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Koenig, Peter John

AN ECONOMIC ANALYSIS OF THE PROSECUTOR

The Ohio State University

Ph.D. 1981

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AN ECONOMIC ANALYSIS OF THE PROSECUTOR

DISSERTATION

Presented in Partial Fulfillment of the Requirements for
the Degree Doctor of Philosophy in the Graduate
School of The Ohio State University

By

Peter John Koenig, B.A., M.A.

* * * *

The Ohio State University

1981

Reading Committee:

Belton M. Fleisher
Howard P. Marvel
William D. Hanson

Approved By

Belton M. Fleisher
Adviser, Department of Economics
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VITA

August 5, 1955........................................Born-Columbus, Ohio

1976-1978........................................Graduate Research Associate, Center
for Human Resource Research, The
Ohio State University, Columbus,
Ohio

1977........................................B.A., M.A., The Ohio State Univer­
sity, Columbus, Ohio

1978-1981........................................Law student, University of Mich­
igan Law School

1980 Summer.....................................Legal intern, Federal Trade Commissi­
on, Bureau of Competition

PUBLICATIONS

"The Migration of Young Families: An Economic Perspective." (with Steve

"The Migration of Young Women and Their Families." Dual Careers, Volume

FIELDS OF STUDY

Major Field: Labor

   Industrial Organization

   Econometrics
CONTENTS

ACKNOWLEDGEMENTS ................................................................. II
VITA ..................................................................................... III
LIST OF TABLES .......................................................................... v
LIST OF SYMBOLS ...................................................................... vi

CHAPTER

I. INTRODUCTION ............................................................... 1

II. THE MODEL ........................................................................ 3

  Assumptions ......................................................................... 3
  Notation ............................................................................... 6
  The Maximization Problem ............................................... 9
  Implications ......................................................................... 13
  Extending the Model ......................................................... 29

III. PRIOR LITERATURE ........................................................ 39

IV. EMPIRICAL ANALYSIS ..................................................... 42

  The Data ............................................................................. 42
  Sample Selection Bias ....................................................... 48
  Empirical Results .............................................................. 55
  Prior Empirical Literature ............................................... 59

V. CONCLUDING REMARKS .................................................. 66

LIST OF REFERENCES ............................................................ 69

APPENDIXES

A. Prosecutor's Categorization of Defendants .................. 74
B. Mathematical Appendix ................................................... 82
C. Estimation of Defendant's Probability of Conviction in a Trial .. 105
# LIST OF TABLES

<table>
<thead>
<tr>
<th>Table</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>List of Empirical Variables</td>
<td>43</td>
</tr>
<tr>
<td>2.</td>
<td>Determinants of Pretrial Detention (DETAINED)</td>
<td>54</td>
</tr>
<tr>
<td>3.</td>
<td>Determinants of Sentence Severity and Postponements Requested by the Prosecutor</td>
<td>56</td>
</tr>
<tr>
<td>4.</td>
<td>Effect of Delay and Pretrial Detention on Sentence Severity</td>
<td>60</td>
</tr>
<tr>
<td>5.</td>
<td>Empirical Variables to Calculate ( \hat{p} )</td>
<td>106</td>
</tr>
<tr>
<td>6.</td>
<td>Determinants of Conviction in a Trial</td>
<td>111</td>
</tr>
<tr>
<td>7.</td>
<td>Determinants of Whether a Defendant has a Trial</td>
<td>113</td>
</tr>
<tr>
<td>Symbol</td>
<td>Description</td>
<td></td>
</tr>
<tr>
<td>--------</td>
<td>-------------</td>
<td></td>
</tr>
<tr>
<td>$A_1$</td>
<td>A vector of factors beyond the prosecutor's control which influence court delay between arrest and final court disposition of the cases of type I defendants.</td>
<td></td>
</tr>
<tr>
<td>$b(P,S)$</td>
<td>Ball bond amount—the cost of pretrial release.</td>
<td></td>
</tr>
<tr>
<td>$B$</td>
<td>Budget of the prosecutor's office.</td>
<td></td>
</tr>
<tr>
<td>$c^1$</td>
<td>Crime rate of type I defendants times the social loss per crime.</td>
<td></td>
</tr>
<tr>
<td>$d^1$</td>
<td>Average number of months until the end of type I defendants' lifetimes.</td>
<td></td>
</tr>
<tr>
<td>$D^1$</td>
<td>Total resources which the prosecutor invests per type I defendant to influence court delay between arrest and final court disposition of their cases.</td>
<td></td>
</tr>
<tr>
<td>$E(\cdot)$</td>
<td>Expected value operator.</td>
<td></td>
</tr>
<tr>
<td>$f$</td>
<td>Added fixed cost to the prosecutor of a trial compared to a settlement.</td>
<td></td>
</tr>
<tr>
<td>$F$</td>
<td>The present value of the reduction in the social loss from future crime from convicting one type 2 defendant, all of whom are free on bond.</td>
<td></td>
</tr>
<tr>
<td>$h^1(v^1)$</td>
<td>Harm from future crimes prevented by the deterrent effect on future crime from imposing punishment $v^1$ on one type I defendant (in present value terms).</td>
<td></td>
</tr>
<tr>
<td>$I$</td>
<td>The present value of the reduction in the social loss from future crime from convicting one type I defendant, all of whom are incarcerated pending trial.</td>
<td></td>
</tr>
<tr>
<td>$J$</td>
<td>The present value of the reduction in the social loss from future crime from the pretrial detention of one type I defendant who is subsequently acquitted.</td>
<td></td>
</tr>
<tr>
<td>$L$</td>
<td>The reduction in the social loss from crime achieved by the prosecutor's policies.</td>
<td></td>
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</tbody>
</table>
### Description

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>$N^I$</td>
<td>Number of type I defendants.</td>
</tr>
<tr>
<td>$p$</td>
<td>Rate of time preference of the prosecutor.</td>
</tr>
<tr>
<td>$P^I$</td>
<td>Proportion of type I defendants who are convicted.</td>
</tr>
<tr>
<td>$r$</td>
<td>Rate of time preference of defendants.</td>
</tr>
<tr>
<td>$R^I$</td>
<td>Resources that the prosecutor spends per type I defendant to facilitate his conviction.</td>
</tr>
<tr>
<td>$s$</td>
<td>The monetary equivalent of the disutility suffered from one month's imprisonment.</td>
</tr>
<tr>
<td>$S^I$</td>
<td>Prison sentence (in months) served by convicted type I defendants.</td>
</tr>
<tr>
<td>$T^I$</td>
<td>Time (in months) between arrest and final case disposition of type I offenders.</td>
</tr>
<tr>
<td>$v^I$</td>
<td>Present discounted value of punishment at the time of the offense for convicted type I defendants.</td>
</tr>
<tr>
<td>$v^a$</td>
<td>Present discounted value of punishment at the time of the offense for type I defendants who are not convicted.</td>
</tr>
<tr>
<td>$w^I$</td>
<td>Average weight of the evidence against type I defendants.</td>
</tr>
<tr>
<td>$z^I$</td>
<td>Diminished future job prospects and psychic costs of lost social status suffered by a convicted type I defendant after release from prison.</td>
</tr>
</tbody>
</table>
A model of the prosecutor is presented that assumes that he minimizes the social loss from crime, subject to the constraints of his budget, the constitution, and criminal procedure. In two aspects the model differs from prior economic models of the prosecutor. First, it examines how he affects and is affected by court delay for crime deterrence reasons. Second, it examines how he treats defendants detained pending trial differently from those released. No predictions of the prior models survive completely intact and many new ones appear. Empirical evidence from the Baltimore courts strongly supports the model.

Some implications of the model follow: (1) The weaker the evidence is against a defendant, the greater the prosecutor's efforts to delay the disposition of his case. For defendants detained pending trial, such efforts seem contrary to notions of fairness and due process. (2) Among defendants incarcerated pending trial, the younger they are and the greater their wealth, the greater the prosecutor's effort to convict them. (3) The prosecutor "price discriminates" (varies the severity of the punishment with a defendant's personal characteristics) more among released than detained defendants. Thus, prosecutors deviate more from the mores of the Anglo-American legal tradition of meting out punishment according to the act, not the man, for released compared to
detained defendants. (4) The prosecutor may treat defendants pleading guilty more harshly than those demanding trials, contrary to popular wisdom. And (5) large falls in the prosecutor's reelection chances cause him to discriminate against poor defendants. I am not aware of any theory of the prosecutor which yields any of these predictions.

The model raises questions about the efficacy of many proposed judicial reforms; e.g., speedy trial legislation, liberalization of pre-trial release standards, expansion of the rights of criminal defendants, and improving pretrial detention facilities. Finally, the model suggests a new empirical approach to examine the courts. Indeed, the finding of previous empirical studies that court delay does not affect the outcome of a defendant's case was found to be erroneous. Previous studies of the effect of pretrial detention on case outcome were found to substantially underestimate its effect.

Chapter II presents an economic model of the prosecutor. Chapter III reviews the prior literature. Chapter IV contains empirical evidence supporting the model. Finally, Chapter V contains some concluding remarks and policy recommendations.
CHAPTER II
THE MODEL

This chapter presents an economic model of the prosecutor which assumes that he minimizes the social loss from crime by allocating resources to facilitate convictions of defendants and influence court delay. After discussing the implications of the model, the effect of relaxing some of its assumptions will be examined.

Assumptions

Prosecutor's Objective Assume, as many do,¹ that the prosecutor's mandate is to reduce the social loss from crime as much as possible, within the constraints of his budget, the constitution and criminal procedure. Further, the population is assumed to contain only two types of people (e.g. rich and poor, young and old). Call them types 1 and 2. Also assume that all type 1 defendants are incarcerated pending trial and all type 2 defendants are released. Finally, assume that the prosecutor cannot affect whether a defendant is released or detained pending trial. The prosecutor minimizes the social loss from crimes committed by both types through means discussed in the following subsection.²

¹Becker (1968), Ehrlich (1973), Forst and Brosi (1977), and Stigler (1970).

²See Appendix A for a discussion of how the prosecutor would classify defendants in a more heterogeneous world.
Prosecutor's Control Variables. The prosecutor influences the crime rate by (1) varying the resources in \((R^1)\) spent per type 1 \((i=1,2)\) defendant to facilitate his conviction and (2) spending time and resources \((D^1)\) influencing delay until final disposition of the cases of type 1 defendants.³ It is well known that long court delay reduces the deterrent effect of criminal sanctions because it reduces their disutility as perceived by the potential criminal at the time he considers committing the crime.⁴ This effect obviously holds only for defendants released on bail pending trial.

The function \(P^1(R^1,W^1)\) relates the probability of conviction of type 1 defendants to \(R^1\) and various exogenous factors affecting the weight of the evidence against type 1 defendants \((W^1)\) where \(\frac{\partial P^1}{\partial R^1} = P^1_R > 0\) and \(\frac{\partial P^1}{\partial W^1} = P^1_W > 0\). Similarly, delay until case disposition of type 1 defendants \((T^1)\) is also a function of two inputs: \(D^1\) and factors beyond the prosecutor's control summarized in the variable \(A^1\). The delay production function, \(T^1 = T^1(D^1,A^1)\), differs greatly between defendants released and detained pending trial. Consider first type 2 defendants, all of whom are released on bail pending trial. Given their positive time preference for freedom, released defendants try to delay the final disposition of their cases and consequent imposition of punishment. In contrast, the prosecutor tries to decrease delay and thereby increase

³The prosecutor has considerable control over the pace of litigation (Church, 1978:39,72; Eisenstein and Jacob, 1977:23; President's Commission 1967:86).

the present discounted value of punishment. Hence, $T_D^2$ is negative, but finite given the resistance of the defendants to reductions in delay.

In contrast, defendants incarcerated pending trial desire quick dispositions for they are forgoing earnings opportunities and freedom. But the prosecutor invests resources ($D^1$) to prolong pretrial detention, a form of punishment. Thus, $T_D$ is positive.$^5$

**Constraints** The prosecutor is not unconstrained in his allocation of $R^1$ and $D^1$ to reduce the social loss from crime. He is subject to a budget constraint:

$$B = (R^1+D^1)N^1+(R^2+D^2)N^2$$ (1)

where $B$ is his total budget and $N^1$ is the number of type 1 defendants. Pages vi-vii list all symbols in this paper.

He is also subject to the constitution. Constitutional constraints on the prosecutor cause his investments to prolong pretrial detention to be subject to diminishing returns—$T_{DD}^1<0$. Each increase in delay strengthens defense arguments to the court that the defendant has been (1) denied his constitutional right to a speedy trial and (2) unfairly singled out for unusually harsh treatment, a denial of equal protection under the law (Hartje, 1975).

$^5$To simplify the model, the following "Joint production" problems are ignored: An increase in $R^1$ may increase $T^1$ (in addition to $P^1$) by preventing an early judicial dismissal of cases due to insufficient evidence. Likewise, an increase in $D^1$ may affect $P^1$ (in addition to $T^1$) since court delay weakens the prosecutor's case for witnesses die, memories fade and so on. Though the empirical evidence rejects that evidence decay effect (Levin, 1977), it is criticized below.
Likewise, constitutional constraints mean that the prosecutor's investments increasing celerity of punishment of defendants released pending trial are subject to diminishing returns—\( T_{DD} > 0 \). As the prosecutor increases celerity of case disposition of only one category of released defendants, it strengthens defense counsel arguments to the court that (1) they lack sufficient time to prepare a defense, a denial of due process and (2) their clients have been unfairly singled out for harsh treatment, a denial of equal protection.

Thus far, subject to a budget constraint, the prosecutor is assumed to invest resources to facilitate convictions and influence court delay to reduce the social loss from crime. Constitutional doctrines cause the resources the prosecutor spends to influence court delay to be subject to diminishing returns. Before this model can be formalized, some notation must be noted.

**Notation**

Two forms of punishment follow a criminal conviction: \( S^1 \) months in prison and a stigma. The stigma consists of the psychic costs of lost social status in the community and reduced future job prospects. Let \( Z^1 \) be the disutility from the stigma suffered by type 1 convicted defendants.

Since all type 2 defendants are released on bail pending trial, the present discounted value of punishment at the time of the crime (if convicted) is:

\[
v^2 = \int_{T_2+S_2}^{d_2} e^{-rt} \, dt + \int_{T_2}^{T_2+S_2} e^{-rt} \, dt
\]

where \( d^2 \) is the average number of months until the end of type 2
defendants' lifetimes and \( r \) is their monthly rate of time preference. The first term is the present discounted value of the disutility the defendant suffers from the stigma of a conviction. The second term is the present discounted value of the disutility of \( S^2 \) months of imprisonment. Let a unit of disutility equal the disutility from a month's imprisonment. The value of \( Z^2 \) is less than one; otherwise increases in \( S^2 \) decrease the total punishment suffered by a defendant.

Since type 1 defendants are incarcerated pending trial, their present discounted value of punishment (if convicted) at the time of the crime is:

\[
v^1 = \int_{S^1}^{1} Z^1 e^{-rt} dt + \int_{0}^{s^1} e^{-rt} dt
\]  

Note that pretrial detention time is deducted from the sentence received if convicted. Such deductions are common and required in federal courts (Freed and Wald, 1969:89). The discussion after (2) applies here and need not be repeated.

Since type 2 defendants are released on bail pending trial, the present value of the reduction in the social loss from future crime from convicting one type 2 defendant \( T^2 \) months after his crime and imprisoning him \( S^2 \) months is:

\[
F = \int_{T^2}^{S^2 + T^2} c^2 e^{-pt} dt + h^2(v^2)
\]  

The first term is the incapacitation effect on the crime rate of \( S^2 \) months of imprisonment imposed \( T^2 \) months after the arrest. That is, convicted offenders cannot commit more crimes while in prison. The

\[\text{For purely notational convenience, it is assumed that criminals, if arrested, are arrested on the day they committed the offense.}\]
symbol \( c^2 \) is the prosecutor's subjective estimate of the rate of supply of crime by type 2 offenders times the social harm per crime. The symbol \( p \) is the prosecutor's monthly rate of time preference. In sum, the first term is the present value of the social loss from crimes type 2 convicted defendants would have committed if not incarcerated.

The second term--\( h^2(v^2) \)--is the prosecutor's subjective estimate of the deterrent effect on the future supply of crime and consequent social losses from imposing punishment \( v^2 \) on one type 2 defendant. Since an increase in the price of crime (an increase in \( v^2 \)) decreases its supply, \( h^2_1 \) is positive. Increases in punishment are subject to diminishing returns--\( h^2_{vv} < 0 \).

Since type 1 defendants are incarcerated pending trial, the present values of the reduction in the social loss from future crime from the conviction and nonconviction (acquittal, dismissal) of one type 1 defendant are, respectively:

\[
I = \int_0^{s_1} c^1 e^{-pt} dt + h^1(v^1) \\
J = \int_0^{T_1} c^1 e^{-pt} dt + h^1(v^a) \text{ where } v^a = \int_0^{T_1} e^{-rt} dt
\]

The first terms of (5) and (6) are the incapacitation effects of imprisonment--incarcerated offenders cannot commit more crimes. The second terms are the deterrent effects on the supply of future crime from punishing one type 1 offender. These terms are self-explanatory from the prior discussion of similar terms for type 2 defendants. The only difference from the case of type 2 defendants is that even type 1 defendants who are not convicted are punished by pretrial
That completes the mathematical specification of the crime deterrence functions. The necessary foundation for the formal maximization problem is now laid.

The Maximization Problem

The prosecutor was assumed to maximize the reduction in the social loss from crime. Formally, he maximizes

$$L = N_1(1-P_1)J + N_1P_11 + N_2P_2$$

with respect to $R_1$, $D_1$, $R_2$ and $D_2$, subject to the budget constraint

$$B = (D_1 + R_1)N_1 + (D_2 + R_2)N_2.$$  

The first term in $L$ is the number of type 1 defendants, all of whom are incarcerated pending trial, who are not convicted times the reduction in crime caused by the pretrial incarceration of one of them. The second term is the number of convicted type 1 defendants times the reduction in crime from convicting one of them. The third term is the number of convicted type 2 defendants, all of whom are released on bail pending trial, times the reduction in crime from convicting one of them. Arresting defendants who are subsequently released on bail and later acquitted is assumed to not affect the crime rate. Solve the budget

---

7A person commits a crime if his expected utility if he does exceeds his expected utility if he does not. If courts punish the innocent, the expected utility from a decision not to commit a crime declines and (hence) the individual will more likely commit a crime (Posner, 1977). Thus, arguably, since defendants who are acquitted are probably innocent, punishing them will not deter crime. This implies that the same functions--$h^1(\cdot)$ and $c^1$--should not be used in $I$ and $J$ and that $J$ may well be negative. However, prosecutors and judges widely believe that almost all defendants are guilty of some crime, even if not the one with which they are now accused (Levin 1975:95). Thus, $J$ ought to be positive. For simplicity, assume $h^1(\cdot)$ and $c^1$ are the same in $I$ and $J$. This assumption is relaxed later.
constraint for \( D^1 \) and substitute that value for \( D^1 \) in \( L \). Now maximize \( L \) with respect to \( R^1 \), \( R^2 \) and \( D^2 \). The first order conditions are:

\[
\begin{align*}
L_{R^1} &= N^1[p^1_R(I-J) - (1-P^1)J_D] = 0 \quad (8) \\
L_{R^2} &= N^2[p^2_R - (1-P^1)J_D] = 0 \quad (9) \\
L_{D^2} &= N^2[p^2_D - (1-P^1)J_D] = 0. \quad (10)
\end{align*}
\]

The first order conditions require that the marginal gains from the reduction of the social cost of crime from increasing \( R^1 \), \( D^1 \), \( R^2 \) and \( D^2 \) are all equal. Appendix B examines the second order conditions for the equilibrium values of \( R^1 \), \( D^1 \), \( R^2 \) and \( D^2 \) yielded by the first order conditions to be a maximum. It is of great interest to examine how the optimal values of \( R^1 \), \( D^1 \), \( R^2 \) and \( D^2 \) are affected by changes in factors upon which they depend. Such a comparative static analysis is done in mathematical Appendix B. This chapter presents merely the intuition behind that analysis.

Discussion of the predictions of the model is facilitated by first examining the marginal returns to the prosecutor's various investment opportunities \( (R^1, D^1, R^2 \text{ and } D^2) \). Consider first defendants incarcerated pending trial (type 1). The marginal return to resources facilitating their conviction \( (R^1) \) is:

\[
N^1p^1_R(I-J) = N^1p^1_R [\int_0^{T^1} c^1 e^{-rt} dt + h^1(\int_0^{T^1} e^{-(r-\gamma)T} dt + \int_0^{T^1} e^{-rt} dt)]
\]

(11)

The marginal return to resources prolonging the pretrial detention of type 1 defendants is

\[
N^1(1-P^1)J_D = N^1(1-P^1)(c^1 e^{-P^1T} + \frac{dh^1(v^1)}{dv} e^{-rT})T^1_D
\]

(12)

Notice that increases in resources spent prolonging pretrial detention \( (D^1) \) increase the duration of the pretrial detention and
consequently [by (11)] decrease the marginal return to resources facilitating convictions of type 1 defendants. Similarly, increases in resources facilitating convictions of type 1 defendants (R1) increase the proportion convicted and thus [by (12)] decrease the marginal return to resources prolonging pretrial detention. In short, D1 and R1 are substitutes in the production of reduced crime. It is important to note that "substitutes" is used in the Edgeworth-Pareto sense that increases in one factor input decrease the marginal return to the other, holding all else equal.

Intuitively, increases in the pretrial detention period (T1) decrease the marginal returns to convicting defendants since (1) the present discounted value (at the time of the crime) of punishment from a conviction declines due to the increase in delay until conviction and (2) the duration of pretrial detention (T1) is subtracted from the prison sentence (S1) obtained from a conviction. Likewise, intuitively, increases in the proportion of type 1 defendants who are convicted decrease the marginal returns to lengthening pretrial detention time since a greater proportion of type 1 defendants would have been incarcerated during that time span even without the increase in the duration of pretrial detention.

