ESTIMATING DETERRENCE: REGION-LEVEL DATA, DIFF-IN-DIFF

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Review and context

In previous lectures:

1. What is economics of crime? Crime as a “bad”.
2. Becker’s model.
    1. Supply of offenses by offenders
    2. Setting ***p*** *(certainty)*, ***f*** *(severity)* to “order” level of crime, based on cost of enforcement and punishment
3. Econometrics issues

Why deterrence?

People commit crimes (nonsocial behavior). Why?

1. Offender has unique motivation, history, psychology, social conditions are explaining it.
2. Or **law violators systematically differ** (illegal activity specialization), but they **respond to incentives** (prices), that we can change.

Why deterrence?

Specific deterrence – will not commit crime after punishment

General deterrence – not yet offender, prevented for committing crime

but **Incapacitation!** – even if no deterrence, people are prevented to commit further crimes (can lead to recidivism in turn)

Marginal deterrence – punish severe crime more then lesser crime, and series of crimes more then one crime of the same kind (criminal should never benefit by committing more crimes)

Data problems and data sources

- Police
  - inherent measurement errors of reporting, stable over time?
- Changes of what is crime in time, legal definitions, statistical definition
- Victimization surveys
- Aggregate statistics

Early literature (till the mid 1990's)

- Region (country, state, county) level data
- Time-series or cross-section
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- Model of individual choice, extension of Becker's model
  - Safe legal activity, risky and illegal activity – people are mixing the two to maximize expected utility
  - Crime against persons are non-market activity, maybe lesser response to outside incentives?
  - Individual supply of offenses translated to aggregate supply of offenses by aggregation (all agents are the same)
- Analysis of aggregate crime variations

$\left(\frac{Q}{N}\right)_i, \left(\frac{Q_i}{N}\right)_{t-1}$ = current and 1-year lagged crime rate: the number of offenses known per capita

$\left(\frac{C}{Q}\right)_i = P_i$ = estimator of probability of apprehension and imprisonment: the number of offenders imprisoned per offenses known

T_i = average time served by offenders in state prisons

W = median income of families

X = percentage of families below one-half of median income

NW = percentage of nonwhites in the population

A_{14-24} = percentage of all males in the age group 14–24

U_{14-24}, U_{35-39} = unemployment rate of civilian urban males ages 14–24 and 35–39

L_{14-24} = labor-force participation rate for civilian urban males ages 14–24

Ed = mean number of years of schooling of population 25 years old and over

$SMSA$ = percentage of population in standard metropolitan statistical areas

$\frac{E}{N}, \left(\frac{E}{N}\right)_{t-1}$ = per capita expenditure on police in fiscal 1960, 1959

M = number of males per 100 females

D = dummy variable distinguishing northern from southern states (south = 1)

$$\ln\left(\frac{Q}{N}\right)_i = a + b_{1i}\ln P_i + b_{2i}\ln T_i + c_{1i}\ln W + c_{2i}\ln X + e_{1i}\ln NW + \mu_i,^{38}$$

$$\ln P_i = a_0 + a_{1i}\ln T_i + a_{2i}\ln\left(\frac{E}{N}\right)_{t-1} + a_{3i}\ln\left(\frac{Q_i}{N}\right)_{t-1} + a_{4i}\ln W + a_{5i}\ln X + a_{6i}\ln U_{35-39} + a_{7i}\ln NW + a_{8i}\ln A_{14-24} + a_{9i}\ln \text{SMSA} + a_{10i}\ln M + a_{11i}\ln N + a_{12i}D + a_{13i}\ln Ed + u_i.^{42}$$

Log-Log Regression $ln(y) = \beta_0 + \beta_1 \cdot ln(x) + \epsilon$	$ln(y)$	$ln(x)$	%Δy=β1%Δx "if we change x by one percent, we'd expect y to change by β1 percent" Note, you cannot include obs. for which x<=0 if x is logged. You either can't calculate the regression coefficients, or may introduce bias.

TABLE 3

OLS (WEIGHTED) REGRESSION ESTIMATES OF COEFFICIENTS ASSOCIATED WITH SELECTED VARIABLES IN 1960, 1950, AND 1940: CRIMES AGAINST PROPERTY (DEPENDENT VARIABLES ARE SPECIFIC CRIME RATES)

OFFENSE AND YEAR	ESTIMATED COEFFICIENTS ASSOCIATED WITH SELECTED VARIABLES						ADJ. R^2
	a Intercept	b_1 with $\ln P_i$	b_2 with $\ln T_i$	c_1 with $\ln W$	c_2 with $\ln X$	e_1 with $\ln NW$	
Robbery:							
1960**	−20.1910	−0.8534	−0.2233*	2.9086	1.8409	0.3764	.8014
1950**	−10.2794	−0.9389	−0.5610	1.7278	0.4798	0.3282	.7839
1940	−10.2943	−0.9473	−0.1912*	1.6608	0.7222	0.3408	.8219
Burglary:							
1960**	−5.5700*	−0.5339	−0.9001	1.7973	2.0452	0.2269	.6713
1950	−1.0519*	−0.4102	−0.4689	1.1891	1.8697	0.1358	.4933
1940	−0.6531*	−0.4607	−0.2698	0.8327*	1.6939	0.1147	.3963
Larceny:							
1960	−14.9431	−0.1331	−0.2630	2.6893	1.6207	0.1315	.5222
1950	−4.2857*	−0.3477	−0.4301	1.9784	3.3134	−0.0342*	.5819
1940	−10.6198	−0.4131	−0.1680*	0.6186	3.7371	0.0499*	.6953
Auto theft:							
1960	−17.3057	−0.2474	−0.1743*	2.8931	1.8981	0.1152	.6948

the crime rate, Q/N, with respect to current expenditure, E/N, is $e = (b_1\beta_1)/(1 - b_1\beta_2)$. In terms of our 2SLS estimates of b_1, β_1, and β_2, e is, then, estimated at -3.04: a 1 percent increase in expenditure on direct law enforcement would result in about a 3 percent decrease in all felony offenses. However, the standard error of this estimate calculated through a

