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A SURVEY OF ECONOMIC MODELS OF CRIMINAL BEHAVIOR

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A SURVEY OF ECONOMIC MODELS OF CRIMINAL BEHAVIOR

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INTRODUCTION

"It is otherwise with the injuries to property.
The benefit of the person who does the injury is
often equal to the loss of him who suffers it.

-- Adam Smith 1776

The economic modeling of criminal behavior is a rather new application of microeconomics. It arose in the United States in response to the growth of crime which began in the 1960's and continued through the 1970's. The psychological approach (criminals are sick) and the sociological approach (society is sick) that were the conventional wisdom in criminology were found wanting. By the late 1960's, the proportions of the crime problem drew the attention and labors of economists. That is not the same as saying they were invited into the debate. They were not.

Economists bring to the study of criminal behavior their usual microeconomic tools: income, costs, elasticity, trade-offs, returns to input factors, supply schedules, demand schedules and equilibrium levels. Not novel in themselves, they were novel when applied to the matter of illegitimate behavior.

The easiest challenge to the economic approach comes in the matter of violent crimes, crimes of passion or acts that are essentially spontaneous responses to targets of opportunity. Conversely, the easiest application of the economic model is to those crimes where the motive is itself largely economic, involving calculation and planning, e.g. embezzlement, professional cargo hijacking, confidence rackets, tax evasion and espionage.

Does an economic theory of criminal behavior have anything to say to the policy and practice of personnel security? It does in that it provides a way of thinking about criminal behavior that departs from the prevailing psychological and sociological approaches.

A psychological approach regards criminal behavior as an aspect of deficient personality. A sociological approach regards criminal behavior as a special case of deviance from social norms within a context of social sanctions and rewards. An economic theory of crime regards the criminal as a rational actor, maximizing profit within a matrix of costs and opportunities.

As an aside, I noted that, with the exception of Ehrlich and to some extent Heineke, economists who have applied economic

theory to criminal behavior have not pursued it as a career interest. Rather, economic theories of criminal behavior have been by-products of searches for something else. The major theorist, Becker, developed his model of the criminal as a rational actor as a set of footnotes while developing a production function of investment in law enforcement activities. Block dropped his work in the economics of crime to pursue anti-trust policy although he is currently serving as a Commissioner on the United States Sentencing Commission.

BECKER

Optimal Level of Crime in Society

Becker asks how many resources and how much punishment should be used to enforce different kinds of laws? How many offenses should be permitted and how many offenders should go unpunished? The numbers will not be zero.

In Becker's model, the optimal quantity of enforcement is a function of:

1. Costs of catching and convicting.
2. Nature of punishments (Fines or incarceration? Recompense?)
3. Response of offenders to changes in enforcement.

He incorporates the following as elements of costs:

1. Enforcement agency costs.
2. Losses by victims.
3. Costs of preventive measures (including unseen costs such as flight to suburbs and attendant metropolitan development sprawl, reliance on autos, avoidance of public transport, avoidance of urban downtown areas after dark).
4. Costs of prosecution and defense.
5. Insurance costs.
6. Corrections system costs.
7. Social costs of enforcement (searches, delays, wrongful arrests, invasion of privacy, administrative reporting).

Out of these elements, Becker examines five relationships:

1. Number of offenses and the cost of offenses.
2. Number of offenses and punishments levied.
3. Number of offenses, arrests, convictions and public expenditures on courts and police.
4. Number of convictions and the costs of imprisonment and other kinds of punishment.
5. Number of offenses and private expenditures on

protection.

Harm to Society

As a group, offenders usually receive diminishing marginal gains from pursuit of crime while causing increasing marginal harm. As the number of offenses rises, criminals encounter decreasing gains while society suffers increasing harm.

Cost of Apprehension and Conviction

The more funds spent on police, courts and equipment, the easier it is to discover offenses and convict offenders. The lower the costs of police, courts and juries and the more that specialized equipment is used to offset labor intensive activities, the more enforcement activity society can afford.

Supply of Offenses

Becker proposes that an increase in the probability of conviction, and an increase in the severity of punishment if convicted, would decrease (perhaps a lot, perhaps a little) the number of offenses committed. People with judicial experience agree with the generalization that a change in the probability of punishment has a greater deterrent effect than a change in the severity of the punishment.

