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Estimates of the Deterrent Effect of Capital Punishment: The Importance of the Researcher's Prior Beliefs

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Introduction

Researchers from different social sciences approach the issue of the deterrent effects of capital and noncapital punishments with conflicting prior beliefs. Some believe that punishments deter and that social and economic variables have little or no influence on the murder rate. Others believe that punishments have little or no impact and that variations in the murder rate between states (or over time) can be explained largely by variations in economic and social conditions. Others hold somewhat different views. If controlled experiments could be designed to test the competing hypotheses, researchers could assess their validity. However, since research in the effectiveness of punishments in reducing the murder rate must be carried out in a nonexperimental setting, there is much uncertainty as to the "correct" empirical model that should be used to draw inferences, and each researcher typically tries dozens, perhaps hundreds, of specifications before selecting one or a few to report. Usually, and understandably, the ones selected for publication are those that make the strongest case for the researcher's prior hypothesis. Because of this,

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research results are greatly discounted and even ignored by professional readers, who are painfully aware, from personal experience, of the great amount of searching for a suitable specification that goes on behind the scene.

In this study I use a Bayesian econometric technology, due to Leamer (1978), to pool several possible alternative prior beliefs concerning the determinants of the murder rate with cross-state data from 1950. The approach is Bayesian in that the researcher's prior beliefs about which variables belong in an equation explaining the murder rate are pooled with the data evidence and the results are summarized by the posterior distribution. In principle, this allows researchers with contrasting prior information or beliefs to reach a mutually accepted conclusion, if the data are sufficiently strong. Conflicting prior beliefs need not lead to conflicting inferences, though they might.

Statistical Background

This section gives a brief description of the econometric procedure I use in this study. For more detailed treatments see Leamer (1978). The idea behind the procedure is that a Bayesian researcher with prior information about some of the parameters in a linear regression model will be led to summarize the evidence by considering a range of constrained least-squares estimates, depending on how he is willing to specify his prior information. The benefit of the Bayesian approach is that prior information, which is implicitly used in any interpretation of data evidence built on constrained estimates, is used explicitly.

Suppose a researcher interested in estimating the effects of different factors on the murder rate has identified two sets of (potential) explanatory variables, one set which he is fairly certain belongs in the regression, and a second set of doubtful variables. The orthodox practice is to run regressions with every possible combination of doubtful variables. Such a practice has much to recommend it, if it is used honestly and wisely. Leamer (1978) and Mayer (1980) suggest this practice if extreme estimates of parameters of interest are reported. Most often, however, a researcher will report only his "best" regression, from the point of view of confirming his hypothesis. At the very least, he ought to report his "worst" estimate as well. The benefit of Leamer's procedure is that reporting of extreme estimates is simpler and more concise.

The alternative technology proceeds by forcing the researcher to specify his prior beliefs in such a way that they can be explicitly pooled with the data. First, he needs to specify a set of doubtful variables, the associated parameters of which are thought to be small relative to

their standard errors. In the context of a linear regression, the coefficients on the doubtful variables are thought to be small. The researcher is willing to control for these variables, in a nonexperimental setting, in any one of a number of ways. This limits the estimated coefficients to lie on what Leamer calls the feasible ellipse, obtained by considering all possible linear constraints on the coefficients of the doubtful variables.

Second, the researcher may pick a measure of doubtfulness—that is, of how far the estimates of the doubtful parameters stray from zero. For example, he may measure doubtfulness for a set of parameters as the sum of their squared deviations from the origin. This limits posterior estimates to what Leamer calls the information contract curve. Finally, he can pick a unique prior standard error or a range of prior standard errors. This specifies how strongly he holds his prior beliefs about the smallness of the doubtful parameters and limits the posterior estimates to portions of the information contract curve.

Quite often the extreme estimates over the feasible ellipse are highly unlikely from the point of view of the data. To prevent dogmatic priors from having an undue influence on inferences, the researcher can report extreme estimates from the feasible ellipse that are also constrained to lie within some (arbitrary) data confidence region. In the empirical application I present here, only the first form of prior information, identification of a set of doubtful variables, is used. This is supplemented with extremes constrained to lie within the 90 percent data confidence region.

