

ESTIMATING DETERRENCE II: QUASI-NATURAL EXPERIMENTS



EVROPSKÁ UNIE
Evropské strukturální a investiční fondy
Operační program Výzkum, vývoj a vzdělávání



MINISTERSTVO ŠKOLSTVÍ,
MLÁDEŽE A TĚLOVÝCHOVY



More creative diff-in-diff

- Comparing groups within population that are treated differently
- Levitt, S. D. (1998). Juvenile Crime and Punishment. *Journal of Political Economy*, 106(6), 1156-1185.

Year-to-year percentage changes in crime rates by age cohort

RELATIVE PUNITIVENESS OF ADULT VS. JUVENILE COURT IN STATES IN WHICH AGE OF MAJORITY IS 18				
COHORT	Most Punitive (<i>N</i> = 61) (1)	Intermediate (<i>N</i> = 115) (2)	Least Punitive (<i>N</i> = 102) (3)	Difference of (1) - (3) (4)
	Violent Crime			
15-16	40.6 (3.8)	37.5 (2.6)	39.9 (3.8)	.7 (5.4)
16-17	25.1 (3.1)	28.4 (2.4)	24.8 (3.2)	.3 (4.5)
17-18	-3.8 (3.6)	10.2 (3.1)	23.1 (3.4)	-26.9 (5.0)
18-19	.5 (2.4)	3.8 (1.8)	5.9 (1.6)	-5.4 (2.9)

Year-to-year percentage changes in crime rates by age cohort

RELATIVE PUNITIVENESS IN STATES IN WHICH AGE OF MAJORITY IS 17		
Most Punitive (<i>N</i> = 29) (5)	Least Punitive (<i>N</i> = 29) (6)	Difference of (5) - (6) (7)
51.2	37.1	14.1
(5.4)	(5.0)	(7.2)
13.0	39.4	-26.4
(4.4)	(6.7)	(8.0)
26.3	29.7	-3.4
(6.1)	(3.6)	(7.1)
-3.8	.5	-4.3
(2.7)	(2.5)	(3.7)

REGRESSION ANALYSIS OF CRIME RATES AND THE TRANSITION FROM JUVENILE
TO ADULT COURT

VARIABLE	PERCENTAGE CHANGE IN VIOLENT CRIME			PERCENTAGE CHANGE IN PROPERTY CRIME		
	(1)	(2)	(3)	(4)	(5)	(6)
Become adult × relative punitiveness	-.114 (.025)	-.117 (.022)	-.121 (.018)	-.049 (.015)	-.053 (.013)	-.050 (.009)
Become adult	.257 (.054)	.199 (.052)	.214 (.039)	.115 (.034)	.083 (.036)	.090 (.025)
Relative punitiveness	-.025 (.006)	-.019 (.005)	-.090 (.015)	-.015 (.004)	-.008 (.003)	-.008 (.007)
Δ % black	...	-.42 (.05)	-.70 (.24)	...	-.19 (.03)	-.52 (.13)
Δ % metropolitan	...	.20 (.04)	-.35 (.15)	...	.03 (.02)	-.21 (.06)
Δ unemployment rate	...	-1.14 (.76)	-.36 (.74)	...	.83 (.36)	1.02 (.38)
Percentage Δ in crime among those aged 22+	...	.41 (.08)	.52 (.06)	...	.06 (.06)	.08 (.05)
Age, cohort, and year dummies?	no	yes	yes	no	yes	yes
State-cohort interactions?	no	no	yes	no	no	yes
Adjusted R ²	.053	.414	.445	.039	.465	.521

NOTE.—Dependent variable is the percentage change in the named crime category for a cohort from the preceding to the current year. The unit of observation is an age cohort in a state and year. Cohorts aged 15–21 are included in the regressions for the period 1978–93, yielding a total of 2,737 observations. All regressions are estimated using weighted least squares, with state populations used as weights. White standard errors are in parentheses. The interaction in the first row captures the effect of relative punitiveness on crime rates in the year following transition to the adult court.