Consider now defendants released on bail pending trial. The marginal return to resources facilitating their conviction is

$$N_2^p_2F = N_2^p_2 \int_{T_2}^{T_2+S_2^2} c_2 e^{-pt} dt + h^2(\int_{T_2+S_2^2}^{d^2} e^{-rt} dt + \int_{T_2}^{T_2+S_2^2} e^{-rt} dt)$$

(13)

The marginal return to resources increasing their celerity of punishment is
For released (unlike detained) defendants, the prosecutor allocates resources to decrease, not increase, court delay. Hence, R^2 and D^2 are complements, since R^1 and D^1 are substitutes. In other words, increases in R^2 increase P^2 which increases the marginal return to D^2, all else equal; similarly, increases in D^2 decrease T^2 which increases the marginal return to R^2. "Complements" is used in the Edgeworth-Pareto sense that an increase in one factor input increases the marginal return to the other factor input, all else equal. This complementarity is readily apparent from (13) and (14).

The intuition behind this complementarity is also apparent. The marginal return to resources facilitating convictions increases with the disutility those considering crimes attach to convictions. And, given positive time preference for freedom, celerity of convictions increases that disutility. Likewise, increases in resources facilitating convictions of type 2 defendants increase marginal returns to resources facilitating celerity of punishment since increasing the celerity of case disposition only deters crime if punishment follows disposition.

The first order conditions of a model which assumes that the prosecutor minimizes the social loss from crime have been examined. They reveal that the factor inputs (R^1 and D^1) used to reduce the crime of type 1 persons are substitutes while the factor inputs (R^2 and D^2) used to reduce the crime of type 2 persons are complements. Note that I am using the words "substitute" and "complement" in a sense different from normal usage. This substitute/complement distinction will
repeatedly appear in the discussion of the model's implications below.

**Implications**

**Prosecutor's Budget** Consider the impact on prosecutor resource allocation (that is, on $R^1, D^1, R^2, D^2$) of increases in his budget. Will not all factor inputs ($R^1, D^1, R^2, D^2$) increase? This intuition can be formally shown for type 2 defendants, all of whom are released on bail pending trial. Given diminishing returns to resources facilitating celerity and certainty of punishment of type 2 defendants ($R^2$ and $D^2$), and since $R^2$ and $D^2$ are complements, the rational prosecutor increases both if he wants to increase the present value of punishment of released defendants.

Curiously, however, it cannot be formally shown that increases in the prosecutor's budget increase resources facilitating convictions and prolonging pretrial detention of type 1 defendants ($R^1$ and $D^1$), all of whom are detained pending trial. If the complementarity between $D^2$ and $R^2$ is great enough to offset the diminishing returns to increasing each individually, then increases in $R^2$ and $D^2$ may absorb all of the budget increase. Even if total resources ($R^1+D^1$) spent prosecuting type 1 defendants increase with budget increases, $R^1$ and $D^1$ may fall. That is, since $R^1$ and $D^1$ are substitutes, increases in one induced by budget increases may decrease the marginal returns to the other and hence the amount of resources allocated to the other.

Many question the constitutionality and fairness of a system where those detained in jail pending trial are, *ceteris paribus*, more likely to be convicted than those released. This model predicts that the
relative amount of resources spent prosecuting released and detained defendants varies with the size of the prosecutor's budget. The reason:

the budget elasticities of demand for convictions (which reflect the marginal benefit function) differ between detained and released defendants. Thus, budget increases may unintentionally affect the fairness of pretrial detention.

In the intuitive discussion that follows and in Appendix B, positive wealth effects must be assumed to unambiguously determine the effect on prosecutor resource allocation of changes in some of the factors upon which it depends. Empirical evidence below and intuition support that assumption. But, in theory, budget increases need not increase resources spent prosecuting detained defendants. In contrast, resources spent prosecuting released defendants were found to rise with the prosecutor's budget.

Recidivism Curiously, increases in the recidivist tendencies of type I defendants (that is, $c^I$) do not necessarily increase both $R^I$ and $D^I$. True, the marginal returns to both $R^I$ and $D^I$ rise [see (11) through (14)]. Thus, the total resources spent prosecuting type I defendants increase ($R^I + D^I$). But the marginal return to $D^I(R^I)$ may rise so much relative to the marginal return to $R^I(D^I)$ that (due to the budget constraint) $R^I(D^I)$, $RJ$ and $DJ$ (j≠1) fall. Indeed, such a result is especially likely for detained defendants because a sufficiently large increase in the marginal return to $R^I$ from an increase in $c^I$ to cause $R^I$ to increase tends to decrease the marginal return to $D^I$ since $R^I$ and $D^I$ are substitutes. Thus, rational prosecutors may appear to act irrationally: an increase in the criminal propensities of one category of
offenders may lead the prosecutor to reduce resources facilitating their conviction.

At first glance, the incapacitative effect of imprisonment—incarcerated offenders cannot commit more crimes—seems a major means of crime control. But things are not always as they seem. Like any occupation, pecuniary criminal offenses are subject to entry until returns are driven down to the competitive level. Therefore, potential crime targets with above competitive returns, available after imprisonment has reduced the supply of offenders, invite entry of new criminals. Hence, assuming an elastic supply of offenses, the incapacitative effect of imprisonment on local crime may be small. This argument easily applies to property crimes, for they are subject to relatively free entry. But, substantial barriers to entry into personal crimes result from the largely nontransferable nature of the gains—often the victim and offender know each other and the crime (e.g., assault) resulted from a personal conflict. Hence, the incapacitative effect of imprisoning those prone to repeating personal crimes may be substantial given the lack of post imprisonment entry of new criminals. Thus, all else equal, a prior record of personal crimes is more likely to induce harsh treatment from the prosecutor than a record of property crimes.

Indeed, if the elasticity of supply of property offenders is very high, then (barring deterrence) the prosecutor may not benefit from incarcerating property offenders. Recidivist property offenders are

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8Costs of producing offenses include the expected punishment.
eager to avoid imprisonment which precludes their profitable crimes. If, as a result, recidivist property offenders spent more on defense than other defendants, then they might well receive more lenient treatment than other offenders. Note that there is no contradiction between an elastic offense supply function and offenses being very profitable to current offenders for returns are competitive only at the margin. That situation only means that some offenders are earning economic rents.

In sum, the only unambiguous effect of a type I defendant's prior record on \( R^I \) or \( D^I \) is that the sum \( R^I + D^I \) increases with the extent of the defendant's prior record of personal crimes.

**Deterrability** The prosecutor will allocate more resources prosecuting deterrable as against nondeterrable offenders. Formally, the more responsive the supply of crime of type I offenders to criminal sanctions, the greater is \( h^I_v \) for all levels of \( v^I \). And the greater is \( h^I_v \) for all \( v^I \), the greater is \( h^I \). The greater the deterrability of type I offenders, the greater the marginal returns to \( R^I \) and \( D^I \) [see (11) through (14)]. But, since the marginal returns to both \( R^I \) and \( D^I \) rise, it is unclear whether both \( R^I \) and \( D^I \) increase, though their sum must increase. The marginal return to \( R^I(D^I) \) may increase so much relative to the marginal return to \( D^I(R^I) \) that \( R^I(D^I) \) alone increases and (due to the budget constraint) \( D^I(R^I) \), \( R^J \) and \( D^J \) decrease. Again, rational prosecutors may appear to act perversely by allocating more resources to facilitating the convictions of nondeterrable compared to deterrable defendants. And, again, such illusory irrationalities are more likely for detained than released defendants.
Consider a defendant characteristic associated with deterrability and the prosecutor's resource allocation response to it. Potential offenders who often migrate invest less than nonmigrant offenders learning about any particular jurisdiction's prosecutorial policies, since the returns to the investment are short-lived. Thus, compared to long time residents, the crimes of nonresidents and temporary residents are less affected by the severity of punishment in the jurisdiction since temporary residents and nonresidents are less likely aware of it. Hence, nonresident defendants will receive more lenient prosecutorial treatment than long time residents (for empirical evidence, see Adelson, 1975; Newmann, 1966). For instance, nonresident defendants who plead guilty to minor crimes often receive suspended sentences if they promise not to return to the city.

**Stigma from a Conviction** Consider the effect on prosecutor resource allocation of an increase in the stigma suffered by type I offenders from conviction—2]. In other words, assume that the psychic costs of lost social status and diminished future earnings prospects resulting from a conviction increase for type I offenders.

Consider first defendants incarcerated pending trial. Increases in the disutility suffered from a conviction increase its deterrent effect and thereby increase the marginal returns to resources facilitating conviction [see (11)]. Hence, increases in the stigma from a conviction increase the resources spent convicting type I defendants. But a change in the stigma from conviction has no direct effect on the marginal return to increasing pretrial detention [see (12)]. Hence, the increase in the proportion of type I defendants convicted due to the
greater stigma decreases the marginal return to pretrial detention (since $D^1$ and $R^1$ are substitutes) and hence decreases resources prolonging pretrial detention ($D^1$). An increase in the stigma, since it directly increases the marginal return to $R^1$ and has no direct effect on the marginal return to $D^1$, increases total resources spent prosecuting detained defendants.

Consider now defendants released on bail pending trial. An increase in the stigma they suffer from a conviction has an ambiguous effect on prosecutor resource allocation. Such an increase in the disutility of conviction increases the deterrent effect of convictions and thus the marginal return to resources facilitating convictions [see (13)]. But the increase in the stigma has an ambiguous effect on the marginal return to resources facilitating celerity of punishment [see (14)]. On the other hand, the greater the disutility of a conviction, the greater the reduction in that disutility from time discounting due to court delay and hence the greater the marginal return to celerity. On the other hand, the greater the disutility of a conviction, the greater the present discounted value of punishment and hence the lower the marginal gain from increasing that punishment still more by any means given diminishing marginal returns to punishment. Formally, an increase in $Z^2$ increases $v^2$, decreasing $h^2_y$ in (14) since $h^2_{vy}<0$. In sum, an increase in the stigma may increase or decrease the marginal return to $D^2$. Thus, $D^2$ may increase or decrease. And since the size of $D^2$ affects the marginal return to $R^2$, the marginal return to $R^2$ and hence $R^2$ may increase or decrease.
For detained defendants, an increase in the stigma increases resources spent facilitating convictions and decreases resources prolonging pretrial detention. Two implications follow. First, the stigma from a conviction for the rich exceeds that for the poor. Hence, among defendants incarcerated pending trial, the greater their wealth the greater the resources spent by the prosecutor facilitating their convictions and the lower the resources spent prolonging pretrial detention. Obviously, most wealthy defendants are released on bail, so this implication hardly contradicts claims that the courts discriminate against the poor. Second, among defendants tried in adult courts, the period over which the stigma from a conviction is suffered declines with their age. Hence, the present value of these psychic costs and diminished future earnings prospects falls with age. Resources that the prosecutor spends to facilitate convictions of detained defendants then fall with their age.

In sum, resources spent facilitating convictions of detained defendants rise with the stigma they suffer from a conviction and their wealth and decline with their age. Resources spent prolonging their pretrial detention decrease with the stigma they suffer from conviction and their wealth and rise with their age. No predictions were possible.

9The effect of wealth on the disutility of imprisonment and hence prosecutor resource allocation is ignored. Arguably, since the value of one's time increases with one's earnings, the disutility of imprisonment increases with wealth. But the stigma from a criminal conviction, by itself, greatly reduces future earnings prospects particularly for high wage earners (Martin and Webster, 1971). Further, wealthy defendants tend to be imprisoned in safer, better furnished facilities than other defendants. In brief, the disutility of imprisonment need not rise with income.
Price Discrimination The prosecutor has been found to "price discriminate" among defendants—vary the severity of punishment with a defendant's personal characteristics. He will price discriminate far more among released than detained defendants. Economic analysis indicates that if a firm, producing output with two factor inputs, tries to expand output, it usually increases both inputs, not just one. This is just the usual marginal condition from production theory if all inputs are subject to diminishing returns. Similarly, if the prosecutor wishes to reduce crimes committed by a given type of offenders, he generally increases both factor inputs—resources influencing convictions and court delay—since both are subject to diminishing returns. But for defendants incarcerated pending trial, these factor inputs are substitutes so that increases in one decrease the returns to the other. The opposite situation exists for defendants released on bail pending trial. For them, increases in one increase the marginal returns to the other since they are complements. Hence, increases in one intensify increases in the other. Accordingly, increases in (say) the deterrability of one type of defendants will likely lead to a greater increase in resources allocated to their cases if they were released, instead of detained, pending trial. This greater price discrimination among released compared to detained defendants means that prosecutors deviated more from the mores of the Anglo-American legal tradition of meting out punishment according to the act, not the man, for released than detained
Prison Sentence if Convicted One factor the prosecutor considers when categorizing defendants is the type of crime committed. Assume that all type 1 detained defendants committed one type of crime while all type 2 defendants committed another type of crime. How is prosecutor resource allocation influenced by the legislatively set prison sentence for each type of crime?

Assume that the legislatively set sentence for the type of crime committed by type 1 detained defendants increases. Since longer prison sentences increase the deterrent and incapacitative effects of a conviction, the marginal return to resources facilitating convictions of these defendants increases [see (11)]. But raising prison sentences has no direct effect on the marginal return to prolonging pretrial detention [see (12)]. As a result, longer prison sentences increase resources devoted to convicting detained defendants. And since R1 and D1 are substitutes, the marginal return to prolonging pretrial detention and hence pretrial detention declines. But, since the only direct effect of longer prison sentences on the marginal returns to R1 and D1 is to increase the return to R1, total resources spent prosecuting detained defendants (R1 + D1) rise.

Now assume that the legislatively set sentence for the type of crime committed by the type 2 released defendants increases. Longer

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Unfortunately, the intuition in this paragraph is hard to prove formally—the mathematics becomes intractable. Thus, the formal proof in Appendix B required some very restrictive assumptions.
prison sentences raise the incapacitative and deterrent effects of convictions and thus the marginal return to resources facilitating convictions [see (13)]. But longer prison sentences ambiguously affect the marginal return to resources hastening punishment [see (14)]. On the one hand, the greater the disutility from a conviction (— the greater the prison sentence), the greater the reduction in that disutility from time discounting caused by court delay and hence the greater the marginal return to celerity. On the other hand, the longer the prison sentence, the greater the present value of punishment and hence the lower the marginal gain from increasing punishment still more by any means including by increasing celerity of punishment. Formally, increases in $S^2$ increase $v^2$, decreasing $h_v^2$ in (14) since $h_{vv}^2 < 0$. On balance, longer prison sentences may increase or decrease the marginal return to $D^2$. Consequently, $D^2$ may increase or decrease. And since the magnitude of $D^2$ affects the marginal return to $R^2$, the marginal return to $R^2$ and hence $R^2$ may increase or decrease. In sum, an increase in the prison sentence for the type of crime committed by type 2 released defendants has an ambiguous effect on prosecutor resource allocation.\footnote{Suppose that type 2 defendants are undeterrollable recidivists. Actually, economic analysis predicts that recidivists are relatively undeterrollable (Ehrlich, 1973). Then, in (14) $h_{vv}^2$ is zero so that increases in $S^2$ increase the marginal return to $D^2$. Since the marginal return to $R^2$ also increases, the prosecutor increases the total resources ($R^2 + D^2$) spent prosecuting these defendants if $S^2$ increases.}

For federal courts, the Bail Reform Act of 1966 requires that any pretrial detention time served by a defendant be subtracted from any
prison sentence he serves. The trend is for states to adopt that policy. What is the prosecutor's response? Such crediting of pretrial detention time in effect reduces the prison sentence detained defendants serve upon conviction. That reduction decreases the marginal return to \( R^1 \) and increases the marginal return to \( D^1 \). Consequently, requiring crediting of pretrial detention time increases the pretrial detention time served by defendants who are subsequently acquitted.

To conclude, for detained defendants the greater the legislatively set sentence for the crime, the greater the resources the prosecutor spends facilitating their convictions and the less he spends prolonging pretrial detention. For released defendants, changes in the legislatively set sentence ambiguously affects prosecutor resource allocation.

**Weight of the Evidence** Suppose the probability of conviction due to factors beyond prosecutor control (e.g. strength of evidence gathered by the police) of one category of defendants exceeds that of another. How does the prosecutor respond to this differential?

For type 1 detained defendants, the greater their probability of conviction, due to factors beyond prosecutor control, the lower the marginal return to resources prolonging pretrial detention [see (12)]. Thus, such resource expenditures fail. Since \( R^1 \) and \( D^1 \) are substitutes, the marginal return to \( R^1 \) and thus \( R^1 \) rise. The only direct effect of an exogenous increase in the probability of conviction on the marginal returns to \( R^1 \) and \( D^1 \) is to decrease the marginal returns to \( D^1 \). Hence, the stronger the evidence against type 1 defendants, the lower the total prosecution resources \( (R^1 + D^1) \) spent per defendant.
Now turn to the effect on prosecutor resource allocation of increases in the probability of conviction of type 2 released defendants due to factors beyond the prosecutor's control. The marginal return to resources hastening case disposition and hence the celerity of punishment increase [see (14)]. Possibly $R^2$ also increases since the increase in its complement, $D^2$, raises its marginal return. In any event, total prosecution resources spent per defendant $(R^2 + D^2)$ increase.

In sum, an exogenous fall in the probability of conviction of all defendants decreases total prosecution resources spent per released defendant but increases such resources spent per detained defendant. Many feel that relatively recent Supreme Court decisions protecting the rights of criminal defendants made convictions much harder to obtain. The prosecutor's response is to shift resources from prosecuting released defendants to prosecuting detained defendants. Yet, many express concern on constitutional and fairness grounds about the allegedly harsher punishment received by detained compared to released defendants, ceteris paribus.\textsuperscript{12} Thus, these Supreme Court decisions may be a mixed blessing.

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Further, if, as alleged, the effect of those Supreme Court decisions was to decrease the probability of conviction of defendants, then the marginal return to resources increasing the celerity of punishment

of released defendants fell while the marginal return to resources prolonging pretrial detention rose. The prosecutor responds by shifting resources from delay decreasing to delay increasing activities. Hence, another unexpected effect of those Supreme Court decisions protecting the rights of criminal defendants is that they induce the prosecutor to seek court delay. Empirical evidence supports the prediction that the weaker the evidence against a defendant, the more the prosecutor delays case disposition (Church, 1978; Carter, 1974).

Many suspect that policemen abuse their discretion in allocating their time investigating and gathering evidence about various crimes and offenders. For instance, policemen spend less time investigating crimes involving only black victims and offenders than other crimes (Sellin and Wolfgang, 1964). How does the prosecutor respond to such police abuse? For released defendants, increases in their probability of conviction because the police gathered more evidence increase resources the prosecutor spends prosecuting them. Thus, for them, the prosecutor's actions exacerbate police investigation abuses. Conversely, for detained defendants such exogenous increases in their probability of conviction decrease the resources spent prosecuting them. Consequently, for detained defendants, the prosecutor's actions counteract police abuse of their investigatory function.

In summary, the greater the weight of the evidence against a defendant, the sooner the prosecutor tries to dispose of his case and the harder he tries for a conviction. Recent Supreme Court decisions protecting rights of the accused induce prosecutors to delay cases and increase the harshness of criminal sanctions imposed on detained
compared to released defendants. For detained defendants the prosecutor counteracts police abuse of their investigatory discretion, while for released defendants he exacerbates it.

**Productivity of $R^1$** How does the prosecutor respond to differences in the productivity of resources facilitating conviction ($P^1_R$) among categories of defendants? For type 1 detained defendants, the greater the productivity of $R^1$, the greater its marginal return and the lower the marginal return to $D^1$ [see (11) and (12)]. In consequence, resources spent facilitating convictions increase and resources spent prolonging pretrial detention decrease. Total prosecution resources spent per defendant may rise or fall. In contrast, for type 2 released defendants, the greater the productivity of $R^2$, the greater are total resources spent prosecuting them, since the marginal return to $R^2$ and $D^2$ are both larger [see (13) and (14)]. But, since the marginal return to both increases, it is unclear whether resources facilitating convictions and celerity of punishment both increase or if only one does. That is, the marginal return to say $R^2$ may rise so much relative to say $D^2$ that $R^2$ increases to such an extent that, given the budget constraint, $D^2$ decreases.

**Equal Treatment of Equals** For several reasons, prosecutors within a jurisdiction strive for equal punishment of similar defendants. First, if prosecutors each pursue different policies, deterrence suffers. Pursuit of divergent policies raises the costs to potential

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13Assuming that the greater $P^1_R$ is for all $R^1$, the greater is $P^1$ for any given $R^1$. 
criminals of obtaining information about expected punishment in a given jurisdiction, reducing the optimal amount of information gathered and (hence) the deterrent effect of the law. Second, for prosecutors in a jurisdiction to price discriminate requires monopoly power. If a few ignored the price discrimination scheme implied by the maximization of (7), then defendants will seek settlement offers from particularly lenient unfaithful prosecutors. Deterrence again suffers. Finally, to minimize the transactions costs of plea bargaining the prosecutor seeks invariant, office-wide policies. Economic analysis reveals that the transactions costs of negotiations between bilateral monopolists may be high given the range of possible prices which invites haggling. Haggling can be protracted, costly, and sometimes unsuccessful in producing an agreement on terms of exchange. Similar problems face the prosecutor and defendant in agreeing on a settlement in plea negotiations since, in a sense, they are bilateral monopolists. To avoid such transactions costs, the prosecutor can insist on a given settlement from a particular type of defendant. True, rigidity occasionally leads to an avoidable trial and hence unnecessary costs. Still the savings in transactions costs from avoidance of haggling in other cases probably means a net benefit to the prosecutor from such inflexibility.

