset{(-)}{S_i}; X_i) \qquad -(1)$$

where C_i is the actual number of offences type i committed (per period) S_i is a measure of the punishment received upon conviction for this offence, P_i is the probability that a person who commits an offence of this type will be convicted,[7] and X_i is a vector of other ("taste" and socioeconomic) variables which might be expected to influence C_i.[8] The parenthesized sign above variables indicate the predicted effects of these variables on the offence rate. The theory does not give any particular insight into the form of this function, whether it be linear or logarithmic, for example, and essentially the "most appropriate" form must be decided by empirical performance.

2.2 The Police Production Function

Even if accurate data on true offence rates were available, it is unlikely that a satisfactory estimate of any supply-of-offences function could be obtained by estimating equations of the form (1) in isolation, because of the problem of simultaneity. Specifically, while we might reasonably regard the sentence variable (S_i) as being determined by basic legal philosophy and notions of justice etc, and while the taste and socioeconomic variables are also determined exogenously, it is unlikley that the probability variable (P_i) is exogenous: the probability of conviction will be itself influenced by the offence rate. For example, holding police resources constant, an increase in the offence rate will spread police resources more thinly, and a lower proportion (though possibly a higher number) of offences will result in convictions.

The statistical problem implied by the simultaneity - P_i both influences and is influenced by C_i - is that any estimates of the supply function (1) derived by estimation of this function in isolation are likely to be biased.[9]

Various econometric techniques are available to cope with this problem. All require that the supply function be estimated as part of a system, rather than in isolation. That is, we need to specify a function showing how P_i is influenced by C_i, and consider this function and the supply function together as a system.

The function which shows how the offence rate influences the probability of conviction can be described as a "police production function". We visualize the police force utilizing various resources - manpower, machines, other capital equipment - to "produce" arrests and convictions.[10] We assume that, holding offences constant, an increase in resources will produce more convictions, while if resources are constant, an increase in offences is also likely to produce more convictions. Other variables, such as the density or age structure of the population, may also influence the number of convictions. These considerations together suggest a police production function of the form:

$$A_i = g_i\,(\overset{(+)}{R},\ \overset{(+)}{C_i}\ ;\ Y_i\ ) \qquad -(2)$$

where A_i is the number of convictions secured for offences type i, R is a measure of police resources, and Y_i is a vector of other influences.

To relate this production function to the probability of conviction, it can be noted that the average expectation of a conviction resulting from an offence is the ratio of convictions to offences. Thus, the link between convictions and the probability of conviction is provided by the identity:

$$P_i \equiv \frac{A_i}{C_i} \qquad -(3)$$

The system consisting of (1), (2) and (3) may be regarded as a complete description of the generation and control of offences type i.[11]

2.3 The Recorded Crime Function

The model outlined above is fairly standard in the economic literature, and indeed there have been many more-or-less successful attempts to estimate models of this kind. However, a problem of possibly major proportions arises because one of the variables in the model - the true offence rate C_i - is not observable, due to the unrecorded crime phenomena. Some - not all - economists reporting empirical results in this area have recognized the problem, but assumed it away. Generally, it is assumed that the recorded offence rate is a constant proportion of the true offence rate,[12] and when the specific forms of the supply and production functions are specified, this assumption allows estimation of the relationships.

However, the constant proportion assumption is an assumption which is, in principle, capable of being tested. Other assumptions may be used. The one considered here is that the ratio will be largely determined by the rational decisions of those who ultimately determine how many offences "reach the record books."

The agents involved in the recording process are the victims, or others who "observe" offences and decide whether or not to report them, and police officers, who decide whether or not to record an (alleged)offence which has been reported. The rationality assumption simply means that these agents will respond to incentives in deciding whether or not to report or record an offence. Victims may believe some offences are "not worth reporting", because the matter seems too trivial, or because they do not expect the police to take any action which may be to the victim's advantage. Similarly, the police may not record a reported offence if it seems "too trivial" or if the report is ambiguous as to whether or not an offence has been committed. However, the likelihood of an offence reaching the record books will increase if the expected benefits (to the victim) of a report or (to the police) of recording an offence increase (or expected costs decrease). A theoretical model of the recording process [13] suggests that the major influences on the recording and reporting decisions in aggregate are the level of resources available to the police, and the police force workload.

The simple arguments behind this are that, for victims or other observers of offences, the greater the resources available to the police, and the lower their aggregate workload, the higher the probability that a report of an offence will be acted on, and lead to some "benefits" to the reporter (whether these benefits be purely of a "psychic" kind - satisfaction at seeing an offender convicted - or more narrowly "economic" - return of stolen property, or compensation for damage, etc). For the police, charged with recording reported offences, a high level of resources and low workload decreases the cost of recording and acting upon (e.g. investigating) reports of offences in terms of other activities foregone, hence makes it more likely that reports of comparatively trivial offences will be acted upon, and that doubtful reports will be further investigated.

Other influences on the ratio of recorded to actual offences are likely to be the nature of the offence itself (some offences are more likely to be observed or reported than others) as well as various social factors. It might, for example, be the case that, other things equal, a low population density will lead to fewer observations and reports of offences, because some offences are less likely to be observed with a low population density, while low density is also likley to imply a high cost of reporting and investigating offences.

These considerations taken together imply the existence of a "recording function" for each offence type i, which has the general form:

$$C_i^* = h_i \overset{(+)\,(+)\,(-)}{(C_i, R, W, Z_i)} \qquad -(4)$$

where C_i^* is the recorded number of offences type i committed, W is the index of the police force workload, and Z_i is the vector of other influences. Further *a priori* restrictions on the form of function $h_i(\cdot)$ may be suggested,[14] but are perhaps more relevantly considered in the context of estimation procedures.