Becker's model assumes that if people commit offenses their expected utility exceeds the utility they would get by using their time and other resources in alternative activities. Some people become criminals not because their motivations are different from those of other people but because their costs and benefits differ. An economic analysis of criminal behavior, Becker contends, does not need ad hoc concepts of differential association, anomie, etc. Nor does it assume perfect knowledge, lightning fast calculation or the other caricatures of economic theory.

Therefore the gain in expected utility from choosing to undertake illegal activity is:

$$EU = pU(Y - f) + (1 - p)U(Y)$$

where

- EU = Expected utility
- p = Probability of conviction
- f = Severity of punishment (specifically a fine)
- Y = Gain from committing an offense
- U = Decision maker's utility index

If EU is positive, Becker's model predicts that a decision maker will choose to engage in illegal activity. If it is negative, he or she will not. EU will be negative if the severity of punishment > gained from an offense and the

probability of conviction is sufficiently high. The model assumes that a convicted criminal loses the monetary gain from an offense as well as paying fines.

Deterrence

The number of offenses that will be committed by any particular person is a function of the probability of conviction, the severity of punishment if convicted, the income available to that person through legitimate means, income available through other illegal activities, and other lesser factors such as frequency of nuisance arrests that a person suffers. Becker also includes, as a variable, a particular person's willingness to commit an illegal act. This is surely the case; yet it strikes the casual reader as an error-term loophole.

The number of offenses committed in a society is a function of (p, f, u) , where:

p = Probability of conviction.

f = Severity of punishment.

u = Portmanteau variable representing other influences.

An increase in either the probability of conviction, or the severity of punishment, reduces the utility of criminal activity and thus drives down the number of offenses committed.

An increase in the probability of conviction with an equal % reduction in the severity of punishment would not change the expected income from offenses. But it would change the expected utility because the level of risk would drop. An increase in the probability of conviction would reduce the utility of offenses and thus reduce the number of offenses committed.

Whether crime pays is, at root, a matter of an individual offender's preferences for risk and is not directly related to the efficiency of the enforcement agencies or the funds spent on combatting crime. If risks were preferred at some combinations of values of probability of conviction and severity of punishment and disliked at others, policy could influence whether crime pays by mixing probability of conviction and severity of punishment.

The more serious the offense, the higher the probability of imprisonment if convicted. About 58% of murder/manslaughter offenders are apprehended, tried and found guilty. Nearly 40% go to prison. Compare that to burglary (Becker 1968, Table 2):

| | <u>Murder</u> | <u>Burglary</u> |
|---------------------------------------------------|---------------|-----------------|
| % found guilty of estimated number of offenses: | 58% | 13% |
| % entered prison of estimated number of offenses: | 40% | 3% |

Summary of Becker's Model

Becker's work establishes that optimal policies to combat illegal behavior are part of an optimal allocation of resources to law enforcement functions. He notes that important contributors to criminology in the eighteenth and nineteenth centuries, Beccaria and Bentham, explicitly applied an economic framework. Becker sees his work as re-establishing the role of economics in the analysis of criminal behavior. Specifically, his economic model of crime supports theories of deterrence: increases in the probability of conviction and in the severity of punishment reduce the number of offenses committed in a society. What his theory does not tell us is the magnitudes of these deterring variables or even which is larger.

Becker's chief contribution is to reassert the economic approaches as an alternative to the psychological and sociological models of aberration and deviance in the literature of criminology. If society has defined certain activities as criminal, Becker contends, then society ought to choose from criminal justice policies that combine probability of conviction with severity of punishment to minimize the social losses to crime. Pyle (1983) notes in his criticism of Becker, that the suggestion that the optimal level of criminal activity in a society would be greater than zero is more useful than it appears at first reading. Clearly, society must tolerate some level of criminal activities and losses to crime.

Society cannot afford the cost of "complete" enforcement of its rules. Instead society provides law enforcement agencies with a budget that dictates a level of enforcement that is considerably lower than "complete."

A potential offender is deterred from committing a crime by the expected punishment, which is (at first approximation) the probability of punishment times the severity of punishment, e.g: \$100 if the probability of conviction is 10% and the fine is \$1000. Hence, increasing the severity punishment would seem as likely to have a deterrent effect as increasing the probability of conviction. Capital punishment is cheaper than long term imprisonment; seizure of an offender's property may not be much more expensive than collecting a moderate fine.