Prosecutors favor equal treatment of similar defendants. That preference is thought to reflect their sense of fairness and justice. But the purely utilitarian concerns above also justify it. There is one case which follows where the prosecutor may treat equals unequally: similarly situated released and detained defendants.
Pretrial Detention A successful policy to ameliorate the allegedly deleterious effect of pretrial detention on case outcome must consider the cause of that effect and the prosecutor's response to that policy. Is the prosecutor a cause? Actually prosecution resources spent per detained defendant may be more or less than those spent per released defendant. If released and detained defendants were alike in all respects, prosecutors would spend more facilitating the convictions of released compared to detained defendants. The proof is simple. From (8) and (9),

$$P_R^1(1-J) = P_R^2F.$$  \hspace{1cm} (15)

Now $F$ exceeds $1-J$ because:

$$h(\int_0^T e^{-rt} dt + \int_0^S e^{-rt} dt) - h(\int_0^T e^{-rt} dt) < h(\int_0^S e^{-rt} dt + \int_T^S e^{-rt} dt)$$

$$+ h(\int_0^T e^{-rt} dt) - h(\int_0^T e^{-rt} dt) < h(\int_0^T e^{-rt} dt + \int_T^S e^{-rt} dt).$$

[since $h_{vv} < 0$ and $Z < 1$]

Since $F$ exceeds $1-J$, $P_R^1$ exceeds $P_R^2$ in (15) and thus $R_2$ exceeds $R_1$ for $P_{RR}^1 < 0$. Apparently, the prosecutor spends more resources facilitating convictions of released compared to detained defendants. However, released defendants can engage in dilatory tactics that reduce optimal prosecution expenditures. On balance, it is unclear whether the prosecutor discriminates against detained or released defendants.

Popular solutions to the deleterious effect of pretrial detention—reducing the duration of pretrial detention and liberalizing pretrial release standards—are suspect. With respect to the former, if anything, reducing pretrial detention time increases the marginal return to resources facilitating convictions and hence actually increases the probability of conviction of detained defendants.
The efficacy of more liberal pretrial release standards is also suspect. Assume that detained and released defendants are alike and that the prosecutor spends more prosecuting detained (than released) defendants. Then, releasing more defendants increases $R^1$, $D^1$, $R^2$ and $D^2$ due to a positive wealth effect. Thus, the benefits of more liberal pretrial release standards are counter-balanced by the longer detention of the remaining detainees. Of course, if initially the prosecutor spent more prosecuting released than detained defendants, then the wealth effect has the opposite effect. That is, more liberal pretrial release standards reduce the detention period of the remaining detainees.

In brief, the prosecutor may spend more effort prosecuting released or detained defendants. Such popular proposed reforms as reducing the duration of pretrial detention and liberalizing pretrial release standards may actually worsen the plight of detained defendants given the prosecutor's response to such policies. That completes the discussion of the implications. Some of the simplifying assumptions which generated those implications were somewhat unrealistic. The effect of relaxing those assumptions deserves consideration.

**Extending the Model**

To make the model more realistic, the following subsections drop the prior assumptions that (1) the deterrent effect of pretrial detention is the same as the deterrent effect of post-conviction incarceration, (2) the prosecutor ignores political considerations and (3) there is no plea bargaining.
Pretrial Detention Pretrial detention facilities are often more overcrowded and in worse shape than prisons housing convicted defendants (Blumberg, 1970). Indeed, many detained defendants are said to plead guilty just to move to better prison facilities. Thus, many (e.g., Adelstein, 1978) predict that improved pretrial detention facilities will increase the bargaining strength of detained defendants in plea negotiations and hence lead to more lenient sentences. To analyze this prediction a simplifying assumption of my model is dropped. That is, (5) and (6) assumed the same deterrence function—\( h_v^1(v) \)—for pretrial detention and post-conviction incarceration. But if a stay in pretrial detention facilities imposes more disutility on defendants than a stay in prisons housing convicted defendants, then the amount of crime deterred by any given duration of incarceration is greater if defendants are in pretrial detention facilities instead of regular prisons. Formally, for any \( v \), \( h^1(v) \) in (6) ought to exceed \( h^1(v) \) in (5). Improving pretrial detention facilities decreases the marginal return to \( D^1 \) and increases the marginal return to \( R^1 \) [see (11) and (12)]. Hence, \( R^1 \) rises and \( D^1 \) falls. Since \( R^1 \) and \( D^1 \) move in opposite directions, it is unclear whether the present value of punishment of type 1 defendants increases. But improving pretrial detention facilities increases prosecution resources facilitating convictions of detained defendants. Thus, such an improvement will not necessarily enhance the defendant's plea bargaining position vis-a-vis the prosecutor, despite many contrary statements in the literature.

Political Scandals, Voter Deception and Prosecutor Resource Allocation To analyze the effect of politics on the prosecutor, the
assumptions of the model must be relaxed. The model assumes that the prosecutor minimizes the social loss from crime. Presumably he does that to maximize his reelection chances. But voters are generally not well informed about the current prosecutor's resource allocation and its impact on local crime. The reason is well known. The marginal cost to the voter of obtaining information about prosecutor resource allocation is substantial. But the marginal benefit to him of such information is minimal since his vote has little impact on the election outcome. However the voter is probably very aware of the local crime rate. The marginal cost of collecting such information is small. Indeed, given the prevalence of information about local crimes (e.g. in the mass media), the voter would actually have to invest time and effort to avoid knowing the local rate. Further, the marginal benefit of investments to acquire information about local crime exceeds that to investments to obtain information about prosecutor resource allocation. The reason: knowledge of the extent, locational distribution and type of local crime helps the voter protect himself from crime. Thus, now assume voters are aware of the local crime rate (but not prosecutor resource allocation) and judge the prosecutor by it.

At all points in time, the prosecutor has a certain political capital stock, reflecting voter evaluation of his performance. This capital stock is subject to depreciation and appreciation (in part from a fading public memory). Increases in the prosecutor's political capital stock enhance his reelection chances.

In my model, the effect of politics on the prosecutor is through its effect on his rate of time discount. Increases in his reelection
chances decrease his rate of time discount \( (p) \). Assuming he has no time preference, if he is certain to win the next election, then he has no reason to discount reductions in crime that occur during the post-election period from his current resource allocations. But if reelection is uncertain, then such future crime reductions are worth less to him than present reductions for he is less likely to be in office in the future and receive credit for them.

The prosecutor's rate of time discount also varies with the time until the next election. Early in his election term, the prosecutor probably has a lower rate of time discount than the voters since for him future reductions in crime are worth more than present ones since he only seeks reelection in the future. Of course, this assumes some fading of the public's memory about the current crime rate. As the election approaches, the prosecutor's rate of discount rises, \textit{ceteris paribus}. Lastly, note that since \( h^I(\cdot) \) is the present value of the reduction in social loss from future crime from the deterrent effect of criminal sanctions, increases in \( p \) decrease \( h^I(\cdot) \).

The easiest way to intuitively demonstrate the political predictions is by example. Assume type 1 individuals are undeterred recidivists and type 2 individuals are very deterred nonrecidivists. Actually, this example is not unlikely (see footnote 11). Also, assume quite reasonably, a time lag between changes in prosecution policy and its recognition by potential offenders. For convenience of exposition assume further that the election is sufficiently close that, given the time lag, present criminal sanctions only deter crimes after the upcoming election. In contrast, the incapacitation effect from incarcerating
recidivists prevents crime before the election.

Suppose a political scandal involving the prosecutor or a crime wave for which he is blamed or that his political party loses popularity or that he is running against a very strong opponent. He then suffers a large depreciation in his political capital stock. His reelection chances fall. His rate of time preference for crime reductions in the present compared to the post-election period rises. Consequently, the marginal return to resources spent prosecuting type 2 defendants falls compared to the marginal return to resources spent prosecuting type 1 defendants. The prosecutor will shift resources to prosecuting type 1 defendants—undeterreable recidivists. The present crime rate is reduced at the cost of increased future crime. Since voters are unaware of this reallocation of resources, the prosecutor's current stock of political capital rises as the crime rate falls. His expected future political capital stock falls since expected future crime increases. In other words, the prosecutor shifted some future political capital to the present. If the prosecutor is very risk averse, such a resource reallocation will occur just before every election, even if his is heavily favored.

If the prosecutor's reelection chances are slight, then his positive rate of time preference probably exceeds that of the voters.
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\[14\] If the prosecutor is very risk averse, such a resource reallocation will occur just before every election, even if his is heavily favored.
Hence, he will allocate more resources to achieving present reductions in crime at the cost of future increases than voters wish. Ironically, the prosecutor tries to regain voter support by ignoring their best interests.

Casual observation reveals that near elections prosecutors are especially concerned with appearing "tough on crime" and not letting likely recidivists slip through their hands into the streets to commit more crimes and generate adverse publicity about the prosecutor. This observation is consistent with the implication that as the election approaches the prosecutor's rate of time preference rises and hence he puts more emphasis on incarcerating likely recidivists.

The prosecutor's office is often viewed as a temporary stepping stone in a political career. Indeed, the incumbent often leaves after one or two terms (President's Commission, 1967:73). Hence, the prosecutor heavily discounts long run effects of his actions since he probably will not be the prosecutor when they occur. For example, many feel that prisons are breeding grounds for criminals. That is, imprisonment causes the depreciation of human capital and the appreciation of illegal skills. Thus, the incarceration of a young first offender may lead him into a lifetime of crime after his release. But the prosecutor largely ignores that if he is not likely to be the prosecutor during most of this offender's subsequent criminal career. The short time horizon and high discount rate of prosecutors predispose him to ignore such externalities of imprisonment. The result may be a supply of incarceration by the prosecutor exceeding the social optimum.
Politics distorts prosecutor resource allocation away from the social optimum. When the prosecutor is in political trouble, he is most likely to ignore the voter's best interests, discriminate against poor defendants, and concentrate on recidivists. Politics also leads him to ignore the tendency of imprisonment to turn first offenders into career criminals.

**Plea Bargaining** The model has assumed all cases go to trial. This simplifying assumption does not affect the predictions. But an important issue is how the prosecutor treats defendants who plead guilty compared to those who demand trials. The answer requires revising the model. Now assume four types of defendants: detained defendants who plead guilty and those who demand trials; released defendants who plead guilty and those who demand trials. Call them types 1, 2, 3 and 4 respectively. Let $f$ be the added cost to the prosecutor of a trial compared to a settlement. Finally, it is well-known that sentences agreed on in plea negotiations between the prosecutor and defendant generally approximate the expected outcome of a trial—the probability that the defendant will be convicted in a trial times the sentence if convicted (Landes, 1971).

The prosecutor now maximizes
\[
L = N^1 \left[ \int_0^{p_1 s_1} c_1 e^{-pt} dt + h^1 \left( \int_0^{p_1 s_1} e^{-rt} dt + \int_{p_1 s_1}^{d_1} e^{-rt} dt \right) \right] \\
+ N^2 (1-p^2) J + N^2 p^2 I \\
+ N^3 \left[ \int_T^{p_3 s_3 + T^3} c_3 e^{-pt} dt + h^3 \left( \int_T^{p_3 s_3 + T^3} e^{-rt} dt + \int_T^{d_3} e^{-rt} dt \right) \right] \\
+ N^4 p^4 F \\
+ \lambda [B - N^1 (R^1 + D^1) - N^2 (R^2 + D^2 + f) - N^3 (R^3 + D^3) - N^4 (R^4 + D^4 + f)]
\]
Initially assume that the demand for trials is unaffected by the leniency of plea bargains. Assume also that type 3 and 4 defendants are alike in all respects except for their decision whether to demand a trial. Since the first order conditions require the equality of type 3 and 4 defendants,

\[ P_j^3 [\text{Sce} - p(P_j^3 S + T) + Sh_v(\cdot)e^{-r(P_j^3 S + T)(1-Z)}] = P_j^4 \left[ \int_T^{T+S} e^{-pt} dt \right. \\
+ h(\int_T^{T+S} e^{-rt} dt + \int_T^d e^{-rt} dt) \].

Which of the two bracketed terms is larger is unclear. If \( P_j^3 \) is zero and \( P_j^4 \) is any value, then the first bracketed term exceeds the second, since

\[ h(\int_T^{T+S} e^{-rt} dt + \int_T^d e^{-rt} dt) = \int_0^S h_v(\cdot) dS < Sh_v(0) \]

Where \( S=0 \) is \( Sh_v(0)e^{-rT(1-Z)} \)

\[ \text{Sce} - pT > \int_T^{T+S} e^{-pt} dt. \]

Hence, \( P_j^4 \) exceeds \( P_j^3 \) so \( R_j^3 \) exceeds \( R_j^4 \) since \( P_{RR}^1 < 0 \). Using the same method of proof, it is easily shown that if \( P_j^3 \) is one and \( P_j^4 \) is any value, then \( R_j^4 \) exceeds \( R_j^3 \). Since the first bracketed term in (16) declines monotonically in \( P_j^3 \), for low values of \( P_j^3 \), \( R_j^3 > R_j^4 \); for high values, \( R_j^4 > R_j^3 \).

In words, if the probability of conviction in a trial of defendants who plead guilty is relatively low (high), then the prosecutor seeks a plea bargained sentence--\( P_j^3 S \)--that exceeds (is less than) the expected sentence from a trial--\( P_j^4 S \). That result is only for released defendants. A similar analysis for detained defendants produced ambiguous

15Assuming: \( hSS < 0; h^1(0)=0; \) if \( P_j^3 \neq 0\), then \( v^3=0; \) if \( S=0\), then \( v^1=0\). To simplify, unnecessary superscripts are suppressed.
results. Still it was theoretically possible that for detained defendants the prosecutor would seek plea bargained sentences that exceed the expected sentence from a trial.

It has been assumed that increasing the expected sentence from demanding a trial compared to settling did not affect the demand for trials. Yet, clearly the demand for trials would decline, saving the prosecutor resources otherwise spent on costly trials. This "wealth effect" induces the prosecutor to seek heavier sanctions for defendants demanding trials compared to others. However, the prosecutor may sometimes allocate more resources prosecuting defendants pleading guilty than those demanding trials if the marginal returns to such resources are greater—a "substitution effect." In sum, a defendant's decision to plead guilty ambiguously affects prosecutor resource allocation. This conclusion conflicts with the conventional wisdom that the prosecutor treats defendants pleading guilty more leniently than those demanding trials.16

At least for released defendants, the price of a trial (the expected sentence from a trial relative to pleading guilty) was found to increase with the probability of conviction of the defendant. Thus, those defendants who are most likely guilty are most likely to plead guilty. This result is noteworthy given (1) the fear of some that many innocent defendants are lured by the prospect of lenient sentences to

16Note that the model only suggests the possibility that the sentence defendants pleading guilty receive exceeds their expected sentence if tried—their probability of conviction in a trial times the sentence received if convicted. The model does not predict that defendants pleading guilty receive a sentence greater than the sentence they would have received if tried and convicted.
plead guilty and (2) the Supreme Court's view that plea bargaining is constitutional since only those who would have been convicted in a trial plead guilty.\textsuperscript{17}

Summarizing, in certain cases (e.g. when the evidence against a released defendant is weak) the prosecutor may seek a harsher expected punishment from a defendant if he pleads guilty than if he demands a trial.

CHAPTER III
PRIOR LITERATURE

Any literature review of this area must begin with Landes' (1971) classic work. Landes' model assumed that, subject to a budget constraint, the prosecutor maximized the number of convictions weighted by their sentences. Forst and Brosl (1977) revised Landes' model by assuming that the prosecutor minimizes the social loss from crime. My model makes two major changes in these models by (1) examining how the prosecutor affects and is affected by court delay for crime deterrence reasons and (2) examining the differential treatment bailed and detained defendants receive from the prosecutor. After these changes, no predictions of prior economic models of the prosecutor survive completely intact and many new predictions appear.

Actually, one study (Adelstein; 1975, 1978) has examined how prosecutors influence and are influenced by court delay. I will argue that his bewildering choice of assumptions leaves his model of doubtful validity. Also his model differs from mine because the prosecutor's motivation for affecting court delay differs in the two models. He analyzed plea bargaining between the prosecutor and defendant. In his model, the greater the prosecutor's sentence offer in exchange for a guilty plea, the longer until the defendant accepts it. This delay is assumed to impose costs on the prosecutor—he bears the cost of pretrial
detention of defendants. The prosecutor is assumed to derive utility solely and directly from the length of prison sentences served by convicted defendants. Accordingly, the prosecutor offers that sentence to a defendant which equates the marginal benefit from further increases in that sentence offer with the marginal cost of the added delay until the defendant accepts that higher offer.

Adelstein's assumptions are bewildering. They are: (1) the prosecutor views pretrial detention as nonproductive and (2) defendants suffer disutility from pretrial detention due to foregone earnings and psychic costs of confinement. But if defendants detest pretrial detention, then it deters crime. Thus, to some extent, the prosecutor will view pretrial detention as productive. Adelstein's assumptions are contradictory.

Adelstein also assumes prosecutors bear pretrial detention costs. Realistically that is not true. But he argues that pretrial detention costs are part of the budget of the corrections department which competes with the prosecutor for operating revenue from a limited governmental allocation for preconviction criminal justice services. If Adelstein is going to unrealistically assume that the prosecutor pays such costs, it seems that he must also assume that the prosecutor pays the cost of incarcerating convicted defendants. Presumably there is also a limited governmental allocation for total criminal justice services and the prosecutor competes with the corrections department for that.

1Arguably Adelstein considers another cost of delay—the decay of evidence. But he abandons it in his formal model.
limited allocation.

Once it is assumed that the prosecutor bears the cost of incarcerating convicted defendants and that pre- and post-conviction incarceration are about equally effective crime deterrents, then Adelstein's model breaks down. In his model, the only constraint on the prosecutor from increasing the sentence he offers the defendant in exchange for a guilty plea is that it takes the defendant longer to accept that offer. But if pre- and post-conviction incarceration are about equally cost-effective crime deterrents, then the prosecutor can only benefit from increasing the sentence offer without bound. Adelstein's model lacks an equilibrium.

To conclude, Adelstein's model critically depends on a contradictory set of assumptions. Further, my model differs from his in that in mine, unlike his, the prosecutor is concerned with court delay because of the effect of court delay on the ability of criminal sanctions to deter crime. The next chapter presents evidence which rejects Adelstein's model and supports mine.
CHAPTER IV
EMPIRICAL ANALYSIS

Empirical tests of the model follow. Unlike prior empirical studies of the courts, this one is guided by strong and coherent theory. Many serious methodological errors of those studies are thereby avoided. The following sections discuss the data used and a sample selection bias, test the model's predictions, and finally contrast the empirical technique and results with prior empirical studies.

The Data

Eisenstein and Jacob's (1977) rich data set, containing about 1500 defendants charged with felonies in the Baltimore courts in 1972, is used. Table 1 lists the empirical variables and their sample means. Monetary variables are in hundreds of dollars.¹

This data set lacks some important theoretical variables. Most notably, it lacks measures of the resources (time and physical inputs) which the prosecutor allocates to facilitate convictions and influence court delay in each case—R¹ and D¹. Instead, the number of postponements requested by the prosecutor, POSTPONE, is used to roughly measure

¹Eisenstein and Jacob describe in detail this data and the Baltimore courts.
<table>
<thead>
<tr>
<th>Variable</th>
<th>Definition</th>
<th>Mean ± Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>ADDICT</td>
<td>1=Evidence of drug use by defendant, 0=Otherwise</td>
<td>0.18 ± 0.39</td>
</tr>
<tr>
<td>AGE</td>
<td>Age of defendant</td>
<td>27.36 ± 8.37</td>
</tr>
<tr>
<td>ARRESTS</td>
<td>Number of prior arrests</td>
<td>2.90 ± 4.60</td>
</tr>
<tr>
<td>ATTORNEY</td>
<td>1=Defense counsel is a public defender or assigned, 0=Otherwise</td>
<td>0.46 ± 0.50</td>
</tr>
<tr>
<td>BOND</td>
<td>Dollar value of bail bond (in hundreds)</td>
<td>78.67 ± 149.95</td>
</tr>
<tr>
<td>CHARGES</td>
<td>Number of charges against defendant</td>
<td>2.33 ± 1.47</td>
</tr>
<tr>
<td>DETAINED</td>
<td>1=Defendant detained in jail pending trial, 0=Defendant released on bail pending trial</td>
<td>0.58 ± 0.49</td>
</tr>
<tr>
<td>DOLLAR</td>
<td>Dollar loss from crime (in hundreds)</td>
<td>296.45 ± 163.77</td>
</tr>
<tr>
<td>EARNINGS(b)</td>
<td>Average earnings (in hundreds) of defendant's occupation for his sex/race/age/current employment (unemployment) status group (1970 Census data). If the defendant's occupation is unknown, then the average earnings of his sex/race/age group is used. Since strong empirical evidence indicates that all else equal, the wage rates of married men exceed those of single men by about 10 percent (Griliches, 1976) the earnings of married defendants are adjusted upward 10 percent. Seven percent of the defendants are married.</td>
<td>37.04 ± 27.01</td>
</tr>
<tr>
<td>EARNNDUM</td>
<td>1=Defendant's occupation is not known, 0=All others</td>
<td>0.37 ± 0.48</td>
</tr>
</tbody>
</table>

\(\text{Mean} \pm \text{Standard Deviation}\)
<table>
<thead>
<tr>
<th>Variable</th>
<th>Definition</th>
<th>Mean (Standard Deviation)</th>
</tr>
</thead>
<tbody>
<tr>
<td>FAMILY</td>
<td>1=Defendant living with parents, siblings or spouse</td>
<td>.38 (0.48)</td>
</tr>
<tr>
<td></td>
<td>0=All others</td>
<td></td>
</tr>
<tr>
<td>FELONIES</td>
<td>Number of prior felony convictions of defendant</td>
<td>.43 (0.95)</td>
</tr>
<tr>
<td>INCIDENTS</td>
<td>Number of separate incidents</td>
<td>1.15 (0.55)</td>
</tr>
<tr>
<td>INJURY</td>
<td>Most serious injury to victim(s):</td>
<td>1.42 (1.04)</td>
</tr>
<tr>
<td></td>
<td>=1 if none</td>
<td></td>
</tr>
<tr>
<td></td>
<td>=2 if minor</td>
<td></td>
</tr>
<tr>
<td></td>
<td>=3 if treated and released</td>
<td></td>
</tr>
<tr>
<td></td>
<td>=4 if hospitalized</td>
<td></td>
</tr>
<tr>
<td></td>
<td>=5 if killed</td>
<td></td>
</tr>
<tr>
<td>JUMPBAIL</td>
<td>1=Defendant has jumped bail in the past</td>
<td>.05 (0.21)</td>
</tr>
<tr>
<td></td>
<td>0=Otherwise</td>
<td></td>
</tr>
<tr>
<td>MINMAX</td>
<td>Average of the legislatively established minimum and maximum sentence for</td>
<td>172.57 (117.46)</td>
</tr>
<tr>
<td></td>
<td>the most serious offense with which the defendant is charged (in months)</td>
<td></td>
</tr>
<tr>
<td>MISDEMEANORS</td>
<td>Number of prior misdemeanor convictions of defendant</td>
<td>1.32 (2.18)</td>
</tr>
<tr>
<td>ONBAIL</td>
<td>1=Defendant released on bail pending trial</td>
<td>.42 (0.49)</td>
</tr>
<tr>
<td></td>
<td>0=All others</td>
<td></td>
</tr>
<tr>
<td>P</td>
<td>Predicted probability of conviction in a trial of the defendant. This variable</td>
<td>.78 (.71)</td>
</tr>
<tr>
<td></td>
<td>is estimated by instrumental variable techniques in Appendix C.</td>
<td></td>
</tr>
<tr>
<td>POSTPOND</td>
<td>Number of postponements requested by defense counsel</td>
<td>.14 (.43)</td>
</tr>
<tr>
<td>POSTPONE</td>
<td>Number of postponements requested by prosecutor</td>
<td>.42 (.77)</td>
</tr>
<tr>
<td>RECORD</td>
<td>1=Defendant has a prior record</td>
<td>.56 (.50)</td>
</tr>
<tr>
<td></td>
<td>0=Otherwise</td>
<td></td>
</tr>
</tbody>
</table>
TABLE 1 (continued)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Definition</th>
<th>Mean ( ^a ) (Standard Deviation)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SENTENCE</td>
<td>Prison sentence (in months). Equals zero if acquitted, dismissed, given a suspended sentence or only a fine. Pretrial detention time is subtracted from the prison sentence if the judge did that.</td>
<td>30.98 (74.09)</td>
</tr>
</tbody>
</table>
| SLOWJUDGE| 1=Judge has case backlog or postponed case  
0=Otherwise                                                                  | .23 (.42)                           |
| WEAPON   | 1=Defendant displayed/used weapon in crime  
0=Otherwise                                                                   | .34 (.47)                           |
| WHITE    | 1=Defendant is white  
0=All others                                                                   | .19 (.39)                           |

\( ^a \)Sample size = 977; monetary variables are in hundreds of dollars.

