The Optimal Size of the Criminal Court System

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Court congestion is not a recent phenomenon. It seems that throughout history courts have rarely been able to cope with their case loads; their sorry state was mocked, in different generations, by Goethe and Shakespeare, Dickens and Balzac. Yet despite the long-standing dissatisfaction with the inability of the court system to handle its cases with dispatch, there is little discussion of what the proper size of a court should be in relation to its case load.

How is court size determined? Additional judges are usually appointed when the old ones cannot cope with their case loads. When congestion seems to become intolerable, a few judgeships are added. Some jurisdictions attempt to go beyond such an ad hoc approach and have adopted systems that are called, with certain exaggeration, "scientific". Ohio, for example, allocates judgeships by population at the statutory rate of one judge per 30,000 inhabitants. Others allocate judgeships according to cases. Iowa, for example, assigns one judgeship per 450 or 550 "filings." California has refined that system and uses a "weighted" case load system that takes into account the length of a trial. For the federal court system there is no statutory rule, but an unofficial standard exists, endorsed cautiously in a Senate report. Four hundred per judge are
used as a threshold indicator of the need for additional judicial manpower within a district.

What these guidelines have in common is their lack of analytical content. They follow essentially a containment strategy: Yesterday's congestion, in retrospect bearable, is to be preserved for tomorrow. The goal is to make the judges' workload manageable by increasing judgeships. Yet there is no reason to believe that the demand for court time is independent of its supply. A speedier access to the courts will affect the litigating behavior of parties to a conflict and the conduct of the proceedings. If the experience of court expansions and managerial reforms is any guide for the future, one should not expect that the supply of court time will match or exceed the demand for it. Many courts will probably be always overburdened, which raises a fundamental problem: If there is no obvious end to congestion, how large or how small should one make the court? The real question is not whether one can succeed in preventing congestion by adding some judgeships, but what the right social investment in the court system should be. This is a problem that to the best of my knowledge has never been addressed. One reason for that omission is that it was not possible to conceptualize in an operationally useful way the benefits of changes in the courts system.

This paper is an attempt to deal with the question of the optimal size of the criminal court system. To solve the problem, a model of several equations is specified, which is used in analyzing the effects of capacity changes in the court system. The empirical results suggest that, at least in the District of Columbia, the optimal size of the court system is approximately four times its current size. Other results show that the unofficial federal guidelines require far too many additional cases for the creation of new judgeships and that the marginal benefits of an expansion of the court system are considerable.

where

\[ Z = \text{total cost} \]

\[ C = \text{revenue} \]

\[ r = \text{adjusted unrate} \]
THE BASIC MODEL

Besides its other functions, a criminal court is concerned with the enforcement of law; its operation will affect crime, either directly or indirectly. How many resources should be spent on this function? Despite society's periodic ardent for law enforcement, it seems unrealistic to expect the courts to be financed without limits, or to the point of minuscule marginal benefits. The operation of the courts is not cost free. From an economic point of view, the criminal court system should be financed up to the point where the benefits of additional resources, in terms of their reduction of crime-related losses Z, are not exceeded by their cost B. This occurs where marginal cost is equal to marginal benefits, \( dZ/dB = 1 \). At that point the sum of crime losses Z and court cost M are at a minimum. Of course, there are other benefits that can be derived from an expansion of the court; an economic analysis can only deal with the lower boundary of optimal court size.

The objective is defined as finding the court size M that fulfills the optimization requirement (1) \( dZ/dB = -1 \) subject to the following relations:

\[
\begin{align*}
Z &= f(C, r, k) \\
B &= g(M, E) \\
C &= h(\alpha, W, \beta, P) \\
W &= \phi(M, \mu, \lambda, V) \\
\lambda &= \Psi(C)
\end{align*}
\]

where

- \( Z \): total losses caused by crime
- \( B \): budget cost of court system
- \( C \): reported crime rate
- \( k \): loss caused by an average crime
- \( r \): adjustment factor for unreported crime
- \( E \): cost per judgeship

Other unreported crimes and

judicial
\[ W = \text{average sentence} \quad \mu = \text{average trial capacity per judge per year} \]
\[ \alpha = \text{other factors influencing crime} \quad \lambda = \text{case fillings per year} \]
\[ \beta = \text{elasticity coefficient of sentencing effect} \quad V = \text{average jury trial sentence} \]
\[ P = \text{population in jurisdiction} \quad M = \text{number of full-time judgeship equivalents} \]

These equations will now be described in detail. The first two are simple definitions. Let the cost to society be defined as
\[ Z = Crk \]  \hspace{1cm} (2)\]