Becker argues that the imposition of fines is superior to other forms of punishment, chiefly because it consumes so few enforcement and criminal justice resources. He proposes that the revenue generated by fines be used to compensate the victims of

crime. This suggestion compels a measurement of the harm done by crime. At first glance, this seems sure to make the application of criminal law even more complicated and lengthy than it already is. Yet, such issues are determined regularly in civil proceedings.

CRITICISM OF BECKER -- STIGLER

Doubtful Value of "Social Value"

Stigler notes that Becker avoids concluding that harsh punishments are a deterrent by introducing a concept called "social value of the gain to offenders." Stigler finds this concept of little value and lacking any empirical base. What, he asks, is the positive social value upon the utility derived from a murder?

Instead, Stigler offers his own explanation of limited deterrent effect of severe punishment. A potential criminal, like everyone else, makes decisions at the margin. The marginal deterrence of heavy punishments could be very small or even negative. If a thief will have his hand cut off for taking \$5, he might as well take \$5000. If an offender is as likely to be executed for a minor assault as for murder, capital punishment inappropriately applied is not a deterrence to murder (and perhaps even an incentive).

A limit on law enforcement is society's avoidance of over-enforcement: the charging and convicting of many innocent people in order to apprehend most of the guilty ones. The conviction of innocent people encourages crime (They're going to punish you anyway whether you do it or not. Therefore, you might as well do it.)

Supply of Offenses

Illegal activity can be either an act of production for income (theft, embezzlement, espionage) or an act of consumption (speeding for thrills). The professional criminal seeks income, reckoning on the present value of the expected returns and the costs of criminal activity, comparing their difference with the net returns of other criminal activity and legitimate activities. The details of occupational choice are not different from those encountered in legitimate occupations:

1. One must choose location of operations.
2. One must decide between frequent, small operations and occasional, large operations.
3. One must consider periods of involuntary unemployment (incarceration).
4. Earnings can be expected to rise for a while on a learning curve of experience.

The probability of apprehension is an increasing function of the frequency of the commission of offenses. The probability of detection rises after each commission because the enforcement agency is learning an offender's habits. This is an incentive for a strategy of infrequent attempts to get large sums. This, however, is countered by the fact that large targets are better protected. A liquor store is more accessible than Fort Knox.

Rational law enforcement will have these properties:

1. Expected penalties increase with expected gains so there is no marginal net gain from larger offenses. Let the criminal commit in a given year S crimes of size Q (monetary value to the criminal of success in the crime). p is the probability of the successful completion of one crime (the % of crimes completed successfully). p is a decreasing function of the expenditure (E) undertaken by society to prevent and punish the crime.

Hence: $p = p(E, Q, S)$.

2. Expenditures on prevention and enforcement should yield a diminution in offenses, at the margin, equal to the return upon the investment of these resources in other areas. An increment of expenditures yields a decrement in offenses.

Enforcement Agencies

A deficiency in the design of enforcement agencies is the use of inappropriate methods to determine the extent of enforcement. The annual report of an enforcement agency is a justification of previous year's expenditures and a plea for enlarged budgets.

Set the scale of enforcement where $MR = MC$ (MR is marginal return, not marginal revenue). If the scale of enforcement is correct, society is not spending two dollars to save itself one dollar of damage or failing to spend one dollar where it will save two dollars.

Guide the selection of cases so that the agency will not seek numerous easy cases (a la FBI pursuit of auto thieves) to boost the record of performance. In 1967, the Secret Service spent roughly half of its \$17 million budget (\$8 1/2 million) to save the public from the loss of \$1.6 million in counterfeit money. The public reviews public policy through to means:

- (1) appropriations to enforcement agencies.
- (2) verdicts by juries.

These reveal the desire of the public not to enforce certain laws.

EHRlich

The Economic Perspective on Crime

The conventional wisdom in the criminology literature is that participation in crime is guided by a predisposition that crime is a deviant behavior; its causes must be sought in deviant circumstances determining behavior. Offenders have a presumed unique motivation that must be traced to a unique inner psychological structure, e.g. the impact of exceptional social or family circumstances.