\( ^b \)Dagenais (1973) discusses the solution used here for unavailable data.
D'. And the length of the prison sentence if convicted (zero otherwise), SENTENCE, is used to roughly measure R'. The prosecutor's control of the outcome of cases is so great that some call him the "de facto judge" (Jacob, 1965:156). Thus, hopefully, any variance of the prison sentences defendants actually receive (zero if acquitted), holding constant the evidence collected by the police and the legislatively set maximum and minimum sentences for the crime charged (MINMAX), reflects differences in R'.

Only the following eight implications of the model are testable with this data: the prosecutor spends more resources facilitating the convictions of detained defendants (and, hence, the greater their SENTENCE) the greater their EARNINGS and the younger their AGE; the prosecutor seeks more POSTPONEMENTs for detained defendants, the greater their AGE, the lower their EARNINGS and Probability of conviction, the fewer the criminal CHARGES against them, and the lower the legislatively established sentence for the crime charged (MINMAX); prosecutors seek fewer POSTPONEMENTs for released defendants, the greater their Probability of conviction. I am not aware of any theory in the literature, economic or otherwise, which makes any of these predictions.

Estimated associations between AGE, EARNINGS and SENTENCE many reflect the collective rationality of all courtroom participants, not just the prosecutor's rationality. But, if anything, the change of optimal defense expenditures with a defendant's AGE and EARNINGS biases the empirical tests of my model towards rejecting its predictions. Optimal defense expenditures likely rise with a defendant's EARNINGS. Such expenditures probably also fall with a defendant's AGE since older
defendants suffer the stigma of conviction over a shorter period than younger ones. Hence, the change in optimal defense effort with AGE and EARNINGS would cause AGE and SENTENCE to be positively associated and EARNINGS and SENTENCE to be negatively associated, just the opposite of my model's predictions.

The number of POSTPONEments the prosecutor requests is a more reliable measure of his demand for court delay than SENTENCE is for $R^1$. To that extent, my model, which predicts what factors affect prosecution resources influencing court delay, is more easily tested than models (those of Landes, Forst and Brosl) which only predict what factors affect prosecution resources facilitating convictions.

To test the above eight predictions, estimate two reduced form equations for separate samples of detained and released defendants:

For the detained defendants:

$$\alpha_1^{\text{AGE}_1} + \alpha_2^{\text{EARNINGS}_1} + \alpha_3^{\text{P}_1} + \alpha_4^{\text{MINMAX}_1} + \alpha_5^{\text{CHARGES}_1} + \text{SENTENCE}_1 + \alpha_6^{\text{POSTPOND}_1} + \alpha_7^{\text{SLOWJUDGE}_1} + \alpha_8^{\text{WHITE}_1} + \alpha_9^{\text{DOLLAR}_1} + \alpha_{10}^{\text{INCIDENTS}_1} + \alpha_{11}^{\text{INJURY}_1} + \alpha_{12}^{\text{WEAPON}_1} + \alpha_{13}^{(\text{defendant's criminal history})} + \alpha_{14}^{\text{EARNDUM}_1} + \alpha_0^{J} + u_1^{J}$$

where $\alpha_x^j (x=0...14)$ are regression coefficients for the $j$th equation ($j=$ SENTENCE, POSTPONE) and $u_1^j$ is a disturbance term. The $i$ subscripts refer to the $i$th defendant. Variables are included to control for the dilatory propensities of the judge and the defendant, the seriousness
of the crime, and the defendant's criminal history.\textsuperscript{2}

Before estimating these equation, a problem must be surmounted: separating the defendants into two samples (detained and released) before estimating the equations biases the estimated coefficients. Turn now to this so-called "sample selection bias."

\textbf{Sample Selection Bias}

The effect on prosecution resources influencing court delay and facilitating convictions of changes in factors upon which they depend was found to differ systematically between detained and released defendants. Hence, equations concerning the determinants of postponements requested by the prosecutor and sentence severity must be estimated for separate samples of released and detained defendants. But a simple model of the demand for pretrial freedom by defendants presented below finds that separate estimation biases the estimated coefficients of each equation. In other words, estimating the \textit{POSTPONE} and \textit{SENTENCE} equations for separate samples of released and detained defendants creates a "sample selection bias." A way of estimating these equations that corrects for that sample selection bias is presented below.

A defendant seeks release on bail pending trial if the value of release exceeds its cost: that is, if

\textsuperscript{2}Several variables measure a defendant's criminal history: RECORD, ARRESTS, FELONIES and MISDEMEANORS. All cannot be in each equation since severe multicollinearity results. Thus, each was put seriatim into each of the equations below and only the one with the greatest statistical significance or contribution to the total explanatory power of the equation was kept. Rao and Miller (1971:35-8) defend this procedure.
\[ U = \int_0^T se^{-rt} dt - \int_S^{T+S} se^{-rt} dt - b(P, S) > 0 \]  

(18)

where "s" is the monetary equivalent of the disutility of one month's imprisonment and \( b(P, S) \) is the cost of pretrial release. The defendant expects \( T \) months of delay until his case is disposed of. All other symbols were defined above.

The first term is the disutility of pretrial detention avoided by release on bail. Assume pretrial detention time is credited to any sentence which the defendant serves if convicted. Then, if a released defendant is convicted, he is incarcerated longer following the conviction than the detained defendant who has already served some of his sentence prior to trial; the second term in (18) reflects such crediting of pretrial detention time. The third term, \( b(P, S) \), the cost of pretrial release, largely reflects the size of the bail bond.

Judges set higher bail bond the more likely a defendant will be convicted and receive a severe sentence so \( \frac{db}{dP} > 0 \) and \( \frac{db}{dS} > 0 \). Note that the disutility of imprisonment (s) falls with the extent of the defendant's prior incarceration (for he grows accustomed to jail life).

My model predicts that the greater a defendant's probability of conviction in a trial (\( \hat{P} \)), the fewer postponements the prosecutor requests (POSTPONE). But the sample selection bias causes POSTPONE and \( \hat{P} \) to be spuriously positively related when their empirical association is

---

3 The cost of pretrial release is independent of court delay. That is, the return from assets used as security for bail bonds are received by the owner. Also, bail bondsmen's fees are independent of delay (Silverstein, 1965).

4 So far I have merely formalized many diverse theoretical points by Landes (1971, 1973, 1974) into a single equation. What follows is original.
estimated for separate samples of detained and released defendants. To prove that, assume a defendant is indifferent between pretrial detention and release: $U=0$. For a sample of such defendants, $P$ and $T$ are positively correlated ceteris paribus. That is, for a defendant initially with $U=0$, increases in $T$ produce a positive new benefit to pretrial release ($U > 0$) which must be offset by an increase in $P$ (which decreases the net benefit to pretrial release) large enough to bring the net benefit back to zero---$U=0$. Formally, using the implicit function theorem on $U=0,$

$$\frac{dP}{dT} = -\frac{du}{du} = \frac{se^{-rT} - Pse^{-r(T+S)}}{\int_{T}^{T+S} se^{-rt}dt + bP} > 0.$$ 

Hence, for a sample of detained defendants, increases in $T$ increase the minimum threshold $P$ above which the condition for sample inclusion is met---$U < 0$---and hence the average $P$. Likewise, for a sample of released defendants, increases in $T$ increase the maximum threshold $P$ below which the condition for sample inclusion is met ($-U > 0$) and hence the average $P$. Thus, if one examines separate samples of released and detained defendants, $P$ and $T$ may appear positively related in each sample. But this positive association results from the criterion for sample inclusion: pretrial status (detained or released). This sample selection bias may cause $\hat{P}$ to be spuriously positively correlated, albeit the true correlation is negative, as theoretically predicted.\(^5\)

---

\(^5\)Arguably, when the prosecutor increases the expected pretrial detention time of a particular category of defendants, they may seek
Many other effects of this sample selection bias on the coefficients in (17) can easily be proven, but the above example illustrates its detrimental nature. Consider the solution to this sample selection bias when estimating the determinants of the severity of SENTENCES received by detained defendants. Formally, estimate

\[
E(\text{SENTENCE}_i | H_i, \text{sample selection rule that } \text{DETAINED}_i = 1) = YH_i + E(U_{1i} | U_{2i} > -qM_i) \tag{19}
\]

where \( \text{DETAINED}_i = qM_i + U_{2i} \tag{20} \).

\( \text{DETAINED}_i = 1 \) if defendant "i" is detained pending trial

\( = 0 \) otherwise

\( Y, q \) are, respectively, \( h \times h \) and \( h \times m \) vectors of parameters

\( H_i, M_i \) are, respectively, \( h \times 1 \) and \( m \times 1 \) vectors of exogenous regressors for the \( i \)th defendant

\( U_{1i}, U_{2i} \) are disturbances for defendant "i" for the SENTENCE and DETAINED equations respectively.

Equation (20) estimates the determinants of sample inclusion. Since pretrial status (detained or released) influences case outcome and expected case outcome influences pretrial status, \( \text{cov} (U_{1i}, U_{2i}) \) is non-zero. Further, most variables in \( H_i \) are also in \( M_i \) or are correlated release, defeating the prosecutor's objective of increasing their punishment. But before the increase in expected pretrial detention time, these defendants revealed by their preference to remain detained pending trial that the cost of the bail bond exceeded the cost of pretrial detention time. When they seek release, they bear the cost of the bail bond. The prosecutor, in effect, increased their punishment.

Incidentally, other types of sample selection biases distorting empirical results can be found in many empirical studies of the courts.

What follows is a specific application of Heckman's (1979) solution to sample selection biases.
with variables in $M_1$. Therefore, ordinary least squares estimates of (19) yield the coefficient vector:

$$\hat{Y} = y + \frac{\delta E(U_{11} | U_{21} > -q_{H_1})}{\delta H_1}.$$

The first term is the meaningful reduced form effect of each variable in $H_1$ on $\text{SENTENCE}_i$, while the second is the probability that the observation is included in the nonrandom sample.

If an estimate of the conditional mean of $U_{11}$, $E(U_{11} | U_{21} > -q_{H_1})$, was included in (19), standard regression analysis applied to (19) would yield the desired parameters—$Y$. Indeed, using a computationally simple technique by Heckman (1979), $E(U_{11} | U_{21} > -q_{H_1})$ can be estimated from the coefficients of (20) estimated by probit analysis. Turn to that task.

From (18) the probability of pretrial detention rises with the defendant's (1) cost of release (the bail bond, $BOND$), (2) probability of conviction and (3) prior criminal RECORD and decreases with (4) his EARNINGS.

Finally, the demand for pretrial release by defendants who are drug addicts is especially price inelastic. Addicted defendants seek pretrial release to obtain drugs. It is well-known that the demand for drugs by addicts is very price inelastic (Rotterberg, 1968). And one of Marshall’s rules of derived demand is that the more price inelastic the demand for a final product (drugs here), the more price inelastic the derived demand for intermediate factors used to produce the final product (pretrial release). Hence, defendants who are drug addicts have a more price inelastic demand for pretrial freedom than other defendants.
Table 2 contains probit coefficients for the probability of pre-trial detention equation. All coefficient signs are as predicted, though RECORD is not statistically significant. Using these coefficients, $E(U_1|U_2 > -q_H) = \frac{1(\xi_1)}{L(\xi_1)}$

where $\xi_1 = a_0 BOND_1 + a_1 (BOND_1)^2 + a_2 BOND_1 \cdot ADDICT + a_3 EARNINGS_1 + \ldots$, and $1(\cdot)$ and $L(\cdot)$ are, respectively, the probability and cumulative distribution functions of a standardized normal variate. The $a_j$ are the probit coefficients in Table 2. The selectivity index, $\phi_1$, is included as a regressor in equation (19) to obtain unbiased estimates of $Y$.

To summarize, the model of the prosecutor predicts that the determinants of SENTENCE severity and POSTPONEMENTs requested by the prosecutor vary between released and detained defendants. Separate estimation for released and detained defendants of those equations leads to a sample selection bias distorting any empirical results. The correction procedure for it in all the equations that follow is analogous to the procedure outlined for the SENTENCE severity equation for detained defendants.

---

8 Reasons for including the remaining variables in Table 2 are intuitive. Given the well-known problems with using ordinary least squares if the dependent variable is dichotomous, as DETAINED is, probit analysis is used. See Theil (1971).

9 Multiply the probit coefficients in Table 2 by $(1/\sqrt{2\pi}) e^{-(1/2)(\xi)^2} = .25$ to get the change in the probability of pretrial detention per unit change in the independent variables at the sample means (Theil, 1971). $\xi$ is the mean of $\xi_1$.

10 Equation (19) is estimated by weighted least squares for entering $\phi_1$ causes heteroscedastic disturbances (Heckman, 1979).
TABLE 2
DETERMINANTS OF PRETRIAL DETENTION
(DETAINED)

<table>
<thead>
<tr>
<th>Variables</th>
<th>Probit Coefficients</th>
<th>Variables</th>
<th>Probit Coefficients</th>
</tr>
</thead>
<tbody>
<tr>
<td>BOND</td>
<td>0.024 (12.51)***</td>
<td>WHITE</td>
<td>-0.215 (1.59)</td>
</tr>
<tr>
<td>(BOND)^2</td>
<td>-0.00002 (9.07)***</td>
<td>CHARGES</td>
<td>-0.380 (2.64)**</td>
</tr>
<tr>
<td>BOND*ADDICT</td>
<td>-0.003 (2.07)***</td>
<td>(CHARGES)^2</td>
<td>0.039 (1.68)*</td>
</tr>
<tr>
<td>EARNINGS</td>
<td>-0.005 (2.56)***</td>
<td>DOLLAR</td>
<td>-0.004 (.54)</td>
</tr>
<tr>
<td>EARNEDUM</td>
<td>0.215 (1.78)*</td>
<td>INCIDENTS</td>
<td>0.122 (1.05)</td>
</tr>
<tr>
<td>P</td>
<td>0.720 (2.27)***</td>
<td>INJURY</td>
<td>0.005 (.08)</td>
</tr>
<tr>
<td>RECORD</td>
<td>0.019 (.16)</td>
<td>MINMAX</td>
<td>0.003 (4.21)***</td>
</tr>
<tr>
<td>JUMPBAIL</td>
<td>0.222 (.96)</td>
<td>WEAPON</td>
<td>-0.011 (.09)</td>
</tr>
<tr>
<td>FAMILY</td>
<td>-0.125 (1.11)</td>
<td>CONSTANT</td>
<td>-0.181 (.28)</td>
</tr>
<tr>
<td>ATTORNEY</td>
<td>0.764 (7.46)***</td>
<td>Variance explained</td>
<td>0.48 (Pseudo R^2)</td>
</tr>
<tr>
<td>AGE</td>
<td>-0.075 (2.18)***</td>
<td>Log likelihood</td>
<td>-445.7</td>
</tr>
<tr>
<td>(AGE)^2</td>
<td>0.001 (1.91)***</td>
<td>Sample size</td>
<td>997</td>
</tr>
</tbody>
</table>

*Asymptotic t-statistics in parentheses.
*Significant at 10% level, **5% level, ***1% level.
A one-tailed test is used only when the coefficient sign is as predicted.
PLEASE NOTE

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page 55

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### Table 3
**Determinants of Sentence Severity and Postponements Requested by Prosecutor**

<table>
<thead>
<tr>
<th>Requested Variable</th>
<th>Sentence Severity</th>
<th>Sentence On Time</th>
<th>Sentence Off Time</th>
<th>Overall Postponement</th>
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<tr>
<td><strong>AGE</strong></td>
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<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>.1785</td>
<td>.0853</td>
<td>.0121</td>
<td>.0121</td>
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<tr>
<td></td>
<td>(.091)</td>
<td>(.088)</td>
<td>(.012)</td>
<td>(.012)</td>
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<tr>
<td><strong>EARNINGS</strong></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>.4325</td>
<td>.3462</td>
<td>.2289</td>
<td>.2289</td>
</tr>
<tr>
<td></td>
<td>(.13)</td>
<td>(.13)</td>
<td>(.13)</td>
<td>(.13)</td>
</tr>
<tr>
<td><strong>O</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>57.7643</td>
<td>65.0995</td>
<td>8.1177</td>
<td>8.1177</td>
</tr>
<tr>
<td></td>
<td>(.06)</td>
<td>(.06)</td>
<td>(.06)</td>
<td>(.06)</td>
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<tr>
<td><strong>FINANCE</strong></td>
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<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>.9215</td>
<td>.9888</td>
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<td>.8589</td>
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<tr>
<td></td>
<td>(.16)</td>
<td>(.16)</td>
<td>(.16)</td>
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<tr>
<td><strong>CHARGES</strong></td>
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<tr>
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<td>3.2193</td>
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<td></td>
<td>(.03)</td>
<td>(.03)</td>
<td>(.03)</td>
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<td><strong>POSTPOST</strong></td>
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<tr>
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<td></td>
<td>(.10)</td>
<td>(.10)</td>
<td>(.10)</td>
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<tr>
<td><strong>SOLARIA</strong></td>
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<td></td>
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<td></td>
<td>5.7777</td>
<td>4.5368</td>
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<td></td>
<td>(.16)</td>
<td>(.16)</td>
<td>(.16)</td>
<td>(.16)</td>
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<tr>
<td><strong>RECORD</strong></td>
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<td></td>
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<tr>
<td></td>
<td>.0990</td>
<td>.1123</td>
<td>.0990</td>
<td>.1123</td>
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<td><strong>ARRESTS</strong></td>
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<tr>
<td><strong>FELONIES</strong></td>
<td>17.9527</td>
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<td>17.9527</td>
<td>17.9527</td>
</tr>
<tr>
<td></td>
<td>(.01)</td>
<td>(.01)</td>
<td>(.01)</td>
<td>(.01)</td>
</tr>
<tr>
<td><strong>INCITEMENTS</strong></td>
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<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>.0165</td>
<td>.0117</td>
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<td></td>
<td>(.10)</td>
<td>(.10)</td>
<td>(.10)</td>
<td>(.10)</td>
</tr>
<tr>
<td><strong>Vandalism</strong></td>
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<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>18.5046</td>
<td>18.5046</td>
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<tr>
<td></td>
<td>(.16)</td>
<td>(.16)</td>
<td>(.16)</td>
<td>(.16)</td>
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<tr>
<td><strong>Vandalism contained</strong></td>
<td>.20</td>
<td>.20</td>
<td>.20</td>
<td>.20</td>
</tr>
<tr>
<td></td>
<td>(.10)</td>
<td>(.10)</td>
<td>(.10)</td>
<td>(.10)</td>
</tr>
<tr>
<td><strong>F ratio</strong></td>
<td>4.190009</td>
<td>4.550009</td>
<td>4.550009</td>
<td>4.550009</td>
</tr>
<tr>
<td></td>
<td>(.01)</td>
<td>(.01)</td>
<td>(.01)</td>
<td>(.01)</td>
</tr>
<tr>
<td><strong>Sample size</strong></td>
<td>179</td>
<td>179</td>
<td>444</td>
<td>444</td>
</tr>
</tbody>
</table>

Notes: All regressions are weighted, dollar, incidents, injury, weapon, and a constant term.