Individual data & quasi-natural experiment

- Drago, F., Galbiati, R., & Vertova, P. (2009). The deterrent effects of prison: Evidence from a natural experiment. *Journal of political Economy*, 117(2), 257-280.
- Large amnesty in Italy in 2006 produced unique differences in the sentence for otherwise identical released prisoners if they commit another crime
- Must serve the sentence forgiven => shorter sentence for those who came to prison earlier

INDIVIDUAL CHARACTERISTICS FOR RESIDUAL SENTENCES ABOVE AND BELOW THE
MEDIAN ($N = 20,950$)

	MEAN			DIFFERENCE (4)
	Whole Sample (1)	Residual Sentence below the Median (2)	Residual Sentence above the Median (3)	
Original sentence (in months)	38.982 (.225)	39.089 (.306)	38.891 (.325)	-.198 (.447)
Residual sentence (in months)	14.511 (.070)	8.475 (.063)	19.730 (.093)	-11.255 (.113)
Recidivism	.115 (.002)	.129 (.003)	.102 (.003)	.027 (.004)
Age on exit	38.764 (.069)	38.762 (.104)	38.766 (.102)	-.004 (.146)
Married	.284 (.003)	.275 (.005)	.292 (.004)	-.017 (.006)
Permanently employed	.339 (.005)	.342 (.007)	.337 (.007)	.006 (.010)
Percentage of males	.954 (.001)	.957 (.002)	.951 (.002)	.006 (.003)
Share of Italians	.621 (.003)	.595 (.005)	.643 (.004)	-.048 (.007)
First judgment taken	.998 (.001)	.999 (.001)	.998 (.001)	.001 (.001)

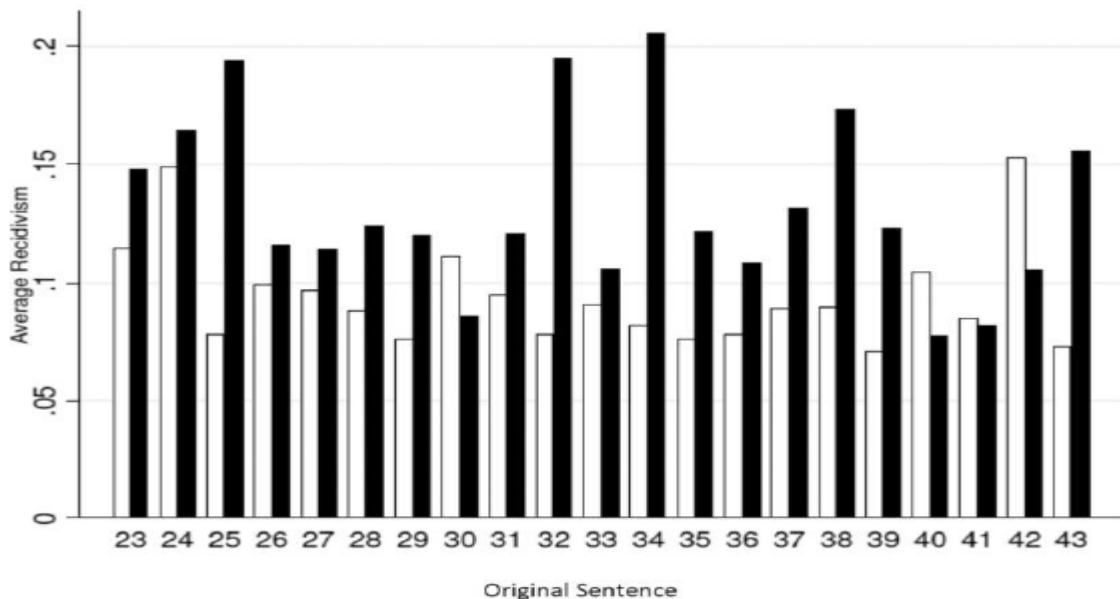


FIG. 3.—Residual sentence and recidivism. Black bars represent average recidivism for individuals with residual sentences below the median conditional on the original sentence, and white bars represent average recidivism for individuals with residual sentences above the median conditional on the original sentence.

