



Universiteit  
Leiden  
The Netherlands

## **Econo(me)trics of crime and litigation**

Tulder, F.P. van; Velthoven, B.C.J. van

### **Citation**

Tulder, F. P. van, & Velthoven, B. C. J. van. (2003). Econo(me)trics of crime and litigation. *Statistica Neerlandica*, 57(3), 321-346.  
doi:10.1111/1467-9574.00234

Version: Publisher's Version  
License: [Leiden University Non-exclusive license](#)  
Downloaded from: <https://hdl.handle.net/1887/15790>

**Note:** To cite this publication please use the final published version (if applicable).

# Econom(etr)ics of crime and litigation

F. P. van Tulder\*

*Council for the Judiciary, P.O. Box 90613, 2509 LP The Hague,  
The Netherlands*

B. C. J. van Velthoven

*Department of Economics, Leiden University, P.O. Box 9521, 2300 RA  
Leiden, The Netherlands*

Economists approach the behaviour of potential criminals, litigants and law enforcement agencies in terms of rational choice: the actors choose the best alternatives in terms of costs and benefits within the choices open to them. The prime focus of economists is on the general factors in society affecting the crime and litigation level and on the interaction between the crime and litigation level and the legal system. In doing so they have to study the interaction between the micro level of individual decision making and the macro level of the law enforcement system reacting on these decisions. Data are often only available at aggregate (macro) level. Econometric studies at the macro level, especially time series, have the problem that many effects have to be estimated from a limited number of data. Various types of studies and some empirical results regarding crime, litigation and the workload of judicial services are discussed.

*Key Words and Phrases:* economics of crime, economics of law, law enforcement, civil litigation.

## 1 Introduction

Econometrics is the statistical tool of empirical economic analysis. Traditionally (political) economics was about Gross Domestic Products, labour markets and demand and supply. So was econometrics. After the Second World War the rise of the welfare state, with the increasing role of the public sector, also had its effect on economics. Economists extended their research to less traditional areas like education, health care and law enforcement. Econometric applications in these areas followed suit.

Whereas econom(etr)ic studies of law and crime are relatively new, the study of law and crime already existed a long time: it was traditionally in the hands of lawyers, sociologists and criminologists. In fact law enforcement is one of the

---

\*f.tulder@rvdr.drp.minjus.nl.

We gratefully acknowledge very useful comments by Debora Moolenaar and Peter van Wijck on an earlier version of this paper. All remaining errors are our own.

traditional fields of government policies and statistical data on crime and litigation have a long tradition. In the 19th century the Belgian pioneer of social statistics QUETELET analysed data on age and crime. Almost a century ago, the Dutch criminologist and socialist BONGER (1916) became famous with his study about the (statistical) relations between poverty and crime.

Economists took their own approach and statistical tools with them to this area. Our contribution is about this econom(etr)ic analysis of crime and litigation. Economists approach the behaviour of the relevant actors (potential criminals, law enforcement agencies, potential litigants) in terms of rational choice: the actors choose the best alternatives in terms of costs and benefits within the choices open to them. So the level of crimes and contestable behaviour in society is not only dependent on attitudes and values in society, but also on the expected costs of these types of behaviour. With potential criminal behaviour these expected costs are related to the probability and severity of punishment, which are influenced by the law enforcement agencies.

The consequence is that, contrary to criminologists, economists do not focus primarily on the explanation of relevant factors behind *individual* decisions to commit crimes. Their prime focus is on the general factors in society affecting the crime and litigation level and on the interaction between the crime and litigation level and the legal system. In doing so they have to study the interaction between the micro level of individual decision making and the macro level of the law enforcement system reacting on these decisions.

In some cases – especially in the sphere of econometrics of litigation – data on a micro level are available and used. However, both the focus on the interaction with the law enforcement system and the availability of (recorded) crime data and data on lawsuits at aggregate level stimulate empirical analyses on the macro (aggregate) level. Studies at the macro level, especially time series, have the problem that many effects have to be estimated from a limited number of data. Studies at the micro level have the problem that conclusions, due to micro–macro interactions, cannot always be added up to the macro level.

Empirical studies are often partial, in the sense that only the crime level is ‘explained’, given the reactions of the law enforcement system. Or, the other way round, that only the performance of parts of the law enforcement system is explained, given the crime level. More complete economic models see both the crime level and the performance of the law enforcement system as endogenous in the model. So simultaneous models are built. This introduces in the first place theoretical complications, in the sphere of micro–macro level interactions and the right choice of identifying restrictions. Secondly, there are empirical issues, relating to the measurement of variables like the probability of punishment and the proxy character of many variables in the analysis.

As far as the econom(etr)ic approach succeeds to overcome these difficulties it may be helpful in thinking about relationships between enacting laws and regulations, assigning budgets, and the resulting workload and performance of law enforcement

agencies. Sometimes policy makers make use of insights of these models. In the Netherlands this is especially true in the sphere of forecasts of the workload for prisons and other sentence executing agencies. Policy applications are roughly hampered by three factors. First, the focus of lawyers and criminologists on individual rational or irrational (potential) criminals is different from that in economic thinking. Secondly, econometric models often result in rather global insights. As long as underlying mechanisms are not clear, they yield too little information for policy makers to make fruitful use of them. Thirdly, in practice different analyses present different conclusions. This problem is inherent to many applications in the sphere of social sciences, where exact knowledge hardly exists. It is worsened by the problems mentioned earlier. Policy makers do not like the uncertainties involved with our partial knowledge and sometimes prefer not to make use of any knowledge at all.

The content of our contribution is as follows. Section 2 describes the core of the economic approach. Section 3 sketches the main elements of the econometric tools used in empirical economic studies of crime and litigation. Sections 4 and 5 give an overview of the empirical results in a selection of studies in the fields of crime and law enforcement and civil litigation, respectively.

## **2 About the economics of crime and litigation**

Since the seminal papers of BECKER (1968) and GOULD (1973) economists have invaded the field of crime and civil procedure using their all-embracing model of individual rational behaviour. It should be noted from the start that, although this model is frequently called 'economic' and is indeed favoured by most economists, it is applicable in a far more general manner than to merely discuss immediate pecuniary costs and benefits. A person acts rationally if he tries to assess the various possible forms of behaviour and their consequences, and chooses the alternative that is best according to his preferences. Thus, a criminal act would be chosen if the total expected result, including sanctions and other costs, is preferred to that of legal alternatives. Punishment as well as socio-economic circumstances may be relevant for this assessment. And the preferences may as well embrace desires about outcomes as about adherence to (personal or internalised social) values, with some individuals having less crime-averse values than others. What is at stake is that the competing wants and values are ordered in a fairly stable manner by individuals, at least in the short run. Then changes in behaviour can be attributed to changes in the environment. Which is not to imply that values and wants cannot be formed by social interaction or change in a longer run.

It should, furthermore, be noted that the model of individual rational behaviour, despite its name, is not about explaining every single act. If so, it would certainly be deficient. As human behaviour depends on a multitude of conditions that we are not (yet) able to specify in full detail, the task of a theory is to be as general and as simple

as possible and to perform better than others. In the same line, changes in the consequences of various actions need not necessarily influence the behaviour of each and every person. What is at stake is that for the population as a whole, given a stable distribution of preferences, gradual changes in those consequences will for an increasing number of people result in changes of behaviour. (The preceding paragraph draws heavily on EIDE (1994), who gives an excellent survey of the economic theory of criminal behaviour.)

### 2.1 *Economics of crime and law enforcement*

When it comes to the number of criminal versus civil procedures in court the institutional background, and hence the economic analysis, differs in important respects.

Speaking about crime first of all presupposes that society has officially declared certain acts to be illegal. Thus, crime is what society determines to be crime through legislation and the practice of the criminal justice system. To underline their illegal character, criminal acts are generally made punishable by unpleasant formal sanctions, inflicting pain, loss or harm on the offenders, through incarceration, fines or otherwise. Of course, as a perpetrator will not denounce himself willingly given that punishment is imminent, the criminal justice system (police, prosecutor, judge) can only impose a sanction if the criminal act is reported by the victim and/or observed by the police, and if the actor is caught, brought to trial and convicted.