\( C \) is the reported crime rate; because many crimes remain unreported, a factor \( r \) adjusts for the real crime rate; \( k \) is the average loss that is associated with a crime. A marginal benefit to society in terms of impact on crime can then be defined as the negative change \( dZ \); the marginal cost of crime is
\[ \frac{dZ}{dC} = rk \]  \hspace{1cm} (2')\]

Looking at the cost side of the court system, \( E \) is defined as the average cost per additional judgeship (including a pro rata share of support staff, overhead, and so on), and \( M \) is the number of full-time judgeships or their part-time equivalents. The marginal effect of an increase in the budget \( B \) on available judgeships \( M \) is then
\[ \frac{dM}{dB} = \frac{1}{E} \]  \hspace{1cm} (3)\]

The next equation, \( C = h(\alpha, W, \beta) \), refers to the relationship between the reported crime rate \( C \), sentencing severity \( W \), and other factors. There are many determinative factors that go into \( C \) and explain a given crime rate: poverty and unemployment are two examples. One can also assume that there is at
least some effect of the risk element, that is, the expected magnitude and probability of punishment for committing a crime. The concept of deterrence is controversial, but for "crimes of property" (as opposed to "crimes of passion") its existence does not appear implausible. A professional burglar, on the margin, may well reduce his activity level if its riskiness increases. To express this effect, let \( \beta \) be defined as the elasticity of the crime rate with respect to sentencing severity \( W \) so that:

\[
\frac{C}{P} = \alpha W^\beta
\]

(4)

This relationship expresses per capita crime \( C/P \) as a function of sentence severity \( W \); other factors that influence crime are included in the \( \alpha \) and are assumed to be given exogenously. The marginal effect of changes in sentencing is then

\[
\frac{dC}{dW} = \alpha \beta W^{\beta-1} P
\]

(4')

A further equation asserts a relationship between the average sentence \( W \) and the state of court congestion: \( W = (M, \mu, \lambda, V) \). It is difficult to conceptualize the impact of increased court capacity, and this problem has prevented the analysis of court size. Most criminal courts in urban areas are heavily congested, and therefore only a small fraction of all cases can be tried. The remaining cases must be disposed of either by dismissal or by inducing the defendant to plead guilty. Such a plea will be offered by a defendant in return for a reward: a promise of a reduced sentence compared with what he could expect to receive after a trial. This process, known as plea bargaining, has become by far the major form of case disposition. The average reward that is necessary to induce defendants to plead guilty can be considered the price paid by the prosecutor. This price will tend to be related to the relative
quantity of guilty pleas that is demanded, just as other prices are usually associated with some quantities. In other words, if the prosecutor needs more guilty pleas to reduce the case load, he will have to offer, on the average, better terms. It is now hypothesized, and later empirically verified, that there is a direct relation between the degree of congestion of a court system and the substantial sentence “discount” that is given for pleading guilty. The degree of congestion can be expressed as the ratio of court trial capacity \( M \mu \) and the rate of case flow \( \lambda \). The entire functional relationship can be expressed as follow:
The average effective sentence \( W \), including trial and plea bargain sentences, is related to average trial sentence \( V \) according to

\[
W = b \frac{M \mu}{\lambda} V
\]

\((5')\)

where \( b \) is a coefficient.

The existence of this relationship is confirmed in the empirical part of the paper. If it is true, then the impact of a change in court capacity on sentencing is expressed as the derivative

\[
\frac{dW}{dM} = b \frac{\mu}{\lambda} V
\]

\((5'')\)

Finally, the case flow is constant. This assumption will be relaxed shortly.

It is now possible to put all of these elements together and solve for the optimization criterion

\[
\frac{dZ}{dB} = -1.
\]

By the chain rule it is

\[
\frac{dZ}{dB} = \frac{dM}{dB} \cdot \frac{dW}{dB} \cdot \frac{dC}{dB} \cdot \frac{dZ}{dC}
\]

\((3)\)
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and, from before
\[
\frac{dM}{dB} = \frac{1}{E} \tag{1}
\]
\[
\frac{dW}{dM} = \frac{b \mu}{\lambda} \nu \tag{5''}
\]
\[
\frac{dC}{dW} = P_a \beta W^{\beta-1} = P_a \beta \left( \frac{bM \mu}{\lambda} \nu \right)^{\beta-1} \tag{4''}
\]
\[
\frac{dZ}{dC} = rk \tag{2}
\]

so that
\[
\frac{dZ}{dB} = \frac{rkP_a \beta}{E} \left( \frac{b \mu \nu}{\lambda} \right)^{\beta} M^{\beta-1} \tag{7}
\]

Solving this equation for the M that fulfills the condition
\[
\frac{dZ}{dB} = -1
\]

one obtains as the optimal M
\[
M^* = \left( \frac{-rkP_a \beta}{E} \right)^{1/1-\beta} \left( \frac{b \mu \nu}{\lambda} \right)^{\beta'/1-\beta} \tag{7}
\]

This equation expresses the optimal court size \( M^* \) when the case inflow is given.