3. Estimation Possibilities

As indicated earlier, it is now standard procedure in the economic and econometric analysis of crime to characterize the "crime system" in terms of a two-equation, "supply and demand" model. If it is believed that (or asserted that) the ratio of actual to recorded offences is a constant[15] then, depending on the exact specification of variables in the model, it may be possible to identify the coefficients of both - or one - equation. To give a simple example, assume (ignoring the type of crime) the "supply" function is specified (in log-linear form, writing natural logs of variables in lower case) as:

$$c = \alpha_0 + \alpha_1 p + \alpha_2 x \qquad \text{(a)}$$

where c and p are (logs of) the crime rate and probability of conviction respectively, and x is (log of) some exogenous variable, while the "production" function is specified as

$$p = \beta_0 + \beta_1 c + \beta_2 y_1 + \beta_3 y_2 \qquad \text{(b)}$$

where y_i is (the log of) some exogenous variable i. Further assume that p is defined as:

$$p \equiv a - c \qquad \text{(c)}$$

where a is (the log of) the number of convictions. If we define c^* and p^* as (logs of) recorded crime rate and probability of conviction, then we may add the identity

$$p^* \equiv a - c^* \qquad \text{(d)}$$

Finally, assuming that the ratio of the recorded offence rate to actual offence rate (C_i^*/C_i) is constant (though subject to random variations with mean zero) we may add the identity:

$$c^* - c \equiv k \qquad \text{(e)}$$

Noting that c and p are not observable, we cannot estimate (a) and (b) (or one of them). However, from (e), $c \equiv c^* - k$; also, from (c) and (e) $p \equiv a - c^* + k$

hence (using (d)), $p = p^* + k$. Substituting these relationships into (a) and (b) and rearranging, we form the "semi-reduced-form" system:

$$c^* = [\alpha_o + k(\alpha_1+1)] + \alpha_1 p^* + \alpha_2 x \qquad (a)'$$

$$p^* = [\beta_o - k(\beta_1+1)] + \beta_1 c^* + \beta_2 y_1 + \beta_3 y_2 \qquad (b)'$$

in which all variables are observable.

Having transformed the structural equations in this way, we can proceed to apply standard econometric criteria to establish which of the coefficients we can identify.[16] This example is constructed in such a way that the rank-order condition for identification is satisfied in respect of (a)' but not (b)'. (This is a result of assuming two exogenous variables, y_1 and y_2, distinct from x, in equation (b)). In turn, this means we may identify the coefficients of (a)' - α_1 and α_2 - and the constant term $[\alpha_o + k(1+\alpha_1)]$. If we are interested in estimating the coefficients of structural equation (a), this is good news: we identify these coefficients directly by estimating (a)'. However, if we are interested in estimating the constant term (α_o) of (a), or the value of k, we shall be disappointed. The procedure used for estimating the coefficients and constant of the semi-reduced form equation (a)' does not give us estimates of α_o or k, which are both components of the one complex constant $[\alpha_o + k(1+\alpha_1)]$ we can estimate.[17]

This example is useful for indicating the procedures which can, in principle, be used to estimate "recording functions" in a roundabout fashion. It also highlights some of the potential problems.

The procedure is to substitute the recording function into the two structural equations to derive two "semi-reduced-form" equations in which all variables are observable, and then to estimate the constants and coefficients of these equations, The problems are:

(i) to choose appropriate forms for the supply, production, and recording functions, such that the two semi-reduced-form functions are linear in all variables or transformations of them and are hence potentially open to estimation using linear regression methods;

(ii) to choose appropriate forms for the three functions so that at least one of the semi-reduced-form equations satisfies the criteria for identifiability;

(iii) to choose appropriate forms for the three functions so that some or all of the parameters of the recording function can be estimated indirectly from the estimates of coefficients and constants of the semi-reduced - form model.

Problems (i) and (ii) are encountered in virtually all econometric work. Problem (i) restricts the range of functions which can be chosen for a system: if, for example, the supply function is linear in the log of variables, it would not be permissible to choose a production function which is linear in the untransformed variables. A few degrees of freedom are available in choice of functional form for one equation, given the form chosen for the other, but not many. Problem (ii) is reasonably tractable in that theory seldom gives complete guidance as to the appropriate specification of variables (especially exogenous variables) in the various functions: hence it is often possible to choose a "reasonable" list which also happens to satisfy the requirements for identification of the equation (or equations) in which the researcher is most interested.

It is problem (iii) which is novel, and which poses the most serious difficulties. These are partly illustrated by the earlier example. If we make the simplest possible assumption - that the ratio of recorded to actual offences is a constant - then it is impossible to measure this constant even if all other problems are solved: in the example, it was possible to estimate $[\alpha_o+k(1+\alpha_1)]$ but impossible to infer the value of k from this. Moreover, even if we could estimate the constant of the semi-reduced-form production function (b)' - the term $[\beta_o - k(1+\beta_1)]$ - these two estimates would not allow us to infer the value of k.[18]

Whatever the form chosen for the recording function, so long as it contains a constant (additive or multiplicative) term, it will be impossible to infer the value of this term from estimates of the semi-reduced-form system. Hence we could never infer the actual ratio of recorded to actual offences at any time.[19] The best that could be done is to infer how this ratio changes with changes in the factors which determine it. That is, the best that can be done is to infer the values of the coefficients of the recording function, but not its constant term. However, whether or not this can be done depends crucially on the functional forms selected; moreover how much credence can be placed on these inferred values is problematic.

