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Economics of Crime

Erling Eide, Paul H. Rubin, and Joanna M. Shepherd

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Erling Eide

*Faculty of Law, University of Oslo
Box 6706
Oslo 0130, Norway*

Paul H. Rubin

*Department of Economics, Emory University
Atlanta GA 30322, USA*

Joanna M. Shepherd

*School of Law Emory University
Atlanta GA 30322, USA*

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Economics of Crime

Erling Eide¹, Paul H. Rubin²
and Joanna M. Shepherd³

¹ *Faculty of Law, University of Oslo, Oslo 0130, Norway*

² *Department of Economics, Emory University, Atlanta GA 30322, USA*

³ *School of Law Emory University, Atlanta GA 30322, USA*

Abstract

This paper starts with a review the economics of criminal behavior. Then, the authors discuss the theory of public enforcement. The economic analysis of criminal behavior and criminal law has been a hugely successful enterprise. As an academic enterprise, it has achieved the goal of research—it has generated a large and growing literature. More important than academic success, however, has been the influence of this branch of learning on actual practice. The understanding of deterrence effects and rational responses by criminals has substantially changed the purpose and functioning of the criminal justice system.

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1

Introduction

During the past 40 years, beginning with the work of Becker (1968) economists have invaded the field of criminology, using their all-embracing model of individual rational behavior. In this model, a criminal act is preferred and chosen if the total payoff, including the expected cost of sanctions and other costs, is higher than that of legal alternatives. The theory of deterrence thus obtained is regarded as a special case of the general theory of rational behavior under uncertainty. Assuming that individual preferences are constant, the model can be used to predict how changes in the probability and severity of sanctions and in various socio-economic factors may affect the amount of crime. Even if most of those who violate certain laws differ systematically from those who abide by the same laws, the former, like the latter, do respond to incentives (i.e., to sanctions and economic conditions). Empirical tests with increasing statistic rigor and refinement have been carried out on the basis of this theory.

Whereas the general preventive effects of sanctions for a long time have occupied a main position in penal legislation and sentencing policy, such effects were almost totally neglected in criminology and modern sociology until the late 1960s. Criminologists have been more

2 *Introduction*

interested in rehabilitation and treatment, and many are still reluctant to accept studies of deterrence in general and models of criminal behavior based on rational choice in particular. However, scholars who are reluctant to accept the assumption of rational choice still find interest in the rather rigorous empirical studies in the economics of crime literature (Andenæs, 1975), and sociologists have in recent years been inspired to carry out similar research.

Models of criminal behavior in which a person is assumed to act rationally on the basis of costs and benefits of legal and illegal opportunities are presented. Many of these models are similar to models of portfolio choice or of supply of labor. The empirical studies that are surveyed use various types of regression analyses and employ data from states and police regions down to campuses and individuals. Most studies corroborate the hypothesis that the probability of punishment, and to a lesser degree also the severity of punishment, has a deterrent effect on crime. The effects of various economic factors are less clear, although unemployment seems to increase crime. Methodologic problems relating to the assumption of rationality, to statistic identification of equations, to measurement errors, and to operationalization of theoretic variables are discussed.

In what follows, we first discuss the economics of criminal behavior. We next discuss the theory of public enforcement. We omit some topics. In particular, we do not discuss corporate crime, organized crime, and criminal procedure. Each of these is worthy of a separate essay; here we discuss the basic model of criminal behavior and of law enforcement.

2

The Economics of Criminal Behavior

2.1 The Basic Model

Theories of criminal behavior based more or less on the assumption of rational choice were proposed by Beccaria (1995) and Bentham (1843). Bentham (1789, 1843, p. 399:) wrote that “. . . the profit of the crime is the force which urges man to delinquency: the pain of the punishment is the force employed to restrain him from it. If the first of these forces be the greater, the crime will be committed; if the second, the crime will not be committed.” From the beginning of the 20th century interest in their point of view dwindled as a plethora of other theories were developed. The main idea of Bentham was vitalized and modernized in the path-breaking article on *Crime and Punishment* by Becker (1968), who suggests that “a useful theory of criminal behavior can dispense with special theories of anomie, psychological inadequacies, or inheritance of special traits and simply extend the economist’s usual analysis of choice” (p. 170). He argues that criminals are like anyone else, and assumes that an individual behaves as if he is a rational utility maximizer. As the total outcome of a criminal act is uncertain,

Becker employs the usual assumption that people act as if they were maximizing expected utility, and also that utility is a positive function of income. The individual's expected utility $E[U]$ from committing an offense is:

$$E[U] = PU(Y - f) + (1 - P)U(Y), \quad (2.1)$$

where $U(\cdot)$ is the individual's von Neumann–Morgenstern utility function, P is the subjective probability of being caught and convicted, Y is the monetary plus psychic income (i.e. the monetary equivalent) from an offense, and f is the monetary equivalent of the punishment. The individual will commit the offense if the expected utility is positive, and he will not if it is negative. The common assumption of stable preferences provides a solid foundation for generating predictions about responses to various changes in parameters, and, according to Becker, prevents the analyst from succumbing to the temptation of simply postulating the required shift in preferences to “explain” all apparent contradictions to his predictions. Comparative statics analysis shows that increases in either the probability or the severity of punishment might change the expected utility from being positive to being negative. For society as a whole Becker introduces a “supply of offense function”, where the two factors have an effect on the total amount of crime.

Whereas Becker considers the income and punishment equivalents of an offense separated from other income, later authors, in accordance with Brown and Reynolds (1973), take the individual's initial income position as a point of reference. Expected utility becomes

$$E[U] = PU(W - f) + (1 - P)U(W + g), \quad (2.2)$$

where W is present income and g is gains from crime. Here, the crime will be committed if the expected utility is higher than the utility of the initial income W . Furthermore, it is sometimes assumed that the offender in case of conviction might retain some gain from the offense. Becker demonstrated that if the elasticity of the expected utility with respect to the probability of punishment exceeded the elasticity of the expected utility with respect to conviction (both in absolute values), the offenders were risk lovers. Empirical studies by Becker and others

corroborated this result. As shown by Brown and Reynolds (1973) Eq. (2.2), at variance with Eq (2.1), does not imply such a conclusion.

2.2 Extensions of the Basic Model

Later, several types of economic models of crime have been developed, all of which draw on the theory of supply and the theory of behavior towards risk. The simplest one is very similar to models of portfolio choice, where a person's wealth is allocated between various risky and non-risky projects. In the economics of crime version of this model the illegal alternatives are considered as risky mainly because of uncertainty about punishment. Allingham and Sandmo (1972), Kolm (1973), and Singh (1973) have constructed such models for tax evasion, where the individual is confronted with the problem of deciding what proportion of income not to report to the tax authorities. At variance with Becker's model where the income of crime is a parameter, here the income of criminal activity is a function of the proportion of the exogenous income not reported.

Both the probability and the severity of punishment are found to deter crime for a risk-averse person. For risk lovers, the effect of the severity of punishment is uncertain. An increase in the severity will have similar effects for illegal activities as a wage decrease in labor supply models will have for legal activities. Two effects obtain: (i) a substitution effect and (ii) an income effect. The substitution effect of a more severe punishment will consist in less crime. The sign of the income effect will depend on individual attitude toward risk. For a risk lover the income effect is positive, and the total effect on crime of a change in severity becomes indeterminate. The effects of changes in gains from crime and in exogenous income depend on whether there is decrease or increase in the risk aversion or risk preference. For the common assumption of decreasing absolute risk aversion an individual will allocate a larger proportion of his or her income to tax cheating the higher his or her exogenous income and the higher the gains from crime.

Heineke (1978) has presented a somewhat different type of model where the individual allocates his or her time (and not his or her wealth

or income) between legal and illegal activities. The individual's income is assumed to be equal to the sum of three elements:

- (1) exogenous income;
- (2) the monetary and monetized benefits and costs of legal activities;
- (3) the monetary and monetized benefits and costs of illegal activities.

(Monetization implicitly takes place if an individual, having to choose between actions involving non-monetary gains and losses, acts rationally according to certain axioms.) If convicted, this income is reduced by a factor that represents the monetary and monetized costs of crime. Here, some of the individuals may choose to specialize in either legal or illegal activities, whereas others may choose a mix of the two. A marginal increase in the probability or the severity of sanctions will affect the optimal mix of activities, whereas such an increase may be insufficient to have an effect on individuals who have specialized in one of the two activities. Assuming leisure time not to be fixed, the same comparative statics results as for the portfolio choice model are obtained. The reason for this similarity is the monetization of psychic benefits, and the high degree of independence between the types of activities. In addition, for some attitudes toward risk, it turns out that an increase in returns to legal activity increases time allocated to both types of activities.

Several authors, beginning with Ehrlich (1973), have studied the latter type of model, but with the additional restriction that time allocated to leisure is fixed (and thus independent of returns and costs for legal and illegal activities). The assumption of a fixed leisure time obviously requires that the time allocated to legal and illegal activity changes in opposite direction (and with equal amounts), but the effects of changes in some of the parameters are also different from the previous model. Whereas the effects on crime of changes in exogenous income and gains to crime are the same as above, the effects of changes in the severity of sanctions become inconclusive without further restrictions on some parameters.

The portfolio model of time allocation with non-fixed leisure time has been somewhat extended by Wolpin (1978) and by Schmidt and Schmidt and Witte (1984), who have introduced four possible criminal justice states, each taking place with a certain probability. In these models the effects of changes in sanctions, and in gains and losses of crime become more ambiguous than in the previous models. Especially, and somewhat surprisingly, illegal activity will decrease with increasing unemployment under the standard assumption of decreasing absolute risk aversion. The explanation is that unemployment implies a lower income, and therefore a higher risk aversion, and then again a lower expected utility of crime. Under risk neutrality time allocated to illegal activity is not affected by a change in the expected employment rate. Baldry (1974) introduces the assumption that a person has to choose between zero or a given number of hours of legal work per week. Transforming the Ehrlich model into a nonlinear programming model, he obtains unambiguous predictions of the effects on crime of changes in sanctions and economic variables.

If one is not willing to accept the assumption that all psychic factors associated with legal and illegal activities can be monetized, one has to use utility functions where time allocations and their attributes are introduced explicitly. Block and Heineke (1975) have studied a model where a vector of attributes of the penalty, interpreted as the length of sentence, is included in the utility function. In this model one obtains considerably more ambiguous results than for the previous models. Unless one is willing to make strong assumptions about individual preferences, it is not possible to decide whether criminal activity will decrease or increase as a result of changes in the probability of punishment, of changes in returns to legal and to illegal activity, and of changes in exogenous income.

Block and Heineke (1975) have shown that changes in legal and illegal remuneration lead to changes in illegal activity that are composed of stochastic counterparts of the substitution and income effects of traditional supply and demand theory. But the similarity is not close. Even if one assumes that illegal activity is inferior (i.e. that such activity is decreasing with income), it is not possible to sign the relevant

terms. Increasing the penalty, for instance, will not unambiguously deter crime.

Witte (1980, p. 59) and Schmidt and Witte (1984) have studied a simplified version of their several sanctions model where time spent in legal income-generating activity (work), time spent in illegal income-generating activity (theft, etc.), time spent in legal consumption activities, and time spent in illegal consumption activities (drug use, assaultive activities, etc.) are separate arguments in the individual's utility function. Here too, similar inconclusive results are obtained. When benefits and costs of legal activities are risky, even more ambiguous results are obtained.

The standard assumption that people maximize *expected* utility is appealing because it follows from the von Neumann–Morgenstern axioms of individual behavior that many scholars regard as reasonable, or at least as a fruitful hypothesis. However, many laboratory experiments have shown that people do not always choose in accordance with these axioms. The surge of studies of *non-expected* utility theories have so far had little impact on the literature of economics of crime. An exception is Lattimore and Witte (1986), who included burglaries in a set of risky prospects to choose between. Eide (1995) has substituted the assumption of rank-dependent expected utility for the ordinary expected utility in various models of criminal behavior. In the latter study it is shown that the qualitative results of comparative statics analyses are the same for both types of assumptions.