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  - Ehrlich, I. (1977). Capital punishment and deterrence: Some further thoughts and additional evidence. *Journal of Political Economy*, *85*(4), 741-788.

FBI statistics on murder and other felonies are available in 1940 and 1950 only as crime rates in samples of urban areas covering, on average, 49 percent of the states' residential population in 1940 and 45 percent in 1950 (see U.S. Department of Justice, *Uniform Crime Reports*, 1940, 1950–51, 1960, 1970). Crime statistics are based on complaints of crime,

LIST OF VARIABLES USED IN THE REGRESSION ANALYSIS

q_i^o = urban crime rate (per 100,000 population) for offense category i, based on *UCR* samples;

h^o = homicide rate (per 100,000 population), based on *VS* data;

$P^oc_i = \frac{C_i^o}{Q_i^o}$ = estimate of probability of conviction: the ratio of prisoners received in state prisons to the estimated (state) total numbers of offenses in category i;

$P^hc = \frac{C^o}{H^o}$ = corresponding estimate of probability of conviction for murder using *VS* data on the number of homicides in a state;

T_i† = median time spent in state prisons by offenders prior to first release;

$PX5 = \frac{\sum_{j=0}^{4} E_{t-j}^o/5}{C_t^o}$ = the ratio of the average number of executions in years t to $t-j$ to the estimated number of convictions for murder in sample year t;

$PX4 = \frac{\sum_{j=0}^{3} E_{t-j}^o/4}{C_t}$ $\quad PXQ1 = \frac{E_{t+1}^o}{C_t^o}$ $\quad PXQ2 = \frac{E_t^o}{C_t^o}$ $\quad PXA = \frac{E_{t+1}^o + E_t^o/2}{C_t}$

$PXQ1Q - PX5Q$‡ = same as the preceding ratios but with E_t^o defined to include only executions for murders;

TABLE 5

HOMICIDE SUPPLY FUNCTIONS: 1940 AND 1950, GLS REGRESSIONS

Constant	T	P^h_c	$P^o_{e\|c}$	NW	X	W	AGE	URB	EPOS
ve executions:*									
			$\overline{PX4Q}$						
9.036	−0.226	−0.562	−0.341	0.432	...	0.262	−2.446	−0.877	...
(2.42)	(−2.07)	(−4.26)	(−3.54)	(6.73)	...	(0.82)	(−2.69)	(−4.56)	...
			$\overline{PX5Q}$						
−2.106	−0.271	−0.253	−0.196	0.401	1.617	0.827	0.098	−0.284	...
(−0.71)	(−2.15)	(−1.45)	(−3.21)	(6.68)	(2.92)	(2.14)	(0.20)	(−0.85)	...
			$\overline{PX4Q}$						
−326.5	−0.276	−0.551	−0.333	0.467	...	0.483	−2.098	−0.818	333.0
(−3.45)	(−2.73)	(−4.60)	(−3.56)	(8.51)	...	(1.59)	(−2.37)	(−4.41)	(3.57)
			$\overline{PX5Q}$						
−194.8	−0.154	−0.211	−0.194	0.335	1.982	0.348	0.303	0.236	194.0
(−2.95)	(−1.36)	(−1.52)	(−2.94)	(5.38)	(3.51)	(0.86)	(0.59)	(0.82)	(2.94)

series. Findings indicate a substantial deterrent effect of punishment on murder and related violent crimes and support the economic and econometric models used in investigations of other crimes. Distinctions between classes of executing and nonexecuting states are also examined in light of theory and evidence.

Hopefully, the main contribution of this research lies in the suggestion that the basic economic and econometric frameworks used by economists to explain behavior in the marketplace can also be applied in explaining criminal and perhaps some other behavior traditionally labeled as "deviant." The regularities uncovered in connection with movements in crime rates and law enforcement activities pose a challenge for future research. The economic approach might prove useful in analyzing recidivism by offenders, the impact of legitimate employment and training opportunities, apparent racial and sex differences in participation in specific crimes, international variations in crime rates, and public and private protection against crime. As to the policy implications emanating

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- Some improvement: panel data and fixed effects
  - Cornwell, C., & Trumbull, W. N. (1994). Estimating the economic model of crime with panel data. *The Review of economics and Statistics*, 360-366.

Abstract—Previous attempts at estimating the economic model of crime with aggregate data relied heavily on cross-section econometric techniques, and therefore do not control for unobserved heterogeneity. This is even true of studies which estimated simultaneous equations models. Using a new panel dataset of North Carolina counties, we exploit both single and simultaneous equations panel data estimators to address two sources of endogeneity: unobserved heterogeneity and conventional simultaneity. Our results suggest that both labor market and criminal justice strategies are important in deterring crime, but that the effectiveness of law enforcement incentives has been greatly overstated.