Reliance on a motivation unique to the offender as the major explanation of actual crime prevents predictions about the outcomes of objective circumstances. There is no persuasive empirical support for this approach.

Even if offenders do differ systematically from non-offenders, both respond to incentives.

Ehrlich looks at measurable opportunities in terms of costs and rewards for both legal and illegal activities. He proposes this as an alternative focus of research interest to looking at the cost of punishments alone. This approach links crime rates, on one hand, to income inequalities and level of enforcement activity on the other. It sees participation in illegal activity as a particular case of occupational choice: an offender's decision to engage in crime approximates an optimal allocation of resources, under uncertainty, to competing activities.

In violating the law, one can increase one's wealth. In violating the law, one risks one's wealth and well-being. In engaging in legal wealth-generating or consumption activities, one is also subject to risks. The net gain in both kinds of activities is subject to uncertainty.

Ehrlich argues that participation in illegal activity is not an either/or decision regarding legal activity. Rather, a person seeks an optimal mix of illegal and legal activities, allocating time and other resources to competing activities.

Ehrlich does not suggest that offenders are the same as non-offenders in all respects or that they respond to the same incentives. Their responses vary with their degree of specialization in illegitimate activities. The role of opportunities for illegitimate or legitimate activities is crucial in determining the extent of participation in illegitimate activities.

Supply of Offenses

Offenders' occupational choices involve an optimal allocation of time among competing legitimate and illegitimate activities that differ in mix of risks and rewards. Offenders are maximizers of expected utility.

Factors in choice of crime as an occupation:

- Probability of apprehension.
- Probability of conviction.
- Probability of punishment.
- Marginal return to legitimate activity.
- Marginal return to illegitimate activity.
- Risk.
- Initial wealth.

A 1% increase in probability of apprehension generates a larger deterrent effect than a 1% increase in probability of conviction (if caught) and probability of punishment (if convicted).

A strong preference for risk among offenders may reverse deterrent effects of sanctions.

Even if a severe sanction has little effect on currently practicing offenders, it can reduce crime rate by deterring entry of potential offenders into the occupation. (Use of a polygraph affects perception of the probability of apprehension).

Demand for Offenses

A society can have a consumer demand for the products of economically-motivated crimes: e.g. drugs, and stolen goods. An explicit demand from a market exists for products of espionage. Prices for espionage products are a result of needs by a monopsony (one major buyer) and the seller's consideration of risk.

Offenses to create wealth (buyer-seller market demand):

- Loan sharking.
- Prostitution.
- Drug dealing.
- Gambling.
- Specialized offenses (custom-ordered by buyer):
 - Continuing acts of espionage.
 - Theft of luxury cars.
 - Theft of fine art.
 - Arson (torching)
 - Insider knowledge of securities transactions.

Smuggling.
Alcohol/tobacco offenses.
Generic theft (fenced goods):
Electronic entertainment goods.
Jewelry.
Non-luxury autos.
Weapons.
Antiques.
Tools.
Initial act of espionage.

Offenses to create wealth directly (no buyer):

Embezzlement
Larceny
Robbery

Offenses for consumption:

Rape
Vandalism
Arson
Auto theft
Serial murder

Crime and Punishment at the Margin

Offenders respond to incentives (negative and positive). In Ehrlich's view it is not necessary, however, that all offenders respond to incentives but that an important number of potential offenders respond to marginal changes in probability of conviction and severity of punishment.

A socially acceptable equilibrium volume of crime is produced through interaction between offenders and enforcement agencies. Search is for optimal probability of conviction and severity of punishment that produce that equilibrium volume. Because of costs of control and protection the optimum volume of offenses is not zero. Rather, the level of offenses is set where the marginal cost of enforcement and prevention equals the marginal return (reduction of losses to offenses) to enforcement activity.

To assess the benefits of criminal activity requires a criterion of choice: Becker and Stigler chose as criterion the maximizing of "social income". This is the same as minimizing the social damage from offenses plus the social costs of law enforcement.

Result: Propositions about

1. Optimal levels of probability of conviction and severity of punishment.
2. Optimal level and mix of expenditure on police, courts, corrections, prevention.

In equilibrium, the deterrent effect of probability of apprehension will exceed the deterrent effect of the probabilities of conviction or severity of punishment. Other criteria of choice, of course, yield different optimal mixes.