Summing up the comparative static results so far, an increase in the probability of clear-up or arrest has, regardless of the sign of the attitude toward risk, a negative effect on the supply of crime. The effect of an increase in the conviction rate, given arrest, is indeterminate without further assumptions, and the same holds true for an increase in the probability of imprisonment given conviction. However, reasonable assumptions will produce the same conclusions as for the unconditional probability of arrest or conviction. These results constitute a certain support for the probability part of the deterrence hypothesis.

For any attitude toward risk in Becker's model, an increase in the severity of punishment has a negative effect on the supply of crime. For the group of portfolio choice models as a whole, the severity part of

the deterrence hypothesis hinges upon the question of attitude toward risk. The effect of more severe sanctions is especially uncertain for risk lovers, whereas risk averters in most models offend less when sanctions increase. Furthermore, a positive shift in punishment in the several sanctions model and in the labor supply model with non-monetized attributes can cause an increase in crime for any attitude toward risk. In the latter model, the restriction necessary to generate this effect is that the income effects must be greater than the substitution effects. The labor supply models with non-monetized attributes give inconclusive effects also for changes in the other parameters that are studied. For the other models the effects of changes in the gains to crime, in exogenous income, and in income from legal activities depend on the individual's attitude toward risk.

Overall, the conclusion is that the effects of changes in the environment depend on the individual's attitude toward risk. If one is willing to stick to the rather common assumption of decreasing absolute risk aversion, and also that psychic effects can be monetized, and that there is just one type of sanctions, the effects are clear: crime is deterred by increases in the probability and in the severity of punishment, and enhanced by increases in exogenous income, and in gains from both legal and illegal activities. The reason why increases in various incomes and gains increases crime is that punishment in the case of decreasing absolute risk aversion produces a smaller reduction in expected (total) income. For risk-neutral people an increase in the probability or severity of punishment and a decrease in the gains to crime will reduce the supply of crime, whereas changes in exogenous income, and in the remuneration of legal activity have no effect. Here, changes in the latter income components do not change the bite of punishment.

A crucial assumption in the studies mentioned above seems to be the Bernoulli distribution of the probability of punishment. Introducing a more general distribution of risk into the Becker-type model of Block and Lind (1975), Baldry (1980) concludes that the "standard" deterrence results cannot be derived. A survey of the main contributions to the development of the economic models of crime is found in Schmidt and Witte (1984).

A type of model somewhat different from those mentioned above is developed by Ormerod *et al.* (2003). The model is similar to those used in mathematic biology to describe how potential epidemics are spread or contained in a population. In their model the amount of crime committed by an individual depends on the amount of crimes committed by others in the person's environment. The potential to commit crime differ among groups of people, and a person may move from one group to another. The probability and severity of punishment influence the flow between groups, and thus the amount of crime.

2.3 The Benefits and Costs of Crime

Various studies have elaborated on the benefits and costs of crime. The gains and losses included in the economic models of criminal behavior are usually meant to represent all kinds of benefits and costs that have an effect on the people's decisions. People are assumed to allocate time to criminal activity until marginal benefits equal marginal costs. For some people marginal benefits are probably always lower than marginal costs, and we then have a law-abiding person. Others will specialize in crime, while most of us possibly commit an offense now and then.

The kinds of gains obtained from a criminal act vary, depending on the type of crime and the individual criminal: Some are monetary, obtained from theft, robbery, insurance fraud, etc. Others are psychic, such as the thrill of danger, peer approval, retribution, sense of accomplishment, or "pure" satisfaction of wants (rape). For some property crimes the prices obtained on markets of stolen goods are of importance. Among the costs one may distinguish between material costs (equipment, guns, vehicles), psychic costs (guilt, anxiety, fear, dislike of risk), expected punishment costs, and opportunity costs.

The punishment costs include all formal and informal sanctions, as well as pecuniary costs arising from lawsuits (lost income and lawyer's fee). The formal sanctions include fines, various forms of incarceration, etc. The more severe these sanctions are, the higher the cost. The informal sanctions include any personal inconveniences connected with arrest, trial, and conviction. The sanctions related to the social stigma caused by arrest and formal sanctions must be added. The nuisance

associated with appearing in court, and the reactions of employer, family and friends might have a stronger effect than formal sanctions. The opportunity cost of crime consists of the net benefit (gross benefit minus cost) of the legal activity forgone while planning, performing and concealing the criminal act. The lower an individual's level of income, the lower is his or her opportunity cost of engaging in illegal activity.

The amount a person can earn in the legal sector may depend on factors such as age, sex, race, education, training, region, rate of unemployment, and IQ. People able to earn only a rather low wage will have a low-opportunity cost of crime, the cost of giving up legal income. We would therefore expect that among criminals there are more young people, men, minorities, and low-paid workers, than in the population at large. This is in fact what crime statistics tell us, but more refined empirical studies are necessary to substantiate such relationships.

Many individual characteristics might have an effect on benefits and costs. Individual rates of discount might be important. The gains from crime often occur immediately, whereas punishment is something that might come in the future, and stretched over a long period of time. A high discount rate will therefore tend to increase crime. The probability of punishment will be different for different people. Some are cleverer than others at concealing the offense and eluding the police. There are also differences in abilities of defending oneself in court, or in engaging good lawyers. The attitude toward risk will also have an effect.

A high rate of recidivism is in accordance with the model of rational choice. If for an offender preferences are stable and the opportunities available remain the same, the degree of criminal activity will not tend to decrease after a conviction. Moreover, serving time in jail may reduce legal opportunities, and convicts may acquire human capital in illegal activities, so that recidivism is not necessarily a result of erratic behavior or lack of self-control, nor is it evidence of a lack of deterrence. Rather, it may be consistent with a theory of rational choice. If it was rational to commit a crime in the first place, it is all the more so after having served a prison sentence. If the sentence has increased the criminal's evaluation of how probable or severe sanctions might be, or if he or she has obtained some benefit of prison education schemes, the tendency to recidivism will be counterbalanced.

2.4 Are Criminals Really Rational?

Exaggerating somewhat the differences between sociologists and economists, one may say that the former consider crime as deviant behavior whereas the latter consider it as rational. The individual has a feasible set of courses of action, some of which are illegal. The environment, including sanctions and wages, determines the outcomes of the various courses of action. The individual is assumed to choose the course of action that best satisfies preferences. Preferences include not only wants, but also binding and non-binding norms. The guilt of acting in conflict with non-binding norms is part of the costs of crime. If individual norms are explicitly included one may speak of norm-guided rational behavior.

In theories of economics of crime, norms are seldom studied, or even mentioned. Preferences as a whole are usually assumed to be constant, and authors do not find it necessary, or do not feel competent to discuss norms. Traditional criminologic theories, on the other hand, suggest that the individual's environment has a significant impact on people's preferences, especially on individual norms, but also on wants. Theories about culture conflict, cultural deviance, anomie, and learning relate individual preferences to various characteristics of the society. Other theories suggest that preferences are inherited or dependent on age, gender, race, intelligence, and other personal characteristics. In the literature of economics of crime these various theories are often neglected, and preferences and individual characteristics are assumed to be constant. The main question studied is how the environment produces incentives to commit, or not to commit, crimes.

In a very broad sense, a deterrent is any factor that exerts a preventive force against crime. Sanctions may have an effect on crime either by causing fear or by influencing norms. The combination of these effects is in parts of the literature on crime called "general prevention" (Andenæs, 1975). In economics of crime one focuses on the effects of law enforcement on the *outcomes* of actions, and thereby on illegal behavior. This is the deterrence mechanism in the narrow sense. The possibility that law enforcement or other aspects of the environment

might affect individual norms and wants, (e.g. by conditioned aversion as suggested by the behavioral perspective), is given less attention.

An interesting question is whether the model of rational choice is in conflict with, a substitute for, a supplement to, or a general framework for other theories of crime. Carr-Hill and Stern (1979) emphasize that the economic and criminologic approaches should be seen as complementary rather than conflicting. They maintain that the economic approach isolates the importance of the probabilities and magnitude of reward and punishment, and show how they can be treated formally. The criminologic approach takes these for granted and indicates how different groups might view and react to these probabilities, rewards, and punishments.

These two approaches are related to the issue of opportunity vs. motivation as explanation of crime. Economists and other researchers who focus on costs and benefits of crime in a rational choice framework, also take into account that crime presupposes potential victims. The better the opportunities of hitting valuable and low-risk targets, the more crime there is. Those who more or less explicitly dismiss the theory of rational choice, often focus on the motivation of individuals, assuming that behavior is determined by individual characteristics and by the norms of the groups to which they belong. The opportunity approach is an element in the market models of crime, where the number of offenses is determined by the interaction of potential offenders, who are seeking the best targets, and potential victims, who by measures of private protection seek to be less attractive or vulnerable to crime, (*cf.* Ehrlich (1981, 1982, 1996) and Cook (1986)).

Several authors have discussed whether people have sufficient information about the environment and about outcomes of actions to make rational choices. Becker and others maintain that even if choices are based on subjective beliefs that are wrong, the choices are meaningful from a subjective point of view, and behavior can be explained and understood on this basis. One may argue that this is not a satisfactory answer to the claim that people have cognitive limitations, and that they stick to “satisficing” and not to maximization. The studies of Carroll and Weaver (1986), Tunnell (1992), and Nagin and Paternoster (1993) suggest that Simon’s theory of bounded rationality might be

a better representation of offenders' behavior than the rational choice theory, a conclusion that is supported by Niggli (1994). Sah (1991) also discusses the information available to criminals and argues that criminals may associate with each other, and so have information based on experiences of acquaintances.

It has also been argued that the simple rational choice theory is inadequate because people's behavior is determined by procedural rationality, in which an individual is portrayed as a follower of rules established by history or social relations, or by expressive rationality, in which an individual, through symbolic acts, demonstrates to him- or her-self and others his or her self-conception and worth. There is disagreement about how serious such criticism is for the use of the rational choice theory in studies of crime. Ehrlich (1973, p. 532) maintains that "[s]ince those who hate need not respond to incentives any differently than those who love or are indifferent to the well-being of others, the analysis ... would apply ... to crimes against the person as well as to crime involving material gains."

2.5 Empirical Studies

In a great number of empirical studies the theoretic models of criminal behavior have been tested, and the effect on crime of the probability and severity of punishment, and of benefits and costs of legal and illegal activities has been estimated. The influence of norms, tastes, and abilities, corresponding to constitutional and acquired individual characteristics, have in some cases been studied indirectly by including variables like age, race, gender, etc. A variety of equation specifications and estimation techniques has been employed, and the studies have been based on levels of aggregation ranging from countries and states down to municipalities, campuses, and individuals.

The awareness of the methodologic problems encountered in this field, combined with easy access to various statistic methods, has gradually led to more sophisticated empirical studies. No effort will be made to explain how the various methodologic problems have been solved (or not solved) in each and every study mentioned below. Only occasionally, some ingenious solution will be pointed. In general, and not

without exceptions, recent studies seem to be more reliable than those carried out 20–40 years ago.

It seems appropriate to introduce the term “criminometric studies” to characterize (advanced) empirical studies of criminal behavior. The subject matter is crime, and it gives the field a somewhat distorted and too limited range to call these studies econometric, although this is what is usually done. The studies are rooted in a general theory of rational choice, and not in some rational choice theory presumably limited to economics.