Our deterrent effects estimates are obtained from a new *panel* dataset in which the unit of observation is the county. Since our data are county level, we are able to achieve a relatively low level of aggregation. The

vas based, and the estimated elasticities of the proba-
bility of arrest (P_A), the probability of conviction (usu-
ally conditional on arrest) (P_C), the probability of im-
prisonment (usually conditional on conviction) (P_P),
and the severity of punishment (S). About one-half of

TABLE 1.—SUMMARY OF PREVIOUS CROSS-SECTION RESULTS

Study (Data)	Estimation Procedure	Crime Type	P_A	P_C	P_P	S
Ehrlich (1973)	OLS	All, 1960			−0.526[a]	−0.585[a]
(U.S. states)	2SLS				−0.991[a]	−1.123[a]
Sjoquist (1973)	OLS	Robbery,	−0.342[a]			−0.212
(U.S. cities)		Burglary & Larceny				
Carr-Hill &	2SLS	All, 1961	−0.66[a]			−0.28[a]
Stern (1973)		All, 1966	−0.59[a]			−0.17[a]
(U.K. police districts)						
Orsagh (1973)	OLS	Felonies		−0.26[a]		
(CA counties)	2SLS			−1.8[a]		
Phillips &	OLS	Felonies	−0.622[a]			−0.347[a]
Votey (1975)	2SLS/3 eq		−0.610[a]			−0.342[a]
(CA counties)	2SLS/4 eq		−0.701[a]			−0.376[a]
Mathieson &	OLS	Robbery	−1.06[a]			
Passell (1976)		Murder	−0.743[a]			
(NYC precincts)	2SLS	Robbery	−2.95[a]			
		Murder	−1.96[a]			
Craig (1987)	3SLS	Felonies	−0.57[a]			
(Baltimore police beats)						
Trumbull (1989)	OLS	All	−0.217[a]	−0.451[a]	−0.325[a]	−0.149[a]
(NC counties)						

[a] Statistically significant at the 5% level.

$$R_{it} = X'_{it}\beta + P'_{it}\gamma + \alpha_i + \epsilon_{it},$$

$$i = 1, \ldots, N; t = 1, \ldots, T, \quad (1)$$

TABLE 2.—MEANS AND STANDARD DEVIATIONS ($N = 90$ and $T = 7$)

	Mean	Standard Deviation
CRIME RATE	0.0316	0.0181
P_A	0.309	0.171
P_C	0.689	1.690
P_P	0.426	0.087
S	8.955	2.658
POLICE	0.00192	0.00273
DENSITY	1.386	1.440
PERCENT YOUNG MALE	0.089	0.024
WCON	245.67	121.98
WTUC	406.10	266.51
WTRD	192.82	88.41
WFIR	272.06	55.78
WSER	224.67	104.87
WMFG	285.17	82.36
WFED	403.90	63.07
WSTA	296.91	53.43
WLOC	257.98	41.36
WEST	0.233	0.423
CENTRAL	0.378	0.485
URBAN	0.089	0.285
PERCENT MINORITY	0.257	0.169

Since we wish to contrast cross-section and panel data estimators for our model, we define the "between" and "within" transformations of (1):

$$R_{i.} = X'_{i.}\beta + P'_{i.}\gamma + \alpha_i + \epsilon_{i.} \quad (2)$$

and

$$\tilde{R}_{it} = \tilde{X}'_{it}\beta + \tilde{P}'_{it}\gamma + \tilde{\epsilon}_{it}. \quad (3)$$

TABLE 3.—RESULTS FROM ESTIMATION
(standard errors in parentheses)