To outline the nature of the problem, consider the previous example, but with the following recording function substituted for (e):

$$c^* - c = k + \gamma_1 z \qquad \text{(f)}$$

where z is (the log of) some exogenous variable which is assumed to affect the recording ratio. In this case, the semi-reduced-form functions become:

$$c^* = [\alpha_o + k(1+\alpha_1)] + \alpha_1 p^* + \alpha_2 x + \alpha_1(1+\gamma_1)z \qquad \text{(a)''}$$

$$p^* = [\beta_o - k(1+\beta_1)] + \beta_1 c^* + \beta_2 y_1 + \beta_3 y_2 - \gamma_1(1+\beta_1)z \qquad \text{(b)''}$$

In this case again the rank-order condition for identification of equation (a)" is satisfied. We get a direct estimate of α_1 and of $\alpha_1(1+\gamma_1)$, hence can infer the value of γ_1. But still we cannot infer the value of k.

This all assumes however, that $\bar{z}$ is distinct from the other exogenous variables in the system - x, y_1 and y_2. The theory suggests though that this will not be the case. It seems likely, for example, that measures of police force resources and workload will appear in the production function equation as well as in the recording function. That is, z will be the same variable as y_1 or y_2 (or, more precisely, the vector z will contain elements in common with the vector y). If this is the case, then the rank-order condition may cease to be satisfied; this will be the case in the above example if $z = y_1$ or $z = y_2$, and if, as assumed, the relevant variable enters both equations in log-linear form.

It is possible, within limits, to circumvent this problem by using a different specification of the recording function, so that exogenous variables z enter the semi-reduced-form system in a different (from logarithmic) form. However, obvious problems of multicollinearity can then arise, which are likely to reduce the statistical significance of any estimates.

A further example may make this point clear. Assume that the supply function contains two (logarithmically-transformed) exogenous variables x_1 and x_2,[20] hence can be written:

$$c = \alpha_o + \alpha_1 p + \alpha_2 x_1 + \alpha_3 x_2 \qquad \text{(a)}$$

Further assume that the recording function is (non-log-linear):

$$c^* - c = k + \gamma_1 Y_1 \qquad \text{(f)'}$$

such that it contains the (untransformed) variable Y_1, which also appears (in logarithmic form) in the production function. The semi-reduced-form system becomes

$$c^* = [\alpha_o + \alpha_1(1+k)] + \alpha_1 p^* + \alpha_2 x_2 + \alpha_3 x_3 + \gamma_1(1 + \alpha_1) Y_1 \qquad \text{(a)"'}$$

$$p^* = [\beta_o - k(1+\beta_1)] + \beta_1 c^* + \beta_2 y_1 + \beta_3 y_2 - \gamma_1(1+\beta_1) Y_1 \qquad \text{(b)"'}$$

The rank-order condition for identification of (a)"' is satisfied, but in the 2SLS procedure required to estimate it - which requires regression of p^* in <u>all</u> exogenous variables - the presence of both Y_1 and y_1, highly correlated, in the list of exogenous variables is likely to make the coefficients of the estimated equation (a)"' extremely sensitive to specification (i.e. they are quite likely to turn out to be statistically insignificant).

This litany of potential estimation problems has referred solely to the question of model specification. However, even if these problems are overcome and a (statistically and theoretically) reasonable estimate of the semi-reduced-form supply function is obtained, from which the values of (some of) the parameters of the recording function can be inferred, a problem of interpretation remains. Consider the previous example. Assume statistically significant estimates of the constant and coefficients of semi-reduced-form function (a)"' are derived, from which the value of the recording function coefficient γ_1, can be inferred. The question which remains is whether γ_1 is really a coefficient of the recording function, and no obvious answer is available. One possibility is that the whole of the estimated coefficient in Y_1 in (a)"' - $\gamma_1(1+\alpha_1)$ - simply measures the direct effect of Y_1 on c, with the disparity between c and c^* being constant or due to other variables. A less clear case would be where Y_1 affects both c and the recording ratio, in which case again no particular interpretation could be just on the inferred value of γ_1: it would simply be an essentially arbitrary number.

This sort of problem may arise in standard multi-equation models, but generally in these there is some way of testing for specification, so as to get a clearer interpretation of estimates. In this structural model though, there is no way of doing this, simply because of the presence of unobservable variables.

The outcome of this is that many of the normal means for assessing the interpretation of estimates in multi-equation models are not available. Indeed, the only way of assessing a particular model structure in this case seems to be by results. If one structure gives results which are more statistically significant, and more in accordance with theoretical expectations than an alternative, then that model is to be preferred. There is though, no hard and fast criterion which can be specified for this. Additionally, should some suitable and relevant information, in the form of data on actual offence rates, be available, it may be possible to carry out some objective statistical tests of the "best fit" variety.[21] Pessimistically, the results obtained suggest that it is difficult enough to get a specification which yields *a priori* "reasonable" results, and that the potential for statistical discrimination between models lies a long way in the future.

4. Model Specifications and Data

4.1 Preliminary Requirements

The models detailed in this section are each in a form which is of necessity circumscribed by the problems discussed in section three. The models are each constrained by the requirements (i) that the relevant structural eqautions should include only variables which are suggested by the theory; (ii) the functional forms selected should be such as to allow, in principle, discrimination between the coefficients of the recording and supply functions, given that (i) suggests that some common variables will appear on both the production and recording functions; and (iii) given (i) and (ii), variables and functional forms should be selected so that identification of the semi-reduced-form supply function should be possible.

Requirement (i) must be satisfied in the light of data availability which, as remarked before, is limited.[22] Requirements (ii) and (iii) are more technical but effectively limit the range of functional forms to choose from.