BASELINE RESULTS

	(1)	(2)	(3)
Residual sentence	-.0016 (-6.54)	-.0017 (-6.87)	-.0017 (-7.02)
Original sentence	-.0001 (-1.93)	.0002 (2.22)	.0002 (2.61)
Individual characteristics	No	Yes	Yes
Type of crime	No	No	Yes
Pseudo R^2	.005	.028	.032
Observations	20,950	19,316	19,316

NOTE.—Logit estimates are reported. The dependent variable is equal to one if the individual returned to prison after release and zero otherwise. Coefficients are marginal effects evaluated at the mean of the independent variables. Robust Z-statistics are in parentheses. Individual variables include education levels, age at the date of release, a dummy indicating marital status, nationality, juridical status, and employment condition before imprisonment.

Key concepts

- Estimating causal effects of p and F on crime – why can't use simple correlations
- Quasi-natural experiments
- Difference-in-differences
 - Difference within group over time, then difference treatment and control after
 - Regressions: dummies pick up the unobserved effect of a region, year, cohort etc
- Diff-in-diff studies generally find some deterrent effect of punishment on crime

- Empirical knowledge (in economics and other social science topics, for that matter)
 - How does it develop?
 - How can we tell whether intervention X indeed affects Y?
 - What to do about conflicting studies?
- The case study: abortion and crime

Abortion and crime

- Donohue, J. and Steve Levitt (2001): Legalized Abortion and Crime, *Quarterly Journal of Economics*.
- Main claim: Legalizing abortion in the early 1970's in the U.S. was a significant factor in the decline of crime during the 1990's

Institutional background

- Abortion historically illegal
- Options: illegal abortion, travel abroad
- 1970: legalized by NY, CA, WA, HI, AK
- 1973 Supreme court case Roe vs Wade: nationwide legalization
- Gradual increase in abortions since legalization

Theoretical mechanisms

- Crime and age/social status profile
 1. Cohort size
 2. Selection effects

Empirical evidence 1

- The paper presents evidence that legalizing abortion cut crime
- Each piece of evidence requires less stringent assumptions to establish a causal effect

1. National time series

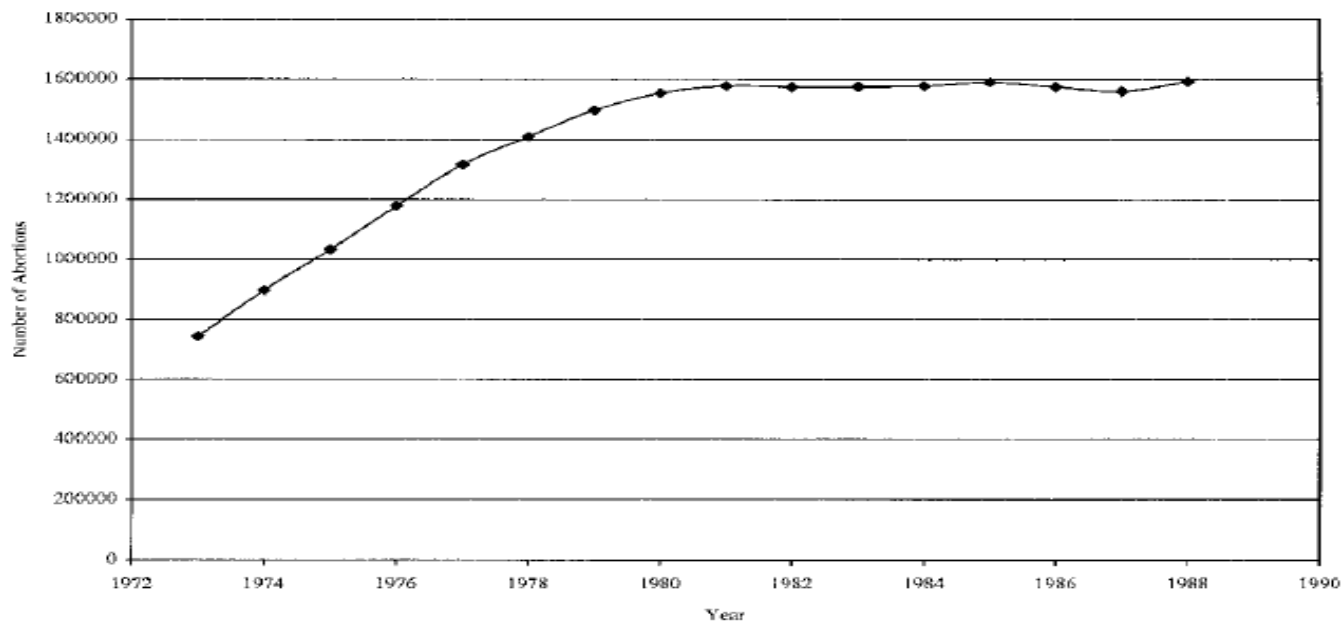


FIGURE I
Total Abortions by Year

Time series (just a glimpse at data)