From this overview directly follow the central research themes in the economics of crime. (See also the yearly reviews (in Dutch) in *Tijdschrift voor Criminologie*, starting from VAN VELTHOVEN, 1996). The first one is about the *explanation of (the size of) criminal behaviour*. Which costs and benefits will be associated with committing an offence in the individual's perception, what are the alternatives that are being considered, and how does he weigh the pros and cons given his preferences, including attitude towards risk and personal values? The second theme is about the *socially optimal (efficient) organisation of law enforcement*. Both crime itself and law enforcement bring along net costs for society. Apart from yielding some gross proceeds, be it material or immaterial, committing the crime may necessitate the use of resources by the offender. And the act will cause harm to victims. In general, this balance of benefits and costs will be negative for society as a whole, so crime is in itself inefficient. The criminal justice system, at the same time, can only work through the actual deployment of police resources, and the operation of courts and prisons, with the concomitant costs for the tax payer. These should be summed with the burden that may follow from the arrest and punishment for the offenders themselves (and their relatives), to obtain the social costs of law enforcement. Now, if society has the possibility of influencing the amount of crime, albeit small, the (net) social costs of crime can be weighed against the social costs of law enforcement, in order to find the overall minimum. That result brings us to the third theme of interest, the proper *extent of criminal law*. From an economic point of view, society would only be wise to declare a certain act illegal and make it subject to the criminal justice system, if the total (net)

social costs of crime and law enforcement – at the optimum – would definitely be less than the net harm in a situation of doing nothing about it. This line of research thus may yield economic arguments for (or against) the penalisation of, for instance, theft, insider trading, or soft drugs. Concluding that it would be efficient for society to declare certain acts illegal and to strive for a certain combination of probability and severity of punishment in the organisation of law enforcement, is one thing. Quite another matter is the incentive structure of those who make the actual decisions. Accordingly, the fourth research theme in the economics of crime is the *actual decision making* within the political arena and the criminal justice system on *the level and use of resources*. How do political pressure, bureaucratic interests, and ideas of fairness work their way through the allocation of budgets, the number of crimes that are officially registered, the kinds of offences and offenders that the police is tracking down, the average size of the prison sentences meted out by judges, and so on?

Although the central research themes may thus be distinguished in a more or less hierarchical sequence, they are clearly interrelated. In empirical work in this field one should especially be aware of *simultaneity* between the level of crime and the probability of arrest and punishment.

Much attention has been given to the modelling of criminal behaviour, starting with BECKER (1968). He calculates an individual's expected utility from committing an offence as:

$$E(U) = (1 - p) \cdot U(W + G) + p \cdot U(W + G - L), \quad (1)$$

where  $U(\cdot)$  is the Von Neumann–Morgenstern utility function of the individual with  $U' > 0$ ,  $W$  his present wealth (legal income),  $G$  the potential net gain from the offence, and  $L$  the severity of the punishment if caught and convicted, the subjective probability of which is  $p$ . Assuming that the individual is interested in maximising his expected utility, he will commit the offence if and only if  $E(U) > U(W)$ . This choice will depend on all the parameters of (1) and on his attitude towards risk. Both increases in the probability ( $p$ ) and/or the severity ( $L$ ) of punishment will lower the expected utility from crime, while increases in the potential net gain ( $G$ ) will do the opposite. For risk averse individuals ( $U'' < 0$ ) expected utility is relatively more sensitive to changes in the severity than in the probability of punishment; for risk loving persons the opposite holds. Under risk aversion it is also the case that increases in present wealth ( $W$ ) will tend to lower the positive marginal effect on utility of  $G$ , while at the same time lowering the negative marginal effect of  $L$ ; the second effect dominates under decreasing absolute risk aversion, so that expected utility from crime will increase with present wealth.

In the course of time, Becker's original analysis has been adapted in various ways. The model has been extended to discuss the allocation of time between legal and illegal alternatives, to include psychological factors that have no monetary equivalent, and to integrate the feedback on the net gains from crime that may result from private protection by (potential) victims. A major conclusion after all the adaptations and extensions is that, while the probability of punishment generally has

a negative effect on the supply of crime, the theory is inconclusive with respect to the effect of changes in the severity of punishment and income, as it is seen to depend on the specific model being used and on the attitude toward risk. (See, among others, BLOCK and LIND, 1975a,b, BLOCK and HEINEKE, 1975, CARR-HILL and STERN, 1979, EHRlich, 1981,1996).

Finally, while the individual supply of crime decisions resulting from expressions like (1) draw attention to the *deterrence effect* that may follow from the probability and severity of punishment, there may also be an *incapacitation effect* at work at the aggregate level. When repeat offenders are disproportionately caught and locked up for longer periods of time, and when this gap is not filled by the entrance of new offenders into the market of crime, the total number of offences may decrease.

## 2.2 Economics of civil litigation

Civil litigation starts with a problem between two individuals (or organisations), as a result of contestable behaviour, such as the breach of a contract or an accident. The party that allegedly suffered harm has to decide whether or not to assert a legal claim and have it filed at a civil court. A rational person makes that decision by balancing expected immediate and future costs (the administrative costs of filing, hiring a lawyer) against expected benefits (the proceeds from a favourable judgement at trial). After a (credible) announcement of the legal claim, a bargaining game arises, which may extend both before and after the filing of the suit, until the final judgement. The interests of the two parties converge with respect to a cost saving solution of the dispute (which generally means that trial should be avoided), but they diverge with respect to the size of the settlement amount. Only if settlement negotiations fail, will the claim actually be litigated in court and will the judge be called upon to give his final verdict. The result is that the courts only adjudicate the tip of the iceberg of civil disputes.

Within the economics of civil litigation three central research themes can be distinguished. (Useful reviews of the field are given by COOTER and RUBINFELD, 1989 and MICELI, 1997. See also the relevant entries in NEWMAN, 1998, starting with vol. 3 pp. 419 and 442.) First and foremost, one is looking for a *positive theory of settlement and litigation*. How can the behaviour of the two parties prior to and during the settlement bargaining best be modelled, and why do these negotiations sometimes fail? The second theme is about the *socially optimal organisation* of settlement and litigation. Through the introduction of class actions, legal aid arrangements, rules of information disclosure etc., society may facilitate the use of the judicial system as a major contribution to social justice. From an economic point of view, however, things are not that simple. In the use of the legal system, SHAVELL (1997) argues, there is a fundamental divergence between the private and the social optimum. This divergence is due to two so-called externalities, one negative and one positive. That is, when an individual decides to bring his case to court, he generally neither will have to bear the full costs nor will he receive the full benefits of this action. He does not need to take account of the legal costs that will be incurred by others (the

opposite party, the government). Nor will he be guided by social benefits, such as the setting of precedent through rule making and the associated effects (e.g., deterring future breach of contract or risky behaviour ending up in an accident). As a consequence, the privately determined level of litigation can either be socially excessive or inadequate. There does not appear to exist any simple policy that will generally result in the socially optimal (efficient) amount of suit. The third research theme relates to the incentive structure and *behaviour of lawyers and judges*. It is easily assumed that the two parties in a dispute can call in lawyers to promote their respective interests skilfully, and can rely on the judge to decide their case independently. However, the model of individual rational behaviour reaches out to lawyers and judges too. Thus, remuneration through an hourly versus contingency fee might make quite a difference to the way in which a lawyer organises his activities on behalf of a client. (The interested reader may for further references consult NEWMAN, 1998, vol. 1 pp. 382 and 415, on contingent fees, and vol. 3 p. 383, on judicial independence). As space forbids that we delve deeper into the latter two research themes, and given the emphasis in existing empirical work, we shall further concentrate on the first.

Modelling the *private decision to litigate* starts from the estimates by both the plaintiff and the defendant (indexed p and d) of the probability  $p$  of recovery of a damage award  $J$  by the plaintiff at trial. The plaintiff's expected trial payoff is thus given by  $p_p J_p$ ; the defendant's expected trial loss equals  $p_d J_d$ . Let  $C$  and  $S$  denote the cost of litigating and the cost of settling of each party ( $C > S$ ), and assume that each party bears its own costs (the American rule of cost allocation). Under risk neutrality the plaintiff's minimum settlement demand is then equal to  $p_p J_p - C_p + S_p$ , while the defendant's maximum settlement offer is  $p_d J_d + C_d - S_d$ .

From here, different theories have been developed in the literature, dependent on the information and bargaining structure that is supposed to obtain. In the *divergent expectations* (DE) theory starting at GOULD (1973), both litigants make independent estimates of the probability that the verdict will be in favour of the plaintiff. Bargaining is taken to be non-strategic and not explicitly modelled. When the plaintiff's threat to litigate is credible (which will be the case if  $p_p J_p - C_p > 0$ ), a settlement will be reached as long as there is room between the minimum demand and the maximum offer. Disputes will only go to trial if this bargaining range is empty, i.e. if

$$p_p J_p - p_d J_d > C_p + C_d - S_p - S_d \quad (2)$$

which can either result from (too) optimistic estimates of the probability of plaintiff victory ( $p_p > p_d$ ) or from (too) optimistic assessments of damages ( $J_p > J_d$ ).