Empirical Application

Data

I use aggregate data from 44 states in 1950 to estimate the effects of economic, social, and deterrence variables on the murder rate.[1] The murder rate is the FBI estimate of the number of murders per 100,000 residents. Independent economic variables are the median income of families (in 1949), the fraction of families (in 1949) with income of less than one-half of the median income (a measure of income dispersion), the state unemployment rate, and the labor force participation rate. Independent social variables are the fraction of the state population nonwhite, the fraction of the population ages 15–24 years, the fraction urban, the fraction male, the fraction of families with husband and wife both present, and a dichotomous indicator for southern states.

[1] Data are available from the author on request.

Deterrence variables are the focus of this study. Length of sentence for murder is the median time served in months by prisoners convicted of murder who were released in 1951. The probability of conviction for murder is estimated by the ratio of the number of convictions for murder in 1950 to the estimated number of murders in the state (the FBI estimate of murders per 100,000 times the population in 100,000s). The conditional probability of execution given conviction is estimated by the average number of executions 1946–50 divided by convictions.

Of the 44 states in the sample, 35 carried out at least one execution between 1946 and 1950; the other nine states did not execute in this time period. A dichotomous variable to indicate an executing state was also included in the analysis.

Alternative Prior Beliefs

To demonstrate how Bayesian statistical techniques can be used to address the deterrence question, I propose five priors of representative researchers that I pool with the data. A longer list could clearly be used, but I think these five are sufficient to give the flavor of the Bayesian approach. A shorter list also has merit, but one of the strengths of the Bayesian techniques I use is the ability to handle numerous alternative priors in a unified framework. I have given each of the priors a short name simply for ease of exposition, not to suggest value judgments.

1. The right-winger: This researcher believes that the deterrence variables belong in the murder rate equation and that the economic and social variables are doubtful. The economic and social variables may be influential, but the right-winger is willing to control for them in any one of a number of ways.

2. The rational maximizer: This researcher has an economist's view of crime. He believes that punishments affect the murder rate through their influence on individual murder "supply" and, to the extent that murders are associated with property crimes, that the economic variables will affect the murder rate through that channel.

3. Eye for an eye: A researcher with this prior treats length of sentence as doubtful along with economic and social variables. He holds that only the probability of receiving capital punishment can deter murderers.

4. The bleeding heart: Deterrence variables and social variables are doubtful. If the economic conditions of individuals with a current high propensity to commit murder were improved, then the social variables would not matter. In addition, the bleeding heart believes that punishments are ineffective in deterring murders.

5. Crime of passion: This researcher considers murders as largely

TABLE 1

TREATMENT OF VARIABLES BY DIFFERENT PRIORS

Prior	Deterrence Variables	Economic Variables	Social Variables
Right-winger	Important	Doubtful	Doubtful
Rational maximizer	Important	Doubtful	Doubtful
Eye for an eye	*	Doubtful	Doubtful
Bleeding heart	Doubtful	Important	Doubtful
Crime of passion	Doubtful	Important	Important

NOTE.—Deterrence variables: probability of conviction, probability of execution (given conviction), and months of prison sentence. Economic variables: median family income, fraction of families with less than half the median income, unemployment rate, and labor force participation rate. Social variables: fraction nonwhite, fraction ages 15–24 years, fraction urban, fraction male, fraction of husband and wife both present in families, southern state indicator.

*The eye-for-an-eye prior treats the probability of conviction and the probability of execution as important variables and the length of sentence as a doubtful variable.

acts of passion, not as the result of rational calculation of costs and benefits. He thinks that the coefficients of the so-called deterrence variables are thus likely to be small and insignificant. On the other hand, the economic and social variables are likely to be influential, since they are proxies for the propensity to violent outbursts that could result in murder.

Table 1 presents a summary of the treatment of variables by researchers with the several priors. This list of potential priors is by no means exhaustive, but there are enough different viewpoints represented to give the flavor of the Bayesian analysis.[2]

A serious problem I faced in specifying the priors was how to treat the dichotomous variable identifying executing states from the nonexecuting states. Ehrlich (1977) argued that this variable ought to be included to prevent a specification bias associated with its omission. This assumes that the variable belongs in the "true" equation, but specification bias can result from inclusion of an inappropriate variable as well as from exclusion of an appropriate variable. Thus, I have pooled each prior with the data two ways: first with the indicator on the included list, and second with the indicator on the doubtful list.