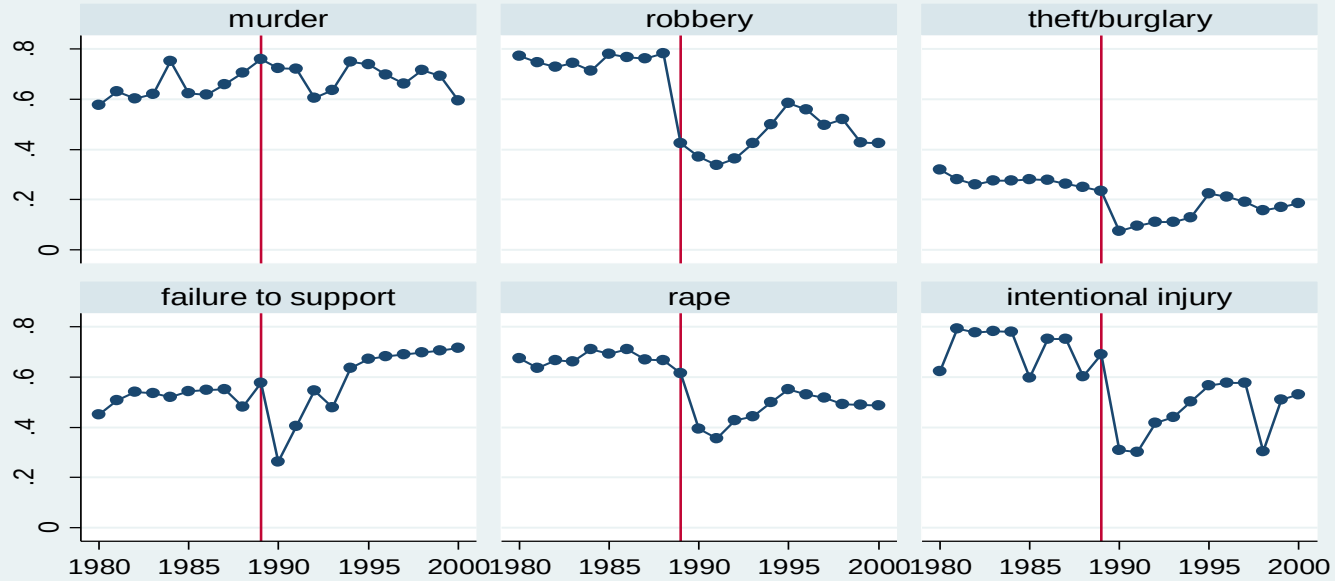
	Between	Within	2SLS (fixed effects)	2SLS (no fixed effects)
CONSTANT	−2.097			−3.719
	(2.822)			(8.189)
P_A	−0.648	−0.355	−0.455	−0.507
	(0.088)	(0.032)	(0.618)	(0.251)
P_C	−0.528	−0.282	−0.336	−0.530
	(0.067)	(0.021)	(0.371)	(0.110)
P_P	0.297	−0.173	−0.196	0.200
	(0.231)	(0.032)	(0.200)	(0.343)
S	−0.236	−0.00245	−0.0298	−0.218
	(0.174)	(0.02612)	(0.0300)	(0.185)
POLICE	0.364	0.413	0.504	0.419
	(0.060)	(0.027)	(0.617)	(0.218)
DENSITY	0.168	0.414	0.291	0.226
	(0.077)	(0.283)	(0.785)	(0.103)

rent effects estimates. Given the statistical consequences of unobserved heterogeneity, future estimation of the economic model of crime with aggregate data should no longer disregard this important source of specification error.

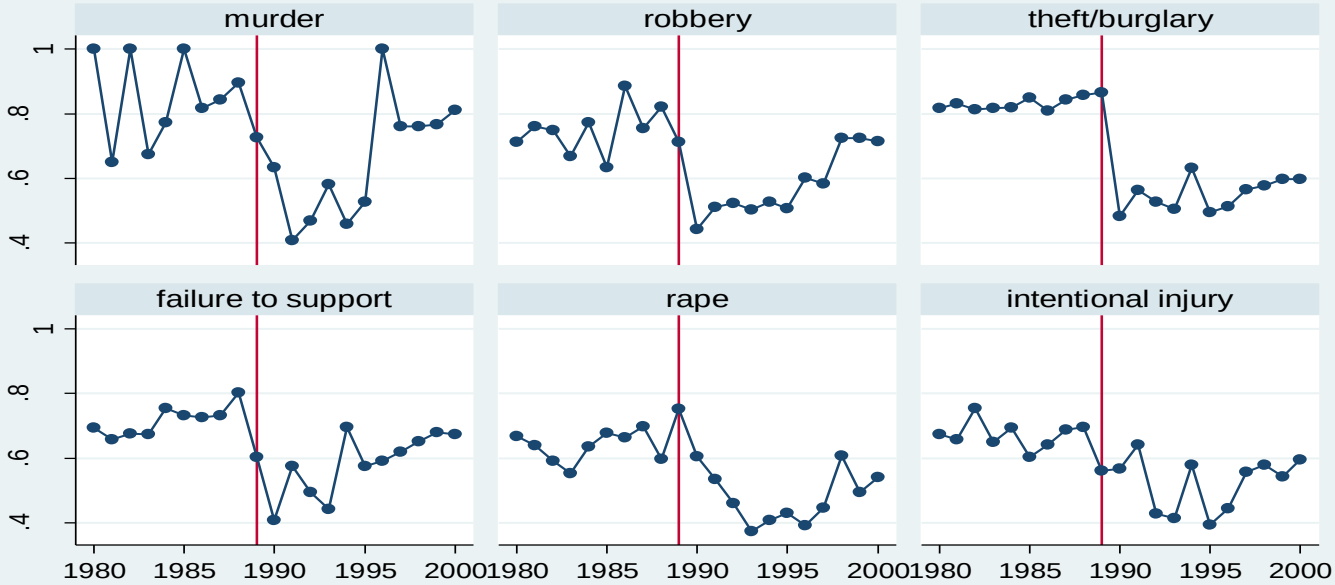
Quasi-natural experiments (since 1990's)

- Know where the variation comes from
  - Dušek, L. (2012). Crime, deterrence, and democracy. *German Economic Review*, *13*(4), 447-469.

We provide new evidence on the effect of deterrence on crime using the experience of a transition country (the Czech Republic) as a quasi-natural experiment. The arrival of democracy in 1989 was accompanied by sharp reductions in all measures of deterrence and sharp increases in crime rates. We test whether deterrence, rather than other factors, was responsible for the post-1989 growth in crime on a panel dataset of Czech regions. The results show significant deterrence effects for robberies and thefts that are quantitatively similar to those found in previous literature, but insignificant deterrence effects for murders and rapes.