The leading model of this kind in empirical research is the one set out by PRIEST and KLEIN (1984). They take it for granted that the relevant characteristics of a case can be summarised in a scalar measure (say, the level of fault of the defendant). In the resulting one-dimensional setting, judges and juries apply a decision standard (D) to resolve disputes. That is, if the characteristics of a case are located to the right



(left) of this decision standard, the decision will be in favour of the plaintiff (defendant). It is further assumed that the parties form random but unbiased estimates of the true position (quality) of their case relative to the decision standard. With symmetric stakes ( $J_p = J_d = J$ ), it then follows that the probability of trial increases with the degree of uncertainty in estimating case quality, increases with the stake at trial, and decreases with trial costs. Settlement acts as a two-sided filter on the population of (filed) cases. If a case has true quality far above or below the decision standard, it is unlikely that parties will disagree sharply about the plaintiff's prospects at trial; hence, they will settle. A disproportionate number of cases selected for trial thus will come from cases that are close to the decision standard. This is the famous *selection hypothesis*. The cases selected for trial are not representative of the population of disputes. Just as famous is the *fifty percent rule*, which, to be sure, only holds as a limiting case. If the distribution of filed cases around the decision standard is approximately symmetric, the model predicts that the plaintiff will prevail at trial approximately fifty percent of the time. If the decision standard is away from the mode of a unimodal and symmetric distribution of filed cases, the distribution of litigated cases will become approximately symmetric around the decision standard only when the variance of the litigants' errors in estimating  $p$  approaches zero.

In the *asymmetric information* (AI) theory, the defendant knows the actual likelihood of prevailing at trial (for instance, because he has private information about his true level of care), while the plaintiff is poorly informed and knows only the distribution of victory probabilities. In the single offer model of BEBCHUK (1984), the uninformed plaintiff makes a take-it-or-leave-it offer  $Q$ . The informed defendant accepts the offer if settling promises to be cheaper than going to trial, that is if  $Q + S_d < p_d J_d + C_d$ . Knowing this, the plaintiff chooses the settlement offer  $Q$  by balancing the benefit of a higher settlement amount if accepted against the trial costs if turned down. The selection of cases for trial is thus one-sided, as the defendants proceeding to trial are those with relatively high chances of winning; the plaintiff win rate at trial is systematically below the fraction of plaintiff winners in the pool of filed cases. The model further predicts that the probability of trial and the plaintiff win rate at trial increase with the size of the stakes and decrease with trial costs.

Most notably, the AI model has been extended by SPIER (1992) to address the dynamics of pre-trial bargaining. She shows that many cases may proceed to court despite ample opportunity for interaction between parties and much of the settlement takes place on the courthouse steps (the deadline effect). When fixed costs of bargaining are introduced, the pattern of settlement over time is U-shaped. When the trial date, prior to filing suit, is not yet fixed, bargaining may even give rise to multiple equilibria.

What the above discussion should have made clear is that the predictions of the DE and AI models partly coincide, but also differ in important respects. Drawing strong inferences from empirical results may yet be difficult, as the conclusions from bargaining models are sensitive to changes in the information structure or in the strategic play of the game. We shall return to this issue in section 5.

### 3 About the tools of econometrics

#### 3.1 The econometric approach

It is not our aim to present a detailed and thorough review of the econometric approach. The interested reader is referred to econometric textbooks like MADDALA (1979) and GREENE (1993). We assume the linear econometric model to be familiar to the reader. This model represents a more general statistical approach that can be found in empirical research in many fields, like sociometrics and biometrics. The typical body of econometrics is to be found in the elaboration and specific application to economic models and the problems involved.

From the start by the pioneers Tinbergen and Frisch, econometric analysis has been orientated at *policy advising* at an aggregate level, mostly the national economy. Making *forecasts* and *simulations* of policy measures at a macroeconomic level is still an important branch of practical econometric work. For this kind of application it is generally insufficient to prove that an effect is significant; analysis thus focused very much on estimating the values of the parameters in the model. Basic assumptions in the linear econometric model are about the distribution of the error terms: they should have common variance, be mutually independent and independent of the explanatory variables. When one or more of the basic assumptions is violated, the OLS-estimator is not efficient or is biased. Econometric theory is about tackling these problems and obtaining 'as good as possible' estimators of the parameters.

- Econometricians often use already available data that are not specifically recorded for their research. Moreover, experiments or quasi experiments are generally not possible in the area of interest. One of the implications is that there may be feedback loops in causal chains. This means that not only  $y$  is 'explained' by  $X$ , but in turn some of the  $X$  are 'to be explained' – among other variables – by  $y$ . Models with this kind of 'simultaneity' imply that the error term of one equation plays a role in the other and vice versa, so that explanatory variables and error terms are no longer independent. A number of techniques have been developed to estimate these models correctly. Often they are based on formulating so called instrumental variables (IV) instead of the problematic explanatory variables. An instrumental variable needs to be highly correlated with the explanatory variable for which it is substituted, but is not correlated with the residual.
- Another implication of the use of available data is the 'errors in variables' problem. Instead of the explanatory variable  $x$  suggested by theory, only a proxy-variable  $x'$  is measured. This causes again a violation of the condition that explanatory variables and error terms are not independent. This adds additional noise to the relation and its estimates. If there is only one explanatory variable measured with error, the coefficient of this variable will be underestimated.
- To analyse *developments* of the variables of interest, econometricians use *time series*. Now time series, usually of aggregate level data, frequently show the characteristics of autocorrelation. This means that error terms are not mutually independent. Often there is a positive correlation between adjacent error terms.

This may be caused by the effect of variables that are left out of the analysis, lasting more than one period. Methods of tackling this problem are already old. Some types of autocorrelation can be eliminated by transforming the relations through taking first differences or growth rates of the variables in the equation.

- But this solution may be too simple and neglect the long term effects of the explanatory variables on the variable to be explained. Lags of different types may exist. The general problem is that economic theory gives some, but only limited guidance to the exact nature of the relations between the variables in the model. This means that empirical research has a large burden to carry. And in econometric analysis, as in other areas where time series models are employed, dependent and independent variables may have common trends. This can lead to nonsense correlation: variables are found to have significant statistical links, whereas there is no causal relation between them. In that connection, HENDRY (1980) stressed the importance of *testing* model specifications in econometric applications, as applied in HENDRY *et al.* (1984). In the last twenty years new methods of testing for common trends in time series analysis have been developed. Unit root tests are applied to see how many times it is necessary to difference (take first differences of) a variable, before the resulting error terms can be considered 'white noise' (DICKEY and FULLER, 1979, 1981). If this is  $n$  times, the variable is said to be integrated to the  $n$ th order, in formal terms: I(n) Error Correction Models or VAR Models have been developed and applied to handle variables of higher order appropriately (ENGLE and GRANGER, 1987).

In the 1960s it became clear that the performance of increasingly complex structural equation models for the analysis of macro-economic relations was not always as good as one hoped for. This problem led to several reactions:

- Some advocated simpler models, which focus on 'pure' time series analysis instead of an analysis of structural equations. In pure time series analysis the endogenous variables are only explained by (lags of) themselves and by trend variables. The device of the adepts of pure time series analysis was to improve the analysis of lag and error structures instead of plugging more or better explanatory variables in the analysis (BOX and JENKINS, 1970). This approach is solely directed at forecasting, not at gaining insight in the background of developments.
- From the 1960s onwards there was a revival of microeconomic theory to give a more thorough foundation to (macro)econometric relationships (KREPS, 1990). Theoretical advances may yield more specificity, which, if correct, can help to extract information from the data. Section 2 sketched the theoretical underpinnings of the models in the sphere of econom(etr)ics of crime and litigation.
- Econometric research uses an increasing variety of data and methods. Important in this respect are trends to make use of *cross section* and of *micro level* data. These types of data became increasingly available, both because of new sources of information (e.g. population or pupil surveys) and because of increasing computing power. Analyses on cross section and micro level data do not

encounter a number of problems typical for time series analysis: no common trends, lags are far less important and so on. The data on this level show generally more variation and enable stronger statistical conclusions. On the other hand, cross section data may be subject to heteroskedasticity: the errors terms have no common variance, e.g. because of huge differences of size of the units involved. This may harm the efficiency of the OLS-estimator. However, if we have any idea of the factors determining this variance, giving more weight to data with less variance gives a satisfactory solution to this problem.