Pooling Data and Priors

The data information is summarized by an unconstrained regression of the murder rate on all of the deterrence, economic, and social

[2] Some of the priors selected will always have more extreme estimates than others, because they are nested. For example, the right-winger and bleeding heart will both have more extreme estimates than the rational maximizer, since they differ from the rational maximizer only in that they both treat more variables as doubtful. A prior nested in another will suggest a wider range of potentially acceptable models and thus wider extreme estimates of parameters of interest.

TABLE 2

EXTREME ESTIMATES OVER THE FEASIBLE ELLIPSE AND WITHIN THE 90 PERCENT DATA CONFIDENCE REGION INCLUDING EXECUTING STATE INDICATOR IN ALL SPECIFICATIONS CONSIDERED

	EFFECT OF VARIABLE ON NUMBER OF MURDERS		
ALTERNATIVE PRIOR BELIEFS	Convictions	Executions	Sentence Length
Right-winger:			
Maximum estimate	−.22	−1.16	−.16
Minimum estimate	−2.50	−22.56	−1.45
Difference	2.28	21.40	1.29
Rational maximizer:			
Maximum estimate	−.72	−10.24	−.38
Minimum estimate	−1.35	−15.91	−.86
Difference	.63	5.67	.48
Eye for an eye:			
Maximum estimate	.22	−.35	.88
Minimum estimate	−2.57	−26.20	−1.55
Difference	2.79	25.85	2.43
Bleeding heart:			
Maximum estimate	1.06	12.37	.51
Minimum estimate	−2.20	−25.59	−.95
Difference	3.26	37.96	1.46
Crime of passion:			
Maximum estimate	.35	4.10	.19
Minimum estimate	−1.49	−17.32	−.63
Difference	1.84	21.42	.82
Data estimate	−1.14	−13.22	−.44
(SE)	(.62)	(7.20)	(.28)

variables. The least-squares estimates of the deterrent effects of capital and noncapital punishment are reported in table 2 as the number of murders prevented for each execution, conviction, or added month of prison sentence.[3] The estimated deterrent effects are that: for each additional conviction for murder, 1.14 murders are prevented, with a standard error of 0.62; for each additional execution, 13.22 murders are prevented, with a standard error of 7.20; and for each month added to the median prison sentence for murder, 0.44 murders are prevented, with a standard error of 0.28.

Table 2 gives the extreme estimates, within the 90 percent data confidence region, of the effects of deterrence variables on the number of murders for the five priors. The executing state indicator was included as an important variable in all possible specifications. The numbers reported are the effect of the variable in question on the

[3] The equation was estimated in a different form, but the transformation allows me to ask, How many murders will be prevented for each execution (conviction, added month of sentence)?

number of murders, so that negative numbers are murders prevented and positive numbers are murders encouraged. Under each prior the extreme estimates of each effect are reported, followed by the absolute difference between the maximum and minimum estimates. The absolute difference between the extremes can be thought of as the specification uncertainty regarding the parameter, to be compared to the sampling uncertainty.

Consider the effect of an extra execution on the number of murders. Table 2 indicates that the choice of prior is important, because the specification uncertainty is great for some priors, and because different priors yield widely different estimates. The right-winger, rational-maximizer, and eye-for-an-eye priors bound the effect of an execution away from zero. The bleeding-heart and crime-of-passion priors, in contrast, do not bound the effect of an additional execution from zero.

The largest estimated deterrent effect of executions, -26.20, is under the eye-for-an-eye prior, which seems sensible since this prior holds that only executions and convictions affect the murder rate. The largest positive effect of executions on murders (which might be called an encouragement effect rather than a deterrent effect) is 12.37 under the bleeding-heart prior. However, the bleeding-heart prior has a minimum estimated effect of -25.59, or a deterrent effect almost as large as the largest under the eye-for-an-eye prior.

Looking at the various extreme estimates in table 2, I conclude that significant conflicts remain over the estimated deterrent effect of an additional execution, even after the researchers have confronted the same data. The conflicting interpretations of the data evidence are serious. The right-winger, rational-maximizer, and eye-for-an-eye researchers will conclude that zero or positive effects of executions are impossible, while researchers with the other two priors will conclude that zero, positive, or negative effects are all possible. Another conflict exists between the eye-for-an-eye and the bleeding-heart priors since they lead to the most extreme estimates of all the priors. Choice of prior is clearly important, but the data do not give strong direction in selecting a prior.