Following convention it was decided to settle on a log-linear form for the supply and production functions,[23] though this limited the range of possibilities for the recording function. If a log-linear form were chosen for the latter, problems of both identification and discrimination arose. However, the recording function had to be specified in such a way that the logarithm of the recording ratio (which is required for substitution into supply and production functions) was a linear combination of transformed or untransformed exogenous variables. This ruled out, for example, a linear or quadratic recording function. The final choice made was for a function of the general form

$$\frac{C^*}{C} = exp[\gamma_o + \sum_i \gamma_i z_i]$$

where the z_i in this expression refer to the (transformed or untransformed) determinants of the recording ratio.[24] Taking logarithms of both sides, this becomes

$$c^* - c = \gamma_o + \sum_i \gamma_i z_i$$

in which form it can be substituted into the log-linear supply and production functions.[25]

The z_i variables were defined as OTOT ≡ the total number of recorded offences, and POECON ≡ total police force expenditure in real terms, or as transformations of these variables. OTOT is designed as a proxy for police force workload, and POECON as a measure of resources available to the police force. An attempt to substitute numbers of policemen and "non-wage expenditure" for the single variable POECON, led to no apparent improvement in results.

In each case, the supply and production functions were specified as follows:

$$LCRIM - LPOP = \alpha_o + \alpha_1\ LPROB + \alpha_2\ LYOUTH + \alpha_3\ LEDUC + \alpha_4\ LINC \qquad -(M1)$$

$$LPROB = \beta_o + \beta_1\ LCRIM + \beta_2\ LPOEC + \beta_3\ LOTOT + \beta_4\ LMET \qquad -(M2)$$

Variables were defined as follows (the first letter L indicating that the natural logarithm is taken):

CRIM ≡ number of offences committed

POP ≡ total population (thousands)

PROB ≡ ratio of convictions to offences for given crime type

YOUTH ≡ proportion of males in the age range 18-24 in the population

EDUC ≡ proportion of the population who have completed at least level 10 of schooling

INC ≡ ratio of the proportion of total income earned by the upper quartile of income earners to that earned by the lowest quartile.

POECON ≡ real police force expenditure (1974-75 prices)

OTOT ≡ total recorded number of indictable offences

MET ≡ proportion of population living in metropolitan areas.

These variables are generally self-explanatory, except perhaps for INC, whichis designed as an index of income inequality. The specification of the equations is also self-explanatory, except that in the supply function the dependent variable is (the natural logarithm) of the offence rate per thousand of the population, implying that a one per cent increase in population is associated with a one per cent increase in the offence rate, thus keeping the rate per head constant. (Earlier runs, with POP as an independent variable, indicated a co-efficient insignficantly different from a unity, hence defining the dependent variable as the rate per head was justified in this way, as well as in terms of preserving degrees of freedom.)

Using these variables and functional forms, models were differentiated according to the way in which OTOT and POECON entered the recording function.

4.2 The Models Tested

(a) The first recording function utilized was:

$$LCRIM^* - LCRIM = \gamma_o + \frac{\gamma_1}{OTOT} + \frac{\gamma_2}{POEC} \qquad -(M.3a)$$

(the asterisk indicating recorded values) which yielded the semi-reduced-form supply function:

$$LCRIM^* - LPOP = [\alpha_o + \gamma_o(1+\alpha_1)] + \alpha_1 LPROB^* + \alpha_2\ LYOUTH + \alpha_3\ LEDUC + \alpha_4\ LINC + \gamma_1 \frac{(1+\alpha_1)}{OTOT} + \gamma_2 \frac{(1+\alpha_1)}{POECON} \qquad \text{-(M.4a)}$$

Taking account of the semi-reduced-form production function, this equation can be estimated using 2SLS, and the values of γ_1 and γ_2 (but not γ_o) inferred. *A priori* expectations are that $\gamma_1 > 0$ and $\gamma_2 < 0$.

(b) The second model introduced OTOT and POECON into the recording function in an untransformed way.

$$LCRIM^* - LCRIM = \gamma_o + \gamma_1\ OTOT + \gamma_2\ POECON \qquad \text{-(M.3b)}$$

giving the semi-reduced-form supply function identical to (M.4a), except that the last two terms are replaced by:

$$\cdots + \gamma_1\ (1+\alpha_1)\ OTOT + \gamma_2(1+\alpha_1) POECON \qquad \text{(M.4b)}$$

A priori expectations are that $\gamma_1 < 0$ and $\gamma_2 > 0$.

(c) The third model considered, simply takes the ratio (OTOT/POECON) as the independent variable in the recording function, which can be rationalized by assuming it is the workload per unit of resources which determines the recording ratio. (Also, degrees of freedom increase.) The recording function is thus specified as:

$$LCRIM^* - LCRIM = \gamma_o + \gamma_1 \frac{OTOT}{POECON} \qquad \text{-(M.3c)}$$

and the semi-reduced-form supply function is the same as (M.4a) except that the last two terms are replaced by:

$$\cdots \quad + \gamma_1 \frac{OTOT}{POECON} \qquad \text{-(M.4c)}$$

The *a priori* expectation is that $\gamma_1 < 0$.

4.3 Data

Initial attempts at collecting and collating sufficient relevant criminal data required to implement the model proved frustrating and unrewarding. Most particularly, the definitions of particular offences vary and have varied between states and over time, making it difficult to collect a long enough run of comparable data. Moreover, even where this did prove possible, the data relating to "crimes reported" could often not be compared with data on convictions on sentences for the same crime category, simply because different aggregation procedures were used for the two classes of data.

Matters improved in 1981 with G. Withers' useful collection of relevant data, and, more recently, the Australian Institute of Criminology's *Source Book of Australian Criminal and Social Statistics, 1900-1980* (1981).