Of course these types of analyses have other problems which gave rise to new developments in econometric methodology. Some of them have clear parallels with statistical analysis in the social sciences. These problems have to do with the nature of the variables to be explained in micro level data, which are 'limited' in their range. They may be categorical (e.g., Did you consult a lawyer in the last year? with possible answers: yes or no), ordinal (number of times victimised in the last year: 0, 1, 2–3 or more than 3 times), or non-negative only. In these cases again the error term is not independent of the explanatory variables, so the standard model does not apply. The methods of tackling this problem are based on creating an auxiliary dependent variable that is not limited dependent and which can be transformed into  $y$  according to some rules, in which thresholds play a role. For these purposes Probit, Logit and Tobit analyses were developed (MADDALA, 1983).

Another application on micro data is related to the explanation of the length of time intervals until a certain event occurs. For that purpose hazard-functions, describing length of time in probability terms, can be formulated (LANCASTER, 1990). Explanatory variables can be introduced as arguments in these functions.

Analysis on micro level data gives insight into the behaviour of individuals: which choices do they make or which events do they experience under the influence of their personal characteristics and the characteristics of their surroundings. As such this empirical analysis on micro level fits well the model of individual behavior sketched in Section 2. However, there are some reasons that empirical analyses is hampered on a micro level in econometrics, and especially in the sphere of crime.

The first one is the availability of good crime data on a micro level. Self-report studies are of limited value, and may properly record the conduct in the sphere of some minor offences only.

The other reasons are of a different nature. Often we want to draw conclusions at the macro level. Translation of micro results to a macro level is however not always clear-cut. Victim surveys, for instance, enable us to conclude that the probability of being victimised has a significant negative relation with security measures taken by persons or households (e.g. locking doors). This does not yet give a clue about the macro effect of an increase of the fractions of households who lock their doors on the total crime rate. That is because of the interaction between the probability of being victimised among various households. There may be a substitution effect: my

probability of victimisation may increase if my neighbour locks his door. In other words: the macro effect is not simply the adding-up of effects on micro level. There is an interaction between micro and macro level.

At the theoretical level there is no guarantee whatsoever that it is valid to translate the results of cross section analysis to time series analysis. The meaning and correlates of the same variable may be different in both types of analysis. Nevertheless, information from cross section relations or from other external sources is sometimes plugged into time series models, for example in the models of the Dutch Central Planning Bureau.

Sometimes *panel data* are available: data of the same units of observation over time. In that case it is possible to combine time series and cross section analysis. This enhances the power of the analysis. The modelling of the interaction between the error terms of one unit of observation in different time periods or the error terms in one time period between different units of observation are important elements here. Micro macro level interactions are, however, generally not tackled in this way.

In principle micro level and macro level information can be combined in one analysis (multi-level analysis). For example, the characteristics of both the person and the neighbourhood he is living in are combined into one relation. The proxy nature of the neighbourhood variables may be a problem here. The possible variation of these variables within the neighbourhood is left out of the analysis. This may create an errors-in-variable problem and may weaken the estimation results.

### 3.2 *An econometric model of crime and civil litigation*

There is no such thing as 'the econometric model of crime' or 'the econometric model of civil litigation'. Some models in the literature are estimated at a macro level, others on micro data; many are partial and focus on one part of the process only. There are, for instance, many models of the crime rate with exogenously (i.e. outside the model) determined probability and severity of punishment. Also, there are many models of civil litigation that take the contestable (problem creating) behaviour for granted. Nevertheless we try to sketch the general framework.

Section 2 presented the theoretical background. Some analyses found in the literature are in fact very loosely related to this theoretical background and mainly empirically based, others have a more firm theoretical foundation. Most, however, are simpler than the general framework set out here. Special features and empirical results of the existing models in the field are discussed in Sections 4 and 5.

The general framework is a simultaneous-equation model. The first equation describes the crime rate or the rate of contestable behaviour as a function of two types of factors. First, demographic, social and economic characteristics (such as age or household income) may influence people's attitude and conduct. The second type of factors has to do with the (estimated) loss when committing a crime or engaging in contestable behaviour. Referring to crime, this loss is related to the (perceived) probability and severity of punishment. With regard to contestable behaviour, the loss has to do with the (perceived) probability and the consequences of a reaction of

the parties that may be harmed. The possibility of a suit being filed can be important here.

$$C = f(A, L, \varepsilon_1) \quad (3a)$$

where:

$C$  = the rate of crime or contestable behaviour,

$A$  = relevant demographic, social and economic characteristics,

$L$  = factors determining the expected loss following from the choice to commit a crime or to engage in contestable behaviour,

$\varepsilon_1$  = error term, describing all relevant factors that are not explicitly modelled.

The second equation addresses the expected loss. At the micro level the expected loss is dependent among others on the type of crime committed or contestable behaviour. At the macro level the total losses, e.g. in terms of punishments or plaintiff victories, are dependent on the number of crimes or the size of contestable behaviour in society respectively (variable  $C$ ). With crime this loss is also related to the (expected) reactions of the law enforcement agencies (police, public prosecutor, court) that operate at macro level. These reactions are dependent on characteristics of the operation of these agencies, in terms of inputs, setting of priorities etc. With contestable behaviour this loss is also related to the individual decision making by those to whom harm is done. This may be influenced by the relevant legal institutions and legal aid system. The characteristics of relevant law enforcement agencies and legal institutions is summarised by the variable  $S$ .

$$L = g(C, S, \varepsilon_2) \quad (3b)$$

with:

$S$  = characteristics of relevant legal institutions and supply of law enforcement/legal aid,

$\varepsilon_2$  = error term, describing all relevant factors that are not explicitly modelled.

The costs of committing a crime are specified in (3b) as a function of the inputs of law enforcement agencies ( $S$ ) and the crime rate ( $C$ ). Increasing the inputs of law enforcement agencies will raise the probability and severity of punishment and so the costs involved in committing a crime. When  $C$  increases, so will  $L$ . But notice that, if the law enforcement agencies must handle more  $C$  with constant inputs  $S$ , the probability of punishment may decrease. Relations of this type are part of the production and cost function literature in econom(etr)ics. This literature relates inputs (labour, material, capital) of producers to their direct output (in this case solved crimes, sanctions etc.) See Section 4 for some more specific references.

The third equation has to do with the supply of law enforcement, legal aid and other characteristics of the relevant legal institutions, and is an equation at the macro level. The rate of crime or contestable behaviour ( $C$ ) may play a role here. Other tendencies in public policy, e.g. the general policy regarding public expenditure levels and budget deficits, are also relevant and summarised by the variable  $O$ .

$$S = h(C, O, \varepsilon_3) \quad (3c)$$

with:

$O$  = public policies regarding inputs/supply of law enforcement agencies/legal aid,  
 $\varepsilon_3$  = error term, describing all relevant factors which are not explicitly modelled.

In many empirical studies this simultaneous-equation model is simplified to one *reduced form* equation:

$$C = f(A, L, S, \varepsilon) \quad (4)$$

with  $A$ ,  $L$  and  $S$  seen as exogenously determined. In crime studies,  $S$  is sometimes left out and  $L$  is represented by the probability and severity of punishment. In other cases,  $L$  is not specified explicitly and instead only  $S$  represents the law enforcement system and its performance. This latter 'shortcut' has the advantage that, at least in theory, not only the deterrent effects of law enforcement agencies are incorporated, but also the general preventive effects, e.g. of police patrolling in the streets.

The theoretical model of crime or contestable behaviour is formulated at the individual level. In many econometric studies the model of crime is estimated at the aggregate level. A potential problem is worth mentioning here. The cost of committing a crime is dependent, among other things, on the probability of punishment. This variable is often measured as the ratio of the number of punishments to the number of crimes. However, the last mentioned variable is exactly the one that is to be explained. If there is an error in measuring this variable  $C$ , there will be a relation between this variable and the error term. So we find a negative correlation between this probability of punishment and the crime rate, which has nothing to do with real effects (TAYLOR, 1978).