In the framework of norm-guided rational behavior, norms may depend on the environment. In most criminometric studies norms, as well as wants, are assumed to be constant, and often also equal among individuals. Becker (1976, p. 5) expresses a rather common attitude by stating that “[s]ince economists generally have little to contribute, especially in recent times, to the understanding of how preferences are formed, preferences are assumed not to be very different between wealthy and poor persons, or even between persons in different societies and cultures.” With this assumption it is relatively easy to test other parts of the theory, such as hypotheses about the effect of sanctions, and of gains and losses of legal and illegal activities. If preferences differ among individuals, estimates of the effects of sanctions will be relevant for an “average” person. The explicit assumption that individual preferences are constant distinguish criminometric studies from most other studies in criminology.

There are good reasons to carry out empirical studies of criminal behavior at the individual level instead of an aggregated level. In the first place it is at best controversial to posit that behavior is anything but individual. Second, the theoretic models that are developed are based on individual rational choice. Third, as will be discussed below, studies based on aggregated data require a number of additional assumptions of questionable validity. Forth, the statistical identification problem is less serious when individual behavior is studied. Using aggregated data one faces the problem of distinguishing between the effect of the probability of arrest on the amount of crime and the effect of the amount of crime on the probability of arrest. In empirical studies at the individual level, it can reasonably be assumed that the probabil-

ity and severity of punishment is determined without being influenced by the actions of a given individual. Thus, the deterrence variables can be considered to be exogenous to the individual's choices, and the problem of simultaneity inherent in macro studies is absent. Unfortunately, empirical tests of these models by use of information on individuals are few. The application of the theoretic models to empirical studies is intricate (Manski, 1978), and suitable data are scarce. The data we have are mainly self-reports on criminal activity, and records of criminal activity compiled by the criminal justice system. The most serious problem with the latter type of data is that they do not constitute representative samples of the population, but are biased in the sense that only convicted persons are included. It is hardly possible to test a general theory of rational criminal behavior by studying only one subgroup of the offenders. A related problem is that most available data sources include information only about choices made, and not about those available, but not chosen. It is difficult, if not impossible to test a theory of rational choice if the choice set in this way is limited. Whereas such data are of limited interest for studies of general deterrence, that is of effects on people in general, they are useful for studies of special deterrence, that is of effects on the individuals that are punished.

The bulk of criminometric studies consists of cross-section regression analyses based on aggregated data. Some of them are rather broad, including many types of regional areas, estimation techniques, and types of crime, whereas others concentrate on particular types of crime, such as property crimes, hijacking, or homicide. A few of them address special questions, such as the effect of police "aggressiveness" in patrolling, or the influence of income differentials. Time-series studies are less numerous, and employ mostly data on total crime.

The majority of these empirical studies of crime have been evaluated in various surveys. In an annotated bibliography Beyleveld (1980) reviews a number of investigations of correlations between crime and deterrence variables, in addition to 35 cross-section and 31 time-series econometric studies of crime. A thorough review of the empirical evidence of general deterrence is also given by Nagin (1978), who comments on 24 correlation and econometric studies, all but two also covered by Beyleveld. Taylor (1978) concentrates on six major

econometric studies, whereas Pyle (1983) reviews the same studies and about 15 others. A shorter, but somewhat more up-to-date, review is Cameron (1988), and more recent comprehensive surveys are found in Eide (1994), Nagin (1998), and Freeman (1999). Reviews of certain parts of the literature are found in Fisher and Nagin (1978), Passell and Taylor (1977), Vandaele (1978), Klein *et al.* (1978), and Nagin (1978). In the most recent survey, covering both criminologic and economic factors influencing crime trends Marris (2000) includes 288 studies.

2.5.1 Empirical effects of punishment variables

In empirical studies the measures used to represent the probability of punishment include the probabilities of arrest, of clearance, of conviction, and of conviction given arrest. The severity of punishment is represented by the amount of fines, by the length of sentence, or by time served.

Some studies are based on individual data. Witte (1980) and Schmidt and Witte (1984) have employed individual data on post-release activities of a random sample of 641 men released from prison in North Carolina. The effects on crime of measures of both the probability and the severity of punishment are found to be more or less negative. Myers Jr. (1983), using a sample of 2127 individuals released from US Federal prisons, finds that severity of punishment has a statistically significant negative effect on crime, whereas the probability measure (the ratio of previous prison commitments to previous convictions) has a positive effect. Higher wages are found to reduce recidivism. Trumbull (1989) has used data on about 2000 offenders released from prisons in North Carolina to study recidivism and special deterrence. He finds that none of the deterrence variables (probabilities of arrest, conviction and imprisonment, and length of sentence) are statistically significant. Trumbull finds this result natural, since the sample consists only of individuals who, whatever the probability and severity of punishment, have chosen to engage in illegitimate activities. However, an increase in an offender's own previous sentence length has a significant negative effect on crime, a result that corroborates the hypothesis of special deterrence. Higher earnings on the first job after release has a

negative effect on crime. Quite unexpectedly, so has unemployment. Viscusi (1986) uses an approach common in labor economics in the studies of hazardous jobs to estimate the risk/reward tradeoff for illegal activities. In labor markets increasing health risks are often rewarded by some amounts of money in addition to non-risk wages. Treating the probability and severity of punishment in the same manner as the probability and severity of injury are treated in analyses of hazardous jobs, Viscusi is able to estimate the effects of changes in these variables. A survey of 2358 inner-city minority youths from Boston, Chicago, and Philadelphia constitutes the data employed. Viscusi finds that the premiums obtained for criminal risks are strong and quite robust. In his framework this is interpreted as a corroboration of the general deterrence hypothesis. Studies of tax cheating based on individual data by Clotfelter (1983), Slemrod (1985), Witte and Woodbury (1985), and Klepper and Nagin (1989) all conclude that both the probability and the severity of punishment have negative effects upon crime.

Many studies of correlation between crime rates and punishment based on aggregated data appeared in the late sixties and early seventies. Using mostly US data on the state or municipal level these studies indicate a negative association between the certainty of arrest and the crime rate for different crime categories. But crime rates are not generally found to vary with the severity of imprisonment, although in some studies a deterrent effect is obtained for homicide and a couple of other crime categories.

A necessary condition for interpreting the results of these correlation studies (mostly carried out by sociologists) as estimates of deterrence is, of course, that there is a one-way causation from punishment to crime, and none in the opposite direction. The many subsequent cross-section criminometric studies allowed for a two-way causation by various specifications of the general model:

$$C = f(P, S, Z_j), \quad (2.3)$$

$$P = g(C, R, Z_k), \quad (2.4)$$

$$R = h(c, Z_l), \quad (2.5)$$

where C is the crime rate (number of crimes per population); P , the probability of punishment; S , the severity of punishment; R , resources

per capita of the criminal justice system (CJS); and Z_j, Z_k, Z_l are the vectors of socio-economic factors. The crime function (2.3) assumes that the crime rate is a function of the probability and the severity of punishment; Eq. (2.4) assumes that the probability of punishment is a function of the crime rate and the resources allocated to the CJS; and Eq. (2.5) assumes that the resources allocated to the CJS is a function of the crime rate. Various socio-economic factors are included as explanatory variables in all three equations. In some studies police resources are included as an explanatory variable in the crime function.

Among the first simultaneous regression analyses in this field we find Ehrlich (1972), Phillips and Votey (1972), and Orsagh (1973). The first major cross-section study appearing after Becker's theoretic article was Ehrlich (1973). He studies seven types of crimes in the USA based on data for all states from 1940, 1950, and 1960. He finds that the probability of imprisonment has a statistically significant negative effect on all types of crime, and, except for murder, not less for crimes against the person than for other crimes. The severity of punishment has a similar effect, but here only about half of the estimates are statistically significant. Crime is also found to be positively related to median family income (presumably more assets to steal) and to income differentials. Ehrlich's study has been thoroughly scrutinized by several authors, some of whom have given harsh evaluations of his work. Revisions, replications, and extensions of Ehrlich's studies by Forst (1976), Vandaele (1978), and Nagin (1978) resulted in more moderate deterrent effects of the probability and severity of punishment. Moreover, Forst found that by introducing variables thought to be correlated with the punishment variables, such as population migration and population density, the punishment variables became statistically insignificant. Nagin found that incapacitation could explain a large part of the apparent deterrent effect. In a fierce attack on Ehrlich's study Brier and Fienberg (1980) conclude an empirical investigation of the Ehrlich type that no deterrence effect of sanctions was found. A response to the criticism from these and other authors is found in Ehrlich (1977). Despite critical remarks by various authors, there is now a long list of studies similar to the one by Ehrlich.

The great majority of correlation studies and cross-section regression analyses show a clear negative association between punishment variables and the crime rate. Almost without exception the coefficients of the punishment variables (which usually are the elasticities of the crime rates with respect to the punishment variables) are negative, and in most of the cases significantly so. Furthermore, the estimated elasticities have rather high values. Eide (1994) summarizes such estimates of 20 cross-section studies based on a variety of model specifications, types of data and regression techniques (Danziger and Wheeler (1975), Ehrlich (1973), Eide (1973), Forst (1976), Holtmann and Yap (1978), Sjoquist (1973), Swimmer (1974), Trumbull (1989), Phillips and Votey (1975, 1981), Avio and Clark (1978), Blumstein and Nagin (1977), Carr-Hill and Stern (1979), Chapman (1976), Forst (1976), Furlong and Mehay (1981), Heineke (1978), Mathieson and Passell (1976), Mathur (1978), Myers Jr. (1980, 1982), Sesnowitz and Hexter (1982), Thaler (1977), Vandaele (1978), Wilson and Boland (1978) Willis (1983), Schuller (1986), Trumbull (1989)) Eide finds the median value of the 118 estimates of elasticities of crime rates with respect to various measures of the probability of punishment to be about -0.7 . The median of the somewhat fewer severity elasticities is about -0.4 . The rates of clearance by arrest are usually considered to be better measures of the certainty of sanction than the rates of conviction (Andenæs, 1975, p. 347). The median of the elasticities of arrest is found to be somewhat smaller than the median of the elasticities of conviction, but the difference is not great.

The most common punishment variable used in criminometric studies is the arrest rate. Only a few, such as Ehrlich (1973), Schmidt and Witte (1984), and Cornwell and Trumbull (1994), have included variables representing also the probability of conviction and the length of sentence. Mustard (2003) argues that the problem of omitted punishment variables may produce wrong estimates of the effect of arrest rates. Using county-level panel data from four US states he finds that arrest rates are negatively correlated with conviction rates and sentence lengths. All three punishment variables are found to have a negative effect on crime. Including only the arrest rate as explanatory punishment variable reduces the effect on crime of this variable by 50%.

Until recently, cross-section studies relying on aggregate data have not controlled for unobserved heterogeneity. Using a panel dataset for North Carolina counties Cornwell and Trumbull (1994) address both unobserved heterogeneity and conventional simultaneity. Compared to previous studies, and to OLS estimates based on their own data, they obtain smaller deterrent effects of both the probability of arrest and that of conviction. However, the deterrent effects in their preferred estimation are no longer statistically significant. Also Eide *et al.* (1994), in a study using panel data from Norwegian police district, treat heterogeneity and simultaneity. For crime in general the elasticity of arrest is estimated to be about -0.9 .

Almost all criminometric time-series studies give additional firm support to the hypothesis that the probability of punishment has a preventive effect on crime. In particular, this result is corroborated also for juvenile crime (Levitt, 1998). Note, however, that time-series studies at best reveal only short-term effects of changes in punishment variables. They usually do not consider the impact of incarceration on the behavior of criminals in the long run.