However, the quality of these statistics, or perhaps their interpretation, is open to question, particularly in respect of the comparison between "crimes reported" and figures on court proceedings, while classification of offences differs between the various figures. One example of the first type of problem is given by statistics on rape in the *Source Book* In table B2 (p.44) data on "reported rapes" (*inter alia*) are given for N.S.W. from 1953 to 1979, while in table C.11 (p.55) details are given of charges, convictions, discharges and committals for trial in respect of rape in N.S.W., 1900-1971.

Of the 19 years (1953-1971) covered in common by both tables, charges for rape exceed reported rapes in 9 years! A possible explanation of this may be that an offence of rape may be committed by more than one person, hence multiple charges may be related to a single offence. In addition, some of the charges laid in are year may be related to offences reported in the previous year. However, whatever the explanation, it is difficult to see how these data can be used as reasonable proxies for anything.

As an example of the second type of problem, we again consider the offence of rape in N.S.W. It is desirable to establish (*inter alia*) how many convictions for rape occurred in a given year. Table C.11 (p.55) gives figures for convictions in lower courts, and also committals for trial to higher courts. To see how many of the committals resulted in conviction, we turn to table D.7 (p.70) to find that statistics on convictions for rape are in respect of "distinct persons" as compared with numbers of offences.

These examples are not unusual: similar problems occur throughout the *Source Book*, and undoubtedly reflect the quality of the basic data, and available information about it, provided by the relevant state departments. To make the data suitable for use in this (and similar) analyses requires at least some "doctoring" of the figures, to make them consistent and comparable. Such doctoring would, however, of necessity utilize simple *ad hoc* procedures of dubious validity: it is difficult to know whether the resulting figures are, in any sense preferable to the "undoctored" figures.

For these reasons, the data used here are those derived by and adjusted by G. Withers (1981). The problems of the raw data, and the details of the *ad hoc* adjustment procedures utilized by the author are fully specified. Whether or not the adjusted data can be regarded in any sense as "better" than the raw, unadjusted data, is a question which cannot be answered.

Using Withers' (1981) figures, data are available for all Australian states and territories, 1964-76. However, because of problems caused by missing data for various offences, the number of observations used in running this model was less than the maximum indicated. Moreover, the peculiar characteristics of the territories (confirmed by earlier runs of the models) suggested that these observations should be discarded. The number of combined cross-section/time-series observations used eventually ranged from 52 to 61, depending on crime type. Crime types considered were homicide, rape, robbery, burglary and larceny.

The procedure used to estimate the models was to estimate the semi-reduced-form supply functions for each model, using both OLS and 2SLS procedures. Estimates of the coefficients of the recording function are then derived and elasticities of the recording ratio with respect to the exogenous variables calculated and evaluated at sample means.

5.1 Model 1

Estimates derived for this model are presented in table one. We notice first that the OLS and 2SLS estimates are fairly similar, indicating that there is perhaps less simultaneity (between supply and production functions) than is normally supposed. The estimated signs of coefficients on the probability and youth variables are all as expected and reasonably significant. The signs of the education coefficients are generally and unexpectedly positive (the reason for this being a mystery!), while the signs on the income distribution variable are consistently negative and frequently significant. Perhaps this peculiar result can be explained in terms of both the imprecision of the income variable as an index of inequality, and in terms of the two distinct effects of income inequality on crime rates: the more unequal the distribution of of income, the greater the incentive to commit offences because of envy, and the greater the rewards from property offences; at the same time though, insofar as high and low income earners tend to live in different areas, an unequal distribution implies more geographical separation, hence less incentive to commit offences.

Of more interest for our present purposes are the estimated coefficients on 1/OTOT and 1/POECON. With the OLS estimates, two (out of five) of the former are significant, and two of the latter. With the (generally similar) 2SLS estimates, the figures change to three and two respectively. However, signs of estimates are not consistent. Under 2SLS, three (of 5) estimates on the 1/OTOT variable are positive, two negative; for the 1/POECON variable, the figures are two and three respectively. Moreover, there is no consistency among the significant estimates.

This of itself is of less importance if the inferred values of γ_1 and γ_2 are consistent. This unfortunately, is not the case: three of the γ_1 estimates are positive, two negative (under both OLS and 2SLS); for γ_2 the figures are reserved. Recall the *a priori* expectations $\gamma_1 > 0$, $\gamma_2 < 0$. Using the 2SLS estimates, we have a "success rate" of 3/5 for γ_1, though of only about <u>one</u> of these "successes" can we be confident, in that 2SLS estimates of the coefficients on both LPROB and 1/OTOT, from which γ_1 is inferred, are both significant. A similar "success rate" holds for γ_2, though in no such cases can we be (statistically) confident. Finally, only in two cases (homicide and rape) γ_1 and γ_2 have the "correct" signs.

Elasticity estimates (E^r OTOT $\equiv [\partial(c_i{*}/c_i)/\partial \text{OTOT}][\text{OTOT}/(c_i{*}/c_i)]$) are correspondingly variable. In the two "successes" (homicide and rape) the estimates suggest that a one percent increase in the <u>total</u> of recorded offences (or "workload") reduces the ratio of recorded to actual offences by 0.27 per cent (hom cide) and 0.06 per cent (rape). Further, an increase of one per cent in real police force expenditure increases the ratio by 0.14 per cent (homicide) and 0.03 per cent (rape).

5.2 <u>Model 2</u>

The results for model 2 are presented in table two. The results in relation to variables LPROB, LYOUTH, LEDUC and LINC are broadly similar to those of model 1, though the probability variable tends to decrease in significance, and are more ambiguous in sign, while the education variable becomes almost totally insignificant. This suggests that there may be a good deal of "noise" in the system, unaccounted for by the formal structural model. For example, variables LEDUC and OTOT may be closely related.