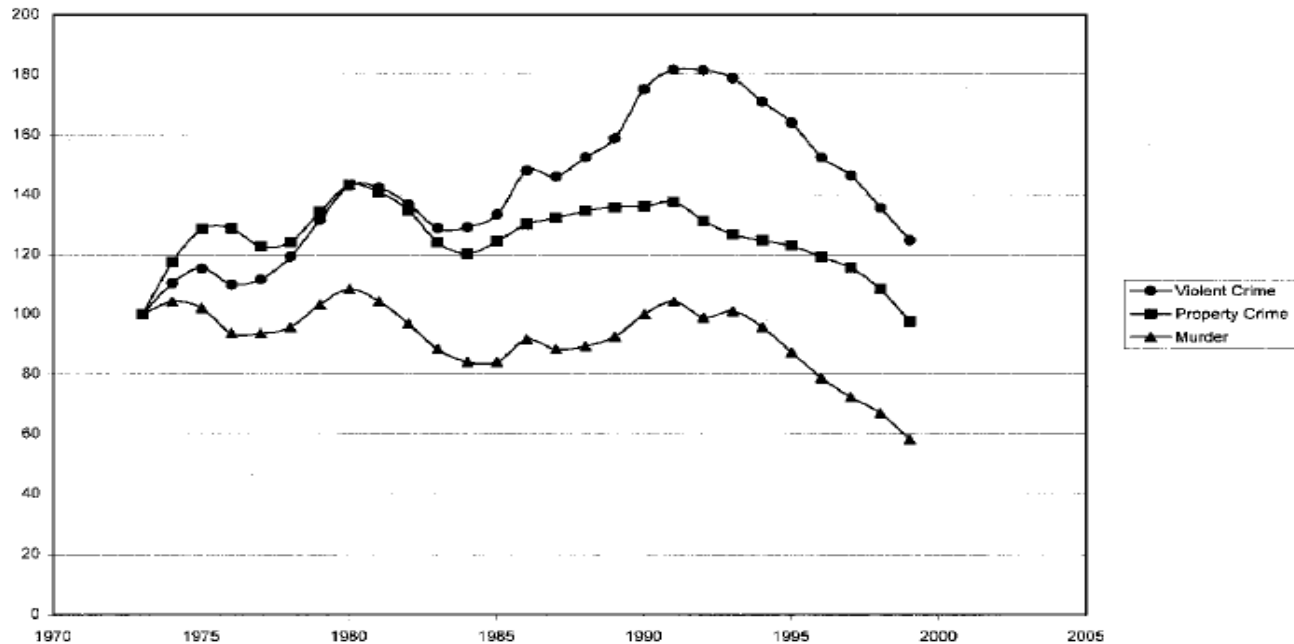


FIGURE II
Crime Rates from the Uniform Crime Reports, 1973–1999

Evidence 2: Early vs late legalizers

- In the early legalizing states, crime rates began to fall few years earlier and the drop was more pronounced than in the rest of the country

Early vs. late legalizers: diverging trends (raw diff-in-diff)

CRIME TRENDS FOR STATES LEGALIZING ABORTION EARLY VERSUS THE REST OF THE UNITED STATES

Crime category	Percent change in crime rate over the period				C
	1976–1982	1982–1985	1988–1994	1994–1997	
Violent crime					
Early legalizers	16.6	11.1	1.9	–25.8	
Rest of U. S.	20.9	13.2	15.4	–11.0	
Difference	–4.3	–2.1	–13.4	–14.8	
	(5.5)	(5.4)	(4.4)	(3.3)	

Evidence 3: Panel data regressions

- Changes in crime are negatively related to effective abortion rates

$$Effective_Abortion_t = \sum_a Abortion_{t-a}^* (Arrests_a / Arrests_{total}),$$

- Regressions explaining the crime rate as a function of the effective abortions, socio-econ control variables
- State and year F.E.