*Significant at .05 level, **.05 level, ***.01 level.
defendants whom a judge or jury will subsequently find innocent. Yet he does precisely that.\textsuperscript{12}

The legislatively set prison sentence for the crime committed (\textsc{minmax}) by the defendant is negatively (as predicted), but insignificantly, related to \textsc{postpone}ments. Maybe this insignificance reflects the impossibility of holding "all else equal" when estimating this relationship. That is, the model predicted only that, holding all else equal, increases in the prison sentence a defendant receives if convicted decrease prosecution resources spent prolonging his pretrial detention. In the regression all aspects of the social harm from the offense he allegedly committed have not been controlled for. \textsc{minmax} may still be positively associated with the social harm caused by his crime. And that association may bias the results towards finding a positive association between \textsc{minmax} and \textsc{postpone}.

Column VII is the postponement regression for released defendants. The defendant's probability of conviction in a trial is negatively and significantly related to the number of \textsc{postpone}ments the prosecutor requests, as predicted.

The model predicted that the determinants of case outcome differ greatly between detained and released defendants. The empirical results in Table 3 strongly support that prediction. For detained defendants, decreases in their AGE and increases in their EARNINGS

\textsuperscript{12}Herbert Packer's (1968:210-21) classic study describes "The Crime Control Model" and "The Due Process Model" of the courts. Which model or mixture of the two the judicial system should or does follow is widely debated.
Increase the SENTENCE they receive. Also, for detained defendants, increases in their AGE and prior record of ARRESTS and decreases in the number of CHARGES against them increase the number of POSTPONEments requested by the prosecutor. For released defendants, all of the above associations are just the opposite.\textsuperscript{13}

The selectivity index ($\phi$), correcting the sample selection bias, is statistically significant in the SENTENCE regression for detained defendants and in the SENTENCE and POSTPONE regressions for released defendants—regressions I, V and VII. Thus, there is empirical evidence of a sample selection bias. With notable exceptions, deleting the selectivity index from the regressions has little effect on the estimated coefficients (see regressions II, IV, VI and VIII). Yet the exceptions are notable. Dropping the selectivity index from the regressions dramatically reduced the size of the coefficients of $\hat{P}$ in the POSTPONE regressions, as predicted. Indeed, for released defendants, the coefficient of $\hat{P}$ became insignificant. Further, dropping the selectivity index from the POSTPONE regression for detained defendants reverses the sign of HINHAX's coefficient. In sum, dropping the selectivity index causes the empirical evidence to reject two of eight theoretical predictions, two which the evidence had supported. More cities must be examined before the size of this sample selection bias is confidently known.

\textsuperscript{13}Formal Chow-tests of the equality of the estimated coefficients of the SENTENCE (and POSTPONE) regressions estimated for separate samples of detained and released rejected the hypothesis of equality at the 5\% level of confidence.
To conclude, the empirical evidence strongly supports the model's predictions. In contrast, two of Adelstein's predictions are rejected. They are that the optimal delay chosen by the prosecutor is greater, (1) the greater the weight of the evidence against the defendant and (2) the greater the defendant's prior record (even if he is released pending trial). The evidence strongly supports the argument that the determinants of case outcome greatly differ between detained and released defendants. The next section notes that prior empirical studies of the courts have not recognized this difference and, as a consequence, have produced misleading results.

Prior Empirical Literature

The model and empirical approach above point to serious errors in prior empirical studies of the effect of pretrial detention and court delay on case outcome. Consider pretrial detention studies first.

Generally, studies of how pretrial detention affects case outcome include a dummy variable equal to one if the defendant is detained pending trial and zero otherwise (--DETAINED) in an equation whose dependent variable is the severity of the defendant's sentence. Regression 1 in Table 4 follows this approach. The estimated coefficient indicates that detained defendants are on average sentenced to 3.6 more months in jail than released defendants, though the estimate is not statistically

14 Or the approach is so close to this that the criticisms below still apply. For example, some studies compare the probability of conviction of (or the mean sentence severity received by) detained and released defendants who have the same (say) prior record and age. Empirical studies of how pretrial detention affects case outcome are cited in footnote 12, Chapter 2.
significant. With this data and similar estimation methods, Eisenstein and Jacob reach similar findings.

**TABLE 4**

**EFFECT OF DELAY AND PRETRIAL DETENTION ON SENTENCE SEVERITY**

<table>
<thead>
<tr>
<th>Regression No.</th>
<th>Independent Variable</th>
<th>Coefficients $^b$</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>DETAINED</td>
<td>3.62 (.62)</td>
</tr>
<tr>
<td>11</td>
<td>DAYSFREE</td>
<td>.07 (2.31)</td>
</tr>
<tr>
<td></td>
<td>DAYSJAIL</td>
<td>.16 (5.18)</td>
</tr>
<tr>
<td>111</td>
<td>DELAY</td>
<td>.11 (4.27)</td>
</tr>
</tbody>
</table>

$^a$The following independent variables are also in all regressions: AGE, EARNINGS, P, MINMAX, WHITE, DOLLAR, INCIDENTS, INJURY, CHARGES, WEAPON, FELONIES and MISDEMEANORS. POSTPOND and SLOWJUDGE are also included in 1.

$^b$t-values in parentheses.

This method ignores important interactions between pretrial detention and other determinants of case outcome. That is, my model predicts that the determinants of case outcome systematically differ between detained and released defendants; the regressions in Table 3 support that prediction. Accordingly, the correct approach to estimate how pretrial detention affects case outcome must consider these interactions. To do that, multiply the sample means of the variables in Table 3 for detained defendants by the appropriate coefficients of the sentence severity.
regression for released defendants (Column 5, Table 3) to calculate what sentence detained defendants would receive if released. The calculations show that detained defendants would receive, on average, a 26.8 month prison sentence if released. In contrast, the average detained defendant actually received 44.8 months. Apparently pretrial detention increases the prison sentence by 18 months, not the 3.6 months predicted above. Analogous calculations show that released defendants would receive, on average, a 21.6 month prison sentence if detained instead. The average released defendant actually received 15.1. Curiously, detaining currently released defendants only increases their prison sentence 6.5 months, while releasing previously detained defendants reduces their prison sentences 18 months. Thus, unfortunately, this method yields conflicting estimates of the effect of pretrial detention. In any event, previous studies have greatly underestimated the deleterious effect of pretrial detention on case outcome.

The most sophisticated empirical study so far of pretrial detention (Landes, 1974) used still another method to examine its effect. Landes regressed the severity of a defendant's sentence on, among other things, two variables measuring the number of days spent awaiting case disposition by detained and released defendants; here labeled DAYSJAIL and DAYSFREE. In Regression II (Table 4), DAYSJAIL has a far greater positive effect on SENTENCE severity than DAYSFREE. Landes' empirical results for his New York City defendants are similar. He infers from these results that pretrial detention diminishes the productivity of defense inputs and thereby increases the severity of a detained defendant's sentence. I disagree. My model predicts that if the prosecutor
wants to increase the punishment of a particular detained defendant (say due to his prior record), the prosecutor tries to lengthen his pretrial detention and prison sentence. This strategy may cause the length of a defendant's pretrial detention and prison sentence to be positively correlated for a reason quite different than Landes' productivity effect.

Further, the sample selection bias discussion hints that the coefficients of DAYSFREE and DAYSJAIL are spuriously positive. There it was shown that, all else equal, the greater a defendant's probability of conviction or the lower the expected delay until disposition of his case, the more likely he remains in jail pending trial. A corollary was that, all else equal, the longer a defendant's expected delay until case disposition, the greater his probability of conviction must be for him to decide to remain in jail pending trial, rather than seek release. Thus, the greater is a detained defendant's expected DAYSJAIL, the greater is his expected SENTENCE. Likewise, the greater is a released defendant's expected DAYSFREE, the greater is his expected SENTENCE. In sum, the coefficients of DAYSJAIL and DAYSFREE are spuriously positive in regression II (Table 4) and in Landes' similar regressions.

The coefficients of SLOWJUDGE and POSTPOND in the SENTENCE regressions for detained and released defendants (I and V, Table 3) are not affected by the above two factors confounding Landes' results. Note that court delay, if anything, decreases detained defendant's SENTENCE. There is no evidence of Landes' productivity effect of pretrial detention.
The policy implications of Landes' and my model are quite different. Landes' productivity effect calls for reducing pretrial detention time or the number detained. My explanation suggests that the prosecutor, wishing to severely punish those whom he currently seeks long detention times for, would merely shift resources to facilitating their convictions following adoption of such policies. Thus, contrary to the implication of Landes' explanation, such defendants will be particularly severely punished even after such policies are adopted.

Consider now empirical studies of the effect of court delay on case outcome. Whether court delay significantly weakens the prosecutor's case because witnesses die and forget and so on has inspired much empirical study. My model suggests that these studies are seriously flawed. They assume that if and only if court delay and the probability of conviction or severity of punishment are inversely related does evidence decay with delay. Actually that inverse relationship is not a necessary or sufficient condition for the evidence decay effect. My model indicated that rational prosecutor behavior, independent of any evidence decay effect, may produce an inverse relationship. That is, the greater the probability of conviction in a particular case and the expected severity of punishment the more the prosecutor presses for quick disposition. Further, exogenous increases in delay until disposition of a particular defendant's case decrease the resources the prosecutor spends facilitating the conviction of that particular

---

defendant and hence increase the leniency of treatment that the defendant receives. Conversely, even if the evidence delay effect exists, rational prosecutor behavior may still produce a positive association between court delay and the probability of conviction or severity of prison sentence. When the prosecutor tries to more severely punish a certain detained defendant, he increases resources facilitating his conviction and prolonging his pretrial detention. This may cause court delay and sentence severity of probability of conviction to be positively related in a sample of released and detained defendants. In sum, prior empirical studies of the evidence decay effect are premised on the erroneous assumption that if and only if court delay and the severity of punishment are inversely related does evidence decay with court delay.

Regression III in Table 4 is close to the usual equation in the literature estimating the evidence decay effect. The large, significant positive association between court DELAY until the disposition of a defendant's case and the severity of his SENTENCE seems to strongly reject the evidence decay effect. Prior studies reach similar findings (see Levin's (1975) literature review). Regressions I and V (Table 3) provide better estimates of the evidence decay effect. That is, by estimating the effect of the number of postponements requested by

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16 That prediction may explain the well-known dilatory tactics of even defense counsel prepared for trial. (Alschuler, 1968:56-7; President's Commission, 1967a:375; Katz, 1972:21).

17 Some studies in footnote 15 just compare the average sentence severity and probability of conviction of defendants with different durations of delay until case disposition. My analysis applies to them too.
defense counsel (POSTPOND) and the judge (SLOWJUDGE), instead of DELAY, on SENTENCE severity, the estimate of the evidence decay effect is largely independent of the distorting effect of prosecutor behavior. Arguably the coefficients of POSTPOND and SLOWJUDGE weakly support an evidence decay effect—the negative coefficient of POSTPOND in regression V is large and significant at the 10% level. Empirical studies of other cities are necessary to determine if evidence really does significantly decay with court delay.

Summarizing, prior empirical studies of court delay and pretrial detention, by ignoring prosecutor behavior, produced misleading results. They greatly underestimated the effect of pretrial detention on case outcome by ignoring interactions between pretrial detention and other determinants of case outcome. They also erroneously found that court delay does not cause the evidence against defendants to decay by failing to recognize that actions of the prosecutor could obscure the existence of such decay in the data.

18"Largely" is used for the negative coefficients for SLOWJUDGE and POSTPOND may be because exogenous increases in delay decrease prosecution resources facilitating convictions.
A model of the prosecutor has been prepared which assumes that he minimizes the social loss from crime. The model differs from prior models of the prosecutor by (1) examining the extent to which he affects and is affected by court delay for crime deterrence reasons and by (2) examining the differential treatment detained and released defendants receive from him. For detained defendants resources facilitating convictions and influencing court delay were found to be substitutes in the sense that increases in one decrease the marginal returns to the other. By contrast, for released defendants, those two resources were complements.

No predictions of prior economic models of the prosecutor survive completely intact and many new ones appear. First, the only effect of defendant i's prior record on resources spent prosecuting him (R_i and D_i) that can be confidently predicted is that the greater his prior record of personal crimes the greater is the sum R_i+D_i. Second, for detained defendants, the greater their wealth and the younger they are, the more the prosecutor spends facilitating their convictions. Third, prosecutors price discriminate (vary punishment with a defendant's personal characteristics) more among released than detained defendants. Such discrimination deviates from the mores of the Anglo-American legal
tradition of meting out punishment according to the act, not the man.

Fourth, the greater the weight of the evidence against a defendant, the more vigorously the prosecutor seeks a conviction and the quicker the prosecutor seeks disposition of the case. Fifth, for purely crime deterrence reasons, prosecutors seek equal treatment of similar defendants. Sixth, it is unclear whether prosecutors seek sentences from plea bargaining that exceed or are less than expected sentences from trials (equal to the probability of conviction in a trial times the sentence received if convicted). Finally, for detained defendants, the greater the prison sentence, if convicted, the greater the resources the prosecutor spends facilitating their conviction and the less prolonging their pretrial detention. No prediction is possible for released defendants.

Empirical evidence from the Baltimore courts strongly confirms the model. Unlike prior empirical studies, an estimation procedure was used which considered that the determinants of case outcome differ between detained and released defendants. The adverse effect on case outcome of pretrial detention and court delay was found to be far greater than previous estimates.

The model yielded many valuable insights into the prosecutor's reaction to past and proposed judicial reforms. First, if the recent line of Supreme Court decisions protecting and expanding the rights of criminal defendants made it harder for prosecutors to obtain convictions, then prosecutors will respond by allocating more resources to delay inducing activities and prosecuting detained defendants. Second, many past and proposed reforms to offset the hardships of pretrial detention suffered
by defendants produce "undesirable" reactions from the prosecutor. For example, legislation requiring the crediting of pretrial detention time to any sentence a convicted detained defendant receives increases the resources the prosecutor spends prolonging pretrial detention. Improving admittedly deplorable pretrial detention facilities or mandating reductions in the duration of pretrial detention increase resources the prosecutor spends to facilitate conviction of detained defendants. The proposed reforms of liberalizing pretrial release standards may lead prosecutors to spend more prolonging the pretrial detention of the remaining detainees. Third, legislation requiring all cases to be disposed of within a certain time limit leads the prosecutor to increase resources facilitating the convictions of detained defendants. Fourth, efforts ought to be made to depoliticize the prosecutor's office. Concern with winning the next election and advancing to higher office leads the prosecutor to price discriminate against poor defendants when he is in political trouble, ignore the effect of imprisonment in turning young first offenders into hardened career criminals and overinvest (from a social viewpoint) in prosecuting recidivists. Finally, these is great concern that some innocent defendants are induced to plead guilty in exchange for lenient sentences offered by prosecutors. The model suggests that, at least for released defendants, these fears are exaggerated.
LIST OF REFERENCES


APPENDIX A

Prosecutor's Categorization of Defendants

The model in Chapter II assumed that the prosecutor has already categorized defendants into types 1 and 2. The model then examined how the prosecutor "price discriminates" among defendants—tries to impose varying sanctions upon defendants depending on (for example) their deterrability and criminal propensities—to minimize the social loss from crime. This appendix examines how the prosecutor categorizes defendants and the equilibrium number and type of categories.

The prosecutor is unable to collect and analyze all relevant information about defendants to insure an efficient allocation of scarce prosecutorial resources among them. At first, the prosecutor will conduct extensive investigations about each defendant concerning traits associated with his deterrability and future criminal propensity. Each investigation conveys information on how much prosecutorial effort should be allocated to the particular case. Eventually, the marginal costs of the additional information acquired by these extensive investigations of defendants exceed the marginal gains. A decision rule with resource allocations based on certain easily determinable defendant "signaling characteristics" found to be associated with deterrability and recidivism (such as age or income) is then adopted. A less costly determination of the allocation of prosecutorial effort among
defendants is then possible. That is, defendants are categorized based on their "signaling characteristics" and defendants within each category are treated equally. Evidence can be found in the descriptive literature that prosecutors categorize defendants and treat each category differently (Eisenstein, 1973).

If prosecutors are particularly lenient to defendants with certain types of "signaling characteristics," defendants will obviously try to acquire such characteristics. Obviously, if all defendants could successfully acquire these favorable signaling characteristics, then the value of such signaling characteristics to the prosecutor would be lost. Of course, certain characteristics, such as age or race cannot be changed by defendants. But defendants can "invest" in acquiring other types of "signaling characteristics" that produce favorable prosecutorial treatment. For instance, defendants who are employed or who have marketable legitimate skills tend to have lower criminal propensities than other defendants simply because the opportunity cost of crime is relatively higher for them. Hence the prosecutor, interested in minimizing the social cost of crime, will be less likely to press for incarceration of such defendants than others who are more likely to be recidivists. Consequently, defendants, prior to trial, will participate in job counseling or training programs or develop a commendable work record or state an intention to enter the military (for job training), hoping thereby to induce leniency from the prosecutor. Indeed,

1This reasoning draws on Stigler's (1968) pathbreaking article on the economics of information.

2All price discriminating monopolists face this problem.
such defendant behavior is frequently observed (see e.g. Skolnick, 1966). The returns to previously unprofitable human capital investments have increased by the returns in prosecutorial leniency.

These pretrial investments by defendants need not undermine the reliability of the "signaling characteristics" as predictors of criminal propensity and deterrability. Pretrial human capital investments increase the defendant's marketable skills and (hence) the opportunity costs of illegitimate activities. Accordingly, his future criminal propensity falls. Further, the equilibrium "signaling characteristics" will only be those that reliably indicate the criminal propensities and deterrability of a defendant. Following the prosecution of a certain category of offenders, the prosecutor observes how many are later rearrested for new crimes. Knowing their prior signaling characteristics, or alternatively knowing their current signaling characteristics and the extent of their prior record, the prosecutor tests his prior probabilistic beliefs concerning the relationship between the "signaling characteristics" and criminal propensities and deterrability. Generally, this newly acquired knowledge causes the prosecutor to alter his former beliefs. When this happens, the resources the prosecutor allocates to prosecuting defendants with various "signaling characteristics" changes. This resource reallocation in turn alters the investment behavior of defendants. Only when the prosecutor's probabilistic beliefs are confirmed is equilibrium reached. Thus, an equilibrium condition is that pretrial investments by defendants to "Impress" the prosecutor really do alter their future criminal propensities.
Beginning with Spence (1973, 1974), a substantial literature has
devolved on "job market signaling." In brief, the literature deals
with the process whereby the prospective employee acquires certain
characteristics (e.g. education) that "signal" to prospective employers
the employee's potential productivity. Concepts developed in that
literature have been applied here to defendant "signaling." However,
though the job market signaling literature predicts overinvestment in
signals by employees (from a social point of view), overinvestment in
signals by defendants need not occur. In the job market signaling
literature, overinvestment results since the private return to the sig­
 nal in the market exceeds its contribution to productivity. 3 Criminals
also decide whether human capital investments are profitable by com­
paring their private returns to costs. Of course, the returns from
such investments equal the difference between the present values of the
income streams with and without such investments. The present value of
the income stream without such investments includes more income from
illegitimate activities than the present value with such investments
because human capital investments (in school or on the job) decrease
the profitability of illegitimate relative to legitimate activities.
Thus, the social return to such investments exceeds the private return
because the the social return calculation generally excludes income

3 In equilibrium, all employees still receive wages equal to the
value of their marginal product. That is, the private return to the
signal exceeds its contribution to productivity only to the extent of
the private return to the signal from identifying the employee's unob­
servable innate abilities to the employer who then offers a higher wage.
from illegitimate activities. Hence, from a social viewpoint, offenders underinvest in signaling capital. The returns in the form of prosecutor leniency from such signaling capital investments tend to offset this underinvestment. In sum, contrary to what one familiar with the job market signaling literature might expect, defendants might not overinvest in signals.

Consider several intriguing implications of this analysis. First, empirical studies almost universally find that, ceteris paribus, defendants detained in jail pending trial receive, on average, far more severe sentences and are more likely to be convicted than released defendants. Such findings have caused much concern in the legal literature and the judiciary regarding the constitutionality and fairness of current pretrial detention practices. The inability of detained defendants to invest in favorable signals is consistent with the relatively harsh punishment they receive.

However, I suspect that defendants detained in jail pending trial would not benefit from such pretrial human capital investments, even if they were possible. The response of the offense rate \( (C) \) of individual offenders to greater legal hourly wages \( (WA) \) is, using the well-known Slutsky decomposition:

\[
\frac{\partial C}{\partial WA} = \frac{\partial C}{\partial WA} \bigg|_Y + \text{HRS} \frac{\partial C}{\partial Y}
\]

where \( Y \) is nonwage income and HRS is total hours worked in legitimate activities when not incarcerated (see Heineke, 1978; Block and Heineke, 1975). The first term to the right of the equality sign is negative, indicating that an increase in legal wages, holding income constant
(as symbolized by $|\nabla|$), decreases the supply of crime since the earnings potential of legitimate relative to illegitimate activities has risen (that is, a "substitution effect"). The second term is also negative since an increase in legal wages earned by an offender increases his income which decreases his criminal propensities, assuming crime is an inferior activity $-\frac{dc}{dy} < 0$. Defendants with low labor market commitments typically cannot obtain bail and judges tend to set higher bail bonds for them (Landes, 1973). Thus, the lower a defendant's labor market commitment the more likely he is detained pending trial. Since HRS is thus smaller for detained than released defendants, an increase in wages of defendants who are detained will not decrease their future criminal activities as much as an increase in wages of defendants who are released. This, on average, lower "signaling reliability" of human capital investments of detainees decreases, to some extent, the returns in prosecutorial leniency that would be forthcoming from such investments.

A second implication is that prosecutors will invest more time and resources acquiring information about the criminal propensities and deterssibility of defendants committing a particular offense, the greater the net social cost harm caused by that offense. The returns to preventing any particular type of offense increase with the net loss that that offense type imposes on society. Thus, the returns to information aiding the prevention of a particular type of offense (by allowing the prosecutor to better price discriminate among defendants of varying degrees of deterssibility and recidivism) will also increase with the net social loss caused by the particular type of offense. Thus, more information will be collected about and hence the price discrimination
will be more refined among defendants committing types of offenses causing particularly large social losses.