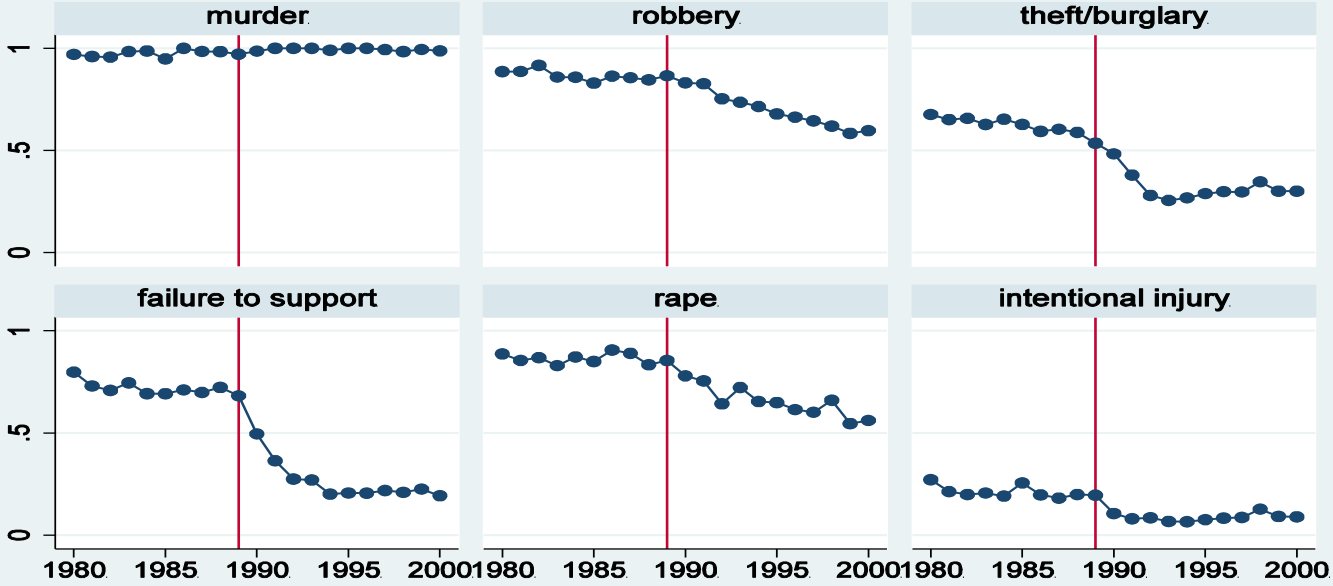


Probability of charge was computed as the total number of persons charged with the respective offense in a given year divided by the total number of offenses



Conditional probability of conviction was computed as the total number of persons convicted for the respective offense in a given year divided by the total number of persons charged with that offense

Conditional probability of prison sentence



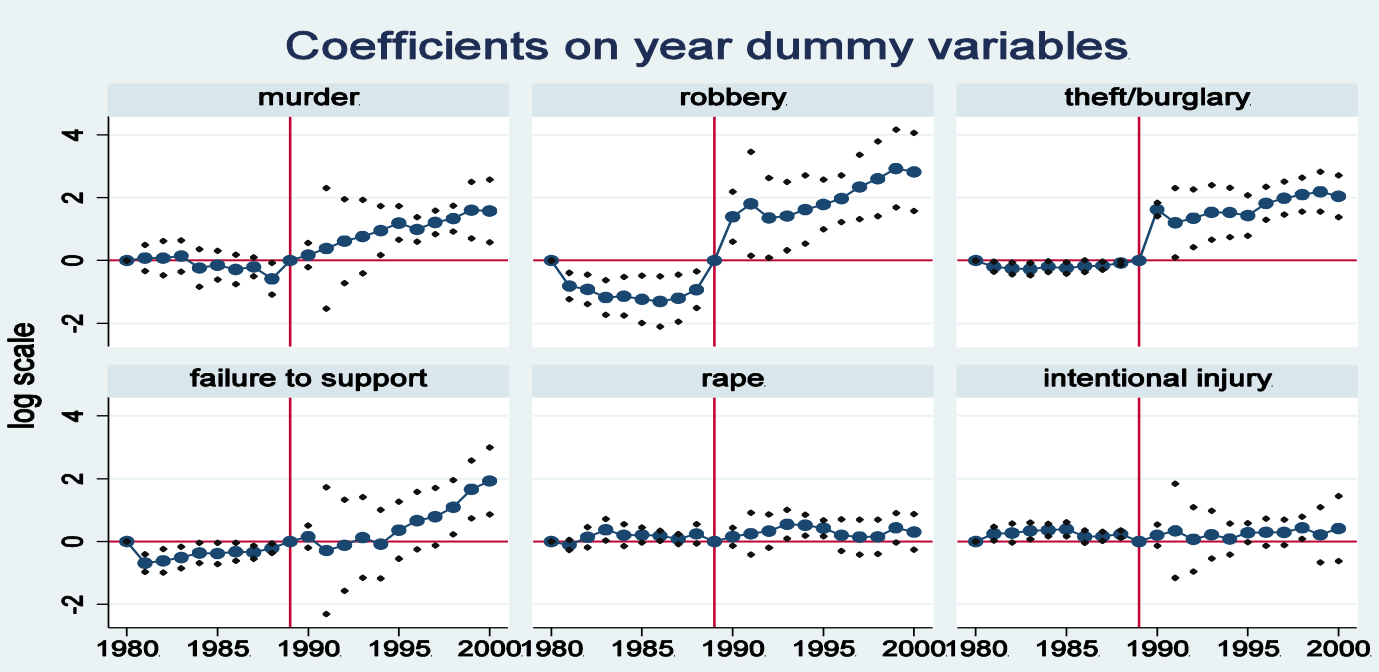
Conditional probability of prison sentence was computed as the total number of persons sentenced to prison for the respective offense in a given year divided by the total number of persons convicted for that offense