Percentage change in crime correlates with the abortion rate

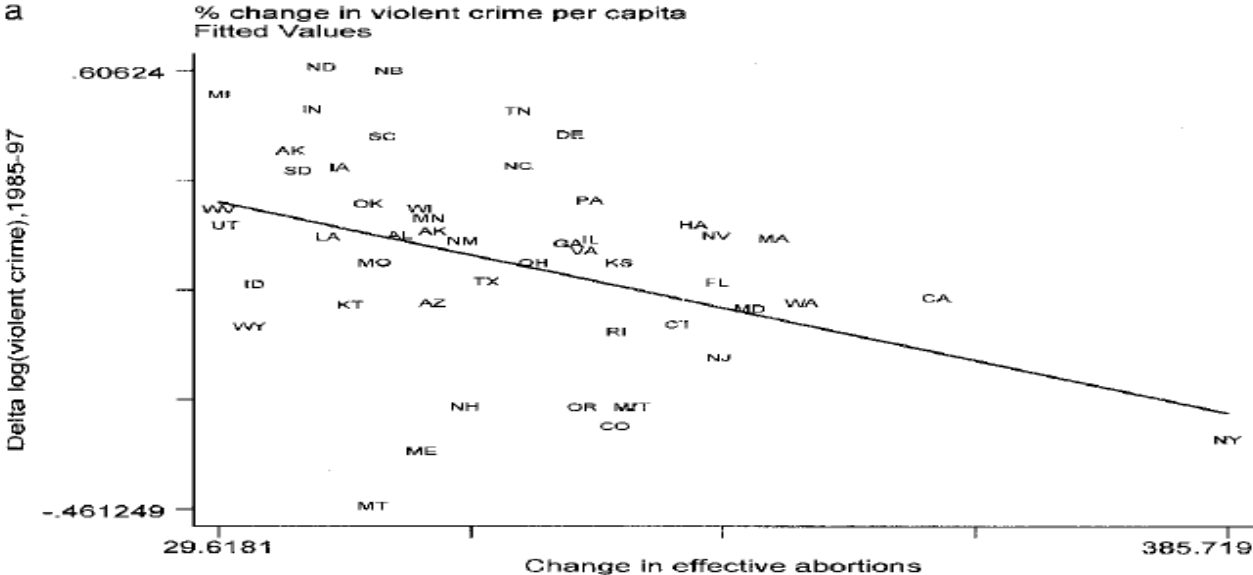


FIGURE IVa
Changes in Violent Crime and Abortion Rates, 1985–1997

Percentage change in crime correlates with the abortion rate

TABLE II

CRIME CHANGES 1985–1997 AS A FUNCTION OF ABORTION RATES 1973–1976

Abortion frequency Ranked by effective abortion rate in 1997)	Effective abortions per 1000 live births, 1997	% Change in crime rate, 1973–1985			% Change in crime rate, 1985–1997		
		Violent crime	Property crime	Murder	Violent crime	Property crime	Murder
Lowest	67.5	+ 31.8	+ 29.8	- 21.1	+ 29.2	+ 9.3	+ 4.1
Medium	135.0	+ 28.8	+ 31.1	- 19.7	+ 18.0	+ 2.2	- 12.6
Highest	257.1	+ 32.2	+ 15.2	- 9.7	- 2.4	- 23.1	- 25.9

Percentage change in crime correlates with the abortion rate

TABLE IV
 PANEL-DATA ESTIMATES OF THE RELATIONSHIP BETWEEN
 ABORTION RATES AND CRIME

Variable	ln(Violent crime per capita)		ln(Property crime per capita)		ln(Murder per capita)	
	(1)	(2)	(3)	(4)	(5)	(6)
“Effective” abortion rate ($\times 100$)	-.137 (.023)	-.129 (.024)	-.095 (.018)	-.091 (.018)	-.108 (.036)	-.121 (.047)
ln(prisoners per capita) ($t - 1$)	—	-.027 (.044)	—	-.159 (.036)	—	-.231 (.080)
ln(police per capita) ($t - 1$)	—	-.028 (.045)	—	-.049 (.045)	—	-.300 (.109)
State unemployment rate (percent unemployed)	—	.069 (.505)	—	1.310 (.389)	—	.968 (.794)
ln(state income per capita)	—	.049 (.213)	—	.084 (.162)	—	-.098 (.465)
Poverty rate (percent	—	-.000	—	-.001	—	-.005

Evidence 4: Indicators of the selection effect

- Age-specific arrest rates negatively correlated with the effective abortion rate.
- Arrest rates measured per number of people below/above 25.