The results concerning the effect of the *severity* of punishment are somewhat less conclusive. Wahlroos (1981), using Finnish data, finds that the severity of punishment has a statistically significant deterrent effect on larceny, but not on robbery. Cloninger and Sartorius (1979), using data from the city of Houston in the USA, obtain a negative, but not statistically significant effect of the mean sentence length. Wolpin (1978), using a time-series for England and Wales in the period 1894–1967, finds that the estimates of the effects of the length of sentences differ among types of crime, and are often not statistically significant. Schuller (1986) on the other hand, using Swedish data, finds a negative effect of the average time in prison. In an international comparison of crime among Japan, England, and the USA, Wolpin (1980) obtains firm support for the deterrent effect of the severity of punishment. Travaglini (2005) obtains a similar result in a panel study for Italy. These somewhat diverging results are not surprising. The theories surveyed above tell us that if there is a significant proportion of risk lovers in the population, and/or if the income effect is greater than the substitution effect, and/or the effects of legal activities are

risky, and/or household protection expenditures are inversely related to the severity of punishment, an increase in the severity of punishment may well cause crime to increase on the macro level. If, however, in spite of these crime increasing effects, macro studies show that crime is reduced when punishment becomes more severe, there is all the more reason to believe in a deterrent and/or a norm formation effect of punishment.

Among the several empirical studies concentrating on just one type of crime, it is worth noting that Landes (1978) obtained firm support for the deterrence hypothesis for hijacking. In a study of draft evasion in the USA, Blumstein and Nagin (1977) avoid four of the main objections against criminometric studies (see discussion of objections below); draft evaders are likely to be well informed about possible sanctions; data are relatively error free; as draft evasion can happen only once, there is no danger of confounding incapacitation effects with deterrence effects; simultaneity problems caused by over-taxing of the CJS are unlikely because draft evasion was given priority in the relatively well-staffed federal courts. The authors consider that their results provide an important statistic confirmation of the existence of a deterrent effect. They find, however, that the severity of the formal sanction has a modest effect on draft evasion compared to the stigma effect of being arrested and convicted.

The economic model of crime suggests that changes in benefits and costs of committing a particular type of crime might have effects on the severity of other types of crime. If, for instance, the probability of being convicted for robbery increases, some robbers might shift to burglary. One crime is substituted for another, just as people buy more apples instead of oranges when the price of oranges goes up. Such substitution effects between crimes have been estimated by Heineke (1978), Holtmann and Yap (1978), and Cameron (1987). A certain number of statistically significant effects are found, indicating that some crimes are substitutes whereas others are alternatives.

Even if more severe punishment often is found to decrease crime, the impact is usually modest and also not statistically significant. Myopia among offenders might be a reason for this result. Lee and McCrary (2005) have studied the behavior of young offenders before and after the

day they turn 18 years. After that day they are legally treated as adults and face longer lengths of incarceration. Sufficiently patient individuals should therefore significantly lower their offending rates immediately on turning 18 years. Lee and McCrary (2005) find rather small behavioral changes and conclude that potential offenders are extremely impatient, myopic, or both. On the other hand, Shepherd (2002) has shown that “three strikes” laws deter even the first crime, suggesting that criminals are sufficiently rational to anticipate indirect consequences of their actions.

Incarceration might reduce crime both because of deterrence and because of incapacitation. In many empirical studies no effort is made to distinguish between the two effects. Focusing on this problem Levitt (1995) and Kessler and Levitt (1999), using various techniques, conclude that deterrence is the more important factor.

As a whole, criminometric studies clearly indicate a negative association between crime and the probability and severity of punishment. The result may be regarded as a rather firm corroboration of the deterrence explanation obtained from the theory of rational behavior: an increase in the probability or severity of punishment will decrease the expected utility of criminal acts, and thereby the level of crime. It should be remembered, however, that in some studies the effect of an increase in the severity of punishment is not statistically different from zero, and a statistically significant positive effect has also occasionally been obtained.

2.5.2 Empirical effects of police

Most studies that regress crime on police do not find statistically significant effects of the latter. Among the reasons for this result might be that only large increases in police resources may have a noticeable effect on crime, and that the police have many other duties than crime prevention. Marvell and Moody (1996), surveying 36 regression studies of the crime–police relationship, also argue that the lack of a revealed effect of police on crime also might be caused by the simultaneity problem. In their own time-series study of US states and cities a Granger test confirm that they have dealt with this problem in a

suitable manner. Contrary to most other studies they find that police has a statistically significant effect on total crime at the level of cities. The point estimates indicate that police has a substantial impact on most types of crime both in cities and states. Buck *et al.* (1983), including both police presence and arrest rates as explanatory variables, find that the former rather than the latter has a deterrent effect. Klick and Tabarrok (2005) use the effect of terror alerts in Washington, DC, to measure the effects of police and find that police do reduce crime. Di Tella and Schargrotsky (2004) perform a similar analysis for Argentina using the police response to the bombing of the Jewish center in Buenos Aires, and also find that police deter crime. Evans and Owens (2006) use the COPS program, a federal program aimed at enabling localities to hire more police, to measure the effect of police on crime and also find that more police lead to reduced crime.

2.5.3 Empirical effects of income variables

In accordance with the theoretic models, most criminometric studies contain income variables representing some of the benefits and costs of legal and/or illegal activities.

2.5.3.1 *Benefits of legal activities*

Looking first at the benefits of legal activities, some studies corroborate the Becker-type models. Using a panel dataset of North Carolina, Cornwell and Trumbull (1994) find that high wages in legal activities are associated with low crime rates. Machin and Meghir (2000), using different wage measures in a time-series study of England and Wales, find that falls in wages of unskilled workers lead to increases in crime. Looking at these and several other studies together one is struck by great variety of proxies applied: median family income, median income, labor income to manufacturing workers, mean family income, mean income per tax unit, mean income per capita, etc. No systematic relationship appears between the income measures applied and the estimates obtained. Although the hypothesis that an increase in legal income opportunities decreases crime is not rejected in most of the studies, others would not reject the inverse hypothesis that an increase in legal

income opportunities would increase crime. This ambiguity in results might be due to the fact that the income measures used represent benefits not only of legal activities, but also of illegal ones: Higher legal incomes (mostly wages) tend to make work more attractive than crime, but to the extent that higher legal income in a region produces a greater number of more profitable targets for crime, the same empirical income measure may be positively correlated with criminal activity. In addition, high legal incomes also mean high incomes foregone when incarcerated, a cost of crime that will have a negative effect on crime. If these mechanisms are at work simultaneously, and their relative strength is not universally constant, it is not surprising that the results of various studies differ. The theory is not necessarily deficient, but the methods applied do not distinguish between the two mechanisms. The main problem is that the incomes of legal and illegal activities are highly correlated, and that it is difficult (or impossible?) to find empirical measures that with enough precision can distinguish between their effects. The impact of income is further obfuscated by the fact that private security measures increase with income, while higher income probably reduces the marginal utility of each piece of property, and therefore also the measures taken to protect property. These problems of correlation are not present in studies where individual data are employed, such as Witte (1980) and Myers Jr. (1980).

2.5.3.2 *Effects of gains from crime and costs of crime*

Studies estimating the effect on crime of gains to crime underscore the problem of finding good empirical measures for theoretic variables. Whereas Ehrlich uses median family income as a measure of *gains from crime*, other authors use the same measure to represent *legal income opportunities*. A variety of measures of gains have been used, with diverse estimated effects on crime. An example is Dhiri *et al.* (1999). Modeling property crime trends in England and Wales they find a substantial effect on crime of the stock of goods. Glaeser and Sacerdote (1999), studying why there in the USA is more crime in large cities than elsewhere, find that higher pecuniary benefits from crime in large cities can explain up to one-quarter of the connection between city size

and crime rates. Corman and Mocan (2005) find that economic opportunity and various measures of deterrence both reduce crime. Imai and Krishna (2004) find that if punishment for crime reduces future employment opportunities, then there is a reduction in crime.

Income inequality. According to criminal statistics the well-to-do are less likely to commit crimes than the poor. In an empirical study of ex-convicts Lott (1992) finds that the reduction in income from conviction is extremely progressive, a result that corroborates the hypothesis that an increase in the costs of committing crimes has a negative effect on the amount of crime. Using a co-integration approach Saridakis (2004) finds in a time-series study for the USA during the period 1960–2000 that income inequality has only a minor effect on violent crime with the exception for murder, where a strong positive relation is obtained. He suggests that murder is a byproduct of crimes with economic incentives. In cross-country studies Fajnzylber *et al.* (1998, 2002a, 2002b) find a clear effect on crime of inequality. On the other hand, Neumayer (2005), extending the cross-country data set used by Fajnzylber *et al.*, and controlling for country-specific effects, concludes that inequality is not a statistically significant determinant of crime.

A large income differential may indicate that crime is a comparatively rewarding activity for the very-low-income group (that may find a lot to steal from the very rich). Estimates of the effect of crime of income differentials also vary across studies. It is interesting to note, however, that a study which includes variables of both legal and illegal income opportunities in addition to one of income differential (Holtmann and Yap, 1978), obtains significant estimates of the expected signs for all three variables. Also Freeman (1995) concludes that wages from legitimate work and measures of inequality have the expected effects on crime.

Unemployment. Unemployment is usually included in criminometric studies as a proxy for (lack of) legal income opportunities. Unemployment will make crime (at least property crime) more attractive if the alternative is a life in poverty. The estimates of the effect of

unemployment on crime, however, are positive in some studies, and negative in others. A comprehensive survey by Chiricos (1987) demonstrates that unemployment in most studies seems to increase crime. He has reviewed 63 aggregate studies published in major journals of economics, sociology, and criminology containing 288 estimates of the relationship between unemployment and crime. He finds that 31% of the estimates were positive and statistically significant, whereas only 2% were negative and statistically significant. Most of the non-significant estimates were positive. A similar conclusion is obtained in a survey by Freeman (1995). Chiricos (1987) finds little support for the hypothesis that unemployment decreases the opportunity for criminal activity because of fewer and better protected criminal targets, an hypothesis that has been launched to explain why in some studies a negative relationship is obtained. Another explanation of such a negative association, suggested by Carr-Hill and Stern (1973), is that unemployed fathers stay at home and keep an eye on their delinquent sons. Furthermore, differences in results might be the variability in unemployment insurance schemes. In some places unemployment insurance is only slightly below ordinary legal income, and in addition, some of the formally unemployed receive income from short-term jobs. According to economic models of crime, the number of offenses will then not increase when unemployment increases. A decrease may even occur. The combination of unemployment insurance and criminal activity might be a preferred alternative. But if unemployment hits people without such income opportunities, the model indicates that crime will increase.

Several recent time-series analyses based on aggregated data show a positive correlation between unemployment and crime (e.g. see Cantor and Land (1985), Land *et al.* (1990), Pyle and Deadman (1994), Freeman and Rodgers (1999), Carmichael and Ward (2001), Entorf and Spengler (1998), Papps and Winkelmann (2000), Raphael and Winter-Ebmer (2001)). In a study based on pooled time-series cross-section data, Levitt (1995) finds a positive relation between unemployment and property crimes, whereas the relation between unemployment and violent crimes appears to be more mixed. Using Swedish panel data Edmark (2005) concludes that unemployment has a positive and

significant effect on some property crimes. Gould *et al.* (2002) examine the impact of crime on both wages and unemployment. In their time-series study of unemployment in the USA they conclude that both the factors are significantly (positively) related to crime, but that wages played the largest role. They also find that this result is robust to the inclusion of deterrence variables, controls for simultaneity, and controlling for individual and family characteristics.

2.5.4 Additional variables

In some studies routine activity and situational opportunity are included as main explanations of crime (*cf.* Cohen *et al.* (1980)). Chapman (1976), for instance, finds that the female participation rate in the labor market, a proxy for the proportion of unguarded homes, has a significant positive effect.