A corollary is that the much discussed "arbitrary" sentencing practices—unequal sentences for defendants with equal easily observable case and personal characteristics—will appear to rise with the seriousness of the offense. The legal observers empirically examine the determinants of the severity of punishment a given defendant receives based on objective defendant characteristics requiring little cost to observe (e.g. race, age, sex). The above analysis predicts that prosecutors will rely on information which is increasingly costly to obtain as the type of offense involved becomes more serious. As a result, the legal observer's ability to explain the determinants of the sentence received by a given defendant will decline with the severity of the offense involved. Indeed, Adelstein (1975) reports, without theoretical explanation, such findings in his econometric study of New York City defendants.

The above analysis offers another reason why the disturbance terms of (17) were heteroscedastic necessitating use of weighted least squares to estimate the regressions in Table 4. The explanatory power of (for example) the SENTENCE severity equation ought to decline (and

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I have been speaking almost as if the prosecutor decides the sentence that a convicted defendant receives. It is important to realize that I mean that in the following sense: Almost 90 percent of all cases are settled through negotiated guilty pleas in which the prosecutor either recommends a sentence to the judge (which is almost always followed) or reduces the charges and thereby reduces the maximum sentence that the judge can impose.
hence the absolute value of the disturbance rise) with the severity of the offense committed by the defendant, implying heteroscedasticity in the equation disturbances. Goldfeld and Quandt's (1965) well-known test for heteroscedasticity found this to be the case.

In sum, defendant reactions to price discrimination do not completely constrain the prosecutor's ability to price discriminate; defendants do not necessarily overinvest in producing favorable signals; detained defendants cannot benefit from such investments; and, finally, arbitrary sentencing practices only appear to rise with the severity of the offense involved.
APPENDIX B
Mathematical Appendix

A. The Model

According to chapter II, the prosecutor maximizes
\[ L = N^1(1-P^1)J + N^1P^1F + N^2P^2F \]  
subject to the budget constraint
\[ B = (D^1+R^1)N^1 + (R^2+D^2)N^2. \]  
All symbols are defined on pages vi and vii. A comparative static analysis of the effect on the equilibrium values of \( R^1, D^1, R^2 \) and \( D^2 \) of changes in various factors upon which they depend follows. Solve (23) for \( D^1 \) and substitute that value for \( D^1 \) in (22). Now maximize \( L \) with respect to \( R^2, D^2 \) and \( R^1 \). The first order conditions are:
\[ L_{R^1} = N^1[p^1_R(I-J) - (1-P^1)J_D] = 0 \]  
\[ L_{R^2} = N^2[p^2_RF - (1-P^1)J_D] = 0 \]  
\[ L_{D^2} = N^2[p^2_{D}F - (1-P^1)J_D] = 0 \]  
Since \( N^1 \) and \( N^2 \) are positive, the expressions in the brackets equal zero.

To insure that the equilibrium values of \( R^1, D^1, R^2 \) and \( D^2 \) represent a maximum of \( L \), certain well-known second order conditions must be met. It turns out that these conditions are met only if sufficiently

\[ L_{R^1} = \frac{\partial L}{\partial R^1}; \quad p^1_R = \frac{\partial p^1}{\partial R^1}; \quad J_D = \frac{\partial J}{\partial D^1} \text{ etc.} \]  

82
large diminishing marginal returns to $R^1$ and $D^1$ are assumed; that is, only if at the equilibrium values of $R^1$, $D^1$, $R^2$ and $D^2$,

$$|(1-P^1)J_{DD}| \geq \frac{P^1}{R^1}$$  \hspace{1cm} (27)
$$|\frac{P^1}{R^1}(1-J)| \geq \frac{P^1}{R^1}$$  \hspace{1cm} (28)

The expression on the left of the inequality sign in (27) reflects the extent to which one more dollar allocated to $D^1$ decreases the marginal return to $D^1$; the expression to the right of the inequality sign reflects the extent to which one more dollar allocated to $D^1$ also decreases the marginal return to $R^1$. Similarly, the term to the left of the inequality sign in (28) reflects the extent to which one more dollar allocated to $R^1$ decreases the marginal return to $R^1$; the term to the right of the inequality sign reflects the extent to which that additional dollar also decreases the marginal return to $D^1$.

Rather than formally work through the cumbersome second order conditions for a maximum to show that indeed (27) and (28) are required for the equilibrium values of $R^1$, $D^1$, $R^2$ and $D^2$ to be a maximum, an intuitive proof is presented: Assume that (27) and (28) do not hold. Rewrite the first order equilibrium conditions (24) to (26) as:

$$P^1_R(1-J) = (1-P^1)_D = \frac{P^2}{R^2} = \frac{P^2}{D^2}$$  \hspace{1cm} (29)

Now, starting from the equilibrium values of $R^1$, $D^1$, $R^2$ and $D^2$, decrease $D^1$ by one dollar. If (27) is false, then the marginal return to $R^1$ now exceeds the marginal return to $D^1$. That is,

$$P^1_R(1-J) > (1-P^1)_D > \frac{P^2}{R^2} = \frac{P^2}{D^2}$$

Thus, if (27) if false, then the prosecutor reached the equilibrium condition in (29) by not allocating his last dollar to the investment with
the highest marginal return. Consequently, the values of $R^1$, $D^1$, $R^2$ and $D^2$ obtained from the first order conditions, (29), do not represent a maximum if (27) does not hold. The proof of (28) is analogous to the proof of (27).

Traditional comparative static techniques are now used. That is, totally differentiating (24) through (26) with respect to some exogenous variable $X$ and solving the three equation system for $\frac{dR^1}{dX}$, $\frac{dR^2}{dX}$, $\frac{dD^2}{dX}$ yields the expression on the next page [(30)] where $|L_{ij}|$ is the determinant of a 3x3 matrix and $L_{ij}$ is the $i,j^{th}$ element and $i$ and $j$ each equal $R^1$, $R^2$ and $D^2$ successively. Summarizing,

$$\frac{dR^1}{dX} = a_{11}L_{R^1X} + a_{12}L_{R^2X} + a_{13}L_{D^2X}$$

$$\frac{dR^2}{dX} = a_{21}L_{R^1X} + a_{22}L_{R^2X} + a_{23}L_{D^2X}$$

$$\frac{dD^2}{dX} = a_{31}L_{R^1X} + a_{32}L_{R^2X} + a_{33}L_{D^2X}$$

The $a_{ij}$ are the coefficients of $L_{R^1X}$, $L_{R^2X}$ and $L_{D^2X}$ in (30).

The next task is to sign the $a_{ij}$. The second order condition for a maximum requires that

$$a_{11} > 0 \quad a_{22} > 0 \quad a_{33} > 0$$

A little algebraic manipulation of $a_{12}$ and $a_{13}$ yields:

$$a_{12} = a_{21} = -\frac{(N^2)^2}{|L_{ij}|} [(1-P^1)J_{DD} + P^1J_{D}] [P^2_{RD} - P^2_{DD}] < 0$$

Suppose the prosecutor spent that last dollar on the investment with the highest marginal return---$R^1$. He would not reach the equilibrium condition (29). That is, for the two expressions to be equal, $|[(1-P^1)J_{DD}]$ would have to equal $P^1J_{D}$ at equilibrium. But that violates the assumption that (27) does not hold.
\[
\frac{dR^1}{dx} = \begin{bmatrix}
L_{R^2R^1D^2D^2} & -L_{R^1R^2D^2D^2} & L_{R^1R^2D^2R^2} \\
-L_{R^2R^1D^2D^2} & L_{R^1R^2D^2D^2} & -L_{R^1R^2D^2R^1} \\
L_{R^2R^1D^2R^2} & -L_{R^1R^2D^2R^2} & L_{R^1R^2D^2R^1}
\end{bmatrix}
\begin{bmatrix}
L_{R^1X} \\
L_{R^2X} \\
L_{D^2X}
\end{bmatrix}
\]

\[
\frac{dR^2}{dx} = \begin{bmatrix}
L_{R^2R^1D^2D^2} & -L_{R^1R^2D^2D^2} & L_{R^1R^2D^2R^2} \\
-L_{R^2R^1D^2D^2} & L_{R^1R^2D^2D^2} & -L_{R^1R^2D^2R^1} \\
L_{R^2R^1D^2R^2} & -L_{R^1R^2D^2R^2} & L_{R^1R^2D^2R^1}
\end{bmatrix}
\begin{bmatrix}
L_{R^1X} \\
L_{R^2X} \\
L_{D^2X}
\end{bmatrix}
\]

\[
\frac{dD^2}{dx} = \begin{bmatrix}
L_{R^2R^1D^2D^2} & -L_{R^1R^2D^2D^2} & L_{R^1R^2D^2R^2} \\
-L_{R^2R^1D^2D^2} & L_{R^1R^2D^2D^2} & -L_{R^1R^2D^2R^1} \\
L_{R^2R^1D^2R^2} & -L_{R^1R^2D^2R^2} & L_{R^1R^2D^2R^1}
\end{bmatrix}
\begin{bmatrix}
L_{R^1X} \\
L_{R^2X} \\
L_{D^2X}
\end{bmatrix}
\]
Both terms--a_{12} and a_{13}--are negative because of the second order conditions \(|[L_{i,j}]| < 0\), (27) and diminishing marginal returns to investments increasing the celerity of punishment and the probability of conviction \((P^2_{DD} < 0 \text{ and } P^2_{RR} < 0)\).

Only \(a_{32}\) and \(a_{23}\) remain to be signed. Unfortunately, their signs are ambiguous:

\[
a_{32} = a_{23} = -[L_{R^2,R^2} + L_{R^2,D^2} + L_{D^2,R^1} + L_{D^2,D^2}] \frac{1}{|[L_{i,j}]|} \geq 0
\]

(36)

Because of diminishing returns to investments increasing the probability of conviction, \(L_{R^1,R^1} < 0\). Further, some simple algebraic manipulations will show that \(L_{R^2,R^1} = L_{R^1,D^2}\). However, the signs of \(a_{23}\) and \(a_{32}\) are ambiguous because the sign of \(L_{R^2,D^2}\) is ambiguous.

\[
L_{R^2,D^2} = N^2 [P^2_{D^2} + \frac{N^2}{N^1} (1-P^1) J_{DD}] \geq 0
\]

(37)

Notice that if the complementarity between the two types of investments \((R^2 \text{ and } D^2)\) increasing the present value of punishment of type 2 released defendants \((P^2_{D})\) is sufficiently great, then \(L_{R^2,D^2} > 0\) and (hence) \(a_{32} > 0\) and \(a_{23} > 0\). Further, (27) and (37) together indicate that a necessary condition for \(a_{32} > 0\) and \(a_{23} > 0\) is that the extent to which \(R^2\) and \(D^2\) are complements exceeds the extent to which \(R^1\) and \(D^1\) are substitutes.

Using (31) to (33) one can determine \(\frac{dR^1}{dX}, \frac{dR^2}{dX}\) and \(\frac{dD^2}{dX}\). Then \(\frac{dD^1}{dX}\) can be determined from the budget constraint:

\[
\frac{dD^1}{dX} = - \frac{dR^1}{dX} + \frac{dR^2}{dX} + \frac{dD^2}{dX} \frac{N^2}{N^1}
\]

(38)

But, the signs of all the right-hand-side derivatives in (38) will not
always be the same, forcing complicated calculations to determine the sign of \( \frac{dD^1}{dx} \). Thus, it is easier just to maximize \( L \) again. But this time rearrange the budget constraint to equal

\[
R^1 = \frac{B - (R^2 + D^2)N^2}{N^1} - D^1
\]

and substitute this expression for \( R^1 \) in \( L \). Label the result \( L^* \). \( L^* \) is a function of \( D^1, R^2 \) and \( D^2 \). The first order conditions are:

\[
L^{*}_{D1} = N^1[(1-P^1)J_D - P^1_R(I-J)] = 0
\]

\[
L^{*}_{R2} = N^2[P^2F - P^1_R(I-J)] = 0
\]

\[
L^{*}_{D2} = N^2[P^2F_D - P^1_R(I-J)] = 0
\]

Since \( N^1 \) and \( N^2 \) are positive, the expression in the brackets in each case equals zero. Though different in form, the two formulations (maximization of \( L \) and \( L^* \), respectively) are, of course, equivalent in substance. Hence, the second order conditions for the maximization of \( L^* \) have already been proved since they have been proved for \( L \). Following the same techniques as above, the following result is obtained:

\[
\frac{dD^1}{dx} = b_{11}L^*_{D1}X + b_{12}L^*_{R2}X + b_{13}L^*_{D2}X
\]  

(39)

where the \( b_{ij} \)'s \((j=1,2,3)\) are coefficients with

\[
b_{11} > 0 \quad b_{12} < 0 \quad b_{13} < 0
\]  

(40)

Equations (31), (32), (33) and (40) are now used to examine the effect of various exogenous changes in personal or case characteristics of a given defendant group on prosecutor resource allocation.

Consider the effect of an increase in the prosecutor's budget \( B \) on prosecutor resource allocation (that is on \( R^1, R^2, D^1 \) and \( D^2 \)):

\[
\frac{dR^1}{dB} = -a_{11}[P^1_{R_D} + (1-P^1)J_{DD}] - (a_{12} + a_{12})\frac{N^2}{N^1}(1-P^1)J_{DD}
\]

\[
= -a_{11}P^1_{R_D} - (a_{12}N^1 + a_{12}N^2 + a_{13}N^2)\frac{(1-P^1)J_{DD}}{N^1} \geq 0
\]  

(41)
To obtain (41) set \( X \) equal to \( B \) in (31) and perform simple algebraic manipulations on the resulting expression. The first term in (41) is negative since \( a_{11} > 0 \) [see (34)] and \( p_{11}J_{DD} > 0 \). Since \((1 - p_1)J_{DD} < 0\) because of diminishing marginal returns to investments prolonging pretrial detention, \( \frac{dR_1}{dB} \) will be positive only if \( a_{11}N_1 + a_{12}N_2 + a_{13}N_2 \) is. But simple addition of its terms finds it is ambiguous in sign and positive only if the complementarity between resources facilitating celerity and certainty of punishment of released defendants (\( R^2 \) and \( D^2 \)), formally \( p_{22}R_D^2 \), is sufficiently small. But even then \( \frac{dR_1}{dB} \) could be negative if the substitutability between resources facilitating convictions and long pretrial detention of detained defendants (\( R^1 \) and \( D^1 \)), formally \( p_{11}R_D^1 \), is sufficiently great. Thus, \( a_{11}N_1 + a_{12}N_2 + a_{13}N_2 > 0 \) is a necessary, but not sufficient condition for \( R^2 \) to be a "normal" factor in the production of reduced crime—for an increase in the prosecutor's budget to cause an increase in \( R^1 \). This conclusion takes on added importance later. Notice that the second order condition (27) makes the bracketed expression in the first line of (41) negative and hence prevents \( \frac{dR_1^1}{dB} \) from being unambiguously negative.
Analysis of $\frac{dD_1}{dB}$ is analogous. That is, first set $X$ equal to $B$ in (38). Simple algebraic manipulations of the first line of (42) yields the second. Since $b_{11}$ is positive [see (40)] the first term of (42) is negative. Since $R^1$ is subject to diminishing returns, $P_{RR}^1 (1-J)$ is negative so $\frac{dD_1}{dB}$ is positive only if $b_{11}N^1 + b_{12}N^2 + b_{13}N^2$ is positive. Simple addition of the terms of the latter equation reveals that it is only positive if the same conditions are met that are required for $a_{11}N^1 + a_{12}N^2 + a_{13}N^2$ to be positive.

The sign of $\frac{dR_2}{dB}$ is unambiguously positive. The first term of the second line of $\frac{dR_2}{dB}$ is positive because $a_{21} < 0$ [see (35)]. And simple addition shows

$$a_{21}N^1 + a_{22}N^2 + a_{23}N^2 > 0.$$ (44)

All other symbols have been previously signed.

Likewise, the sign of $\frac{dD_2}{dB}$ is unambiguously positive. The first term of the second line of $\frac{dD_2}{dB}$ is positive because $a_{31} < 0$. Simple addition shows that

$$a_{31}N^1 + a_{32}N^2 + a_{33}N^2 > 0.$$ (45)

Again, all other symbols have been previously signed.

B. Effect on Prosecutor Resource Allocation of Changes in the Characteristics of Type I Defendants, all of Whom are DETAINED Pending Trial.

1. The effect on prosecutor resource allocation ($R^1$, $D^1$, $R^2$ and $D^2$) of an increase in the recidivism rate on type I defendants:

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3The first step in the calculation of all total derivatives is to refer to the appropriate equation (31), (32), (33) or (38) and let $X$ be some factor upon which $R^1$, $D^1$, $R^2$ and $D^2$ depend; therefore, this step is not mentioned in subsequent discussion.
\[
\frac{dR^1}{dc^1} = a_{11}N^1 \left[ P^1_R (1 - J^c) - (1 - P^1) J^d_c + (P^1_D + (1 - P^1) J^d_D \right] \frac{(B - (D^2 + R^2) N^2 N^1)}{(N^1)^2}
\]
\[
+ (a_{12} + a_{13}) N^2 [- (1 - P^1) J^d_c + (1 - P^1) J^d_D \left( \frac{B - (D^2 R^2) N^2 N^1}{(N^1)^2} \right)
\text{which by (23) and (41) is}
\]
\[
= a_{11}N^1P^1_R (1 - J^c) - (a_{11} + a_{12} N^2 a_{13} N^2) (1 - P^1) J^d_c - (D^1 + R^1) N^1 \frac{dR^1}{cdB} \geq 0 \quad (46)
\]
\[
\frac{dD^1}{dc^1} = b_{11}N^1 (1 - P^1) J^d_c - (b_{11} + b_{12} a_{21} a_{22} a_{23} N^2) P^1_R (1 - J^c) - (D^1 + R^1) N^1 \frac{dD^1}{cdB} \geq 0 \quad (47)
\]
\[
\frac{dD^2}{dc^1} = a_{21}N^1P^1_R (1 - J^c) - (a_{21} + a_{22} a_{23} a_{23} N^2) (1 - P^1) J^d_c - (D^1 + R^1) N^1 \frac{dD^2}{cdB} < 0 \quad (48)
\]
\[
\frac{dD^2}{dc^1} = a_{31}N^1P^1_R (1 - J^c) - (a_{31} + a_{32} a_{33} a_{33} N^2) (1 - P^1) J^d_c - (D^1 + R^1) N^1 \frac{dD^2}{cdB} < 0 \quad (49)
\]

Since the procedure for deriving (46) is the same for (47) to (49) only the unabridged form of the derivation for \( \frac{dR^1}{dc^1} \) is presented.

The first term in (46) is positive because an increase in \( c^1 \) increases the marginal return to \( R^1 \), \( N^1 P^1_R (1 - J^c) \) [see (11)], and hence (all else equal) increases \( R^1 \). The second term in (46) indicates that an increase in \( c^1 \) increases the marginal return to \( D^1 \) [see (12)], increasing \( D^1 \) and hence, all else equal, decreases \( R^1 \) (assuming \( a_{11}N^1 + a_{12} N^2 + a_{13} N^2 > 0 \Rightarrow \frac{dR^1}{dB} > 0 \)). The third term in (46) is a negative "wealth effect" because an increase in the criminal propensities of type 1 individuals, \( c^1 \), increases the number of type 1 defendants, \( N^1 \), decreasing the prosecution resources available per defendant. On balance, \( \frac{dR^1}{dc^1} \) is ambiguous in sign. The first two expression in (46) indicate the change in \( R^1 \) from the change in the marginal returns of \( R^1 \) and \( D^1 \) due to the increase in \( c^1 \), holding \( N^1 \) constant; this "substitution effect" is represented as \( \frac{dR^1}{dc^1 \bigg|_{N^1}} \). Thus, (46) can be rewritten as
\[
\frac{dR^1}{dc^1} = \frac{dR^1}{dc^1 \bigg|_{N^1}} - (D^1 + R^1) N^1 \frac{dR^1}{cdB} \quad (48)
\]
Multiplying all terms in (48) by \( \frac{c_1^1}{R_1^1} \) and the last term by \( \frac{B N_1^1}{B N_1^1} \) yields

\[
\eta_{R_1^1} = \eta_{c_1^1} \left| \frac{B N_1^1}{B N_1^1} \right| - \alpha_1 \eta_{N_1^1} \frac{R_1^1}{c_1^1} - \eta_{B_1^1} \frac{R_1^1}{c_1^1}
\]

where \( \alpha_1 \) is the share of the prosecutor's budget spent on type 1 defendants and \( \eta_x^y \) is the elasticity of \( x \) with respect to \( y \). This is just the familiar Slutsky equation in an unfamiliar setting.

The sign of \( \frac{dD_1}{dc_1^1} \) is also ambiguous for the same reasons that \( \frac{dR_1^1}{dc_1^1} \) was ambiguous. The reader can easily verify that

\[
\eta_{D_1^1} = \eta_{c_1^1} \left| \frac{B N_1^1}{B N_1^1} \right| - \alpha_1 \eta_{N_1^1} \frac{D_1^1}{c_1^1} - \eta_{B_1^1} \frac{D_1^1}{c_1^1} \tag{49}
\]

The total derivatives \( \frac{dR_2^1}{dc_1^1} \) and \( \frac{dD_2^1}{dc_1^1} \) are unambiguously negative. The first and second expressions of (48) and (49) indicate that an increase in \( c_1^1 \) increases the marginal returns to \( R_1^1, N_1^1 P_1^1 (1-J), N_1^1 (1-P_1^1) J_D, \) and \( D_1^1 \), and thus (all else equal) decreases \( R_2^1 \) and \( D_2^1 \). The third expression in (48) and (49) indicates that an increase in \( c_1^1 \) increases \( N_1^1 \), decreasing the amount of the prosecutor's budget available per defendant, decreasing \( R_2^1 \) and \( D_2^1 \).

In sum, resources spent prosecuting type 1 defendants could decline as \( c_1^1 \) rises. Since the relative size of the negative wealth effects on resources spent prosecuting type 1 or 2 defendants is unclear, it is also unclear whether relatively more resources will be spent prosecuting type 1 or 2 defendants after a rise in the criminal propensity of type 1 defendants.