The relationship bw abortion and crime holds only for cohorts affected by abortion (under 25)

Specification	ln (arrest per person, under age 25)			ln (arrests per person, age 25+)		
	Violent crime	Property crime	Murder	Violent crime	Property crime	Murder
Effective abortion rate (× 100) only, no covariates included	-.095 (.029)	-.085 (.023)	-.214 (.051)	.022 (.054)	-.019 (.037)	-.034 (.037)
Effective abortion rate (× 100), including full set of covariates	-.044 (.030)	-.054 (.023)	-.180 (.062)	.033 (.046)	.008 (.031)	-.036 (.050)

Evidence 5: The alleged hallmark

- Cohorts affected (cumulatively) more by abortions have fewer arrests
- Regressions at the state-year-age level
- Controlling for state, year, and state-year effects

$$\ln (ARRESTS_{stb}) = \beta_1 ABORT_{sb} + \gamma_s + \lambda_{tb} + \theta_{st} + \epsilon_{stb},$$

- Further, controlling for state-age effects

Table 7: within a state, cohorts with higher abortion rate experience a decline in violent arrests

THE RELATIONSHIP BETWEEN ABORTION RATES AND ARREST RATES,

	ln (Violent arrests)			
Abortion rate ($\times 100$)	-.015 (.003)	—	-.028 (.004)	—
Abortion rate ($\times 100$) interacted with				
Age = 15	—	.018 (.008)	—	-.008 (.010)
Age = 16	—	.008 (.007)	—	-.007 (.008)
Age = 17	—	-.010 (.006)	—	-.021 (.007)
Age = 18	—	-.035 (.004)	—	-.039 (.007)
Age = 19	—	-.040 (.005)	—	-.043 (.007)
Age = 20	—	-.043 (.006)	—	-.043 (.007)
Age = 21	—	-.039 (.009)	—	-.039 (.008)
Age = 22	—	-.028 (.013)	—	-.024 (.009)
Age = 23	—	-.031 (.023)	—	-.026 (.013)
Age = 24	—	-.027 (.040)	—	-.016 (.020)
R^2	.972	.972	.985	.985
Number of observations	5,737	5,737	5,737	5,737
State-fixed effects or State-age interactions?	State-fixed	State-fixed	State * Age interactions	State * Age interactions

Economic significance

- Findings imply that as much as 50% of the large decline in crime during the 1990's is attributed to abortion
- Authors very careful with normative statements (but read Freakonomics for crude welfare analysis)

Follow-ups

- Foote, Ch. L. and Christopher Goetz (2005): Testing Economic Hypothesis with State-Level Data: A Comment on Donohue and Levitt (2001), Federal Reserve Bank of Boston working paper.
- Donohue, J. and Steve Levitt (2005): Measurement Error, Legalized Abortion, the Decline in Crime: A Response to Foote and Goetz, unpublished manuscript, 2005.
- Joyce, T.: Did Legalized Abortion Lower Crime? (2004) Journal of Human Resources.
- Donohue, J. and Steve Levitt (2004): Further Evidence That Legalized Abortion Lowered Crime: A Reply to Joyce, Journal of Human Resources.

Issues raised by Foote & Goetz

- No dispute about the (weaker) evidence 2-4.
 - All the dispute is about Table 7
1. Donohue and Levitt used raw number of arrests, rather than arrests per capita (cohort size effect)
 2. Programming error

Foote and Goetz (2005)

- Re-estimate without error
- Run the regressions on arrests per capita
- Emphasize the importance of state-year, state-age effects
 - Crack cocaine epidemic

Foote and Goetz (2005)

Table 1: Estimated Effects on (Log of) Violent Crime Arrests

	Original DL Specification	Add State-Year Controls	Add Population	Arrests on Per Capita Basis
<i>No State-Age Controls</i>				
Log of Abortion Exposure	-.0184** (.0030)	.0017 (.0050)	.0263** (.0053)	.0255** (.0048)
Log of Population			1.035** (.090)	
<i>With State-Age Controls</i>				
Log of Abortion Exposure	-.0271** (.0044)	-.0094** (.0034)	-.0032 (.0032)	-.0002 (.0033)
Log of Population			0.670** (.080)	