It has been argued that the rational choice framework might be relevant for certain property crimes, but not for violent crimes that are considered to be “expressive” and not “instrumental”. Undoubtedly, the degree of “expressiveness” differs among crimes. Many empirical studies may be interpreted as support for the view that threat of punishment also has a preventive effect on “expressive” crime. At least substantial elements of rationality are revealed in a study of mugging by Lejeune (1977), in a study of rape and homicide by Athens (1980), and in a study of spouse abuse by Dobash and Dobash (1984). Although the effect of punishment may differ among types of crimes, evidence so far indicates that the rational choice framework is relevant for all types of crimes, and that analyses rejecting *a priori* that some particular types of crimes are deterrable are inadequate.

2.6 Methodologic Problems and Criticism

Objections to economic studies of criminal behavior have been many and occasionally fierce, (see e.g. Blumstein *et al.* (1988), Brier and Fienberg (1980), Blumstein *et al.* (1978), Orsagh (1979), Prisching (1982)) and Cameron (1988). In particular, studies based on aggregated data

have been criticized. There is an ongoing discussion about which statistic techniques to use (Britt (2001), Cantor and Land (2001), Greenberg (2001a,b), Levitt (2001), O'Brien (2001), Paternoster and Bushway (2001)) and other methodologic problems. In addition to attacks on the assumption of rational behavior, the main criticism relates to interpretations of empirical results, to statistical identification of equations and unobserved heterogeneity, to measurement errors, and to operationalization of theoretic variables.

2.6.1 Interpretation of empirical results

It has been argued that many studies do not take into consideration that more certain or more severe punishment may prevent crime by two different mechanisms: either directly as a cost or indirectly through norm formation. A type of crime that is cleared up more and more seldom, or sanctioned more and more leniently, will easily be considered as not very serious by the population. Individual norms may adjust accordingly, people's crime aversion decreases, and consequently the level of crime increases. It seems true that in most empirical studies no effort is made to distinguish between this mechanism and the more direct deterrence effect of an increase in punishment. Results are often interpreted as a deterrent effect, and not as a general prevention effect where also the indirect norm formation mechanism is included.

Can criminometric studies possibly distinguish between the two mechanisms? In cross-section studies one can imagine that people living in regions where the clearance probability is low tend to consider crime as less serious than do people in other regions. If such differences in norm formation exist, they are probably more predominant the longer the distance between the regions that are compared, for instance in international comparisons, or in studies of states in the USA. It is not probable that norm formation differs among the districts within a rather small region, especially if news about punishment can be assumed to be more or less the same, and mobility of people is high. The effect on crime of variation in the severity of punishment found in studies using data from rather small areas within a region can therefore hardly be explained by a norm-formation mechanism.

Where one obtains a negative relationship between the crime rate and the clearance probability when data representing counties of only one state (Avio and Clark (1978), Chapman (1976), Trumbull (1989)), or of police districts in a metropolitan area (Furlong and Mehay (1981), Mathieson and Passell (1976), Thaler (1977)), one will have reason to believe that the norm-formation mechanism must be of minor importance. The same holds true for some studies of substitution of crime which show that an increase in punishment of one type of property crime will have a statistically significant effect on the number of other property crimes. It is not probable that a higher probability of being punished for burglary has any effect on the norms regarding robbery. It is more reasonable to think that robbery is substituted for burglary because of a change in relative costs. Even if the importance of each mechanism is regarded as uncertain, the estimates obtained in various studies are still of interest. Not only from a political point of view, but also from a scholarly one, it may be useful to know that the probability of punishment has a certain negative effect on crime, notwithstanding the mechanism(s) involved.

Another possible uncertainty concerning the evaluation of results is that there might exist an underlying phenomenon, unknown and/or not studied, a phenomenon that at the same time produces a low crime rate and a high probability of punishment. Individual norms may create such a relationship. If people in one region appreciate each others' welfare more than on average, they will both have a relatively strong aversion against criminal infringements against others, and a high interest in clearing up crimes to decrease crime in general. If such differences in norms exist, they must be rooted in cultural differences of some kind. Possibly, such differences can develop if regions are situated far from each other, or if distance in time is substantial. For the smaller regions, such differences seem less realistic.

Theories of criminal behavior show that a whole series of "causes" may be involved, and that recorded differences in crime between regions, gender, races, drug abuse, etc. might be related to more fundamental explanations of crime, involving norms, wants, opportunities, and circumstances. The intricacy of relationships shows the difficulty in interpreting the estimates of the effects of crimes on such variables.

2.6.2 Identification and unobserved heterogeneity

If, in an empirical study, one finds that crime rates and probabilities of punishment are negatively correlated, one cannot easily distinguish between the hypothesis that higher probabilities of punishment cause lower crime rates (Eq. (2.3)), or the hypothesis that higher crime rates cause lower probabilities of punishment (because of police overloading, Eq. (2.4)). If such a simultaneity exists it is not acceptable to use the method of ordinary least squares (OLSs) to estimate each equation. Using the Hausman test Layson (1985) and Trumbull (1989) have for homicide found that simultaneity was not a problem in their data, and OLS could be applied. If simultaneity is present, the standard procedure to identify the first relation, the crime function, consists of introducing exogenous variables that have an effect on the probability of punishment, but not on the crime rate. In a discussion of the (im)possibility of identifying the crime function in macro studies, Fisher and Nagin (1978, p. 379) declare that they know of no such variables. The equations may be technically identified, but by false assumptions. (The consequence of this view is that attempts by this procedure to identify relations in empirical macro studies are illusory.) Marvell and Moody (1996) discuss how the simultaneity problem is (not) dealt with in a number of empirical studies. They suggest that Granger tests should be applied to test the direction of causation, a procedure that is found in rather few other studies. Aasness *et al.* (1994) have solved the problem of simultaneity by demonstrating that the structural parameters of the crime and clear-up functions are explicit functions of the theoretic second-order moments of crime and clear-up rates. In studies based on individual data, the question of identification is much less serious. (*cf.* above)

It is interesting to note that in the cross-section studies reviewed by Eide (1994) the method of ordinary least squares tend to give smaller estimates of the elasticities of crime with respect to the probability and severity of sanctions than do the methods of two stages least squares, full information maximum likelihood, and other more advanced methods. The difference in estimates is, however, not great.

Cornwell and Trumbull (1994) point to the fact that aggregate cross-section econometric techniques do not control for unobserved heterogeneity. Addressing this problem by use of a panel data set of North Carolina counties, they obtain more modest deterrent effects on the arrest and conviction rates than those obtained from cross-section estimation.

2.6.3 Measurement errors

Since a substantial part of all crimes is not registered by the police, one may have serious doubts about the results of empirical studies based on official statistics. However, the problem of underreporting is not damaging to empirical research if the rate at which actual crimes are reported is constant across regions (in cross-section studies) or over the years (in time-series studies). This seems to be an implicit assumption in most studies. Blumstein *et al.* (1978) explain how differences in “dark numbers” between observational units create a spurious negative association between the recorded crime rate and the probability of clearance. Aasness *et al.* (1994) introduce, in addition to the recorded crime rate, a latent variable for the real crime rate, and relate the latter to the former by a linear function and a stochastic term. By this procedure measurement errors are given an explicit stochastic treatment that allows for a distribution of “dark numbers” among police districts. Deadman *et al.* (1997) present a thorough discussion of the effect of underreporting in statistic models of criminal activity. Investigating the biases because of underrecording in conventional regression analyses, Pudney *et al.* (2000) find that these biases are modest. Applying a simulated maximum likelihood procedure on data from England and Wales they obtain significant effects on crime of both economic and punishment variables.

The existence of a substantial “dark number” of crimes has fostered a greater interest in using victimization studies to obtain more reliable data. These studies give more or less similar results as those based on recorded crimes. A prominent example is Goldberg and Nold (1980) who find that the reporting rate, and thus the probability of clearance, has a great impact on the amount of burglaries. Another comprehensive study

is Myers Jr. (1982), who obtains almost the same estimates of the effects of sanction variables by correcting crime rates by victimization data.

2.6.4 Wrong beliefs

If people have wrong beliefs, one may also question the validity of estimates of the effects of punishment variables and various socio-economic factors. Presumably, the true risk of sanction is not known to the individual. Empirical studies suggest that people tend to overestimate the average risk, while at the same time believing that the risk they themselves run is lower than average. Offenders, however, seem to be better informed. Wilson and Herrnstein (1985, p. 392) refer to a study where over 2000 inmates of jails and prisons in California, Michigan, and Texas were interviewed about their criminal careers. The study revealed a close correspondence between the actual and perceived risk of imprisonment in Michigan and Texas, whereas a somewhat weaker correspondence was found in California. The study further corroborated the theoretic result that an increase in the probability of imprisonment will decrease crime.

Even if beliefs to some extent are wrong, macro studies might still be of some value. It may well be that some persons do not observe a given change, and also that they have been mistaken in their beliefs. But the gradual change from very lenient to very harsh punishment will certainly be registered by at least a part of the population, and behavior will change, more or less, as already explained.

2.6.5 Various operationalizations

Many studies give weak arguments for the choice of theoretic variables (e.g. of variables of punishment, benefits and costs), and of their empirical measures. Orsagh (1979) argues that the great diversity of variables in empirical criminology shows that no good theory exists, and that macro studies of the usual kind have little interest. The objection is certainly relevant, but the consequence is not necessarily that such analyses should be avoided. Problems of operationalization do not make a theory irrelevant. Better than to drop such studies is to continue the theoretic discussion about determinants of crime, and produce more

empirical studies, to improve the foundation for choosing acceptable measures of theoretic constructs. If various operationalizations produce similar results, there is reason to believe that the theory is robust to such differences. Then, one might even conclude that the theory is quite good, despite the fact that each and every formal test of significance is of limited value.

The studies reviewed above reveal quite consistent results as far as the sign of effects of the punishment variables is concerned. The insensitivity of these results to various operationalizations is comforting. The effects of income variables are less consistent, a result that might either imply that economic factors do not have a uniform effect on crime or that some, or all, of the operationalizations tried so far are unacceptable. Chisholm and Choe (2005) contribute to clarification of the effects of income variables by relating the net expected gains from crime to a measure of income inequality (the Gini coefficient) and the mean income of a society.

Several measures of punishment variables have been employed. When only one type of sanctions is included, one would expect that the effect assigned to this variable really includes effects of punishment variables correlated with the one included. A better alternative is to use several sanctions simultaneously, as proposed and employed by Witte (1980) and others.

2.7 The Case of Capital Punishment

In this section, we consider the special case of capital punishment. While the actual effect of capital punishment is relatively small, since it is not often used, it is an important issue since it is highly politically charged. Moreover, for many people, the belief in deterrence depends on whether or not capital punishment is a deterrent. We discuss the various sets of studies that have been done to examine this issue. The first two studies were by an economist, Ehrlich (1975, 1977). The first of these was a time-series study and the second was a cross-section state. While techniques have since advanced, these studies did begin the econometric analysis of capital punishment.

2.7.1 Modern economics papers using panel-data techniques

All of the modern papers “in economics journals” that use panel-data analysis find a deterrent effect.

Dezhbakhsh *et al.* (2003) examine whether deterrence exists using county-level panel data from 3054 US counties over the period 1977–1996. This is the only study to use county-level data, allowing a better estimation of the demographic, economic, and jurisdiction differences among US counties that can affect murder rates. Moreover, the large number of county-level observations extends the empirical tests’ reliability. (Technically, it extends the analysis’ degrees of freedom, increases variability, and reduces colinearity among variables.) This paper finds a substantial deterrent effect; both death row sentences and the executions themselves result in decreases in the murder rate. The conservative estimate is that each execution results in, on average, 18 fewer murders. The main finding, that capital punishment has a deterrent effect, is robust to many different ways of performing the statistical analysis. The deterrent effect remains with different choices of functional form (double-log, semi-log, or linear), state-level vs. county-level analysis, sampling period, endogenous vs. exogenous probabilities, and level vs. ratio specification of the main variables.