Two escapes from this problem are possible. The first one, in time series analysis, is to assume that there is a time lag between changes in the probability of punishment and its effects on the estimation of costs by the potential criminal. The other one is estimating a simultaneous-equation model of type (3a,b,c). In such a model the error terms  $\varepsilon_1$ ,  $\varepsilon_2$  and  $\varepsilon_3$  are not stochastically independent and so the standard OLS-estimator will not be the best one. A simultaneous-equation procedure has to be implemented, in which the probability of punishment is replaced by an instrumental variable. A theoretical and an empirical observation are in place here. This structural model, if correctly specified and estimated, has a clear advantage over the reduced form equation (4): it gives more information about the relevant relation. It may give enough information to estimate which type of policies is more cost effective in reducing crime. Combination of equations (3a) and (3b) enables us to link the way we organise law enforcement ( $S$ ) with the resulting level of crime ( $C$ ). Section 4 presents an example of a study in this sphere. But the advantage of this structural model has a caveat. If, for example, the specification of relation (3c) is incorrect, this will hamper the correct estimation of the other relations (3a) and (3b) as well. And the inclusion of  $O$  in (3c) is essential. If  $O$  were not there, the system of equations

would in fact be *not identified*. For in that case  $S$  would be, apart from the error term, solely explained by  $C$  (equation 3c). So  $L$  would also be explained solely by  $C$  (equation 3b). But then the effect of variables  $A$  in (3a) vanishes automatically, so we have a theoretical problem here. In practical terms: simultaneous-equation models are more sensitive (less robust) to misspecifications and data errors than non-simultaneous models.

This simultaneity problem does not arise in this way when the econometric analysis takes place at micro level. Such a situation is present with the (rare) analyses of criminal behaviour at the micro level (equation (3a); e.g. SCHMIDT and WITTE, 1988, 1989) and the analyses determining individual litigation behaviour (equation (3b); see Section 5). (The individual decision to commit a crime will have no measurable effect on the macro amount of crime, and so no effect on the probability of punishment. The estimations of micro relations may, however, give rise to other problems in identifying causality relations. For example, a relation between unemployment and crime may be caused not only by the crime stimulating effect of joblessness, but also by the effect of a criminal record on the possibilities to find a job, e.g. VAN TULDER, 1985). The drawing of conclusions at macro level may then be hampered because of micro-macro interactions, as described in Section 3.1.

#### 4 Economics of crime and law enforcement: empirical results

As the number of econometric studies in the field of crime and law enforcement has grown fast from the 1970s to the present day, we can only touch on some findings in the literature. Surveys of international findings can be found in HEINEKE (1978), EIDE (1994) and MAC DONALD and PYLE (2000). Here, we shall present empirical results of Dutch studies in somewhat more detail. Firstly, we discuss the level of crime and secondly, we focus on the outputs of law enforcement. Many studies focus on one of these topics. Some studies, however, present a simultaneous-equation model.

##### 4.1 Results about crime

Section 2 showed how economic theory relates the crime level to the probability and severity of punishment. Many econometric studies estimate the effects of both variables on crime. Notice that the probability of punishment is often measured by the solution rates of crimes by the police, which is rather a measure of the probability of coming into contact with the law enforcement system. We shall not dwell on the quality of the statistics involved here, which are sometimes subject to discussion. Various Dutch studies find significant effects of the probability of punishment (VAN TULDER, 1985, 1994, THEEUWES and VAN VELTHOVEN, 1994, VAN DER TORRE and VAN TULDER, 2001). The elasticities, i.e. the effect (in percentages) on crime of a 1% increase of the solution rate, range from  $-0.1$  to  $-0.8$ , depending not only on the type



of crime but also on the method used (time series analysis, cross sectional analysis). The effects of the severity of punishment in these studies are less clear.

While the main focus of econometric studies of crime is on the effects of law enforcement, nearly all of them include variables to capture, or in other words: *to correct for*, possible effects of other factors on the crime level. To that end a wide variety of variables has been used. The theoretical underpinning for the choice of the variables is generally somewhat loose. It is a combination of: (1) eclectic use of theoretical notions in criminological or economic literature, (2) information about relevant characteristics of criminals in micro level data, and (3) a pragmatic consideration about the availability of data, which ends up in a series of proxy-variables at the aggregate level. Theoretical notions and micro data suggest that age, social and ethnic background and income and job status may be important. So usually some variables representing *demographic, social and economic* factors are included. PYLE (1998) and DEADMAN and PYLE (2000) present an overview of studies in this area. For the Netherlands examples can be found in VAN TULDER (1985, 1994), BEKI *et al.* (1999), THEEUWES and VAN VELTHOVEN (1994); VAN DER TORRE and VAN TULDER (2001); HUIJBREGTS *et al.* (2001).

The degree to which the crime level is 'explained' by the factors included in the model strongly depends on the nature of the analysis. Some results of Dutch crime studies may illustrate this. The time series Error Correction Model by THEEUWES and VAN VELTHOVEN (1994) explained 83 percent of variance in the *growth* of total crime per capita. The cross section analysis of 148 Dutch non rural municipalities by VAN TULDER (1994) showed a degree of explained variance varying from 25 percent for vandalism to 73 percent for aggravated theft. Of course analyses of data at the aggregate level can yield a higher percentage of explained variance than analyses of cross sectional data, that in turn can reach a higher degree of explanation than micro data.

Given the distinction made above between law enforcement and other factors in econometric modelling, it is interesting to see which of the two types of factors is more important in explaining the variance in crime levels. Of course this may depend on the specification chosen. Generally, we can conclude that both play a role and that the 'social' factors are the most important ones (THEEUWES and VAN VELTHOVEN, 1994; VAN TULDER, 1994). The results of VAN DER TORRE and VAN TULDER (2001) are somewhat more mixed in this respect.

A general overview of the estimation results of deterrence effects in the international literature (TAYLOR, 1978, EIDE, 1994) enables us to draw two main conclusions: (1) there is ample proof to the existence of a deterrence effect of the probability, and (2) the proof is less strong for the deterrence effect of the severity of punishment. There are also indications that the effects are dependent on the type of crime.

The practical value of these studies for policy makers appears to be rather limited, as no exact knowledge about the difference between types of crime, background circumstances etc. can be drawn from them. How the deterrence effects operate is not clear either, as is stressed by NAGIN (1998). It is unclear on which estimates of the

probability and severity of punishment potential criminals base their decisions and what the relation is between actual and perceived probabilities and severity.

GAROUPA (1998, 1999) studied the possible consequences of errors in the estimates of the probability and severity of punishment by potential criminals. These errors tend to reduce the deterrence effects, but not fully. This is because of the 'noise' introduced between actual and estimated probability and severity of punishment. Thus, it may be important for the government to provide good information in this sphere. The publication on the internet of the fines given in relation to specified traffic offences by the Dutch law enforcement agencies is an example here.

## 4.2 Results about law enforcement

### 4.2.1 Inputs and outputs of law enforcement agencies

The probability and severity of punishment are the result of the performance of law enforcement agencies, like the police, the public prosecutor and the courts. The police has been a frequent object of study in the 'economics of crime' literature. See PYLE (1983) for an overview. Analyses of the courts are fewer in number. There is, again, a wide variety of methods and results.

The oldest approach is via production functions, in which the output is the variable to be explained by various types of inputs. A pressing problem is the heterogeneous nature of police output. A production function can in principle only handle one type of output. Even in analyses restricted to solving crimes this is a problem: aggregating murders and petty thefts is unsatisfactory. So some additional simplifications have to be made (see e.g. VOTEY and PHILIPS, 1972, WALZER, 1972, VAN DER TORRE and VAN TULDER, 2001).

Other studies introduce cost functions and indirect approaches to production analysis. Cost functions relate the costs to various types of outputs and unit prices of inputs. This makes it possible to deal with more types of output. In a simple cost function approach (GOUDRIAAN *et al.*, 1989) the question is which costs have to be made to produce outputs in an exogenously determined (fixed) quantity. Because in the real world some police outputs are certainly not predetermined, other authors have tried to relax this assumption. DARROUGH and HEINEKE (1978, 1979) and VAN TULDER (2000a) use a 'value maximisation' model, inspired by profit maximisation models in the market sector. They formulated and tested the hypothesis that police departments maximise the added value: the difference between value of outputs and costs. Outputs are defined as the number of solved crimes of different types. The 'prices' of different outputs in the sphere of property crimes are based on the average values of stolen goods. Empirical testing does not lead to convincing results, however.

There is not only a variety in methods but also in empirical results. We present just one example for the Netherlands. VAN TULDER (1994) estimated that a 1% increase of inputs into the police causes a 0.5% increase of the (weighted) number of

solutions, so roughly a 0.5% decrease of the solution rate. An increase of inputs into the courts of 1% has a comparable effect on the number of cases dealt with.

#### 4.2.2 *Cost-effectiveness*

Combining the analysis of the effects of probability and severity of punishment on crime (Section 4.1.1) with the analysis of the effects of police and court inputs on solution rates and punishment rates (Section 4.2.1), enables us to estimate the effects of additional inputs into various parts of the law enforcement system on crime. So this gives an indication of which type of deterrence policy is the most cost effective. VAN TULDER and VAN DER TORRE (1999) and VAN DER TORRE and VAN TULDER (2001) estimated in this way that for the Netherlands inputs in the later parts of the law enforcement system have larger crime reducing effects than inputs in earlier parts. Spending an additional amount of money on more or higher prison sentences or more punishments by the courts has more effect than spending the same amount on increasing the input of the police. This seems to contradict the aforementioned conclusions that the effects of the probability of punishment are generally larger than that of the severity of punishment. But it has to do with the relatively small effects of additional police inputs on solution rates.