Crime rates
murder
robbery
theft/burglary
failure to support
rape
intentional injury
1
2
3
4
10
20
30
40
50
1000
2000
3000
0
50
100
150
5
6
7
8
50
60
70
80
90
1980
1985
1990
1995
2000

Table 4 Static SUR specification with lagged deterrence variables

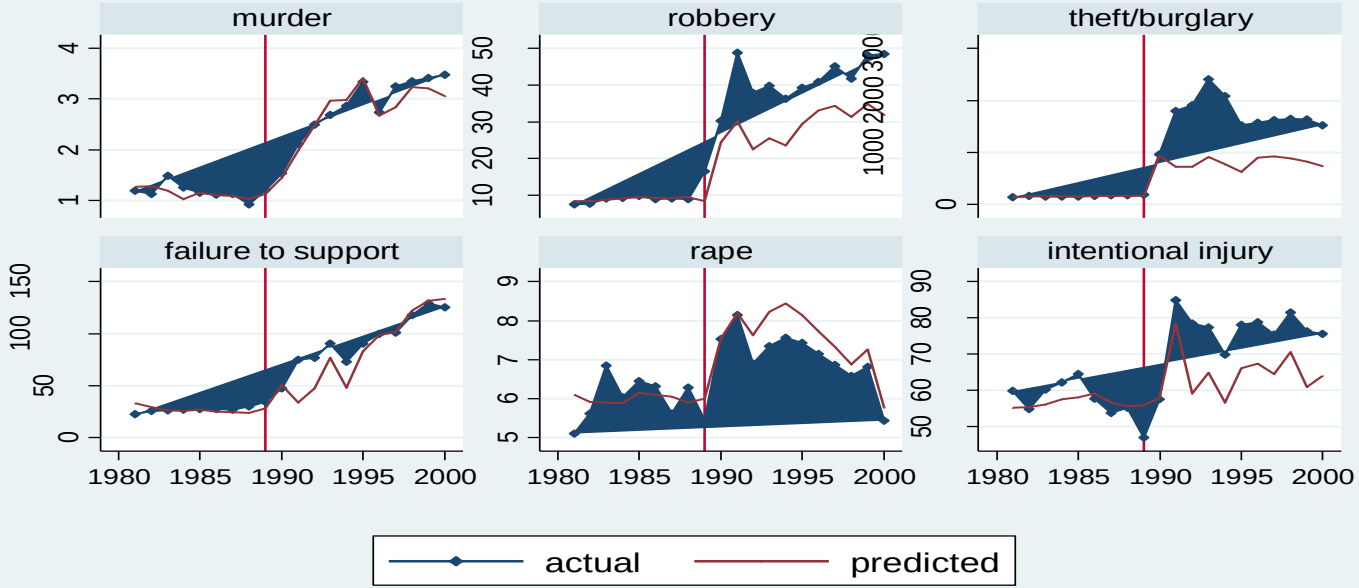
	Murder	Robbery	Theft	Failure to support	Rape	Injury
Lag probability of charge	−0.100	−0.250***	−0.509***	−0.314	0.027	−0.331*
	(0.103)	(0.058)	(0.080)	(0.219)	(0.102)	(0.173)
Lag probability of conviction	−0.068	−0.147**	−0.140	−0.068	0.054	−0.116
	(0.094)	(0.073)	(0.107)	(0.094)	(0.059)	(0.096)
Lag punishment	−0.086	−0.093	−0.213*	−0.407**	0.022	−0.084***
	(0.153)	(0.228)	(0.129)	(0.170)	(0.034)	(0.031)
Effective supply of offenders	2.249	8.863**	3.483**	−2.538	−3.076	−0.0885
	(2.946)	(3.490)	(1.550)	(3.065)	(3.105)	(3.497)
Average wage	−0.626	−0.366	−1.153	−2.372	−0.086	−0.068
	(2.702)	(1.727)	(1.420)	(2.823)	(0.738)	(2.056)
Inequality	0.0188	−1.198	−1.390*	0.216	−0.831	0.462
	(1.736)	(1.017)	(0.760)	(1.697)	(1.208)	(1.060)
Unemployment	−0.056	−0.022	−0.029	−0.083**	−0.041*	−0.017
	(0.040)	(0.033)	(0.018)	(0.036)	(0.021)	(0.034)
Region fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	159	159	159	159	159	159
'R-squared'	0.82	0.96	0.99	0.97	0.84	0.92

Absolute values of block-bootstrapped standard errors in parentheses.
All variables except unemployment are in logs.
*Significant at 10%; **5%; ***1%.



Coefficients on year dummy variables and their 95% confidence intervals from the SUR specification with lagged deterrence variables (Table 4)

Crime rates: actual vs predicted under unchanged deterrence



The predicted crime rates are national aggregates of the fitted values from the 3SLS specification of Table 8. For the years after 1989 the probability of charge, probability of conviction, and the length of prison sentence are held at their 1989 levels.