SIMULTANEOUS EQUATIONS MODEL

The previous model assumed that the total number of criminal cases filed, \( \lambda \), is constant. This assumption will now be relaxed. The number of criminal cases can be expected to have a functional relationship to crime.
\[ \lambda = f(C) \]

This relation can be linear, such as
\[ \lambda = tC \quad (6') \]
or exponential, as in
\[ \lambda = \delta C^\gamma \quad (6'') \]

The introduction of this new element changes the model into a system of simultaneous equations; court size is a function of crime, and crime is also a function of the court size, namely,
\[ M = g(C) \]
\[ C = h(M) \]

To solve this system is again a question of finding an optimal court size so that
\[ \frac{dZ}{dB} = -1 \]

Let
\[ Z = f(C) \]
\[ B = g(M) \]
\[ C = h(W) \]
\[ W = \phi(M, \lambda) \]
\[ \lambda = \psi(C) \]

Then
\[ dZ = f'dC \quad (2*) \]
\[ dB = g'dM \quad (3*) \]
\[ dC = h'dW \quad (4*) \]
\[ dW = \phi_1 dM + \phi_2 d\lambda \quad (5*) \]
\[ d\lambda = \psi'dC \quad (6*) \]

Substituting from (6*) into (5*)
\[ dW = \phi_1 dM + \phi_2 \psi'dC \quad (8*) \]

and (4*) into (8*)
\[ dW = \phi_1 dM + \phi_2 \psi'h'dW \]
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Therefore
\[ dW = \frac{\phi_1}{1 - \phi_2 \psi' h'} \, dM \]

and, from (3*)
\[ dW = \frac{\phi'}{g'(1 - \phi_2 \psi' h')} \, dB \]  \hspace{1cm} (9*)

Similarly, from (2*), (3*), and (9*)
\[ dZ = \frac{f' h' \phi_1}{g'(1 - \phi_2 \psi' h')} \, dB \]  \hspace{1cm} (10)

Substituting the partials, one has
\[ \frac{dZ}{dB} = \frac{r k \cdot \alpha \beta P W \beta^{-1} \frac{b \mu V}{\lambda}}{E (1 - \frac{-b M \mu V}{\lambda^2} + \alpha \beta P W \beta^{-1})} = -1 \]  \hspace{1cm} (10*)

Substituting \( \lambda = t C, W = \frac{b M \mu V}{\lambda} \), and defining \( a = \frac{b \mu V}{t} \), this becomes
\[ \frac{dZ}{dB} = \frac{r k \alpha \beta P \left( \frac{a}{C} \right) M \beta^{-1}}{E (1 + \left( \frac{a}{C M} \right) \alpha \beta P)} = -1 \]

so that
\[ \frac{r k}{E} + \frac{M + M \beta^{-1} \left( \frac{b \mu V}{t C} \right)^{-\beta}}{\alpha \beta P} = 0 \]  \hspace{1cm} (10*)
The solution for equation \((10^*)\) is an expression for the optimal court size \(M^{**}\).

**EMPIRICAL RESULTS**

Results can now be obtained by finding and substituting the appropriate parameters. The following section attempts to solve equations \((7')\) and \((10^*)\) and some further relationships. The jurisdiction that is investigated is the District of Columbia; the crimes considered are five of the seven FBI index crimes. (Murder and forcible rape are omitted because of their special nature and because of their small number relative to total crime; they do not lend themselves to an elasticity-based analysis. Court capacity for these cases must be based on different considerations.)

The parameter \(r\) is the adjustment factors for unreported crime. The share of unreported crime in Washington was estimated from a recent victimization survey of 9,541 households, 18,353 residents, and 1,528 businesses.\(^6\) The weighted average of actual index crime as a proportion of reported index crime is \(r = 1.87\).

\(k\) is the direct economic loss to society caused by an average felony. Its estimation presents some conceptual and practical problems. The figures used are those found by a presidential commission.\(^7\) The weighted average for the five index crimes, in terms of 1978 dollars, is \(k = \$331\).