#### 4.2.3 *Forecasts of the workload of law enforcement agencies*

There is one branch of law enforcement in which policy makers show a clear willingness to use the results of econometric forecasts. This is in the capacity planning of prisons and of other institutions in the sphere of executing punishments, e.g. agencies which organise and handle compulsory community services. The tools and methods used by policy advisers are again widely different. The British Home Office makes forecasts of the number of prisoners every year, and has changed its methods a few times. At the moment fairly simple extrapolation models are used.

In the Netherlands a model of interrelations between the various parts of the law enforcement system sketched in Section 3 is expanded with a series of equations describing the attribution of punishments by the public prosecutors and the courts. The model is used to make forecasts of the numbers and types of punishments. These result in a forecast of the capacity need of the punishment executing agencies (VAN TULDER, 2000b). Of course special changes of punishment policies can be pursued and their results on the forecasts can be included. It should be noted that policy makers find it hard to accept that even these 'complex' models have forecast errors. The economic forecasts of the Central Planning Bureau have their errors (see for an analysis CPB, 1999) and this is even more true for forecasts in the area of crime and the work load of law enforcement agencies.

When it comes to reacting on crime and planning inputs into police and courts policy makers make less direct use of the results of econometric models. The planning of inputs into police and courts is mainly based on politically motivated choices in the sphere of allocation. Sometimes policy makers draw simple links between various parts of the law enforcement chain: e.g. 1% more police means that

the need of court inputs also increases with 1%. These estimates are, however, not based on empirical evidence. According to the econometric findings in VAN TULDER (1994) and VAN DER TORRE and VAN TULDER (2001), the actual effect is clearly smaller.

## 5 Economics of civil litigation: empirical results

Empirical work on the economics of civil litigation really started with the contribution by PRIEST and KLEIN (1984). It has centred since then on their selection hypothesis: trials tend to be closer to the decision standard than cases settled, cf. Section 2. We follow the historical development in the international literature by focusing first on the fifty percent rule, then presenting more general studies of the selection process, and ending with some recent applications of hazard models. Unless stated otherwise, all empirical research refers to the US. The few Dutch studies in the field have a somewhat different angle and directly address the number of civil cases and the workload of judicial services.

### 5.1 *The fifty percent rule*

A direct test of the selection hypothesis requires both data on trials and settlements that were not readily available. So, PRIEST and KLEIN (1984) started at the fifty percent rule and calculated the proportion of plaintiff victories in approximately 15,000 tort cases in Illinois. The resulting 48% could be interpreted to support the theory. But in some categories of disputes the proportion of plaintiff victories is significantly different from 50%. Priest and Klein explain that a systematic difference from 50% may be observed in two separate circumstances. First, if a very high proportion of disputes is litigated because either litigation costs are relatively low compared with settlement costs or expected adjudications are extremely high relative to litigation costs, there will be relatively less selection and the rate of success at trial will more closely reflect the underlying distribution of disputes. Secondly, there may be some asymmetry in the stakes of the parties. (EISENBERG, 1990, presents a somewhat more elaborate version of the 50% test, with comparable results. In terms of distribution theory, the outcome of tried cases is a binomial variable with a probability of plaintiff success equal to 0.5, analogous to a flip of an unbiased coin. Rather than any particular plaintiff win rate in a given year or court, the distribution of plaintiff success rates across time or courts tests whether a binomial variable selection process is a useful analogy for the outcome of litigated cases).

VISCUSI (1986, 1988) was among the first to test the economic model on *individual claims*, by using data that stem from insurance company files on product liability claims. Here, the selection process can be clearly seen at work, as 19% of the 10,784 cases filed were dropped at some point, 95% of the remaining cases were settled out of court, and only 435 cases ended with a verdict. Although the plaintiff success rate in court is a mere 37%, this departure from the fifty percent rule in Viscusi's view

does not imply that the selection model is useless. Most likely, the payoffs to the parties are asymmetric here, companies having a larger stake in the outcome than do the claimants. This would lead, within the model, to a predicted success rate of over 50% for companies. Risk aversion, which presumably is also asymmetric as claimants will be more risk-averse than companies, will also tend to give the edge to defendants. Viscusi then tries to substantiate the economic model by running Logit regressions to find the determinants for the drop, settlement and plaintiff win probabilities. VISCUSI (1986) reports a strong negative correlation between injury level and dropping or settling the suit. This result implying that, as the ratio of legal costs to injury level decreases, the probability that a suit will be dropped or settled decreases, is consistent with the model. He also finds a positive correlation between a negligence type of liability and the drop decision, which is plausible given the high burden of proof for plaintiffs under negligence.

The discussion on the fifty percent rule is reviewed in KESSLER *et al.* (1996), who list the findings of 22 studies. Within the DE model, persistent departures from the fifty percent rule might be explained by a whole series of case characteristics: mismeasurement of plaintiff victory (damages versus liability), high settlement costs relative to litigation costs, risk aversion and the level of awards, the decision standard favouring one side, differential stakes, differential information of parties, and agency effects (hourly fee versus contingency fee lawyers). They go on to examine the relative importance of these characteristics on data for some 3,500 civil cases from Appeal Courts. After having classified the 70 suit types according to each of the seven case characteristics above, they estimate a Probit model, relating the probability of plaintiff victory in case  $i$  to the vector of characteristics of the case. It turns out that all characteristics affect the win rate in the way theory would suggest, and (with the exception of the position of the decision standard) in a statistically significant manner. Thus, Kessler *et al.* conclude, the best approach to understanding the selection of cases for litigation would be a 'multimodal' one, which does not rely on any single overarching theory to predict trial outcomes.

### 5.2 *The selection process*

The idea that the DE model is more than just the fifty percent rule, and that the DE model is not the only one conceivable, can be found in several other papers.

The selection process within the DE model is central to a series of papers by WALDFOGEL (1995, 1998) and SIEGELMAN and WALDFOGEL (1999). Starting from a standard normal distribution of filed cases, it is argued that the Priest–Klein model gives rise to both a relationship for the trial rate  $T = T(D, \sigma, \alpha)$  and the plaintiff win rate  $P = P(D, \sigma, \alpha)$  as a function of the decision standard  $D$ , parties' uncertainty about the quality of their case  $\sigma$ , and the degree of stake asymmetry  $\alpha$ . (Reductions in relative trial costs,  $(C - S)/J$ , have an effect similar to an increase in the parties' uncertainty. Thus, variations in party uncertainty and relative trial costs are observationally equivalent. Referring to most common contingency fee arrangements,  $(C - S)/J$  is formally held constant in the model at 0.33, while  $\sigma$  varies). It

follows that there is some kind of relationship between  $T$  and  $P$ , which however cannot be derived in closed-form, no more than the functions for  $T$  and  $P$ . To give empirical content to the relationships, an innovative path is chosen. First, simulating the model for a range of parameter values  $D$ ,  $\sigma$  and  $\alpha$ , and then fitting the resulting simulated  $T$  and  $P$  to fully interacted polynomials, suggests that third-order logistic regressions fit well. Secondly, their data cover federal civil cases from the Southern District of New York that could be matched to the judge who handled the case. As cases are randomly assigned to judges,  $D$  and  $\sigma$  may vary with judge, but not  $\alpha$ , which makes estimation feasible. The empirical findings in WALDFOGEL (1995) show that plaintiff win rates vary systematically with trial rates, both across case types and across judges. The decision standard estimates imply that among cases filed the plaintiff win rate for torts is definitely below, and for contracts above, 50%. Comparing these figures with the plaintiff win rates among trials indicates that litigated cases are not representative of filed cases. However, the selection effect does not operate as a simple convergence to 50%, due to stake asymmetry. Plaintiffs have relatively higher stakes in contract and intellectual property right cases and lower stakes in tort cases. Tort cases engender the greatest uncertainty. WALDFOGEL (1998) formulates an explicit test between the DE and AI models, in a situation where uncertainty differs across parties. With relatively uninformed plaintiffs, the two theories should lead to different relationships between  $T$  and  $P$ . Regressing  $P$  on  $T$  (by OLS and IV) yields results that support DE, not AI. Waldfoegel adds some interesting evidence on plaintiff win rates in early rounds of adjudication (summary judgements and other decisions on motions prior to the pre-trial conference). The process of pre-trial adjudication and settlement appears to reflect the presence of AI, eliminating (depending on the type of suit and the kind of informational asymmetry) high- or low-quality cases from the pool proceeding to trial. (A study by FARBER and WHITE (1991) of medical malpractice claims against a single hospital finds some evidence that supports the AI position. Of 252 claims only 13 were tried in court, all of which were decided for the defendant. Although the result is suggestive, the number of trials was too small to estimate a model determining trial outcomes). The general tendency, however, is toward central, not extreme plaintiff win rates at trial.