Quasi-natural experiments (since 1990's)

- Know where the variation comes from
  - Dušek, L. (2012). Crime, deterrence, and democracy. *German Economic Review*, *13*(4), 447-469.
- **Difference-in-differences**: several regions adopt a policy at different times

Rudimentary difference-in-differences

- Simple Treatment and Control group
- Kessler, D. P., & Levitt, S. (1999). Using Sentence Enhancements to Distinguish between Deterrence and Incapacitation. *Journal of Law and Economics*, *42*(2), 5.

One important shortcoming associated with almost all of these empirical analyses, however, is the difficulty in distinguishing between deterrence and incapacitation. As long as the primary means of punishment is imprisonment, policy changes that increase the expected punishment per crime lead to both greater deterrence and greater incapacitation. Consequently, most empirical tests of deterrence are, in practice, joint tests of deterrence and incapacitation. For example, reductions in crime associated with increased arrest rates or rising prison populations are consistent with the presence of deterrent effects, incapacitation, or both. Given the strong evidence in support of incapacitation effects,[4] caution is warranted in attributing a causal role to deterrence in such contexts.[5]

tion. The criminal is already required to serve the basic sentence. Only after that term[7] has elapsed and the sentence enhancement takes effect will there be an added incapacitation effect. Any deterrent effect, however, will arise immediately as the criminal incorporates the increased punishment associated with the sentence enhancement into the decision calculus. Thus, by looking at changes in crime immediately following the introduction of a sentence enhancement, it is possible to isolate a pure deterrent effect that is not contaminated by incapacitation.

TABLE 2

ESTIMATES OF THE IMPACT OF PROPOSITION 8 ON CALIFORNIA CRIME RATES

GEOGRAPHIC REGION AND CRIME CATEGORY	PRE–PROPOSITION 8		POST–PROPOSITION 8			
	1977–81	1979–81	1981–83	1981–85	1981–87	1981–89
California:						
Crimes eligible for Proposition 8	20.4	7.6	−17.5	−20.7	−19.9	−15.6
Crimes not eligible for Proposition 8	9.5	−1.0	−8.6	−7.2	9.1	17.8
California eligible − California ineligible	10.9	8.6	−8.9	−13.5	−29.0	−33.3
Rest of United States:						
Crimes that would be eligible for Proposition 8 in California	21.1	7.9	−13.0	−9.8	−4.0	.3
Crimes that would not be eligible for Proposition 8 in California	11.1	−.3	−8.0	−4.1	4.4	12.3
Rest of U.S. eligible − Rest of U.S. ineligible	10.0	8.2	−5.0	−5.7	−8.4	−12.0
(California eligible − California ineligible) − (Rest of U.S. eligible − Rest of U.S. ineligible)	.9	.4	−3.9	−7.8	−20.6	−21.3

NOTE.—Table entries are average percent changes in crime rates per 100,000 residents over the relevant crime categories in the years listed. Crimes eligible for sentence enhancements in California under Proposition 8 are murder, rape, robbery, aggravated assault with a firearm, and burglary of a residence. Ineligible crimes included in the table are aggravated assault with no firearm, burglary of a nonresidence, motor vehicle theft, and larceny. Values in the third row are the difference between rows 1 and 2. Values in the sixth row are the difference between rows 4 and 5. Values in the bottom row are the difference between rows 3 and 6. Proposition 8 took effect in June 1982.

Typical difference-in-differences

- Shepherd, J. M. (2002). Police, Prosecutors, Criminals, and Determinate Sentencing: The Truth about Truth-in-Sentencing Laws. *Journal of Law and Economics*, *45*(2), 509-533.

This study explores the impact of truth-in-sentencing (TIS) legislation on police, prosecutors, and criminals. Truth-in-sentencing laws are determinate-sentencing laws that require violent offenders to serve at least 85 percent of their prison sentences. The standard economic model of crime suggests that TIS laws will deter violent offenders but also reduce probabilities of arrest and conviction. However, I explain that if states share the goals of TIS legislation, police and prosecutors may increase these probabilities. My theoretical model also predicts that the legislation will cause more trials and impose higher maximum prison sentences. Using a county-level data set, empirical results confirm that TIS laws deter violent offenders, increase the probability of arrest, and increase maximum imposed prison sentences. Truth-in-sentencing laws decrease murders by 16 percent, aggravated assaults by 12 percent, robberies by 24 percent, rapes by 12 percent, and larcenies by 3 percent. However, offenders substitute into property crimes: burglaries increase by 20 percent and auto thefts by 15 percent.

ENACTMENT OF STATE TRUTH-IN-SENTENCING LAWS BEFORE 1997

State	Year Enacted	State	Year Enacted
Arizona	1994	Missouri	1994
Connecticut	1996	New York	1995
California	1994	North Carolina	1994
Delaware	1990	North Dakota	1995
Florida	1995	Ohio	1996
Georgia	1995	Oregon	1995
Illinois	1996	Pennsylvania	1911
Iowa	1996	South Dakota	1996
Kansas	1995	Tennessee	1995
Maine	1995	Utah	1985
Michigan	1994	Virginia	1995
Minnesota	1993	Washington	1990
Mississippi	1995		

SOURCE.—U.S. General Accounting Office, Truth in Sentencing: Availability of Federal Grants Influenced Laws in Some States (1998).