Conflicts over the interpretation of the data evidence do not stop with the effect of executions. Similar conflicts involve the effects of convictions and months of sentence. In table 2, the right-winger and rational-maximizer priors bound both effects away from zero, but the other priors do not. The choice of prior is important for these effects as well as for the effects of executions, but the data do not help in the choice of prior.

Table 3 repeats the exercise of table 2, with the exception that the executing state indicator is treated as a doubtful variable by each

TABLE 3

EXTREME ESTIMATES OVER THE FEASIBLE ELLIPSE AND WITHIN THE 90 PERCENT DATA CONFIDENCE REGION TREATING EXECUTING STATE INDICATOR AS A DOUBTFUL VARIABLE FOR EACH PRIOR

	EFFECT OF VARIABLE ON NUMBER OF MURDERS		
ALTERNATIVE PRIOR BELIEFS	Convictions	Executions	Sentence Length
Right-winger:			
Maximum estimate	−.14	7.84	−.06
Minimum estimate	−2.63	−23.40	−1.53
Difference	2.49	31.24	1.47
Rational maximizer:			
Maximum estimate	−.53	4.66	−.21
Minimum estimate	−1.73	−15.90	−1.11
Difference	1.20	20.56	.90
Eye for an eye:			
Maximum estimate	.23	7.87	.89
Minimum estimate	−2.65	−29.10	−1.60
Difference	2.88	36.97	2.49
Bleeding heart:			
Maximum estimate	1.53	17.80	.72
Minimum estimate	−2.70	−31.40	−1.17
Difference	4.23	49.20	1.89
Crime of passion:			
Maximum estimate	.56	6.54	.28
Minimum estimate	−1.70	−19.77	−.72
Difference	2.26	26.31	1.00
Data estimate	−1.14	−13.22	−.44
(SE)	(.62)	(7.20)	(.28)

prior. The differences between tables 2 and 3 are startling. If the executing indicator is a doubtful variable, then none of the priors can bound the deterrent effect of executions from zero. The largest estimated deterrent effect in table 3 is under the bleeding-heart prior (−31.4), though the eye-for-an-eye prior is not far behind (−29.1). The greatest encouragement effect is under the bleeding-heart prior (17.8). The minimum (negative) estimates in table 3 are not significantly different from the minimum estimates in table 2, but all the maximum estimates are seriously affected. Specification of prior beliefs concerning the executing indicator is very important, especially for the priors that could bound the deterrent effect away from zero with the indicator treated as an important variable.

In table 3 the bounds for the effects of convictions and months of prison sentence are not significantly different from those in table 2. The main effect of treating the executing state indicator as doubtful is to increase greatly the uncertainty about the deterrent effect of executions.

In the single-equation context of this study, the interpretation of

the executing state indicator relates to the functional form of the effect of the probability of execution on the murder rate. The question is whether the probability of execution has a linear effect on the murder rate or a more complex functional form. The states that do not execute in the sample have a lower murder rate than the executing states (1.9 vs. 6.2), so they are outliers in both the murder rate and the probability of execution. If there is uncertainty regarding the functional form, then outliers produce the familiar "dumbbell" regression problem where little can be inferred about signs and magnitudes of coefficients.

Conclusions

Several alternative prior beliefs that different researchers might approach the deterrence issue with were pooled with data for states in 1950. The paper demonstrates how Bayesian statistical methods can be used to shed light on the importance of researchers' prior beliefs in empirical work. The data analyzed are not sufficiently strong to lead researchers with different prior beliefs to reach a consensus regarding the deterrent effect of capital punishment. Right-winger, rational-maximizer, and eye-for-an-eye researchers will infer that punishment deters would-be murderers, but bleeding-heart and crime-of-passion researchers will infer that there is no significant deterrent effect.

If researchers treat the executing indicator as a doubtful variable, then they will all infer that there is not a significant deterrent effect of capital punishment. The importance of this indicator in drawing inferences suggests that the single-equation framework used here, and in many other studies of the determinants of the murder rate, may be inadequate for resolving the issue.

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