So far, it has been assumed that, despite the increase in the crime rate, the prosecutor's budget remains constant. But economic theory predicts that increases in the crime rate increase the demand
for law enforcement expenditures, increasing the prosecutor's budget (Ehrlich, 1973). Thus, the wealth effect of an increase in recidivism might be short-lived--within the current budgetary period. But it is important to recognize it because it might influence empirically observed associations between the recidivist tendencies of defendants and the harshness of treatment received from the prosecutor. Indeed, with the substantial recent increases in the crime rate, some prosecutor's offices are becoming greatly overburdened since their budgets have not increased proportionately (Work, 1971).

Prior economic models of the prosecutor have not considered these wealth effects. Actually, they assume, without explanation, that the number of defendants entering the courts is constant. In other words, implicitly they are assuming that the prosecutor's budget increases proportionately with the number of defendants. This approach should be satisfactory for examining the long run effects on prosecutor resource allocation of changes in the various factors upon which it depends. Since I am mainly interested in these long run effects, henceforth assume that the number of defendants is constant and in effect examine "income compensated substitution effects."

Assuming no or minimal "wealth effects" (the expressions after the last minus sign in (46) to (49) approximate zero), $\frac{dR^2}{dc^1}$ and $\frac{dD^2}{dc^1}$ are unambiguously negative, while $\frac{dR^1}{dc^1}$ and $\frac{dD^1}{dc^1}$ are still ambiguous in sign. Thus, while the sum $R^1+D^1$ unambiguously increases with an increase in $c^1$, it is unclear whether $R^1$ or $D^1$ individually increases.

2. The effect on prosecutor resource allocation of an increase in the deterrability of type I defendants:
Let "x" be such that \( \frac{dh^1}{dx} \) is positive for all \( v^1 \). As a consequence, \( \frac{dh^1}{dx} \) is also positive.

\[
\frac{dR^1}{dx} = a_{11}N_1^1R(1-x) - (a_{11}N_1^1 + a_{12}N_2 + a_{13}N_2^1)(1-P^1)J_{dx} \geq 0
\]

\[
\frac{dD^1}{dx} = b_{11}N_1^1(1-P^1)J_{dx} - (b_{11}N_1^1 + b_{12}N_2 + b_{13}N_2^1)(1-x) \geq 0
\]

\[
\frac{dR^2}{dx} = a_{21}N_1^1R(1-x) - (a_{21}N_1^1 + a_{22}N_2 + a_{23}N_2^1)(1-P^1)J_{dx} < 0
\]

\[
\frac{dD^2}{dx} = a_{31}N_1^1R(1-x) - (a_{31}N_1^1 + a_{32}N_2 + a_{33}N_2^1)(1-P^1)J_{dx} < 0
\]

An increase in the deterrability of type I defendants increases the marginal returns to resources devoted to convicting them--\( P^1(1-J_x) > 0 \). While the last statement may seem reasonable, it can be shown formally. By (11) the term \((1-J)\) includes

\[
h^1(f_s^1Z^1e^{-rt}dt + f_0^1 e^{-rt}dt) - h^1(f_0^{T^1} e^{-rt}dt)
\]

A Taylor series expansion of the first term in (50) shows that (50) equals

\[
(f_s^1Z^1e^{-rt}dt + f_0^1 e^{-rt}dt) \frac{dh^1(f_0^{T^1} e^{-rt}dt)}{dv^1} + \text{a function of } h_{vv}^1.
\]

Thus, increases in \( h_v^1 \) increase \((1-J)\). An increase in \( h_v^1 \) also increases \((1-P^1)J_D\) [by (12)]. The signs of the above total derivatives now follow straightforwardly, assuming \( \frac{dR^1}{dv} > 0 \) and \( \frac{dD^1}{dv} > 0 \).

3. The effect of prosecutor resource allocation of an equal increase in future crime deterred at every level of possible punishment of type I defendants.

That is, let \( x \) be such that \( h_x^1 \) equals a positive constant. Then,

\[
\frac{dR^1}{dx} = 0 \quad \frac{dD^1}{dx} = 0 \quad \frac{dR^2}{dx} = 0 \quad \frac{dD^2}{dx} = 0
\]
4. Consider the effect on prosecutor resource allocation of an increase in the stigma suffered by type 1 defendants from a conviction: \((Z_1)\):

\[
\begin{align*}
\frac{dR_1}{dZ_1} &= a_{11}N_1^{p_1}l_1 > 0 \\
\frac{dB_1}{dZ_1} &= -(b_{11}N_1+b_{12}N_2+b_{13}N_2)p_1l_1 < 0 \\
\frac{dR_2}{dZ_1} &= a_{21}N_1^{p_1}l_1 < 0 \\
\frac{dB_2}{dZ_1} &= a_{31}N_1^{p_1}l_1 < 0.
\end{align*}
\]

All variables and coefficients have been previously signed. Note that \(\frac{dB_1}{dZ_1}\) is negative if and only if \(b_{11}N_1+b_{12}N_2+b_{13}N_2 > 0\)--if \(\frac{dB_1}{dB} > 0\) [see (42)]. The effect on prosecutor resource allocation of an increase in the average number of months until the end of the lifetimes of type 1 defendants is precisely the same as that from an increase in \(Z_1\).

5. The effect of an increase in the prison sentence \((S_1)\) imposed on type 1 detained defendants if convicted:

\[
\begin{align*}
\frac{dR_1}{dS_1} &= a_{11}N_1^{p_1}l_1 > 0 \\
\frac{dB_1}{dS_1} &= -(b_{11}N_1+b_{12}N_2+b_{13}N_2)p_1l_1 < 0 \\
\frac{dR_2}{dS_1} &= a_{21}N_1^{p_1}l_1 < 0 \\
\frac{dB_2}{dS_1} &= a_{31}N_1^{p_1}l_1 < 0.
\end{align*}
\]

Note that \(\frac{dB_1}{dS_1}\) is negative if and only if \(b_{11}N_1+b_{12}N_2+b_{13}N_2 > 0\); that is, if \(\frac{dB_1}{dB} > 0\).
6. The effect of an exogenous increase in the probability of conviction of type 1 defendants—\( P_{W}^{1} > 0 \):

\[
\frac{dR_{1}}{dw_{1}} = (a_{11}N_{1}^{1} + a_{12}N_{1}^{2} + a_{13}N_{2}^{2})P_{W}^{1}J_{1} > 0
\]

\[
\frac{dD_{1}}{dw_{1}} = -b_{11}N_{1}^{1}P_{W}^{1}J_{1} < 0
\]

\[
\frac{dR_{2}}{dw_{1}} = (a_{21}N_{1}^{1} + a_{22}N_{1}^{2} + a_{23}N_{2}^{2})P_{W}^{1}J_{2} > 0
\]

\[
\frac{dD_{2}}{dw_{1}} = (a_{31}N_{1}^{1} + a_{32}N_{1}^{2} + a_{33}N_{2}^{2})P_{W}^{1}J_{2} > 0
\]

Note that \( \frac{dR_{1}}{dw_{1}} \) is positive if and only if \( a_{11}N_{1}^{1} + a_{12}N_{1}^{2} + a_{13}N_{2}^{2} \) is positive; that is, if \( \frac{dR_{1}}{db} > 0 \) [see (41)].
7. The effect of a fall in the prosecutor's ability to influence the pretrial detention time of type 1 defendants. That is, let "x" be such that $T_{Dx}^1 < 0$. Then,

$$\frac{dR_1}{dx} = -(a_{11}N_1^1+a_{12}N_2^1+a_{13}N_2^1)(1-p_1)J_{Dx}^1 > 0$$

$$\frac{dD_1}{dx} = b_{11}N_1^1(1-p_1)J_{Dx}^1 < 0$$

$$\frac{dR_2}{dx} = -(a_{21}N_1^1+a_{22}N_2^1+a_{23}N_2^1)(1-p_1)J_{Dx}^1 > 0$$

$$\frac{dD_2}{dx} = -(a_{31}N_1^1+a_{32}N_2^1+a_{33}N_2^1)(1-p_1)J_{Dx}^1 > 0$$

Except for $(1-p_1)J_{Dx}^1$, all terms have already been signed. And $(1-p_1)J_{Dx}^1$ is negative because the greater the resources $(D_1)$ required to cause a given marginal increase in the duration of pretrial detention so as to reduce crime, the lower the marginal returns to those resources [see (12)]. Note that $\frac{dR_1}{dx} > 0$ if and only if $a_{11}N_1^1+a_{12}N_2^1+a_{13}N_2^1$ is positive; that is, if $\frac{dR_1}{dB} > 0$.

8. The consequences of a rise in the productivity of prosecution resources $(R_1)$ devoted to facilitating convictions of type 1 defendants:

That is, let "x" be such that $P_1^1 > 0$. Note that an increase in $P_1^1$ for all levels of $R_1$ means that $P_1^1$ is also greater for all levels of $R_1$. Thus, $P_1^1$ is also positive.

$$\frac{dR_1}{dx} = a_{11}N_1^1P_1^1 (1-J) + (a_{11}N_1^1+a_{12}N_2^1+a_{13}N_2^1)P_1^1J_{Dx}^1 > 0$$

$$\frac{dD_1}{dx} = -b_{11}N_1^1P_1^1 J_{Dx}^1 -(b_{11}N_1^1+b_{12}N_2^1+b_{13}N_2^1)P_1^1 (1-J) < 0$$

$$\frac{dR_2}{dx} = a_{21}N_1^1P_1^1 (1-J) + (a_{21}N_1^1+a_{22}N_2^1+a_{23}N_2^1)P_1^1J_{Dx}^1 \geq 0$$

$$\frac{dD_2}{dx} = a_{31}N_1^1P_1^1 (1-J) + (a_{31}N_1^1+a_{32}N_2^1+a_{33}N_2^1)P_1^1J_{Dx}^1 \geq 0$$
9. Contrary to prior assumptions, assume that the deterrence function for detained defendants who are acquitted \([h^1(v) \text{ in } J]\) differs from the deterrence function for detained defendants who are convicted \([h^2(v) \text{ in } I]\). Further, assume a decline in \(h^1(v)\) for every \(v\) only for defendants who are acquitted.

That is, let \(x^*\) represent this decline so that \(J_x < 0\) and \(J_{dx} < 0\).

\[
\begin{align*}
\frac{dR_1^1}{dx} &= -a_{11}N_1^1 p_1^1 J_{R^1} - (a_{11}N_1^1 + a_{12}N_2^2 + a_{13}N_2^3)(1-p^1)J_{dX} > 0 \\
\frac{dD_1^1}{dx} &= b_{11}N_1^1 (1-p^1)J_{dX} + (b_{11}N_1^1 + b_{12}N_2^2 + b_{13}N_2^3)P_1^1 J_{R^1} < 0 \\
\frac{dR_2^2}{dx} &= -a_{21}N_1^1 p_1^1 J_{R^2} - (a_{21}N_1^1 + a_{22}N_2^2 + a_{23}N_2^3)(1-p^1)J_{dX} \geq 0 \\
\frac{dD_2^2}{dx} &= -a_{31}N_1^1 p_1^1 J_{R^2} - (a_{31}N_1^1 + a_{32}N_2^2 + a_{33}N_2^3)(1-p^1)J_{dX} \geq 0
\end{align*}
\]

Note that \(\frac{dR_1^1}{dx}\) is unambiguously positive and \(\frac{dD_1^1}{dx}\) is unambiguously negative if \(a_{11}N_1^1 + a_{12}N_2^2 + a_{13}N_2^3\) and \(b_{11}N_1^1 + b_{12}N_2^2 + b_{13}N_2^3\) are positive—i.e., if \(\frac{dR_1^1}{dB} > 0\) and \(\frac{dD_1^1}{dB} > 0\).

10. The effect of releasing defendants who were to be detained. That is, assuming \(dN^1/dN^2 = -1\),

\[
\begin{align*}
\frac{dR_1^1}{dN^2} &= \left[ a_{11}N_1^1 \left[ -P_1^1 J_{D^1} - (1-p^1)J_{DD} \right] - (a_{12} + a_{13})N_2^2(1-p^1)J_{dD} \right] \frac{R_1^1 + D_1^1 - R_2^2 - D_2^2}{(N_1^1)^2} \\
&= \frac{dR_1^1}{dB} \frac{(R_1^1 + D_1^1 - R_2^2 - D_2^2)/N_1^1 \geq 0}{[\text{by (41)}]} \\
\frac{dD_1^1}{dN^2} &= \frac{dD_1^1}{dB} \frac{(R_1^1 + D_1^1 - R_2^2 - D_2^2)/N_1^1 \geq 0}{[\text{by (41)}]} \\
\frac{dR_2^2}{dN^2} &= \frac{dR_2^2}{dB} \frac{(R_1^1 + D_1^1 - R_2^2 - D_2^2)/N_1^1 \geq 0}{[\text{by (41)}]} \\
\frac{dD_2^2}{dN^2} &= \frac{dD_2^2}{dB} \frac{(R_1^1 + D_1^1 - R_2^2 - D_2^2)/N_1^1 \geq 0}{[\text{by (41)}]}
\end{align*}
\]

The complete derivation is only given for \(\frac{dR_1^1}{dN^2}\) since the derivation for the others is analogous. Notice that this proof assumed that the
released and detained defendants were similar [same $c^1$ and $h^1(*)$] because the release of those to be detained defendants did not affect $c^2$ or $h^2(*)$.

C. Effect on Prosecutor Resource Allocation of Changes in the Characteristics of Type 2 Defendants, all of whom are RELEASED on bail pending trial.

1. The resource allocation effect of an increase in the recidivism rate of type 2 defendants is:

$$\frac{dR^2}{dc^2} = a_{21}N^1[P_{R^1D}^1+(1-P_{R^1D}^1)J_{DD}](D^2+R^2)N^2_c/N^1 + a_{22}N^2[R^2_{F^2}+(1-P_{R^1D}^2)J_{DD}](D^2+R^2)N^2_c/N^1$$

$$+ a_{23}N^2[P_{F^2}^2+(1-P_{R^1D}^2)J_{DD}](D^2+R^2)N^2/N^1$$

which by (43)

$$= a_{22}N^2p^2_{F^2} + a_{23}N^2p^2_{F^2} - (D^2+R^2)N^2dR^2_{cb} < 0$$

(51)

$$\frac{dd^2}{dc^2} = a_{32}N^2p^2_{F^2} + a_{33}N^2p^2_{F^2} - (D^2+R^2)N^2dd^2_{cb} < 0$$

(52)

$$\frac{dR^1}{dc^2} = a_{12}N^2p^2_{F^2} + a_{13}N^2p^2_{F^2} - (D^2+R^2)N^2dR^1_{cb} < 0$$

(53)

$$\frac{dd^1}{dc^2} = b_{12}N^2p^2_{F^2} + b_{13}N^2p^2_{F^2} - (D^2+R^2)N^2dd^2_{cb} < 0$$

(54)

Since (51) through (54) are calculated in the same way, I have only presented the full computations for (51) and presented only the results of those computations for (52) through (54). Consider the sign of $\frac{dR^2}{dc^2}$.

The expression preceding the first plus sign in (51) is positive because an increase in $c^2$ increases the marginal return to $R^2, p^2_{F^2}$ [by (13)] and thus (all else equal) $R^2$. The second expression is ambiguous because $a_{23}$ is ambiguous; $N^2p^2_{F^2} > 0$ [by (14)]. The third expression is a negative "wealth effect" because an increase in the criminal propensities of type 2 defendants will increase the number of type 2 defendants, $N^2$, decreasing the amount of the prosecutor's budget.
available per defendant, decreasing $R^2$. On balance, $\frac{dR^2}{dc^2}$ is ambiguous in sign. The first two expressions in (51) indicate the change in $R^2$ from the change in the marginal returns of $R^2$ and $D^2$ caused by the increase in $c^2$, holding $N^2$ constant; this "substitution effect" can be represented as $\frac{dR^2}{dc^2}\bigg|_{N^2}$. Thus, (51) can be rewritten as

$$\frac{dR^2}{dc^2} = \frac{dR^2}{dc^2} - (D^2+R^2)N^2\frac{dR^2}{dB}$$

(55)

Multiplying all the terms in (55) by $\frac{c^2}{R^2}$ and the last term by $\frac{BN^2}{R^2}$ yields

$$\eta^R = \eta^R - a_2 N^2 \eta^R$$

where $a_2$ is the share of the prosecutor's budget spent on type 2 defendants and $\eta_y^x$ is the elasticity of $x$ with respect to $y$.

The sign of $\frac{dD^2}{dc^2}$ is also ambiguous for the same reason that $\frac{dR^2}{dc^2}$ was ambiguous. The reader can easily verify that

$$\eta^D = \eta^D - a_2 N^2 \eta^D$$

The total derivatives $\frac{dR^2}{dc^2}$ and $\frac{dD^2}{dc^2}$ are unambiguously negative. The first and second expression of (53) and (54) indicate that an increase in $c^2$ increases the marginal returns to $R^2(P^2_{R^2})$ and $D^2(P^2_{D^2})$ and thus (all else equal) decreases $R^1$ and $D^1$. The third expressions in (53) and (54) indicate that an increase in $c^2$ increases $N^2$, decreasing $R^1$ and $D^1$ respectively.

Assuming no or minimal "wealth effects" (i.e. the expressions after the last minus signs in (51) to (54) approximate zero), then $\frac{dR^1}{dc^2}$ and $\frac{dD^1}{dc^2}$ are unambiguously negative, while $\frac{dR^2}{dc^2}$ and $\frac{dD^2}{dc^2}$ are still ambiguous.
in sign. Thus while the sum $R^2 + D^2$ unambiguously increases with an increase in $c^2$, it is unclear whether $R^2$ or $D^2$ individually increases.

2. The effect of an increase in deterrability of type 2 defendants:

That is, let $''x''$ be such that $h_{vv}^2 > 0$ for all $v^2$. As a consequence of $h_{vv}^2 > 0$, $h_x^2$ is also positive. Then

$$\frac{dR^2}{dx} = a_{22}N_2p_2^2R_x + a_{23}N_2p_2^2F_x > 0$$

$$\frac{dD^2}{dx} = a_{32}N_2p_2^2R_x + a_{33}N_2p_2^2F_x > 0$$

$$\frac{dR_1}{dx} = a_{12}N_2p_2^2R_x + a_{13}N_2p_2^2F_x < 0$$

$$\frac{dD_1}{dx} = b_{12}N_2p_2^2R_x + b_{13}N_2p_2^2F_x < 0$$

Both $N_2p_2^2R_x$ and $N_2p_2^2F_x$ are obviously positive [see (13) and (14)].

In other words, any increase in deterrability of defendants increases the marginal returns to resources facilitating certainty and celerity of punishment. The signs of the total derivatives are now readily apparent.

3. The effect of an equal increase in the future social loss of crime prevented at every level of possible punishment of type 2 defendants:

In other words, let $x$ be such that $h_x$ equals some positive constant. Clearly,

$$\frac{dR^2}{dx} = a_{22}N_2p_2^2h_x^2 > 0$$

$$\frac{dD^2}{dx} = a_{32}N_2p_2^2h_x^2 > 0$$

$$\frac{dR_1}{dx} = a_{12}N_2p_2^2h_x^2 < 0$$

$$\frac{dD_1}{dx} = b_{12}N_2p_2^2h_x^2 < 0$$
Earlier it was shown that only if the complementarity between $R^2$ and $D^2$ is sufficiently great will $a_{32}$ be positive and (hence) will $\frac{dD^2}{dx}$ be positive. Notice that the variance in this characteristic--$x$--among defendants only induces price discrimination among released and not detained defendants.

4. The effect of an increase in the stigma from a conviction ($Z^2$) of a type 2 defendant:

\[
\frac{dR^2}{dZ^2} = a_{22}N^2P^2h^2_a + a_{23}N^2P^2F_DZ \geq 0
\]

\[
\frac{dD^2}{dZ^2} = a_{32}N^2P^2h^2_a + a_{33}N^2P^2F_DZ \geq 0
\]

\[
\frac{dR^1}{dZ^2} = a_{12}N^2P^2h^2_a + a_{13}N^2P^2F_DZ \geq 0
\]

\[
\frac{dD^1}{dZ^2} = b_{12}N^2P^2h^2_a + b_{13}N^2P^2F_DZ \geq 0
\]

The greater the disutility defendants associate with a conviction, the greater the deterrent value of a conviction and (hence) the greater the marginal return to resources facilitating convictions--$p^2h^2_a > 0$ [see (13)]. But, the sign of $P^2F_{DZ}$ is ambiguous:

\[
p^2F_{DZ} = p^2[h^2_a((1-Z^2)e^{-r(T^2+S^2)} - e^{-T^2})]/S^2_T e^{-rT^2} - h^2_e - r(T^2+S^2)]T^2_D
\]

Since the bracketed expression is ambiguous in sign, so is $P^2F_{DZ}$. The effect on prosecutor resource allocation of an increase in the average number of months until the end of the lifetimes of type 2 defendants ($d^2$) is the same as that from an increase in $Z^2$.