Program Office, are awarded to states that can prove that offenders convicted of a part 1 violent crime[12] serve at least 85 percent of their sentences. In

We are at a fortunate point to study the impact of TIS legislation; examining crime levels in the years immediately following a law change allows for the separation of the legislation's deterrent effect from its incapacitation effect.[20]

I present the results from the estimation of equations (11)–(15) on county-level data in Tables 3–6.[44] I estimate the simultaneous system of equations with a two-stage weighted least squares regression and control for county-level fixed effects.[45]

[42] The sentencing variables are estimated with data from the BJS National Corrections Reporting Program (NCRP). Since 1983, BJS has compiled the NCRP data series. It is the only national-level database that is collected annually at the county level with information on prison population movement data and parole population data and provides a comprehensive description of offenders as they enter and leave correctional custody and supervision. During the 1990s,

TABLE 3

Two-Stage Least Squares Regression Results for Violent Crime Rates

Regressors	Murder	Aggravated Assault	Robbery	Rape
Deterrent variables:				
Truth-in-sentencing legislation	−1.178	−44.809	−39.615	−4.226
	(3.14)*	(5.81)*	(7.46)*	(5.12)*
Probability of arrest	−.003	−.504	−.291	.030
	(.59)	(3.00)*	(3.35)*	(.94)
Conditional probability of imprisonment	.012	−4.549	.082	−.105
	(2.47)*	(11.29)*	(1.26)	(5.60)*
Economic variables:				
Real per capita personal income	.0001	−.008	.003	−.001
	(3.45)*	(5.07)*	(3.14)*	(4.10)*
Real per capita unemployment insurance payments	.001	−.349	.174	−.034
	(.22)	(6.63)*	(4.41)*	(5.37)*
Real per capita income maintenance payments	.008	−.079	−.264	−.020
	(4.56)*	(2.17)*	(9.96)*	(4.46)*

TABLE 4

TWO-STAGE LEAST SQUARES REGRESSION RESULTS FOR PROPERTY CRIME RATES

Regressors	Burglary	Larceny	Auto Theft
Deterrent variables:			
Truth-in-sentencing legislation	174.721	−89.486	70.252
	(11.73)*	(2.80)*	(3.95)*
Probability of arrest	6.288	16.060	9.419
	(3.47)*	(6.75)*	(5.52)*
Conditional probability of imprisonment	.794	−2.663	5.253
	(1.60)	(2.96)*	(3.64)*
Economic variables:			
Real per capita personal income	−.001	−.024	−.003
	(.50)	(4.09)*	(.68)
Real per capita unemployment	.574	−.733	1.610
insurance payments	(6.09)*	(3.49)*	(9.45)*
Real per capita income maintenance	.204	.216	.377
payments	(2.92)*	(1.62)	(3.52)*

TABLE 5

TWO-STAGE LEAST SQUARES REGRESSION RESULTS FOR PROBABILITY OF ARREST

Regressors	Murder	Aggravated Assault	Robbery	Rape
Truth-in-sentencing legislation				
	18.077	9.985	7.376	12.266
	(1.87)$^{+}$	(1.87)$^{+}$	(.99)	(2.63)*
Crime rate	−9.009	−.156	−.167	−2.098
	(11.29)*	(13.34)*	(10.75)*	(13.68)*
Police expenditure	.001	−.001	−.001	.001
	(3.03)*	(1.11)	(.54)	(6.57)*
Police employment	−.002	.001	−.001	.001
	(1.68)$^{+}$	(1.26)	(2.10)*	(3.28)*
Intercept	238.696	94.574	112.524	130.284
	(9.89)*	(9.03)*	(7.30)*	(10.09)*
N	13,978	26,083	17,473	19,213
F-statistic	16.21	30.48	11.84	21.13
Adjusted R^2	.1579	.3223	.1397	.1290

TABLE 6

TWO-STAGE LEAST SQUARES REGRESSION RESULTS FOR MAXIMUM IMPOSED PRISON SENTENCES

Regressors	Murder	Aggravated Assault	Robbery	Rape
Truth-in-sentencing legislation	2,162.082	195.316	656.576	758.923
	(4.28)*	(3.02)*	(5.71)*	(3.32)*
Corrections expenditure	.002	.001	.001 (6.87)*	.001
	(13.08)*	(5.17)*		(2.54)*
% Republican in 1984	−365.899	−28.273	−68.637	−115.831
	(8.27)*	(5.84)*	(7.87)*	(6.57)*
% Republican in 1988	−32.699	9.254	7.313	−24.980
	(.86)	(2.13)*	(.95)	(1.67)+
% Republican in 1992	−65.468	−4.505	−16.477	−63.845
	(1.88)+	(1.14)	(2.32)*	(4.58)*
% Republican in 1996	−194.736	−.966	−8.101	−34.940
	(5.54)*	(.27)	(1.27)	(2.83)*
Intercept	29,253.000	2,240.068	5,402.703	8,524.235
	(11.33)*	(7.87)*	(10.58)*	(8.28)*
N	12,748	16,795	15,308	11,404
F-statistic	32.58	25.11	50.61	20.74
R^2	.3259	.1439	.1020	.2889

NOTE.—The dependent variable is the median maximum sentence in days imposed for each crime. Absolute values of t-statistics are in parentheses. The estimated coefficients for year and county dummies

Summary

- Deterrence from crime is a key question of public policy
- As we know from Becker's model, complete deterrence is not possible thanks to increasing marginal cost of policing
- Specific, general, marginal deterrence
- How to estimate deterrence? Time series approaches, first attempts to diff and diff

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