In another paper, Shepherd (2004) uses state-level, monthly panel data from 1977 to 1999 to examine two gaps in the capital punishment literature. First, this paper investigates the types of murders deterred by capital punishment. Some people in the debate on capital punishment’s deterrent effect believe that certain types of murders are not deterrable. They claim that murders by intimates or crimes of passion are products of uncontrollable rage, and they are therefore nondeterrable. Others even argue that executions could even increase the number of murders by strangers, as the brutality of executions incites criminals. To the contrary, Shepherd finds that the combination of death row sentences and executions deters all types of murders: murders between intimates, acquaintances, and strangers, crime-of-passion murders and murders committed during other felonies, and murders of African-American and white people. (Intimates are defined as spouses,

common-law spouses, parents, children, siblings, in-laws, step-relations, and other family. Crime-of-passion murders include lovers' triangles, murders by babysitters, brawls under alcohol, brawls under drugs, arguments over money, other arguments, and abortion-murders (i.e., abortions performed during the murder of the mother.) The estimate from the paper is that each death row sentence deters approximately 4.5 murders and that each execution deters approximately 3 murders. The second issue that the paper addresses is the impact on deterrence of execution delays. This paper finds that that shorter waits on death row increase deterrence. Specifically, one extra murder is deterred for every 2.75-year reduction in the death row wait before each execution.

Dezhbakhsh and Shepherd (2003) use state-level panel data from 1960 to 2000 to examine capital punishment's deterrent effect. This is the only study to use data from before, during, and after the 1972–1976 Supreme Court moratorium on executions. First, the authors perform before-and-after moratorium comparisons by comparing the murder rate for each state immediately before and after it suspended or reinstated the death penalty. These before-and-after comparisons are informative because many factors that affect crime (e.g., law enforcement, judicial, demographic, and economic variables) change only slightly over a short period of time. In addition, the moratorium began and ended in different years in different states. Considering the different start and end dates, the duration of the moratorium varied considerably across states, ranging from 4 to 30 years. Observing similar changes in murder rates immediately after the same legal change in different years and in various states provides compelling evidence of the moratorium's effect on murder. The before-and-after comparisons reveal that about 91 percent of states experienced an increase in murder rates after they suspended the death penalty. In about 70 percent of the cases, the murder rate dropped after the state reinstated the death penalty. The paper supplements the before-and-after comparisons with time-series and panel-data regression analyses that, unlike many existing studies, use both pre- and postmoratorium data. The regressions disentangle the impact of the moratorium itself on murder from the effect of actual executions on murder; we find that the moratorium has a significant positive effect on murder and that executions have significant negative

effects on murder. These estimates suggest that both adopting a capital statute and exercising it have strong deterrent effects. To test for robustness, the paper examines changes in our choice of regressors, estimation method, and functional form. The deterrent variables' coefficients are remarkably consistent in sign and significance across 84 different regression models. Before-and-after moratorium comparisons and regressions reveal that the death penalty does not cause a decrease in property crimes, suggesting that the deterrent effect is not reflecting general trends in crime.

Lott Jr. and Landes (2000) use state-level panel data from 1977 to 1995 to examine whether right-to-carry concealed handgun laws deter multiple-victim public shootings. Included in their analysis are tests of the deterrent effect of executions on murder. The authors find that right-to-carry concealed handgun laws do result in fewer multiple victim public shootings. They also find that executions have a significant deterrent effect on the overall murder rate. Specifically, a 1 percent increase in the execution rate is associated with a 7 percent decline in the overall murder rate.

Two papers by FCC economist Zimmerman (2004, 2006) find a deterrent effect. In his first paper, Zimmerman uses state-level panel data from 1978 to 1997 to examine the relationship between state execution rates and murder rates. In his second paper, he employs state-level panel data from 1978 to 2000 to examine which execution methods have the strongest deterrent effects. In both papers, Zimmerman finds a significant deterrent effect on capital punishment. He estimates that each execution deters an average of 14 murders and that executions by electrocution have the strongest impact.

Mocan and Gittings (2003) use state-level panel data from 1977 to 1997 to examine the relationship between executions, commutations, and murders. Again, the authors find a significant deterrent effect; they estimate that each execution deters an average of 5 murders. Their results also indicate that both commuting death row prisoners' sentences and removing them from death row cause increases in murder. Specifically, each commutation results in approximately 5 extra murders and each removal from death row generates 1 additional murder.

A recent paper by Katz *et al.* (2003) uses state-level panel data covering the period 1950 to 1990 to measure the relationship between prison conditions, capital punishment, and crime rates. They find that the nonexecution death rate among prisoners (a proxy for prison conditions) has a significant, negative relationship with overall violent crime rates and property crime rates; worse prison conditions deter crime. As expected, the execution rate has no statistically significant relationship with overall violent crime rates (which consist mainly of robbery and aggravated assault rates) and property crime rates; that is, executions have no effect on noncapital crimes. The authors estimate several different models to test for a relationship between the execution rate and murder rates. Although some specifications show no relationship, some estimations, and especially those that control for the economic and demographic differences among states, do produce a deterrent effect.

2.7.1.1 *Modern economics papers using other techniques*

Modern economics papers that use techniques other than panel data also all find deterrence.

Instead of a panel-data study, Cloninger and Marchesini (2001) conduct a portfolio analysis that is, in effect, a controlled group experiment: the Texas unofficial moratorium on executions during most of They find both that the moratorium appears to have caused additional homicides and that murder rates significantly decreased after the moratorium was lifted. Brumm and Cloninger (1996) use cross-section data covering 58 cities in 1985 to distinguish between criminals' perceived risk of punishment and the *ex post* risk of punishment measured by arrest rates, conviction rates, or execution rates. They find that the perceived risk of punishment, including the probability of execution, is negatively and significantly correlated with the homicide commission rate.

Two other papers, one by Ehrlich and Liu (1999) and the other by Liu (2004), use Ehrlich's original state-level, cross-section data. Both find a strong deterrent effect. The study by Ehrlich and Liu offers a theory-based sensitivity analysis of estimated deterrent effects. Liu's study uses switching regression techniques in estimations that take into account the endogenous nature of the status of the death penalty.

2.7.1.2 *Modern papers by sociologists and criminologists*

Sociologists have also studied the deterrent effect of capital punishment in several papers in sociology journals in the past decade. Although they employ empirical analysis, the methods they use are often very different from the methods used by economists. In contrast to the economics studies, most of the sociology studies find no deterrence.

Cochran *et al.* (1994) examined the deterrence question using weekly, time-series data from Oklahoma from 1989 to 1991. Although their weekly data is very disaggregated by time, the researchers severely restrict the number of observations in their study by limiting their analyses to the state of Oklahoma: they have only 156 observations. In fact, only one execution took place in Oklahoma during this period. Furthermore, the authors include no variables to control for demographic, economic, law enforcement, or other factors on murder rates. The researchers conclude that there is no deterrent effect because they find no evidence of deterrence after the one execution during their sample period. Bailey (1998) used the same data as Cochran *et al.* to explore the deterrence issue and finds no evidence of a deterrence effect. Although his data suffer from having few observations and only one execution, Bailey does extend the analyses to include control variables. Moreover, Bailey examines the effect of executions in other states on Oklahoma's murder rate. Although most capital punishment studies have assumed that deterrence is limited to the state where the execution occurs, Bailey measures whether there is a cross-state effect. He finds no evidence of a deterrent effect within states or across states.

A paper by Sorensen *et al.* (1999) tests the deterrence hypothesis in Texas. The authors use monthly time-series data from the state of Texas from 1984 to 1997, and find no deterrent effect when including the appropriate control variables. The authors restrict their analysis to an OLS regression which assumes that the causality between murder and law enforcement variables runs in only one direction: conviction rates, incarceration rates, and executions affect crime rates, but crime rates do not affect conviction rates, incarceration rates, or executions. In contrast, almost all other capital punishment papers assume that causality runs in both directions; for example, increasing murders may

lead officials to direct more resources to fighting crime, increasing convictions, incarcerations, and executions. Ignoring the reverse causality can lead to biased results that underestimate, overestimate, or reverse the impact of law enforcement variables on crime.

Yunker (2002) tests the deterrence hypothesis using two sets of postmoratorium data: state cross-section data from 1976 to 1997 and national time-series data from 1930 to 1997. These data are vulnerable to many of the same criticisms as early economic studies: national time-series data may cause aggregation bias and cross-section data cannot consider trends in crime or law enforcement variables and are unable to control for omitted jurisdiction-specific variables that may affect crime. He finds a strong deterrent effect in the time-series data that disappears when the data are limited to the 1930–1976 period. Therefore, he concludes that postmoratorium data is critical in testing of the deterrence hypothesis.

A paper by Berk (2005), a sociologist, finds that eliminating a few specific states from the data causes estimates of capital punishment's average impact on murders across all states to show no deterrence.

2.7.1.3 *Modern papers in law reviews*

Three empirical papers testing whether capital punishment deters have been published in law reviews in the past decade. Two find no deterrence and one finds mixed results. A fourth paper is a critical examination of many of the others.

Albert (1999) tests the deterrence hypothesis using state-level panel data from 1982 to 1994. He includes many of the same control variables as Ehrlich did in his early studies, but does not include any time variables. Like Ehrlich, he also performs both OLS regressions and two-stage least squares regressions. Albert finds no evidence of a deterrent effect.

Stolzenberg and D'Alessio (2004) use monthly data and a different statistic procedure from other papers to examine the relationship between the frequency of executions, newspaper publicity, and the incidents of murder in Houston, Texas. They examine the period from January 1990 to December 1994. The authors include no control

variables to capture changes in economic, demographic, or other factors during the time period. The authors report no deterrent effect.

Shepherd (2004) uses techniques similar to those in Dezhbakhsh *et al.* (2003) to examine the effect of capital punishment in each state. She finds that for states that do not execute many people, there is actually a “brutalization” effect—each execution seems to lead to increased homicides. However, for states that execute a sufficient number of persons, there is a deterrent effect. Since executing states had more executions, the net effect is that on a national level each execution did reduce homicides. She argues that these results in part explain the differences in findings between economists (who tend to look at all states, those executing many and those executing few persons) and sociologists, who tend to look at only a few states, which may not execute many persons. Ekelund *et al.* (2006) examine marginal deterrence. They find that capital punishment is a deterrent, but that it only deters the first homicide, not subsequent murders.

In an important paper in the *Stanford Law Review*, Donohue and Wolfers (2005) critically examine many of the papers cited above. They claim that capital punishment is used too erratically in the USA for there to be a detectable deterrent effect. They purport to find that the results in many of the papers cited above are spurious and due to econometric misspecifications. For example, many of the articles use a technique called “instrumental variables” to control for the simultaneous causality discussed above. Donohue and Wolfers claim that this technique is misused in these papers and if it were used correctly there would be no deterrent effect, or even an increase in homicides caused by executions. Although replies to their article may be currently in progress, the Donohue and Wolfers’ paper has cast some doubt on the deterrence hypothesis.

2.8 Guns and Abortions

Two other empirical issues have generated substantial interest in the literature. One is the effect of allowing citizens to carry guns; the other is the effect of abortion on crime.

2.8.1 Guns

In a well-known paper, Lott Jr. and Mustard (1997) argued that states that allowed citizens to carry concealed weapons (“shall issue” laws) observed substantially reduced crime rates. These results have been highly controversial in the literature and have generated lively debates in journals, books, and on blogs. Dezhbakhsh and Rubin (1998, 2003) and Ayres and Donohue (1999) among others have written critiques of the Lott–Mustard analysis and Lott has replied in numerous places, including his books (Lott, 1998, 2003). A survey of this entire debate is beyond the scope of this paper; the interested reader is referred to the entry for Lott on Wikipedia; a Google Search of “Lott, guns, and crime” will also lead into the debate. An emerging consensus seems to be that concealed carry laws do not lead to the reductions in crime that Lott and Mustard found, but that they do not lead to the increases that critics had suggested, although Lott still believes that these laws lead to large decreases in crime.