In Ehrlich's model, a decision maker can only choose one thing, the amount of time to be spent in illegal activity (t_1). Once this choice is made, the amount of time allocated to legal employment is immediately determined as the remainder. So, too, is the amount of available wealth for the decision maker since his or her wealth, in Ehrlich's model, is determined by the time spent in either crime or legitimate work. Such variables as the probability of conviction are not determined by the decision maker; the only choice left to him or her is the allocation of time.

Ehrlich's expected utility function of entering a criminal occupation is:

$$EU = pU(X_a) + (1 - p)U(X_b)$$

where

- EU = Expected utility
- U = Decision maker's utility index
- p = Probability of conviction
- X_a = Returns from legal activity
- X_b = Returns from illegal activity

As a decision maker spends more time in illegal activity (as t_1 increases from zero), X_a will increase and X_b will decrease. The response of decision makers to (1) the probability of conviction, (2) the severity of punishment and (3) the comparative returns to crime or to legitimate work (as that response is developed in mathematical manipulation of Ehrlich's model) depends upon the decision maker's personal history of criminal involvement. That is to say, a professional criminal will be little moved by small changes in the probability of conviction or in the severity of punishment (although this is not present explicitly in the model). This lack of response is entirely rational in that practicing specialists in criminal activity will perceive greater opportunities in criminal activity than will prospective criminals.

BLOCK AND HEINEKE

In nearly every economic model of criminal activity there are fixed probabilities for criminal justice outcomes such as arrest and imprisonment. This is not realistic because, as an offender engages in more acts of crime, the probability of arrest and conviction rises. Block and Heineke present a more realistic treatment.

Block and Heineke propose that the psychic costs of crime and employment must be accounted for in models of decisions to undertake illegal activities. Each individual must allocate available time between legal activities (which they designate as "labor") and illegal activities (which they designate as "theft" since their analysis is restricted to property crimes of which espionage is a particular case).

The Block and Heineke utility function for criminal activity is:

$$U = U(L, T, W)$$

where U = Utility
 L = Labor
 T = Theft
 W = Wealth of decision maker

W is determined by:

$$W = W_0 + W_L L + (W_1 - pF)\Theta(T)$$

where W_0 = Endowed wealth of the decision maker
 W_L = Rate of return from legal activity
 W_1 = Rate of return from illegal activity
 F = Severity of punishment (specifically fine per offense)
 p = Probability of arrest/conviction
 Θ = Number of offenses committed by decision maker

Pyle (1983) points out that the inclusion of L and T directly in the calculation is an important departure from Becker and from Ehrlich with significant behavioral implications. L and T embody the psychic costs of crime and legitimate employment (what Pyle describes as the "disagreeability of work or of crime").

A decision maker chooses how much time to allocate to T in order to maximize U . Like Ehrlich, Block and Heineke assume that the amount of leisure time was fixed. Therefore leisure does not enter the model as a third option for a decision maker. Labor supply models, of course, commonly use leisure as the trade-off alternative to the amount of time a decision maker allocates to employment.

As with most economic models of criminal behavior, the Block and Heineke model assumes that an individual's allocation of time between L and T depends on his or her attitude toward risk. But it also implies that the allocation depends upon their preference for honesty ($U_L - U_T$). This, unhappily, gravitates, as do so many of these models, to an elaborate highlighting of the obvious. To wit, if the probability of conviction is raised, severity of punishment is increased or the attraction of legitimate employment is enhanced, then an honest person who is averse to risk will reduce his or her participation in illegal activities. Otherwise, the Block and Heineke model shows that a decision maker who is risk-averse but dishonest will not respond in the same way to the same deterrent changes. Ethical considerations, not surprisingly, are found to be important determinants of criminal behavior.

OPTIMAL INCOME TAX EVASION -- ALLINGHAM AND SANDMO

Allingham and Sandmo (1972) looked at income tax evasion as a special case of a decision to engage in criminal behavior. I have reviewed it here because of the similarity between a decision to evade taxes and a decision to engage in espionage. Specifically, a decision maker must decide, in a specific time frame, (1) whether to under-report income on a tax return and (2) then how much to under-report the income. Unlike time allocation models of criminal behavior in which time spent in crime is a trade-off against time spent in legitimate activities, a decision to under-report income has no such competitive variables. A decision to under-report requires little investment in time.