5. The effect of an increase in the prison sentence ($S^2$) imposed on type 2 released defendants if convicted:

\[
\frac{dR^2}{dS^2} = a_{22}N^2P^2F_S + a_{23}N^2P^2F_D S \geq 0
\]
\[ \frac{dD^2}{ds^2} = a_{32}N^2p^2F_{RS} + a_{33}N^2p^2F_{DS} \geq 0 \]
\[ \frac{dR^1}{ds^2} = a_{12}N^2p^2F_{RS} + a_{13}N^2p^2F_{DS} \geq 0 \]
\[ \frac{dD^1}{ds^2} = b_{12}N^2p^2F_{RS} + b_{13}N^2p^2F_{DS} < 0 \]

The term \( N^2p^2F_{RS} \) is positive [by (13)]. In other words, longer prison sentences raise the deterrent effect of convictions and (hence) the marginal return to resources facilitating convictions. But the sign of \( p^2F_{DS} \) is ambiguous. Longer prison sentences can increase or decrease the marginal return to resources promoting celerity of punishment, \( N^2p^2F_{DS} \) [see (14)]:

\[
N^2p^2F_{DS} = N^2p^2[-pc^2e^{-p(T^2+S^2)} + h_v^2((-1-Z^2)e^{-r(T^2+S^2)}})((1-Z^2)e^{-r(T^2+S^2)} \\
- e^{-rT^2}) - rh_v^2(1-Z^2)e^{-r(T^2+S^2)}]T_D^2
\]

Since \( Np^2F_{DS} \) is ambiguous in sign, all the total derivatives above are ambiguous. If type 2 defendants are undeterrible recidivists, then \( h_v^2 \) and \( h_{vv}^2 \) equal zero so that \( Np^2F_{DS} \) is positive. Then increases in \( S^2 \) increase \( R^2+D^2 \) since \( \frac{dR^1}{ds^2} \) and \( \frac{dD^1}{ds^2} \) are negative.
6. The effect of an exogenous increase in the probability of conviction of type 2 defendants—$P_2^2 > 0$:

\[
\frac{dR^2}{dw^2} = a_{23}N^2P^2_{FD} \geq 0
\]

\[
\frac{dD^2}{dw^2} = a_{33}N^2P^2_{FD} > 0
\]

\[
\frac{dR^1}{dw^2} = a_{13}N^2P^2_{FD} < 0
\]

\[
\frac{dD^1}{dw^2} = b_{13}N^2P^2_{FD} < 0
\]

Earlier it was shown that only if the complementarity between $R^2$ and $D^2$ is sufficiently great is $a_{23}$ positive and (hence) will $\frac{dR^2}{dw^2}$ be positive.

7. The effect of a fall in the prosecutor's ability to influence delay until case disposition of type 2 defendants:

That is, let "x" be such that $T_{Dx}^2$ is positive. Then,

\[
\frac{dR^2}{dx} = a_{23}N^2P^2_{FDx} \geq 0
\]

\[
\frac{dD^2}{dx} = a_{33}N^2P^2_{FDx} < 0
\]

\[
\frac{dR^1}{dx} = a_{13}N^2P^2_{FDx} > 0
\]

\[
\frac{dD^1}{dx} = b_{13}N^2P^2_{FDx} > 0
\]

Except for $P^2_{FDx}$, all other terms have already been signed. And $P^2_{FDx}$ is negative since an increase in the resources ($D^2$) required to cause a marginal change in delay until case disposition will decrease the marginal returns to those resources, $P^2_{FD}$. Earlier it was shown that if there is sufficient complementarity between $R^2$ and $D^2$, then $a_{23} > 0$. 
and hence \( \frac{dR^2}{dx} < 0 \).

8. The effect of an increase in the impact of prosecution resources (\( R^2 \)) on the probability of conviction of type 2 defendants:

That is, let \( x \) be such that \( P^2_{Rx} \) is positive. Note that an increase in \( P^2_R \) for all levels of \( R^2 \) means that \( P^2 \) is also greater for all \( R^2 \). Consequently, \( P^2 \) is positive.

\[
\frac{dR^2}{dx} = a_{22}N^2p^2_F + a_{23}N^2p^2_F X_D < 0 \quad (59)
\]

\[
\frac{dD^2}{dx} = a_{32}N^2p^2_F + a_{33}N^2p^2_F X_D > 0 \quad (60)
\]

\[
\frac{dR^1}{dx} = a_{12}N^2p^2_F + a_{13}N^2p^2_F X_D < 0 \quad (61)
\]

\[
\frac{dD^1}{dx} = b_{12}N^2p^2_F + b_{13}N^2p^2_F X_D < 0
\]

Again, if there is sufficient complementarity between \( R^2 \) and \( D^2 \), then \( a_{23} \) and \( a_{32} \) are positive. Consequently, (59) and (60) would be positive.
APPENDIX D

Estimation of the Defendant's Probability of Conviction in a Trial

Using standard instrumental variable techniques, the probability of conviction in a trial (\( \hat{P} \)) for each defendant will be estimated based on the evidence against him. The procedure involves estimating the following equation for a sample of defendants who were tried by a judge or jury:

\[
\text{CONVICT}_i = \beta \text{EV}_i + U_{ii}
\]

(62)

where \( \text{CONVICT}_i \) equals one (zero) if the \( i \)th defendant is convicted (acquitted) in a trial, \( \beta \) is a 1x13 vector of parameters, \( \text{EV}_i \) is a 13x1 vector of exogenous regressors reflecting the weight of the evidence against defendant \( i \) and \( U_{ii} \) is a disturbance term for the \( i \)th defendant. The vector \( \text{EV}_i \) contains all of the weight of the evidence variables in Table 5 except \( \text{CONVICT} \). Then \( \beta \) and defendant \( i \)'s values for \( \text{EV}_i \) are used to estimate the probability of conviction in a trial for defendant \( i \).

The strength of evidence variables are listed in Table 5. Most are self-evident. Four are not:

1. Because there are economies of scale in self-protection expenditures and because the returns (in value of property protected) to such expenditures are greater for firms than households, business and private INSTITUTIONS will spend more on self-protection than
<table>
<thead>
<tr>
<th>Variable</th>
<th>Definition</th>
<th>Mean(\bar{\text{x}})</th>
<th>(Standard Deviation)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CODEF</td>
<td>1=There are codefendants, 0=Otherwise</td>
<td>.47</td>
<td>(.50)</td>
</tr>
<tr>
<td>CONFOSSED</td>
<td>1=Defendant confesses, 0=Otherwise</td>
<td>.09</td>
<td>(.29)</td>
</tr>
<tr>
<td>CONVICT</td>
<td>1=Defendant convicted in trial, 0=Defendant acquitted in trial</td>
<td>.78</td>
<td>(.41)</td>
</tr>
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<td>DAYS2AREST</td>
<td>Days between offense and arrest</td>
<td>15.66</td>
<td>(77.92)</td>
</tr>
<tr>
<td>INSTITUTION</td>
<td>1=Victim is a business or institution, 0=Otherwise</td>
<td>.16</td>
<td>(.36)</td>
</tr>
<tr>
<td>PHOTOID</td>
<td>1=Defendant identified in a photo by witnesses, 0=Otherwise</td>
<td>.06</td>
<td>(.23)</td>
</tr>
<tr>
<td>PHYSICALEV</td>
<td>1=Stolen property, weapon or other tangible evidence, 0=Otherwise</td>
<td>.19</td>
<td>(.40)</td>
</tr>
<tr>
<td>REFUSE</td>
<td>1=Complaining witness refused to testify, 0=Otherwise</td>
<td>.06</td>
<td>(.24)</td>
</tr>
<tr>
<td>RESISTED</td>
<td>1=Defendant resisted arrest, 0=Otherwise</td>
<td>.08</td>
<td>(.27)</td>
</tr>
<tr>
<td>SUPPRESS</td>
<td>1=Defense motion to suppress evidence, 0=Otherwise</td>
<td>.19</td>
<td>(.39)</td>
</tr>
<tr>
<td>TRIAL</td>
<td>1=Defendant had a trial, 0=All others</td>
<td>.37</td>
<td>(.48)</td>
</tr>
<tr>
<td>WITNESSES</td>
<td>Number of witnesses</td>
<td>2.82</td>
<td>(1.82)</td>
</tr>
<tr>
<td>Variable</td>
<td>Definition</td>
<td>Mean (Standard Deviation)</td>
<td></td>
</tr>
<tr>
<td>---------------</td>
<td>---------------------------------------------------------------------------</td>
<td>---------------------------</td>
<td></td>
</tr>
<tr>
<td>YVICTIM</td>
<td>Average earnings of victim's occupation for his sex/race/age group (obtained from 1970 Census data). If his occupation is not known, then the average earnings of his sex/race/age group is used. The mean value of YVICTIM is used where it cannot be computed due to missing data. If there are several victims, then their average computed earnings is used. In hundreds.</td>
<td>36.45 (18.50)</td>
<td></td>
</tr>
<tr>
<td>YVICTIMDUM</td>
<td>1=Victimless crime or missing data precluded the computation of YVICTIM 0=Otherwise</td>
<td>.79 (.92)</td>
<td></td>
</tr>
</tbody>
</table>

---

*aSample size = 977

*b*Dagenair (1973) discusses the solution used here for unavailable data.*
private households. By their nature, some self-protection expenditures (guards, cameras) provide evidence strengthening the prosecutor's case. Hence, when the victim is an INSTITUTION, the defendant is more likely to be convicted.

2. Defendants who RESISTED arrest are more likely to be convicted than others. That is, the greater the arrestee's probability of conviction for (say) burglary, the greater his gain from avoiding trial by successful escape from the arresting officer(s). Moreover, the cost of an attempted escape from the arresting officers declines with his probability of conviction for burglary. That is, if a defendant convicted for burglary had also unsuccessfully resisted arrest, then any prison sentence imposed for that attempt (i.e. from assaulting the arresting officer) could only be served after the defendant served time for the burglary conviction. Given that the arrestee has a negative time preference for imprisonment, his expected disutility from serving the prison sentence for the assault charge is discounted by this delay until its imposition. In sum, an arrestee's expected gain from resisting arrest increases and his expected costs decline with his expected probability of conviction in a trial. Consequently, defendants who RESISTED arrest are those who most expect to be convicted.

3. The more CODEFendants in a particular case, the greater the marginal gain to the prosecutor from collecting more evidence.

---

1 Or, conversely, the defendant could first serve the sentence for assaulting an officer and then the sentence for the burglary conviction. Either way, the argument holds.
against each one since much of the evidence would have "public good" aspects--it contributes to the conviction of all the codefendants.

Assuming marginal cost of evidence collection does not also rise with the number of codefendants, then the amount of evidence the prosecutor collects per defendant increases with the number of codefendants (Adelstein, 1978). If each codefendant has a separate attorney and the gains to the other codefendants from evidence collected by one codefendant's attorney are not appropriable by that attorney, then defense evidence collected per defendant will not increase with the number of codefendants. In such a case, an increase in codefendants increases the probability of conviction of each. But if all codefendants have the same attorney or public defendant, evidence collected by the defense will also increase with the number of codefendants, again because of its public good aspects. In that event, the net effect of the number of codefendants on the probability of conviction on each is unclear.

4. By influencing the costs and benefits of testifying, a complaining witness' annual earnings (YVICTIM) influences his not unusual decision to refuse to testify. On the one hand, the opportunity costs of testifying increase with a witness' wage rate. Witnesses spend a surprisingly large amount of time waiting in and repeatedly returning to courtrooms (Ash, 1973). On the other hand, the benefits from testifying also increase with a witness' wage rate. His testimony leading to a conviction deters future victimization of him. And since the value of appropriable property from property offenses and time lost in convalescence or impairment of human
capital from personal crimes rises with his wage rate, so does his deter-
rence gain from testifying. Thus by influencing whether or not the 
complaining witness will testify, YVICTIM influences a defendant's 
probability of conviction. But the direction of the effect is un-
clear.

Variables related to the strength of the evidence against a 
defendant have now been isolated. Multivariate analysis can now be 
used to determine the relative empirical importance of these variables 
in determining which defendants who are tried before a judge or jury 
are convicted. But the dependant variable, CONVICT, is dichotomous, 
creating certain statistical problems. That is, several well-known 
problems arise with ordinary least squares if the dependent variable 
is dichotomous. These include inapplicability of the usual tests of 
significance of the estimated coefficients and the sensitivity of 
the explanatory variables (especially to extreme values). Probit 
analysis avoids these problems (Thell, 1971).

Table 6, column 1, contains the probit coefficients for the 
probability of conviction equation. As predicted, defendants who 
victimized institutions or resisted arrest are more likely to be 
convicted, though the former is only significant at about the 10 
percent level. Further, defendants with codefendants are signifi-
cantly less likely to be convicted. However, the complaining wit-
ness' annual earnings is not significantly related to the defendant's 
probability of conviction.

The estimated probability of conviction in a trial for the 
ith defendant (P), based on the weight of the evidence against him,
<table>
<thead>
<tr>
<th>Variables</th>
<th>Prob Coefficientsa</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>I</td>
</tr>
<tr>
<td>INSTITUTION</td>
<td>.334</td>
</tr>
<tr>
<td></td>
<td>(1.26)</td>
</tr>
<tr>
<td>RESISTED</td>
<td>.903</td>
</tr>
<tr>
<td></td>
<td>(2.52)***</td>
</tr>
<tr>
<td>CODEF</td>
<td>-.392</td>
</tr>
<tr>
<td></td>
<td>(2.52)***</td>
</tr>
<tr>
<td>YVICTIM</td>
<td>-.023</td>
</tr>
<tr>
<td></td>
<td>(.77)</td>
</tr>
<tr>
<td>YVICTIMDUM</td>
<td>.479</td>
</tr>
<tr>
<td></td>
<td>(2.73)***</td>
</tr>
<tr>
<td>SUPPRESS</td>
<td>-.669</td>
</tr>
<tr>
<td></td>
<td>(3.79)***</td>
</tr>
<tr>
<td>REFUSE</td>
<td>-.865</td>
</tr>
<tr>
<td></td>
<td>(1.16)</td>
</tr>
<tr>
<td>PHOTOID</td>
<td>-.230</td>
</tr>
<tr>
<td></td>
<td>(.79)</td>
</tr>
<tr>
<td>WITNESSES</td>
<td>.130</td>
</tr>
<tr>
<td></td>
<td>(2.80)***</td>
</tr>
<tr>
<td>DAYS2AREST</td>
<td>-.001</td>
</tr>
<tr>
<td></td>
<td>(.70)</td>
</tr>
<tr>
<td>CONFESSIONED</td>
<td>-.217</td>
</tr>
<tr>
<td></td>
<td>(.99)</td>
</tr>
<tr>
<td>PHYSICALEV</td>
<td>.112</td>
</tr>
<tr>
<td></td>
<td>(.51)</td>
</tr>
<tr>
<td>θ1</td>
<td>-.00002</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>CONSTANT</td>
<td>.465</td>
</tr>
<tr>
<td></td>
<td>(1.83)**</td>
</tr>
<tr>
<td>Variance</td>
<td>.18</td>
</tr>
<tr>
<td>explained</td>
<td></td>
</tr>
<tr>
<td>Log Likelihood</td>
<td>-186.5</td>
</tr>
<tr>
<td>Sample size</td>
<td>407</td>
</tr>
</tbody>
</table>

a t values in parentheses.

*Probit coefficient significant at 10% level, **5% level, ***1% level.
is then

$$\hat{P}_i = \frac{1}{\sqrt{2\pi}} \int_{-\infty}^{T_i} e^{-t^2/2} dt$$

where $T_i = \beta_0 + \beta_1 (\text{INSTITUTION}_i) + \beta_2 (\text{RESISTED}_i) + \beta_3 (\text{CODEF}_i) + ... \beta_j$ are the probit coefficients in Table 6 and the $i$ subscripts refer to the $i$th defendant.  

One might object that the estimated probit coefficients, estimated from a sample containing only defendants tried by a judge or jury, are invalid estimates of the true coefficients for the entire population of defendants (including defendants who plead guilty and whose cases are dismissed). The following discussion presents statistical evidence rejecting this objection.

Ideally, in the above procedure to estimate $\hat{P}_i$, (62) should have been estimated for the entire sample of felony defendants. But, unfortunately, (62) could be estimated only for a sample of defendants who were tried before a judge or jury. That is, the following equation was estimated in Table 6, column 1:

$$E(\text{CONVICT}_i / \text{EV}_i, \text{sample selection rule that TRIAL}_i = 1) = \text{BEV}_i + E(U_{1i} / U_{2i} > -\Omega H_i)$$

where $\text{TRIAL}_i = \Omega H_i + U_{2i}$ (64)

$E(\cdot)$ is the expected value operator

---

2 Multiply the probit coefficients in Table 6, column 1, by

$$\left(\frac{1}{\sqrt{2\pi}}\right)^2 e^{-1/2(E)^2} = .35$$ to get the change in the probability of conviction per unit change in the independent variables at the sample means (see Theil, 1971). $E$ is the mean of $E_i$.

3 The analysis below applies Heckman's (1979) general discussion of sample selection bias to the specific case at hand. Since I discussed Heckman's paper earlier (see Sample Selection Bias section of Chapter IV), this analysis can be presented in abbreviated form.
### Table 7: Determinants of Whether a Defendant Has a Trial

<table>
<thead>
<tr>
<th>Variables</th>
<th>Probit Coefficients</th>
<th>Variables</th>
<th>Probit Coefficients</th>
</tr>
</thead>
<tbody>
<tr>
<td>INSTITUTION</td>
<td>.018 (.11)</td>
<td>CHARGES</td>
<td>.011 (.29)</td>
</tr>
<tr>
<td>RESISTED</td>
<td>.214 (1.19)</td>
<td>DOLLAR</td>
<td>.001 (1.74)*</td>
</tr>
<tr>
<td>CODEF</td>
<td>.001 (.01)</td>
<td>INCIDENTS</td>
<td>.134 (1.23)</td>
</tr>
<tr>
<td>YVICTIM</td>
<td>.001 (3.41)**</td>
<td>INJURY</td>
<td>.172 (3.14)**</td>
</tr>
<tr>
<td>YVICTIMDUM</td>
<td>-.393 (2.87)**</td>
<td>MINMAX</td>
<td>-.001 (1.19)</td>
</tr>
<tr>
<td>SUPPRESS</td>
<td>.229 (1.97)**</td>
<td>WEAPON</td>
<td>.264 (2.14)**</td>
</tr>
<tr>
<td>REFUSE</td>
<td>-1.345 (4.01)*****</td>
<td>AGE</td>
<td>.003 (1.42)</td>
</tr>
<tr>
<td>PHOTOID</td>
<td>.118 (.55)</td>
<td>ARRESTS</td>
<td>.017 (1.62)*</td>
</tr>
<tr>
<td>WITNESSES</td>
<td>.157 (3.62)*****</td>
<td>EARNINGS</td>
<td>.0001 (.27)</td>
</tr>
<tr>
<td>DAYSAREST</td>
<td>-.001 (.72)</td>
<td>EARNDUM</td>
<td>-.547 (4.93)*****</td>
</tr>
<tr>
<td>CONFERSED</td>
<td>.127 (.80)</td>
<td>WHITE</td>
<td>-.148 (1.11)</td>
</tr>
<tr>
<td>PHYSICALEV</td>
<td>.063 (.47)</td>
<td>ONBAIL</td>
<td>-.124 (1.17)</td>
</tr>
<tr>
<td>ATTORNEY</td>
<td>.069 (.69)</td>
<td>CONSTANT</td>
<td>.17 (2.48)**</td>
</tr>
<tr>
<td>BOND</td>
<td>-.00006 (1.59)</td>
<td>Variance explained (Pseudo R²)</td>
<td>.27</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Log likelihood</td>
<td>-497.7</td>
</tr>
</tbody>
</table>

Universe: 897 defendants

*Significant at 10% level, **5% level, ***1% level (2 tailed test).
\[ \text{TRIAL}_i = 1 \text{ if defendant } i \text{ was tried by a judge or jury} = 0 \text{ otherwise} \]

\[ \Omega \text{ is a } 1 \times 26 \text{ vector of parameters} \]

\[ H_i \text{ is a } 26 \times 1 \text{ vector of exogenous regressors} \]

\[ U_{2i} \text{ is a disturbance term.} \]

Again, all subscripts refer to the \( i^{th} \) defendant. If, as seems reasonable, the cases of defendants who are very unlikely to be convicted in a trial are dismissed, then \( \text{cov}(U_{1i}, U_{2i}) \) may be positive. Yet, if, as again seems reasonable, defendants who are especially likely to be convicted plead guilty, then \( \text{cov}(U_{1i}, U_{2i}) \) could be negative. In any event, \( \text{cov}(U_{1i}, U_{2i}) \) is probably nonzero. Further, included in the variables in \( H_i \) are the variables in \( EV_i \) because the strength of the evidence against a defendant is one determinant of whether his case is dismissed or he pleads guilty or demands a trial. Thus, if equation (62) is estimated for a sample of only defendants who had trial, then the estimated coefficients will be

\[
\frac{\text{dE(CONVICT}_i/\text{EV}_i, \text{ sample selection rule})}{\text{dEV}_i} = \beta + \frac{\text{dE}(U_{1i}/U_{2i}>\text{NH}_i)}{\text{dEV}_i}
\]

That is, the estimated coefficients of (62) include meaningful structural parameters, the first term, plus the parameters of a function determining the probability that an observation is in the nonrandom sample, the second term. Thus, the probability of conviction equation in Table 6, column 1, estimated only for a sample of defendants tried before a judge or jury, may contain biased estimates of the true coefficients.

If an estimate of \( E(U_{1i}/U_{2i}>\text{NH}_i) \) could be included in (62), I
could estimate the parameters of interest—\( \beta \). Indeed, using the same approach used in the section entitled "Sample Selection Bias" in Chapter IV to estimate \( \phi \), I can estimate \( E(U_{11}/U_{21} > \alpha H_i) \) for each defendant. That estimate is labeled \( \theta_i \) and, analogous to the estimation of \( \phi \), is calculated from the estimated coefficients of probit analysis applied to (64). The estimated probit coefficients of (64) are listed in Table 7. The calculated selectivity index, \( \theta_i \), is then included in equation (62), estimated for a sample of defendants who had trials; see column II, Table 6. The insignificance of \( \theta_i \) indicates that the sample selection bias in the estimated coefficients of (62), from estimating it only for a sample of defendants who had trials, is minimal. In column III, \( \theta_i \) is excluded and, thus the coefficients of equation III should be afflicted by the sample selection bias, unlike those of equation II. But the differences in the estimated coefficients of equations II and III are minimal. In sum, there is no sample selection bias from estimation (62) for a sample of only those defendants who had trials instead of the entire sample of felony defendants.\(^4\)

\(^4\)Inclusion of \( \theta_i \) in equation II, Table 7, necessarily meant that observations had to be deleted from the sample if \( \theta_i \) was not known because certain variables in the equation used to estimate \( \theta_i \) were unknown. That explains the smaller sample size in columns II and III compared to column I of Table 6.