OLS and 2SLS estimates are again fairly similar. Variable OTOT enters as a significant variable in four out of five crime types (under 2SLS), while POECON is signficant in only two cases. However, the inferred values of γ_1 and γ_2 give little cause for comfort. The "expected" sign of γ_1 is negative. In only one case (under 2SLS) - homicide - is the sign as expected, and the probability coefficient on which this inference is (partly) based is insignificant. The inferred value of γ_2 (expected sign positive) is "correct" in three out of five cases (2SLS), but in none of these cases are both the coefficients from which the inferences are derived, significant.

Elasticity estimates are similarly ambiguous. The only offence for which inferred values of both γ_1 and γ_2 are of the expected sign is homicide, and these estimates differ greatly from those derived from model 1.

5.3 Model 3

In model 3, variables OTOT and POECON do not enter separately, but rather as a ratio. Although the procedure introduces an implicit additional constraint into the model, it seems to produce some improvement in performance.

Estimates of coefficients on the probability, youth, education and income variables are much as in the previous models, with the probability variable in particular having a negative coefficient in four cases, of which three are significant (2SLS). The composite variable OTOT/POEC has a significant impact in two out of five cases, though these are of opposite sign. The inferred value of γ_1 (expected sign negative) is of "correct" sign in three out of five cases, though in none of these cases are both the coefficients from which the inferences are derived significant. Elasticities in this model are symmetrical: the elasticities of the recording ratio with respect to OTOT is the negative of its elasticity with respect to POEC. Those of "correct" sign give elasticities with respect to OTOT of -0.45 (homocide), -0.087 (rape) and -0.15 (larceny).

5.4 Comparison

None of the three models considered here can be regarded as at all successful in terms of the aims of the exercise. Most importantly, estimates of the effects of the two "key" variables on the recording ratio vary widely between models, often are inconsistent with theoretical predictions, and can seldom be regarded as significant. Of the three models though, model 3, in which the composite variable OTOT/POEC entered, is perhaps the most successful in terms of signs of inferred coefficients. With due caution, they suggest that the reporting rate for homicide is reasonably sensitive to police workload and resources, that for rape almost completely unaffected by these variables, and larcency somewhat affected. These conclusions though are extremely tentative, for reasons already specified.

6. Conclusions

This exercise has proved extremely disappointing in terms of results, and the experience suggests that there is no clear research direction which can confidently be expected to improve the performance.

One problem is that of the quality and consistency of data. Should this improve, then one hurdle to further research will be removed, but it is doubtful if this hurdle is at all crucial. The basic reason for pessimism lies in the technique itself. Given the requirements that (a) any structural model must be specified in such a way that the coefficients of the semi-reduced form are capable of identification; (b) specification (especially functional forms selected) must be "reasonable" and allow for values of the recording function coefficients to be inferred; and (c), variables entering the recording function are also likely to enter the supply or production functions (or both), the chance of finding a specification which satisfies these requirements, and produces "reasonable" results, is small. The only advice possible seems to be to try as many options as are available, and hope that a suitable specification is found by luck. Such an unguided procedure will, naturally prove extremely costly.

Moreover, even if a reasonable and "successful" specification can be found, it cannot be simply assumed that inferred values for the coefficients of the recording function can actually be interpreted as such. They may merely reflect more complex interactions between the various relationships in the structural system, and themselves combine the many effects of an exogenous variable on the particular relationship.

Finally, even if confidence in the model is such that inferred coefficients are interpreted as such, there remains the problem of empirical verification. If the results of victimization surveys can be regarded with a high degree of confidence, and if there are sufficient of them, then some testing may be feasible.

It remains to ask whether any other type of research effort can yield further information on the true extent of unrecorded crime. One line of approach, which seems promising in principle, but could turn out to be difficult in practice, is to carry out one or more intensive case studies of police recording procedures, perhaps in conjunction with victimization surveys. The aim would be to "get behind" formal police procedures, and attempt to identify the number of reported or observed offences actually brought to the notice of police officers, before comparing these data with the number of offences which actually reach the record books. In conjunction with a victimization survey carried out over the same period, it may be possible to identify the extent of "leakage" at the various stages in the recording of what "crimes reported" actually means, and to obtain some grass-roots empirical information on the determinants of the various types of leakage. At this stage, such a "micro" approach seems more appealing than the "macro" approach examined here.

NOTES

1. Perhaps the best-known example is of recorded homosexual offences in England and Wales. When it became clear (in 1956) that the Wolfenden Committee, inquiring into homosexual offences (*inter alia*) was going to recommend a substantial de-criminalization of homosexuality, the numbers of recorded offences of this type dropped substantially - by 50 per cent or so over ten years, due largely to a change in police practices. See Walker (1971), 26-27.

2. The most obvious example of this is in national income statistics, where errors of counting mean that gross national expenditure never equals gross national income, though the two figures are definitionally identical.

3. Though if accurate data on true offence rates were available, it would be possible to directly test a model of the recording process. It might be possible to go some way in this direction using victimization surveys: to see, for example, how the probability of a victim reporting an (alleged) offence is related to his or her personal characteristics.

4. Though Becker acknowledges his intellectual predecessors, Beccaria and Bentham.

5. The list of relevant contributions is extremely long. Among the more important are Sjoquist (1963), Ehrlich (1975, 1977) and Wolpin (1978a, 1978b).

6. It should be emphasized that for some economists "realistic assumptions" are all-important, but these economists would be unlikely to be analysing a "social" question such as crime, and indeed, they would probably argue that economists cannot and should not attempt to investigate such questions.

7. There are, of course, more than two possible outcomes of an offence (from the offenders' viewpoint) each associated with particular probabilities and having particular costs involved. In this more general case, P_i and S_i can be regarded as vectors.