2.8.2 Abortion and crime

In a well-known paper, Donohue III and Levitt (2001) argued and showed empirically that the liberalization of abortion laws led to lower crime rates some years later. The argument was that parents who wanted to abort children would otherwise have had unwanted children and the children would have been more likely to become criminals. This thesis was also a theme of a best-selling book (Levitt and Dubner, 2005). This paper has been criticized by Joyce (2003) and others, and Donohue III and Levitt (2004) have replied. This paper has been politically controversial because it deals with abortion, itself a highly controversial issue. However, it has been less controversial among academics, although there has been some debate as indicated above. Again, there is a Wikipedia article “Legalized abortion and crime effect” that is a lead into the relevant literature and controversy.

3

The Economics of Public Criminal Law Enforcement

If criminals can be deterred, a society wishing to maximize social welfare should determine the best way to achieve deterrence. (For surveys of the theory of public law enforcement that include formal modeling, see Garoupa (1997), Mookherjee (1997), Polinsky and Shavell (2005).) In this section, we focus on public enforcement of crime, the detecting and sanctioning of criminal offenders by government agents. (There has also been substantial work on the advantages and disadvantages of private enforcement: see Becker and Stigler (1974), Benson (1998), Landes and Posner (1975), Polinsky (1980).) Although Beccaria (1995), Bentham (1789), and other scholars began writing about public law enforcement in the 1800s, Becker (1968) was the first to develop a formal economic model for public criminal law enforcement.

The economic theory of public law enforcement is based on a specific perception of justice as efficiency. (Ehrlich (1982) discusses perceptions of justice.) Under this perception, the purpose of public law enforcement is to maximize social welfare, where social welfare is the benefits that individuals obtain from crime minus the costs of committing crime, the costs of harm to victims, and the costs of enforcement. (Many researchers have questioned whether the

benefits that individuals obtain from crime should be considered. For a discussion, see Lewin and Trumbull (1990), Shavell (1985), Stigler (1970).) The government can maximize the social welfare function through three policy instruments: (i) the probability of capture and punishment, (ii) the length of prison terms, and (iii) the level of fines.

The socially optimal deterrence occurs at the point where the marginal social cost of additional deterrence equals the marginal social benefit. Following most of the literature, we focus on optimal enforcement when deterrence is a goal. (Incapacitation as a goal has received much less attention. See Shavell (1987) and Ehrlich (1981) for a discussion of optimal enforcement when incapacitation is a goal.) Under the traditional definition, efficient deterrence balances the marginal costs of enforcement and the reduction in illegal gains to criminals against the marginal benefit of harm reduction. Thus, deterrence is inefficient if the marginal gains to criminals plus marginal enforcement costs exceed the marginal harm to victims. However, many researchers have questioned whether the gains to criminals should be considered. If we ignored these gains, optimal deterrence would occur at the point where the marginal enforcement costs equal the marginal harm to victims. With fewer costs of deterrence to consider (i.e., ignoring the reduction in criminal gains that results from deterrence), the socially optimal level of deterrence increases.

In this section, we focus on optimal law enforcement policies. After discussing the optimal choice between probability and severity and between fine and imprisonment, we consider several extensions of the basic theories: risk preferences, imperfect information, targeted and general enforcement, repeat offenders, reductions in enforcement costs, and incentives of enforcers. (For other extensions, see Garoupa (1997), Polinsky and Shavell (2005).)

3.1 Probability and Severity

After determining the optimal level of deterrence, law enforcement should decide how to produce the expected penalty that achieves the optimal deterrence. In her decision to commit a crime, a criminals' expected penalty is the product of the probability of punishment and

Table 3.1 Combinations of certainty and severity with identical expected penalties: the risk neutral case.

Probability of sanction	Severity of sanction	Expected penalty
100%	100	100
50%	200	100
25%	400	100
10%	1000	100

the severity of punishment. As law enforcement is responsible for both of these, it must choose the optimal combination of probability and severity to achieve the desired expected penalty. Andreoni (1991) and Malik (1990) have asked whether the probability and severity can be set independently.

Table 3.1 shows several combinations of probability and severity (presented as either a fine or the cost of imprisonment) that produce identical expected penalties.

If potential offenders are risk neutral and have no wealth constraints, all of the combinations of probability and severity should produce identical levels of deterrence.

It is relatively cheap for society to increase the severity of sanctions. Increasing a monetary fine imposes almost no additional collection costs, rather it generates additional revenue for society. Thus, a low-probability/high-fine combination will achieve the same deterrence as a high-probability/low-fine combination, but at much lower cost to society. Absent the complications we discuss in the next few sections, a high-fine/low-probability combination is the optimal because it reduces enforcement costs.

In contrast to fines, increasing the severity of imprisonment imposes additional enforcement costs on society; see Kaplow (1990a). Nevertheless, it may still be relatively cheaper to increase the severity of imprisonment than to increase the probability of sanctions. As in the case of fines, absent the complications discussed below, the optimal combination of probability and severity is a long prison sentence and low probability. Although the longer prison sentences increase enforcement costs, fewer individuals are imprisoned, which decreases enforcement costs and offsets the increase from longer sentences.

Thus, regardless of the form of sanction, high severity and low probability is, in general, the optimal combination because it achieves deterrence at the lowest possible cost. Polinsky and Shavell (1984) show that some underdeterrence may be optimal. Factors that may contradict this generality are discussed below, but first we discuss the optimal choice of fines versus imprisonment.

3.2 Fines and Imprisonment

Criminal sanctions can be monetary or nonmonetary. As we discussed in the previous section, fines impose little cost on society, and even generate revenue. In contrast, imprisonment imposes substantial enforcement costs on society. Thus, fines are the preferred sanction. However, a combination of fines and imprisonment is necessary in many situations. If a fine exceeds an individual's wealth level, then the individual's expected penalty will be less than the expected penalty that law enforcement anticipated when selecting the probability and severity of sanctions. For example, in Table 3.1, a probability of 10% and a fine of \$1000 for an individual with a wealth level of only \$500 will achieve an expected penalty of only \$50 instead of \$100. When there are wealth constraints, the fine should be set as high as possible, equal to the individual's wealth level. A prison sentence should also be imposed to bring the expected penalty to the desired level. Polinsky and Shavell (1984) discuss the optimal combination of fines and imprisonment,

3.3 Risk Preferences

The previous discussion of optimal certainty and severity assumed that criminals are risk neutral. When criminals are either risk averse or risk loving, the optimal combination of probabilities and sanctions may differ.

First, consider the case where individuals are risk averse in sentences so that their disutility of the expected penalty rises more than in proportion to the expected penalty. In the case of prison sentences, this could result from an increasing desire for freedom or growing distaste for the prison environment as the time in prison increases (Polinsky

Table 3.2 Combinations of certainty and severity with identical disutility; the risk averse case.

Probability of sanction	Severity of sanction	Disutility of expected penalty	Expected penalty
100%	100	100	100
40%	200	100	80
10%	400	100	40
1%	1000	100	10

and Shavell, 2005). Risk-averse individuals prefer a certain penalty, f , to an uncertain penalty with a mean of f .

Table 3.2 shows several combinations of certainty and severity (presented as either a fine or the cost of imprisonment) that produce the same disutility, but have different expected penalties. In contrast to the risk-neutral case where combinations with equal expected penalties produce equal deterrence, as severity increases, combinations with lower expected penalties produce equal deterrence.

With risk-neutral offenders, high fines and low probability of punishment are optimal because it achieves deterrence at the lowest possible cost. Similarly, as long as imprisonment costs are less than enforcement costs, long sentences and low probability of punishment are optimal. However, when offenders are risk averse, it is not clear that a 1 percent probability of a \$1000 fine is more optimal than the other combinations in Table 3.2. Although enforcement costs are low, the expected fine, and therefore fine revenue is also low. If the decrease in fine revenue is greater than the savings in enforcement cost, the high-fine combination could be a more expensive combination. This was first shown in Polinsky and Shavell (1979). See also Kaplow (1992) and Chu and Jiang (1993). In contrast, if the sanctions in Table 3.2 were prison sentences instead of fines, then low expected sentences would not be costly. That is, the 1 percent probability of a 1000-day sentence has both low enforcement costs and low-imprisonment costs. Thus, when offenders are risk averse, the high-sentence/low-probability combination is unambiguously the optimal combination.

Next, consider the case when offenders are risk loving in sanctions; their disutility of the expected penalty rises less than in proportion to the expected penalty. In the case of prison sentences, this could occur

Table 3.3 Combinations of certainty and severity with identical disutility; the risk-loving case.

Probability of sanction	Severity of sanction	Disutility of expected penalty	Expected penalty
100%	100	100	100
60%	200	100	120
40%	400	100	160
30%	1000	100	300

for several reasons: if the disutility from the stigma of prison does not increase with the length of imprisonment, if more brutalization of prisoners occurs at the beginning of a sentence, or if discounting of future disutility makes earlier years in prison seem worse than later years. (Risk-loving individuals prefer a uncertain penalty with a mean of f to a certain penalty, f .)

Table 3.3 shows several combinations of certainty and severity (presented as either a fine or the cost of imprisonment) that produce the same disutility, but have different expected penalties. In the risk-loving case, as severity increases, combinations with higher expected penalties produce equal deterrence.

If Table 3.3 referred to fines, then the optimal combination of certainty and severity would be high fine and low probability. This combination would achieve the same deterrence as other combinations, and the expected fine, or fine revenue, would be high and enforcement costs would be low.

If Table 3.3 referred to prison sentences, then the optimal combination may not be the long-sentence/low-probability combination. Because the increase in prison sentences is proportionally larger than the decrease in probability, the expected penalty, or expected prison term rises. If the cost of longer imprisonment exceeds the savings in enforcement costs, then the high-sanction/low-probability combination would not be the cheapest way to achieve deterrence (Polinsky and Shavell, 1999).

3.4 Imperfect Information

Although we have assumed that individuals know the probability and magnitude of punishment, it is rare that individuals have accurate infor-

mation about these variables. Obviously, deterrence depends not on the actual probabilities and magnitudes, but on the perceptions of them. Imperfect information about these variables has an important impact on optimal deterrence policy. Bebchuk and Kaplow (1992) first demonstrated that inaccurate perceptions about the probability of punishment call for lower than maximal sanctions. They illustrate the problem with the following example. Suppose that the socially optimal expected penalty is 10. The maximal possible sanction is 500, which requires a probability of 2 percent. Alternatively, the government could impose a sanction of 100 and a probability of 10 percent. Suppose, however that half of the individuals overestimate the probability by 1 percent and half of the individuals underestimate the probability by 1 percent. Under the 500 sanction, half of the individuals will face an expected penalty of 5 (1 percent * 500) and the other half will face an expected penalty of 15 (3 percent * 500). Under the 100 sanction, half of the individuals will face an expected penalty of 9 (9 percent * 100) and the other half will face an expected penalty of 11 (11 percent * 100). Obviously, under the 500 sanction, there will be greater overdeterrence of the overestimating individuals and greater underdeterrence of the underestimating individuals. If this loss of social welfare is greater than the increase in enforcement costs from 2 to 10 percent, then the 100 sanction is better than the 500 sanction.

Similarly, Garoupa (1999) first explored how imperfect perceptions about the magnitude of sanctions affect optimal law enforcement policy. He concludes that the maximal sanction is still optimal. He presents the following example. Consider the same actual sanctions and actual probabilities as in Bebchuk and Kaplow (1992) illustration. Suppose, however, that half of the individuals overestimate the sanction by 50 and half of the individuals underestimate the sanction by 50. Under the 500 sanction, half face an expected penalty of 11 (2 percent * 500) and half face an expected penalty of 9 (2 percent * 450). Under the 200 sanction, half face an expected penalty of 15 (10 percent * 150) and half face an expected penalty of 5 (10 percent * 50). The result is reversed from Bebchuk and Kaplow's result; in this case the maximal sanction produces less underdeterrence and overdeterrence. Thus, it is still socially optimal.