\(E\), the cost of a judgeship, was calculated by the Administrative Office of U.S. Courts as \(E = \$196,000.\(^8\)

\(\beta\), the determinants of the crime rates, are from an estimation by I. Ehrlich.\(^9\) The weighted average elasticity is \(\beta = -.65\), and \(\sigma = .83366\).

From census figures, \(P = 763956\).

\(t\), the ration of cases \(\lambda\) to the crime rate \(C\), has been, on the average during the past five years, \(t = .067.\(^10\)

\(\lambda\), the felony case inflow, is for 1976 \(\lambda = 3737.\(^11\)


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\( \mu \) is the average trial capacity per judge per year. The average number of trials per judge for the federal court system was forty-seven in 1972.\(^\text{12}\) Because this figure includes civil cases, proper consideration of the respective time averages\(^\text{13}\) results in an estimated criminal trial capacity of \( \mu = 59 \) per judgeship per year.

The existence of the relationship

\[
\frac{W}{V} = \frac{bM\mu}{\lambda}
\]  \( (5') \)

was confirmed by estimating a regression across federal district courts with a heavy criminal case load.\(^\text{14}\) The equation used was

\[
\frac{W}{V} = b \frac{M\mu}{\lambda} + aS.\(^\text{15}\)
\]

Values for \( W \) (average sentence for trial and guilty plea disposition) and for \( V \) (average sentence for trial disposition) were obtained from data of the Administrative Office of the United States Courts.\(^\text{16}\) These records contain all federal criminal cases for the year 1973. Data for the court case load and trial capacity are also from the Administrative Office of the United States Courts.\(^\text{17}\) Details of the estimation are described in a different paper.\(^\text{18}\)

The results show the strong explanatory power of the hypothesis with \( R^2 = .9824 \); the coefficient that is found is \( b = 2.15 \) at a significance level of 95 percent.

The remaining parameters are as follows:

The reported index felony crime rate for the District of Columbia in 1975 was \( C = 55,158.\(^\text{19}\) The weighted average trial sentence \( V \) for the available years 1967–1971 is \( V = 81.2.\(^\text{20}\)

After determining these parameters, we can calculate the optimal court size. Substituting, we find as results for

\[
M^* = \left( \frac{r_k \alpha \beta P}{E} \right)^{1/1-\beta} \left( \frac{b \mu V}{\lambda} \right)^{\beta/1-\beta} \]  \( (7) \)
the optimal court size as $M^* = 51.83$.

When allowance is made for the impact of the changing crime rate on the case load, we have, from equation \(10''\)

$$\frac{r \delta}{E} + \frac{M - b}{c} + \frac{M^{1-\beta} \left( \frac{b \mu \nu}{1-c} \right)^{-\beta}}{\alpha \beta P} = 0 \quad \text{(10'')}$$

and the optimal court size is $M^{**} = 61.2$.

It is interesting to contrast these results with the actual number of criminal judgeships. In 1976 a total of forty-four trial level judgeships existed in Washington\(^{21}\) to handle criminal as well as civil, family, juvenile, small claims, and other cases. It is not easy, in the absence of better data, to identify the fraction of time attributable to criminal cases. Forty percent of all cases in the court system were criminal.\(^{22}\)

Assuming generously that trials are allocated in a similar proportion and considering that civil cases take, on the average, somewhat longer,\(^{23}\) criminal case capacity is comprised of roughly the equivalent of $M = 15.6$ full-time judgeships.

As can be seen, the calculated optimal size of the court is about three times as large as the actual size. This result suggests that a serious underinvestment in the court system exists.

**FURTHER FINDINGS**

The suboptimal capacity of the criminal courts can also be observed by looking at the marginal benefit of investment in the present court. Since

$$\frac{dZ}{dB} = \frac{r \delta P \alpha \beta}{E} \left( \frac{b \mu \nu}{\lambda} \right)^\beta M^{(\beta - 1)}$$

the benefit of the marginal dollar spent is

$$\frac{dZ}{dB} = 9.06$$
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This is a very high-return of nine dollars of benefits for one dollar of investment in the criminal court system.

It is also interesting to express the optimal numbers of judgeships as a function of the crime rate, so that, for example, court needs can be anticipated from a projected crime rate. From equations (7') and (6')

\[ M^* = f(C) = \left[ -\frac{rkp\alpha\beta}{E} \right]^{1/1-\beta} \left[ \frac{b\mu V}{t} \right]^{\beta/1-\beta} C^{-\beta/1-\beta} \]

which solves fairly exactly into the simple relationship

\[ M^* = .7C^{1.4} \]

The marginal requirement for judgeships is \( \frac{\partial M^*}{\partial \mu} = .286^{1.4} \). For the present crime rate \( C \) this becomes \( \frac{\partial M^*}{\partial \mu} = .0004 \), or one additional full-time criminal judge for an increase of 4.5 percent in crime rate.