For practical purposes, empirical work discussed up till now started from the given set of filed cases. Going one step back in the selection process, it should be noticed that only a small fraction of the number of potential claims results in the filing of a lawsuit. Of course, the almost insurmountable problem here is that potential claims that do not result in lawsuits are not observed, nor even counted. SIEGELMAN and DONOHUE (1995) circumvent the problem by studying employment discrimination disputes over the business cycle. Grouping disputes by the quarter they use grouped Logit regressions to find out whether the aggregate settlement and win rates are affected by the unemployment rate. It turns out that higher unemployment rates induce a significant rise in the number of disputes, but the incremental cases are substantially weaker than the average when unemployment is low. Siegelman and Donohue conclude that the screening

mechanism of the Priest–Klein model exists, but that it is not perfect as it does not completely filter out all the additional low-quality cases. EISENBERG and FARBER (1997) try to include the selection leading up to filings by focusing on (differential) litigation costs. Probit analysis on over 200,000 federal civil cases suggests that the selection of claims for filing by (potential) claimants is an important phenomenon.

### 5.3 *Dynamics of settlement bargaining*

Legal disputes often take considerable time after the initial filing to go to trial, if at all. This process of delay in litigation can be studied through dynamic models of bargaining, generating empirical hazard functions for the conditional probability of settlement over time. Three recent papers are in this direction. KESSLER (1996) analyses some 18,000 insurance claims with a non-parametric baseline hazard and log–linear regressors. The results suggest that delay in trial courts increases delay in settlement. In other words, the cost of clogged courts may reach beyond the scope of litigated cases. FOURNIER and ZUEHLKE (1996) apply a generalised Weibull hazard model to a large dataset of civil lawsuits. The estimates appear to be consistent with the simulated predictions of SPIER (1992) model. The time path of the hazard function shifts downward with increases in trial stakes and uncertainty about the defendant's liability, and decreases in litigation costs. It is, furthermore, concluded that fee shifting discourages settlement, but the magnitude of the disincentive diminishes with the duration of litigation. Spier's model is also the starting point for FENN and RICKMAN (1999) who directly derive a functional form for the hazard. Contrary to Kessler's decline, Fenn and Rickman find the baseline hazard to be monotonically increasing. Settlement delay is increased when the litigants face low costs of bargaining (for instance, when the plaintiff is legally aided), when the estimated damages are high, and when the defendant feels that he is not liable for the damages. Together, the three papers present enough evidence of time-dependent behaviour to warrant further study of the dynamic structure of settlement negotiations in the line of Spier.

### 5.4 *Workload of judicial services*

All the empirical work up till now, with the one exception of SIEGELMAN and DONOHUE (1995), started from a given pool of disputes or filed suits to study the working of the selection process. The determinants of the number of disputes, and hence of the number of cases brought to trial and the workload of judicial services, remained underexposed. These latter issues are addressed in contributions on the situation in the Netherlands.

VAN TULDER and JANSSEN (1988) want to know which combination of factors is decisive for litigating parties to call in professional legal help. This problem is tackled first by a Probit analysis of the demand for lawyer services on data from a 1983 survey. They find a price elasticity of  $-0.3$  and an income elasticity of  $0.6$ , besides the significant effects of a series of variables controlling for the emergence of legal

disputes (e.g. being divorced, self-employed, welfare recipient). They also present some OLS time series results. Worthy of mention is the significant effect of court fees on the two types initiated by business corporations, implying a price elasticity of  $-0.3$  and  $-0.6$ , in line with the other findings.

The time series approach to the analysis of civil and administrative lawsuits is elaborated in VAN VELTHOVEN (2002). He sets out to try and unravel the relative impact of various socio-economic and cultural developments. First, a growing number of disputes in society may emanate from a complex of factors, such as population size and density, real GDP, unemployment, divorce, the rental price of housing, and immigration. The degree to which these problems will be transformed into legal disputes in turn depends on socio-cultural factors such as the prevailing range of rules and legislation, the degree of social cohesion, and the availability of institutions and resources that inform citizens about their legal rights and provide first aid in asserting these rights. Litigation costs are, of course, important in the decision to actually file a suit and to proceed into court. Finally, the size of the Bar and the judiciary may pose limits to the number of cases that can be handled in court. Unit root tests point out that all variables have clear trends in the development over the fifty year period 1951–2000, so as to be at least  $I(1)$ , and some of them  $I(2)$ . Accordingly, an error correction model is estimated on the first and second differences of the total per capita number of civil and administrative trials. Major findings are that the model performs reasonably well, given an  $R^2$  of 0.65 for civil and 0.94 for administrative trials. Litigation costs turn out to have a significantly negative effect, with a price elasticity of  $-0.3$  for civil and  $-0.5$  for administrative cases. The other complexes of factors also play their role. The number of trials grows along with population size. The decline in social cohesion (approximated by the number of non-Dutch among the population) has led to an overall growth in the number of trials, while the effect of the growing range of laws and regulation is concentrated in administrative procedures. Finally, the delay in court proceedings and the capacity of the Bar tend to contain the number of disputes that actually go to trial.

## References

- BEBCHUK, L. A. (1984), Litigation and settlement under imperfect information, *RAND Journal of Economics* **15**, 404–415.
- BECKER, G. S. (1968), Crime and punishment: an economic approach, *Journal of Political Economy* **76**, 169–217.
- BEKI, C., K. ZEELENBRG and K. VAN MONTFORT (1999), An analysis of the crime rate in the Netherlands 1950–93, *British Journal of Criminology* **39**, 401–415.
- BLOCK, M. K. and J. M. HEINEKE (1975), A labor theoretic analysis of criminal choice, *American Economic Review* **65**, 314–325.
- BLOCK, M. K. and R. C. LIND (1975a), Crime and punishment reconsidered, *Journal of Legal Studies* **4**, 241–247.



- BLOCK, M. K. and R. C. LIND (1975b), An economic analysis of crimes punishable by imprisonment, *Journal of Legal Studies* **4**, 479–492.
- BONGER, W. (1916), *Criminality and economic conditions*, Little Brown, Boston (republished by Agathan, New York).
- BOX, G. E. P. and G. M. JENKINS (1970), *Time series analysis: forecasting and control*, Holden-Day, San Francisco.
- CARR-HILL, R. A. and N. H. STERN (1979), *Crime, the police and criminal statistics. An analysis of official statistics for England and Wales using econometric methods*, Academic Press, London.
- COOTER, R. D. and D. L. RUBINFELD (1989), Economic analysis of legal disputes and their resolution, *Journal of Economic Literature* **27**, 1067–1097.
- CPB (Central Planning Bureau) (1999), *Centraal Economisch Plan 1999*, SDU, Den Haag.
- DARROUGH, M. N. and J. M. HEINEKE (1978), The multi-output translog production cost function: the case of law enforcement agencies, in: J. M. HEINEKE (ed.), *Economic models of criminal behavior*, North Holland, Amsterdam (Contributions to economic analysis 118).
- DARROUGH, M. N. and J. M. HEINEKE (1979), Law enforcement agencies as multiproduct firms: an econometric investigation of production costs, *Public Finance* **34**, 176–195.
- DEADMAN, D. and D. PYLE (2000), Crime, deterrence and economic factors, in: Z. MAC DONALD, and D. PYLE (eds.), *Illicit activity. The economics of crime, drugs and tax fraud*, Ashgate Publishing Company, Aldershot, 61–74.
- DICKEY, D. and W. FULLER (1979), Distribution of the estimators for autoregressive time series with a unit root, *Journal of the American Statistical Association*, **74**, 427–431.
- DICKEY, D. and W. FULLER (1981), Likelihood ratio tests for autoregressive time series with a unit root, *Econometrica*, **49**, 1057–1072.
- EHRlich, I. (1981), On the usefulness of controlling individuals: an economic analysis of rehabilitation, incapacitation, and deterrence, *American Economic Review* **71**, 307–322.
- EHRlich, I. (1996), Crime, punishment, and the market for offenses, *Journal of Economic Perspectives* **10**, 43–67.
- EIDE, E. (1994), in cooperation with J. AASNESS and T. SKJERPEN, *Economics of crime. Deterrence and the rational offender*, North-Holland, Amsterdam.
- EISENBERG, T. (1990), Testing the selection effect: a new theoretical framework with empirical tests, *Journal of Legal Studies* **19**, 337–358.
- EISENBERG, T. and H. S. FARBER (1997), The litigious plaintiff hypothesis: case selection and resolution, *RAND Journal of Economics* **28**, S92–S112.
- ENGLE, R. and C. GRANGER (1987), Co-integration and error correction: representation, estimation and testing, *Econometrica* **35**, 251–276.
- FARBER, H. S. and M. J. WHITE (1991), Medical malpractice: an empirical examination of the litigation process, *RAND Journal of Economics* **22**, 199–217.
- FENN, P. and N. RICKMAN (1999), Delay and settlement in litigation, *Economic Journal* **109**, 476–491.
- FOURNIER, G. M. and T. W. ZUEHLKE (1996), The timing of out-of-court settlements, *RAND Journal of Economics* **27**, 310–321.
- GAROUPA, N. (1998), Optimal law enforcement and imperfect information when wealth varies among individuals, *Economica* **65**, 479–490.
- GAROUPA, N. (1999), Optimal law enforcement with dissemination of information, *European Journal of Law and Economics* **7**, 183–196.
- GOUDRIAAN, R., F. VAN TULDER, J. BLANK, A. VAN DER TORRE and B. KUHYRY (1989), *Doelmatig dienstverlening. Een onderzoek naar de productiestructuur van vier voorzieningen in de quartaire sector*, Sociaal en Cultureel Planbureau, Samson, Rijswijk/Alphen aan de Rijn. (Sociale en Culturele Studie 11).
- GOULD, J.P. (1973), The economics of legal conflicts, *Journal of Legal Studies* **2**, 279–300.
- GREENE, W. H. (1993), *Econometric analysis*, MacMillan, New York (2nd ed.).