Tax evaders are assumed to be risk-averse.

In the Allingham and Sandmo model, a decision maker chooses a value of declared income to maximize expected utility:

$$EU = (1 - p)U(W - \theta * X) + pU[W - \theta * X - \Pi(W - X)]$$

where

- EU = Expected utility
- W = Income
- X = Declared income
- θ = Constant tax rate on declared income
- p = Probability of being investigated by tax authority
- W - X = Undeclared income
- Π = Severity of penalty (specifically a fine which is assumed to be greater than θ)

A manipulation of this model led to the conclusion that decision makers would declare more income for taxation if Π exceeded 100%. However, if Π were less than 100%, the mathematics of the manipulation prevented Allingham and Sandmo

from concluding how a decision maker would behave except to propose that risk aversion, as always, would be a major determinant.

MARKET EQUILIBRIUM MODEL

A market equilibrium model of criminal behavior began to emerge in the work of Ehrlich (1981) and van den Haag (1975). This model attempts a joint determination of volume of offenses and net return from crime.

One early result of this model: the suggestion that the efficacy of deterring sanctions cannot be assessed by reference to the elasticity of the aggregate supply of offenses. The primitive renderings of this model also suggest that the efficacy of rehabilitation and incapacitation programs cannot be inferred solely from the impact on individual offenders. It depends on elasticity of market supply and demand schedules that determine the extent to which rehabilitated offenders will be replaced by others attracted by high net returns to crime.

EMPIRICAL STUDIES OF ECONOMIC MODELS OF CRIME

Empirical analysis of the economic models of criminal behavior have been hampered by a general lack of relevant data. This, in turn, has been a barrier to the development of a comprehensive economic model of criminal behavior. For example, Ehrlich (1986) complains that few studies attempt to determine the private demand for self-protection.

Some researchers have attempted to link models of criminal activity to models of law enforcement activity through three sets of structural equations (Ehrlich, 1973):

1. Supply of offenses linking rate of offenses with deterrence variables.
2. Production functions of law enforcement activity linking probabilities of conviction with resource inputs.
3. Demand for enforcement linking resource spending with determinants of public intervention.

Econometric studies have been limited by methodological problems such as the under-reporting of crime rates by the FBI Uniform Crime Reports. Measurement errors in the estimation of the risk of punishment have led to biased and spurious correlations. Often, results are biased by "missing variables" such as markets for illicit drugs or the market for handguns.

Studies of similar offenses generally report similar

findings: the probability of conviction and the severity of punishment are inversely related to crime rates. Crime rates are also found to be more elastic in response to changes in the probability of apprehension than they are to changes in the probabilities of conviction (if caught) or the severity of punishment.

Crime rates are often found to be directly related to measures of income inequality and levels of community wealth (the more wealth in a community, the greater the opportunities and perceived returns to criminal activity). Unemployment effects are ambiguous. These patterns seem to hold whether the data are gathered cross-culturally, taken from FBI records or acquired from Victimization Survey information.

Measures of police output are weakly responsive to increases in input resources. The response varies with the definition of output and the specification of police production functions.

While Forst (1976) found that not all studies are consistent with the deterrence hypothesis, his analysis has been criticized by Wadycki and Balkin (1979).

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APPENDIX A

MAJOR FEATURES OF SELECTED ECONOMIC MODELS OF CRIME DEALING WITH PROPERTY OFFENSES

Source: Peter Schmidt and Ann White. An Economic Analysis of Crime and Justice. Orlando: Academic Press, 1984, 166-171.

Theorist: Becker (1968)
Concept: Expected utility.
Objective: Maximize expected utility which is direct function only of wealth.
Allocation: Time.
Factors controlled: Omnibus vector for factors such as "law abidingness."
Relationships: Number of offenses is affected by legal alternatives, but is not determined simultaneously with them.
Assumption about risk: Risk aversion.

Theorist: Ehrlich (1970, 1973)
Concept: Expected utility.
Objective: Maximize expected utility which is a direct function only of wealth.
Allocation: Time.
Factors controlled: Race, education, location and sex.
Relationships: Crime function and labor supply function are inversely related.
Assumption about risk: Risk aversion.