8. The components of vector X_i may differ between offence types.

9. See, for example, Johnston (1960), Ch. 9.

10. This abstracts from the other functions carried out by any police force.

11. Modifications to this basic structure are sometimes suggested by empirical considerations. For example, Ehrlich (1973) adds an equation "explaining" R in terms of the previous period's aggregate offence rate.

12. Ehrlich (1973) utilizes an assumption of this type.

13. Specified in Baldry (1980).

14. It might, for example, be reasonably assumed that the ratio C_i^*/C_i tends towards some finite limit as R tends to infinity (or W to zero). However, the fact that any empirical observations on R *or* W will be positive and finite suggests that such refinements will be of minimal importance in practice.

15. Or strictly, that the non-stochastic component of the ratio is a constant.

16. This involves seeing if the rank-order condition is established for one or both equations. See Johnston, *op.cit.*

17. Carr-Hill and Stern (1973) followed a procedure almost identical to that outlined above.

18. We derive estimates of α_1 and β_1 and also of $[\alpha_o + k(1+\alpha_1)]$ and $[\beta_o - k(1+\beta_1)]$. But to infer the value of k requires the solution of two equations in three unknowns (α_o, β_o and k), which cannot be done.

19. There may be no constant in the recording function, in which case the problem does not arise. However, it is impossible to ascertain empirically whether or not the recording function contains a non-zero constant.

20. This assumption is made to preserve the rank-order condition in respect of the semi-reduced-form supply function.

21. By this we mean that given some data on true crime rates, it may be possible to discriminate between models in terms of minimizing the sum of squared deviations of the models' predictions from objective data. The question of whether sufficient data to do this will ever be available, and, if so,

what its quality will be, remains open.

22. See Withers (1981) for a discussion of Australian data on crime.

23. As in Ehrlich (1973), Carr-Hill and Stern (1973), for example.

24. This function is a simplification of the more general recording function outlined earlier, in that the recording ratio is taken as the dependent variable. This implies that, other things equal, a given proportional change in the recorded crime rate is associated with the same proportional change in the true rate.

25. Given requirement (ii) above, and the selection of log-linear forms for the supply and production functions, none of the z_i can be logarithms of variables which already appear (in logarithmic form) in the former two functions.

26. See Withers (1981) for details of data derivation.

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COEFFICIENT ESTIMATES

CRIME TYPE	LPROB	LYOUTH	LEDUC	LINC	1/OTOT	1/POECON	CONSTANT	$\bar{R}^2$	N	Y_1	Y_2	E^r_{OTOT}	E^r_{POECON}
(i) OLS estimates													
HOMICIDE	-0.3*	1.17*	-0.59*	-0.21*	9570.5*	-4248.1*	1.04	.99	61	13672	-6068	-0.28	0.14
	(0.058)	(0.03)	(0.1)	(0.07)	(2392.7)	(1970.4)							
RAPE	-0.42*	1.0*	0.13	-0.27*	1613.8	-840.02	-1.03	.95	61	2782	-1448	-0.06	0.03
	(0.11)	(0.05)	(0.17)	(0.11)	(3999.1)	(3271.9)							
ROBBERY	-0.1	0.98*	0.81	-0.48*	-4193	-1950	-0.8	.97	61	-4659	-2167	0.096	0.05
	(0.1)	(0.04)	(0.44)	(0.09)	(3784)	(2904)							
BURGLARY	-0.08*	0.88*	0.27*	-0.32*	-8278.8*	4691*	3.95	.99	61	-9038	5121	0.19	-0.12
	(0.02)	(0.02)	(0.08)	(0.05)	(1987.7)	(1537.8)							
LARCENY	-0.57*	0.95*	-0.07	-0.25*	1256.6	1608.7	4.75	.99	52	2922	3741	-0.06	-0.09
	(0.04)	(0.02)	(0.08)	(0.05)	(1624.9)	(1272.5)							
(ii) 2SLS estimates													
HOMICIDE	-0.28*	1.17*	-0.6*	-0.22*	9539.2*	-4259.1*	1.11	.99	61	13249	-5915	-0.27	0.14
	(0.19)	(0.04)	(0.16)	(0.09)	(2410.8)	(1975.0)							
RAPE	-0.42	1.0*	0.14	-0.27*	1610	-841.87	-1.03	.95	61	2776	-1450	-0.06	0.03
	(0.32)	(0.07)	(0.25)	(0.13)	(4283)	(3354)							
ROBBERY	0.01	0.98*	0.85*	-0.48*	-6065	-1036	-0.75	.97	61	-6126	-1046	0.13	0.02
	(0.15)	(0.04)	(0.15)	(0.1)	(4183)	(3050)							
BURGLARY	-0.11*	0.89*	0.23*	0.33*	-7375*	4236.7*	3.99	.99	61	-8287	4760	0.17	-0.11
	(0.03)	(0.02)	(0.09)	(0.05)	(2067)	(1575)							
LARCENY	-0.64*	0.95*	-0.06	-0.21*	2930.4*	422.47	-0.64	.99	52	8140	1173	-0.17	-0.03
	(0.04)	(0.02)	(0.09)	(0.05)	(1723.1)	(1345.2)							

Results: Model 1

Table One

Note: Standard errors in parenthesis;
* indicates significant at 10% level in two-tailed test