Other interesting results can be found by differentiating optimal court size \( M^* \) with respect to other variables. For example, if the “efficiency” of judges increases, the optimal court capacity will change according to

\[ \frac{\partial M^*}{\partial \mu} = \left( -\frac{rkp\alpha\beta}{E} \right)^{1/1-\beta} \left( \frac{b\mu V}{\lambda} \right)^{\beta/1-\beta} \left( \frac{2\beta-1}{1-\beta} \right) = .3816 \]

Therefore, an increase of one case per year per criminal trial judgeship equivalent will reduce required optimal resources by nearly \$75,000.

If the cost per judgeship increases, optimal court capacity is reduced according to

\[ \frac{\partial M^*}{\partial E} = \left( -\frac{b\mu V}{\lambda} \right)^{\beta/1-\beta} \left( \frac{rkp\alpha\beta}{E} \right)^{1/1-\beta} \left( \frac{-1}{1-\beta} \right) E \left( \frac{\beta-2}{\beta-1} \right) \approx .00038 \]

Finally, an increase in the case load should lead to a change of the court size according to
\[
\frac{\partial M^*}{\partial \lambda} = \left(\frac{-rkP_0\beta}{E}\right)^{1/1-\beta} \left(b_\mu\nu\right)^{\beta/1-\beta} \left(1-\frac{\beta}{1-\beta}\right) \lambda^{\frac{\beta}{1-\beta}} = .006.
\]

This results in one additional judgeship for each 164 additional criminal cases, a figure that may be contrasted with the much higher current unofficial standard of 400 cases per new judgeship in the federal court system.²⁴

**SUMMARY**

This paper is an attempt to determine the resource requirements of the court system. In contrast to the usual *ad hoc* approach of calculating the required number of judgeships on the basis of current court overload, this analysis tries to find an optimal level of the social investment in the court system. A seven-equation model is defined. It traces the effect of additional court capacity and permits a new way of analyzing costs and benefits in the courts. Optimal court size can then be expressed as a function of several factors, such as the crime rate, the case load, the cost of a judgeship and its capacity to try cases, economic losses caused by crime; the effects of sentences, and so on. These equations can be applied to analyze the resource needs of most jurisdictions.

The empirical part of the paper concentrates on the District of Columbia. Optimal criminal court capacity is found to be about three times its present size. For the relationship of optimal court size to the crime rate, the result is given by the simple relation \( M = .7C^{-1/4} \). The model suggests that there should be an additional criminal judgeship for every 164 additional cases per year, as contrasted with the present unofficial guideline of 400 in the federal system. The need for additional judgeships is also suggested by the high marginal benefits that are found in the courts. An additional dollar spent of expanding the criminal court results in at least nine dollars worth of crime reduction—a cost-benefit ratio that is
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impressive in an absolute sense and considerably higher than the one usually found for the police.

The benefits of the criminal court that were investigated were those associated with crime reduction. There are other benefits to be gained from court expansion, for example, improvements in the speed and quality of the disposition of justice.

Thus the magnitudes found in this paper represent only a lower boundary. Where values beyond efficiency are considered, the optimal size of the court will be even larger.

NOTES

1. Special thanks go to James E. McCafferty of the Administrative Office of U. S. Courts. Advice by Martin Feldstein and research assistance by Scott Alvarez are gratefully acknowledged. All responsibility remains with the author.


5. U. S. Senate, Committee on the Judiciary, Report 95-117, Omnibus Judgeship Bill, 95th Congress, 1st Session, March 28, 1977, p. 10. The Committee was helped by a sophisticated forecast of cases for each district. See Battelle Pacific Northwest Laboratories, District Court Case Load Forecasting, October 1975: Executive Summary Federal Judicial Center 75-7, and four volumes.


7. President's Commission on Law Enforcement and the Administration of Justice. Assessment Task Force Report, p. 42. Values for aggravated assault were extrapolated using the Wolfgang-Sellin Index.


14. Defined as those courts with 300 or more criminal trials per year; the Middle District of Florida was omitted because of problems with its data.
15. S is a dummy variable for southern courts, because of regional variation.
16. Administrative Office of U.S. Courts, James A. McCafferty, Chief, Statistical Analysis and Reports Branch. Part of the computation of the data was done at the Criminal Justice Research Center in Albany.
19. District of Columbia, Criminal Division, Clerk's Office, communication.
22. Ibid., p. 45.

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