- HEINEKE, J. M. (ed.) (1978), *Economic models of criminal behavior*, North-Holland, Amsterdam.
- HENDRY, D. (1980), Econometrics, alchemy or science?, *Economica* **47**, 387–406.
- HENDRY, D., A. PAGAN and J. SARGAN (1984), Dynamic specification, in: Z. GRILICHES and M. INTRILIGATOR (eds.), *Handbook of Econometrics*, vol. 2, North Holland, Amsterdam.
- HUIJBREGTS, G. L. A. M., F. P. VAN TULDER and D.E.G. MOOLEMAAR (2001), *Model van justitiële jeugdvoorzieningen voor prognose van de capaciteit*, WODC, Den Haag (Onderzoek en Beleid nr.192).
- KESSLER, D. (1996), Institutional causes of delay in the settlement of legal disputes, *Journal of Law, Economics and Organization* **12**, 432–460.
- KESSLER, D., T. MEITES and G. P. MILLER (1996), Explaining deviations from the fifty percent rule: a multimodal approach to the selection of cases for litigation, *Journal of Legal Studies* **25**, 233–259.
- KREPS, D. M. (1990), *A course in microeconomic theory*, Harvester Wheatsheaf, Hertfordshire.
- LANCASTER, T. (1990), *The analysis of transition data*, Cambridge University Press, New York.
- MAC DONALD, Z. and D. PYLE (eds.) (2000), *Illicit activity The economics of crime, drugs and tax fraud*, Ashgate, Aldershot.
- MADDALA, G. S. (1979), *Econometrics*, McGrawHill, Tokyo.
- MADDALA, G. S. (1983), *Limited dependent and qualitative variables in econometrics*, Cambridge University Press.
- MICELI, T. J. (1997), *Economics of the law: torts, contracts, property, litigation*, Oxford University Press.
- NAGIN, D. S. (1998), Criminal deterrence research at the outset of the twenty-first century, in: M. TONRY (ed.), *Crime and justice. A review of research* **23**, The University of Chicago Press, Chicago/London.
- NEWMAN, P. (ed.) (1998), *The new Palgrave dictionary of law and economics*, Macmillan, London.
- PRIEST, G. L. and B. KLEIN (1984), The selection of disputes for litigation, *Journal of Legal Studies* **13**, 1–55.
- PYLE, D. J. (1983), *The economics of crime and law enforcement*, Macmillan, London.
- PYLE, D. J. (1998), Crime and unemployment: what do empirical studies show?, *International Journal of Risk, Security and Crime Prevention* **3**, 169–180.
- SCHMIDT, P. and A. D. WITTE (1988), *Predicting recidivism using survival models*, Springer, New York (Research in Criminology).
- SCHMIDT, P. and A. D. WITTE (1989), Predicting criminal recidivism using ‘split’ population survival time models, *Journal of Econometrics* **40**, 141–159.
- SHAVELL, S. (1997), The fundamental divergence between the private and the social motive to use the legal system, *Journal of Legal Studies* **26**, 575–612.
- SEGELMAN, P. and J. J. DONOHUE III (1995), The selection of employment discrimination disputes for litigation: using business cycle effects to test the Priest–Klein hypothesis, *Journal of Legal Studies* **24**, 427–462.
- SEGELMAN, P. and J. WALDFOGEL (1999), Toward a taxonomy of disputes: new evidence through the prism of the Priest/Klein model, *Journal of Legal Studies* **28**, 101–130.
- SPIER, K. E. (1992), The dynamics of pretrial negotiation, *Review of Economic Studies* **59**, 93–108.
- TAYLOR, J. B. (1978), Econometric models of criminal behavior: a review, in: J.M. HEINEKE (ed.), *Economic models of criminal behavior*, North-Holland, Amsterdam.
- THEEUWES, J. J. M. and B. C. J. VAN VELTHOVEN (1994), Een economische visie op de ontwikkeling van criminaliteit, *Justitiële Verkenningen* **20**, 42–65.
- VAN DER TORRE, A. G. J. and F. P. VAN TULDER (2001), *Een model voor de strafrechtelijke keten*, Sociaal en Cultureel Planbureau, Den Haag.

- VAN TULDER, F. P. (1985), *Criminaliteit, pakkans en politie*, Sociaal en Cultureel Planbureau, Rijswijk (SCP-cahier nr.45).
- VAN TULDER, F. P. (1994), *Van misdaad tot straf. Een economische benadering van de strafrechtelijke keten*, Sociaal en Cultureel Planbureau, Rijswijk (with summary in English).
- VAN TULDER, F. P. (2000a), The revenue approach to Dutch police departments, in: J.L.T. BLANK (ed.), *Public provision and performance*, Elsevier North-Holland, Amsterdam, 247–275.
- VAN TULDER, F. P. (2000b), Crimes and the need for sanction capacity in the Netherlands: trends and backgrounds, *European Journal on Criminal Policy and Research* **8**, 91–106.
- VAN TULDER, F. P. and S. JANSSEN (1988), *De prijs van de weg naar het recht*, Sociaal en Cultureel Planbureau, Rijswijk.
- VAN TULDER, F. P. and A. G. J. VAN DER TORRE (1999), Modelling Crime and the Law Enforcement System, *International Review of Law and Economics* **19**, 471–486.
- VAN VELTHOVEN, B. C. J. (1996), Kroniek: Economische bijdragen op het terrein van de criminologie, *Tijdschrift voor Criminologie* **38**, 311–316.
- VAN VELTHOVEN, B. C. J. (2002), Civiele en administratieve rechtspleging in Nederland 1951–2000, Research Memorandum 2002.01 (deel 1: tijdreeksdata) and 2002.02 (deel 2: tijdreeksanalyse), Department of Economics, Faculty of Law, Leiden University.
- VISCUSI, W. K. (1986), The determinants of the disposition of product liability claims and compensation for bodily injury, *Journal of Legal Studies* **15**, 321–346.
- VISCUSI, W. K. (1988), Product liability litigation with risk aversion, *Journal of Legal Studies* **17**, 101–121.
- VOTEY, H. L. Jr. and LI. PHILIPS (1972), Police effectiveness and the production function for law enforcement, *Journal of Legal Studies* **1**, 423–436.
- WALDFOGEL, J. (1995), The selection hypothesis and the relationship between trial and plaintiff victory, *Journal of Political Economy* **103**, 229–260.
- WALDFOGEL, J. (1998), Reconciling asymmetric information and divergent expectations theories of litigation, *Journal of Law and Economics* **41**, 451–476.
- WALZER, N. (1972), Economies of scale and municipal police services: the Illinois experience, *Review of Economics and Statistics* **54**, 431–438.

Received: August 2002. Revised: December 2002.