CRIME TYPE	COEFFICIENT ESTIMATES LPROB	LYOUTH	LEDUC	LINC	OTOT	POECON	CONSTANT	$\bar{R}^2$	N	γ_1	γ_2	E^r_{OTOT}	E^r_{POECON}
(i) OLS estimates													
HOMICIDE	-0.29*	1.2*	-0.17	-0.22*	-0.84^{-05*}	0.17^{-05}	0.65	.99	61	1.18^{-05}	2.39^{-06}	-0.57	0.1
	(0.06)	(0.03)	(0.15)	(0.07)	(0.17^{-05})	(0.19^{-05})							
RAPE	-0.39*	0.98*	0.1	-0.25*	0.93^{-06}	-0.11^{-06}	-0.99	.95	61	1.52^{-06}	-1.8^{-07}	0.07	-0.008
	(0.11)	(0.06)	(0.23)	(0.1)	(0.31^{-05})	(0.32^{-05})							
ROBBERY	-0.14	0.91*	-0.01	-0.53*	0.73^{-05*}	0.62^{-05*}	0.08	.98	61	8.49^{-06}	7.21^{-06}	0.41	0.3
	(0.12)	(0.04)	(0.18)	(0.08)	(0.33^{-05})	(0.31^{-05})							
BURGLARY	-0.03	0.85*	0.01	-0.26*	0.1^{-04*}	-0.47^{-05*}	4.18	.99	61	1.03^{-05}	-4.8^{-06}	0.5	-0.2
	(0.03)	(0.02)	(0.1)	(0.04)	(0.17^{-05})	(0.19^{-05})							
LARCENY	-0.41*	0.98*	0.44*	-0.13*	0.77^{-05*}	-0.13^{-04*}	4.17	.99	52	1.31^{-05}	-2.2^{-05}	0.63	-0.93
	(0.04)	(0.02)	(0.1)	(0.04)	(0.19^{-05})	(0.22^{-05})							
(ii) 2SLS estimates													
HOMICIDE	0.03	1.24*	-0.44	-0.33*	-0.78^{-05*}	0.2^{-05}	1.9	.98	61	-8.1^{-06}	2.07^{-06}	-0.39	0.09
	(0.25)	(0.05)	(0.28)	(0.12)	(0.22^{-05})	(0.24^{-05})							
RAPE	-0.43*	0.98*	0.1	-0.26*	0.52^{-06}	0.1^{-06}	-1.01	.95	61	9.12^{-07}	1.75^{-07}	0.04	0.01
	(0.22)	(0.06)	(0.24)	(0.1)	(0.38^{-05})	(0.34^{-05})							
ROBBERY	0.11	0.92*	-0.02	-0.53*	0.12^{-04*}	0.26^{-05}	0.32	.98	61	1.35^{-05}	2.92^{-06}	0.65	0.12
	(0.26)	(0.05)	(0.19)	(0.08)	(0.55^{-05})	(0.46^{-05})							
BURGLARY	-0.05	0.85*	-0.01	-0.26*	0.95^{-05*}	-0.4^{-05*}	4.19	.99	61	9.95^{-06}	-4.19^{-06}	0.48	-0.18
	(0.04)	(0.02)	(0.1)	(0.04)	(0.19^{-05})	(0.22^{-05})							
LARCENY	-0.49*	0.98*	0.44*	-0.13*	0.51^{-05*}	-0.11^{-04*}	4.03	.99	52	1.0^{-05}	-2.16^{-05}	0.48	-0.91
	(0.05)	(0.02)	(0.1)	(0.04)	(0.21^{-05})	(0.24^{-05})							

Results: Model 2

Table Two

Note: $0.1^{-05} \equiv (0.1)(10^{-5})$
$\equiv (0.1)\ (0.00001) \equiv 0.000001$

CRIME TYPE	LPROB	LYOUTH	LEDUC	LINC	OTOT/POECON	CONSTANT	$\bar{R}^2$	N	γ_1	$E^r_{OTOT} \equiv -E^r_{POECON}$
	COEFFICIENT ESTIMATES									
(i) OLS estimates										
HOMICIDE	-0.28 (0.59)	-1.08* (0.22)	-0.57* (0.11)	-0.14* (0.06)	-0.34* (0.72)	1.32	0.99	61	-0.47	-0.54
RAPE	-0.42* (0.11)	0.99* (0.03)	0.14 (0.17)	-0.26* (0.1)	-0.04 (0.12)	-1.0	0.95	61	-0.07	-0.09
ROBBERY	-0.24* (0.14)	1.09* (0.04)	0.67* (0.16)	-0.62* (0.1)	0.03 (0.15)	-0.5	0.97	61	0.04	0.04
BURGLARY	-0.04 (0.03)	0.95* (0.02)	0.33* (0.08)	-0.34* (0.04)	0.35* (0.07)	3.58	0.99	61	0.37	0.42
LARCENY	-0.55* (0.05)	0.89* (0.02	0.02 (0.1)	-0.15* (0.05)	0.02 (0.1)	4.45	0.99	52	0.05	0.06
(ii) 2SLS estimates										
HOMICIDE	0.16 (0.3)	1.15* (0.06)	-0.86* (0.25)	-0.31* (0.14)	-0.33* (0.1)	2.94	0.97	61	0.39	-0.45
RAPE	-0.42* (0.2)	0.99* (0.03)	0.14 (0.18)	-0.26* (0.1)	-0.04 (0.14)	-1.0	0.95	61	-0.08	-0.09
ROBBERY	-0.24 (0.23)	1.09* (0.05)	0.67* (0.17)	-0.62* (0.1)	0.03 (0.2)	-0.5	0.97	61	0.03	0.04
BURGLARY	-0.07* (0.03)	0.94* (0.02)	0.29* (0.09)	-0.35* (0.04)	0.3* (0.08)	3.66	0.99	61	0.32	0.37
LARCENY	-0.61* (0.05)	0.88* (0.02)	0.05 (0.1)	-0.13* (0.05)	-0.05 (0.09)	4.35	0.99	52	-0.13	-0.15

Results: Model 3

Table Three