Theorist: Sjoquist (1973)
Concept: Expected utility.
Objective: Maximize expected utility which is a direct function only of wealth.
Allocation: Time.
Factors controlled: Race, population density, education, city size.
Relationships: Crime function and labor supply function are inversely related.
Assumption about risk: Risk aversion.

Theorist: Allingham and Sandmo (1973)
Concept: Expected utility function.
Objective: Maximize expected utility which is a direct function only of wealth.
Allocation: Wealth.
Factors controlled: Unspecified shift parameters in illegal gain and penalty function.
Relationships: Crime is inversely related to amount of wealth devoted to other activities.
Assumption about risk: Risk aversion.

Theorist: Block and Heineke (1975)
Concept: Expected utility.
Objective: Maximize expected utility which depends on wealth and time allocation.
Allocation: Time.
Factors controlled: Tastes for labor and theft.
Relationships: Time in theft and working are determined simultaneously.
Assumption about risk: Risk aversion.

Theorist: Heineke (1978)
Concept: Expected utility.
Objective: Maximize expected utility which depends on time allocation and level of consumption.
Allocation: Time and wealth.
Factors controlled: Tastes for alternative time allocations.
Relationships: Time allocations and level of consumption determined simultaneously.
Assumption about risk: None.

Theorist: Witte (1980)
Concept: Utility function.
Objective: Maximize utility which depends on time allocation and expected wealth.
Allocation: Time.
Factors controlled: Age, prior record, addiction supervision, marital status and prior behavior.
Relationships: All time allocations are determined simultaneously.
Assumption about risk: None.

APPENDIX B

RESULTS AND ADVANCES OF SELECTED ECONOMIC MODELS OF CRIME DEALING WITH PROPERTY OFFENSES

Source: Peter Schmidt and Ann White. An Economic Analysis of Crime and Justice. Orlando: Academic Press, 1984, 166-171.

Theorist: Becker (1968)
Results: Increases in penalty or fine decrease the number of offenses; increased fines are relatively more effective than increased probability of apprehension.
Advances over Previous Work: Resurrection of Bentham's insights.

Theorist: Ehrlich (1970, 1973)
Results: Time allocated to illegal activity decreases with increases in probability of apprehension, severity of penalty or wage rate; it increases with increased wealth and illegal gains; fines are relatively more effective for risk averse potential offenders.
Advances over Previous Work: Elaboration of Becker's insights. Introduces both gains and losses in illegal activity and gains in legal activity.

Theorist: Sjoquist (1973)
Results: Time allocated to illegal activity decreases with increases in probability of sanctions, wage rate and severity of punishment; increases with returns to illegal activity.
Advances over Previous Work: Elaboration of Becker's insights. Introduces both gains and losses in illegal activity and gains in legal activity.

Theorist: Allingham and Sandmo (1972)
Results: Proportion of wealth allocated to illegal activities decreases with increases in severity of penalty or the probability of its imposition; increases with increases in wealth and illegal gains; increased fines are more effective than increased probabilities for risk averse potential offenders.
Advances over Previous Work: Combines Becker's model with portfolio theory in application to tax evasion.

Theorist: Block and Heineke (1975)
Results: No comparative static results forthcoming under normal preference restrictions.
Advances over Previous Work: Introduces time allocation directly into utility function; shows restrictions needed to get comparative static results.

Theorist: Heineke (1978a)
Results: Time allocated to illegal activity decreases with increases in severity of penalty and the probability of imposition; increases with increases in wealth, illegal gains, and legal gains; increased fines are relatively more effective than increased probability of apprehension for the risk averse.
Advances over Previous Work: Shows that when leisure is allowed to vary, legal and illegal activities are gross complements; points up the nature of restrictive assumptions in Ehrlich's and Sjoquist's models.

Theorist: Heineke (1978b)
Results: No comparative static results are forthcoming.
Advances over Previous Work: Models joint labor supply decision for larceny, burglary, robbery and the labor market. This allows substitution among property offenses.

Theorist: Witte (1980)
Results: No comparative static results forthcoming.
Advances over Previous Work: Combines insights from Block & Heineke and Ehrlich by introducing unemployment rate, criminal justice sanctions and time allocation into the utility function.