Hence, the degree and type of imperfect information is important to consider when determining optimal law enforcement policy. Kaplow (1990b) discusses imperfect information about whether acts are subject to sanctions. Sah (1991) discusses how individuals form perceptions about probabilities. Anderson (2002) finds that convicts have little information about probabilities or magnitudes of sanctions. However, those who have committed crimes and been caught and convicted are an obviously biased sample of all potential criminals (including those who were actually deterred) and so it is not clear what weight to put on this finding.

3.5 Targeted and General Enforcement

Enforcement is often *general* in the sense that many different types of crimes can be detected by the same enforcement effort. For example, a police officer on a street corner could observe a mugging, or a drug deal, or a traffic violation. In contrast, some types of enforcement effort are *specific* because they will only detect one type of crime, or even a specific crime. For example, detectives investigate specific crimes that have already occurred.

Specific enforcement permits independent selection of the probability of detection for each crime. Thus, the standard law enforcement policies are optimal: in general, sanctions should be as high as possible and probabilities should be as low as possible to achieve a given level of deterrence. In contrast, as shown by Shavell (1991) and Mookherjee and Png (1992), with general enforcement, the optimal sanction should increase with the severity of the harm from the criminal act. Suppose law enforcement is concerned with deterring two crimes: *a more serious crime* which imposes substantial harm on victims and *a less serious crime*. Because the probabilities of detection are the same for different crimes under general enforcement, the probability for one crime cannot be lowered without reducing the probability of another crime. Thus, it would be impossible to impose the maximal sanction for both crimes, but to reduce the probability of detection for the less serious crime below that of the more serious crime so that the expected penalties reflect the marginal social benefits of enforcement.

Instead, the maximal sanction should be imposed for the more serious crime and the combined probabilities of detection should be adjusted so that the expected penalty achieves the desired level of deterrence. Then, the sanction for the lesser crime should be reduced so that the expected penalty achieves the desired level of deterrence for the lesser crime.

This policy will also accomplish marginal deterrence which increases social welfare. (For more detailed discussions of marginal deterrence, see Mookherjee and Png (1994), Shavell (1992), Stigler (1970), Wilde (1992).) By creating a schedule of sanctions which increases with the severity of the crime, potential offenders will substitute out more serious crimes and into lesser crimes where they face lower expected penalties. Other more serious crimes may be avoided without a resulting increase in lesser crimes: a robber that would murder a potential eyewitness if the sanctions for robbery and murder were the same may choose not to murder the eyewitness if the sanction for murder was greater than the sanction for robbery. Although the lower expected penalties will increase lesser crimes, the reduction in harm from the decrease in more serious crimes may more than offset the increase in harm from the lesser crimes, increasing social welfare.

3.6 Repeat Offenders

Repeat offenders are typically punished more severely than first-time offenders for the same offense. Several studies have explored whether this is the optimal strategy.

If deterrence is at the optimal level so that the only crimes that occur are ones where the marginal harm to victims is less than the marginal gains to criminals plus marginal enforcement cost, then an offender's offense history is irrelevant to the sanction decision. Increasing sanctions on subsequent acts based on offense history instead of the costs and benefits of the marginal deterrence of the subsequent act would likely overdeter repeat offenders. Thus, only if deterrence is below the socially optimal level would offense history matter to deterrence. There are several reasons why it may be optimal to increase sanctions for repeat offenders. First, as discussed in Polinsky and Rubinfeld

(1991), Rubinstein (1979), and Chu *et al.* (2000), a prior criminal record signals that an individual has a higher propensity to commit criminal acts because either the costs of crime are lower for her or the benefits of crime are higher. Thus, higher sanctions are necessary to deter these high-risk offenders. Second, Polinsky and Shavell (1998) show imposing higher sanctions on subsequent crimes increases the cost of committing first offenses; not only does a first offense carry an immediate penalty, but also increases future penalties. Thus, higher sanctions for subsequent crimes may deter first crimes. Third, Miceli and Bucci (2005) argue that a repeat offender has already suffered the social stigma of conviction from the first offense. The cost of committing subsequent crimes is less because they do not carry the potential cost of social stigma. Thus, other costs of subsequent crimes, like the expected sanction, must be increased to maintain deterrence. Finally, as Polinsky and Rubinfeld (1991) argue, repeat offenders may be better able to avoid detection and apprehension of subsequent crimes because they understand the system and have a larger criminal network. If the probability of punishment is lower for repeat offenders, the magnitude of punishment must be higher to maintain deterrence.

Burnovski and Safra (1994) and Emons (2003) have presented theories where it may be optimal to lower sanctions for repeat offenders. For example, if cumulative sanctions are limited by either wealth constraints or death that limits prison terms, shifting dollar fines, or prison years from a second-offense penalties to first-offense penalties may increase deterrence because the probability of being caught once is greater than the probability of being caught twice. Thus, with higher sanctions for first-time offenders, there is a higher expected cumulative sanction. Polinsky and Rubinfeld (1991) argue that high sanctions for first-time offenders will prevent all crimes but those with the highest net benefit, so that the only offenders that become second-time offenders are individuals that receive a very high net benefit from crime. Hence, it is not socially optimal to prevent these crimes with higher sanctions. Dana (2001) argues that repeat offenders actually face higher probabilities of detection because law enforcement already has a record of their criminal activity. Thus, lower sanctions are necessary to offset the higher penalties to prevent overdeterrence. Finally, Rubinstein (1980)

argues that individuals with specific utility functions may commit more crimes if the sanction for the first crime is lower than the sanction for the second crime.

3.7 Enforcement Errors

Two errors are possible in law enforcement: Type I errors result when individuals are convicted of crimes they did not commit and Type II errors result when individuals are exonerated of crimes they did commit.

There are three costs of the enforcement errors. First, there is the social cost resulting from the miscarriage of justice. Second, errors reduce the expected benefit of enforcement, reducing the socially optimal level of enforcement efforts. Finally, enforcement errors decrease deterrence. Type II errors decrease the expected penalty for criminal acts, increasing criminal activity. Type I errors decrease the difference in the net payoffs between criminal activity and non-criminal activity, increasing criminal activity. Moreover, Type I errors lead to Type II errors when a mistaken conviction results in an actual offender getting away with a crime.

The first two costs suggest that there should be less enforcement effort: Ehrlich (1982) and Miceli (1991) argue that penalties should be lower to reduce the miscarriage of justice resulting from Type I errors and fewer resources should be spent on either detection and/or imprisonment to balance the expected benefits and costs of enforcement. Moreover, increasing the sanction when there is the possibility of mistakes will impose additional costs on risk averse individuals that do not violate the law. Polinsky and Shavell (1979) and Block and Sidak (1980) argue that sanctions should be lower on risk-averse individuals when there are enforcement errors. In contrast, the third cost suggests that the expected penalty should be increased to offset the errors' effect and achieve a desired level of deterrence, thus increasing enforcement effort and resources. Either effect could dominate and lead to either a higher or lower optimal enforcement.

Regardless, errors impose large social costs and resources should be spent to reduce them, as discussed in Kaplow and Shavell (1994a).

3.8 Reductions in Enforcement Costs

In this section, we discuss the two most common ways to minimize enforcement costs: plea bargains and self-reporting.

Plea bargains benefit both offenders and public enforcement by reducing litigation costs. In addition, plea bargains benefit risk-averse parties by eliminating the risk inherent in trials. (For a detailed discussion of the benefits of plea bargains, see Grossman and Katz (1983), Kobayashi and Lott Jr. (1992), Landes (1971), Miceli (1996), Polinsky and Rubinfeld (1989), Reinganum (1988).) Plea bargains reduce deterrence; by definition, offenders prefer plea bargains because the expected disutility of penalties is lower (Polinsky and Rubinfeld, 1989). However, the magnitude of punishment imposed under plea bargains could be increased to offset this reduction in deterrence.

As discussed by Kaplow and Shavell (1994b), Malik (1993), and Innes (1999, 2000), self-reporting also lowers enforcement costs by removing the need of law enforcement to detect, apprehend, and convict offenders. Moreover, self-reporting benefits risk-averse individuals by eliminating risk. Self-reporting may also decrease future harm if future criminal acts are prevented. Thus, law enforcement should encourage self-reporting by lowering the sanctions imposed on offenders that self-report. However, the sanctions should not be substantially lower than the sanctions without self-reporting to maintain deterrence at the socially optimal level.

3.9 Incentives of Enforcers

The previous sections assumed that law enforcement desires to maximize social welfare. However, the social goal of law enforcement as a whole and goals of individual law enforcers may differ substantially. In this section, we discuss two types of law enforcement behaviors that may oppose the goals for welfare maximization: corruption (Bowles, 2000) and rent-seeking.

Corruption can take two forms: bribery, where law enforcers accept payments in return for not reporting crimes or apprehending offenders, and extortion, where law enforcers demand payments for not falsely

accusing individuals. Both types of corruption will increase crime. Bribery reduces deterrence by lowering expected penalties; by definition, the bribe payment is less than the potential sanction. Extortion reduces deterrence by reducing the difference in the net payoffs between criminal activity and non-criminal activity. Different policies can reduce the law enforcers' incentives to engage in corruption. Penalties for corrupt behavior will increase the cost of engaging in bribery or extortion. (See Bowles and Garoupa (1997) for a discussion. Polinsky and Shavell (2001) discuss why there should be no penalties for the victims of extortion.) Also, rewards for reporting bribery and extortion may reduce this behavior. In addition, paying efficiency wages to law enforcers will increase the costs of corrupt behavior because they stand more to lose if they are caught. Finally, lowering potential sanctions may reduce corruption; the higher the sanction an offender faces, the more he or she is willing to pay to avoid the sanction. However, although lowering the sanction will reduce corruption and the increase in crime that accompanies corruption, it will directly reduce deterrence by lowering expected penalties. (See Becker and Stigler (1974), Mookherjee and Png (1995), which discuss additional aspects of corruption.)

The government and law enforcement may also engage in rent-seeking behavior that does not maximize social welfare. The motivation under rent seeking is to maximize the sum of revenues minus the harms to the government and expenditure on law enforcement. As a rent-seeking government cares primarily about revenue and ignores harm to non-government victims, it will set expected penalties for major crimes too low, underdetering these crimes. However, it will set expected penalties for minor crimes too high to increase revenue from minor violations, and thus will overdeter these crimes from a social welfare perspective. Although the public choice literature has long had this view of government, Freidman (1999) first argued that the law enforcement literature fails to consider the self-interest of the government. Miceli (1996) and Glaeser *et al.* (2000) have explored what prosecutors maximize. Garoupa and Klerman (2002) also discuss rent seeking.

4

Conclusion

The economic analysis of criminal behavior and criminal law has been by any measure a hugely successful enterprise. As an academic enterprise, it has achieved the goal of research—it has generated a large and growing literature. Indeed, it is a very successful branch of law and economics, itself a flourishing enterprise. This may be because hypotheses in the economics of crime are sharp and testable and, because there is substantial data available for testing these hypotheses.

More important than academic success, however, is the influence of this branch of learning on actual practice. When Becker began his research, the standard view among students of crime was that prison served no useful purpose except revenge. The demonstration over the past 40 years of the existence of deterrence effects and rational responses by criminals has caused a substantial rethinking by virtually everyone in the criminal justice system of the purpose and functioning of that system. Since the ultimate justification for resources spent on social science research must be to improve the functioning of society, we may say that in this area we scholars have earned our keep.

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