Donohue and Levitt (2005) reply

- Acknowledge the error
- Counter-critique
 - Arrests are a proxy, population measured with error: cumulating measurement error
- Alternative dataset on the number of abortions
 - Use as instrument
- Sharpening the measurement error in abortions
 - Mobility to obtain abortion
 - Mobility after abortion
 - Assigning abortion year to year/age of arrest

Removing the measurement error

Table 4
Estimated Effects of Abortion on Crime with and without Measurement Error Correction

	ln (Violent arrests)		
Abortion measures:			
original	-0.018 [0.003]**	-0.027 [0.004]**	-0.009 [0.003]**
with corrections	-0.045 [0.007]**	-0.083 [0.008]**	-0.046 [0.008]**
IV using CDC	-0.045 [0.007]**	-0.078 [0.010]**	-0.055 [0.013]**
Controls include:			
fixed effects for state and age*year interactions	yes	yes	yes
state*age interactions	no	yes	yes
state*year interactions	no	no	yes

Per capita regressions

Table 5
Distinguishing Between the Channels Through Which Abortion Affects Crime

	ln (Violent arrests)	ln (Violent arrests)	ln (Violent arrests per capita)
Abortion measures:			
original	-0.009 [0.003]**	-0.003 [0.003]	0.000 [0.003]
with corrections	-0.046 [0.008]**	-0.031 [0.008]**	-0.021 [0.008]**
IV using CDC	-0.055 [0.013]**	-0.037 [0.014]**	-0.023 [0.013]
Controls include:			
fixed effects for state and age*year interactions	yes	yes	yes
state*age interactions	yes	yes	yes
state*year interactions	yes	yes	yes
ln(population)	no	yes	no

Big conceptual issue

- The state-year, state-age etc effects may remove too much variation from the data
- These methods are asking ``too much'' of the available data
- After all, a highly crude natural experiment

Abortion in a different context

- Pop-Eleches, C. (2006). The Impact of an Abortion Ban on Socioeconomic Outcomes of Children: Evidence from Romania, *Journal of Political Economy*.

Monthly birth rates in Romania around the abortion ban

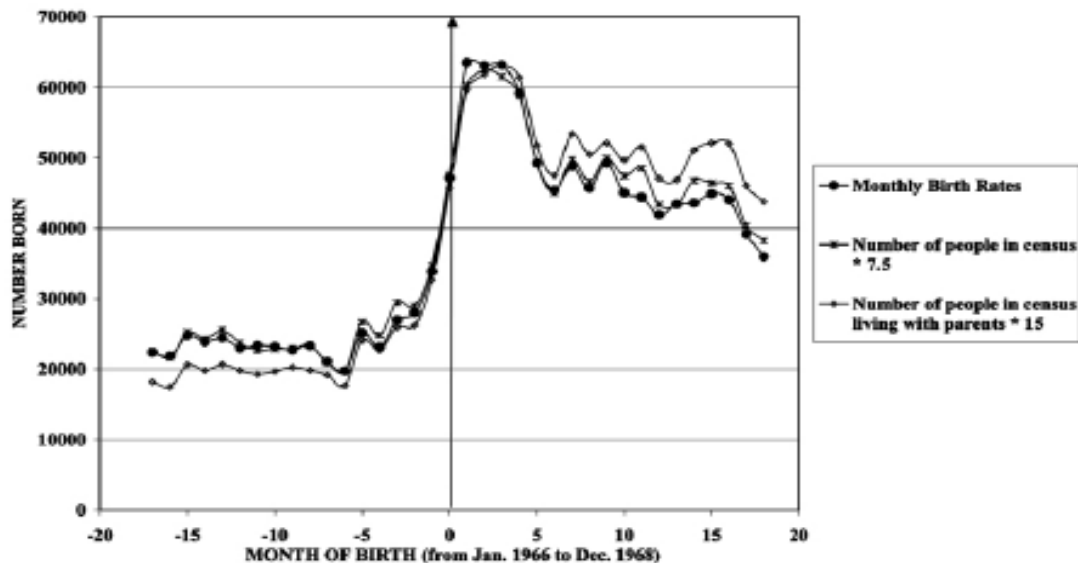


FIG. 2.—Monthly birth rates: vital statistics and representation in the 1992 census sample. The graph plots the number of persons born between 1966 and 1968 by month of birth. Month 0 refers to June 1967, the first month with large fertility increases due to the restrictive abortion policy. Also plotted are the number of persons born in the same period

TABLE 3
EDUCATIONAL ACHIEVEMENTS FOR COHORTS BORN BETWEEN JANUARY AND OCTOBER
1967

Dependent Variable	Full Sample (1)	Restricted Sample (2)	Restricted Sample (3)	Restricted Sample (4)
Apprentice school:				
Treatment dummy	.00643* (.00376)	.00199 (.00602)	.01960*** (.00560)	.02134*** (.00556)
Observed probability	.226	.232	.232	.232
High school or more:				
Treatment dummy	.03789*** (.00449)	.04147*** (.00713)	-.00565 (.00795)	-.01713** (.00816)
Observed probability	.46	.512	.512	.512
University or more:				
Treatment dummy	.00573** (.00257)	.00611 (.00479)	-.01232*** (.00405)	-.01470*** (.00392)
Observed probability	.091	.132	.132	.132
Observations	55,337	22,847	22,847	22,847
Background controls	No	No	Yes	Yes
Household controls	No	No	No	Yes

NOTE.—The table presents the results of probit regressions. For continuous variables, the coefficient estimates represent the marginal effect of variables evaluated at their mean; for dummy variables, the coefficients capture the effect of switching the value from zero to one. The sample contains people born between January and October 1967. The dependent variables are three educational achievement dummies. The treatment dummy equals one for people born after June 1967, zero otherwise. The background controls included are two educational dummies of the mother, two educational dummies of the father, an urban dummy for place of birth of the child, a dummy for the sex of the child, and 46 region of birth dummies. The household controls are homeownership, rooms per occupant, surface area per occupant, and availability of a toilet, bath, kitchen, gas, sewerage, heating, and water. The full sample refers to all individuals in a given cohort included in the census sample. The restricted sample refers to those individuals in the census sample who live with their parents at the time of the census. Robust standard errors are shown below the coefficients in parentheses. Variables are further defined in App. table A1.

TABLE 7
CRIME BEHAVIOR IN SIBIU, ROMANIA

Dependent Variable	Total Crime (1)	Crime against Persons (2)	Property Crime (3)	Other Crimes (4)
Dummy for birth:				
1967-69	-.116 (.102)	-.095 (.065)	.059 (.053)	.001 (.056)
After 1970	.301** (.124)	.088 (.095)	.232*** (.081)	.221*** (.071)
Age dummies included	Yes	Yes	Yes	Yes
Time controls included	Year dummies	Year dummies	Year dummies	Year dummies
Average crime rate for 1967-69 cohort	.77	.36	.26	.28
Observations	550	550	550	550
R^2	.64	.52	.54	.48

Abortion and crime: Who's right?

It is easy to be perplexed or misled

- Empirical research is necessary for understanding the world but it is hard
- Theoretical hypothesis: $X \Rightarrow Y$
- Empirical research:
 - Many studies test one claim
 - Frequently opposing results
 - Bitter fights between academics
 - Publication bias
 - Selective interpretation by the media, lobbies, think-tanks, researchers with agendas etc.
- Is there a truth?

Some guidance

- Empirical research => evidence supporting or contradicting a hypothesis
- One paper is never enough to reject/accept a hypothesis!
- We never **“prove”** a theory with empirical research!
- Rather, we gradually accumulate evidence that eventually supports or rejects the hypothesis with a relatively large degree of confidence

Some guidance

- Never cherry-pick one study!
- Do not let your ideology or priors see the desired conclusions
- Findings based on obvious, exposed errors should be discarded
- Findings based on obviously wrong, inadequate, obsolete methodologies should be discarded
- Studies vary in quality – more weight put on findings from high-quality studies

Hierarchy of methods (effects of interventions)

Randomized experiment

Natural experiment (IV, regression discontinuity, diff-in-diff)

Panel data

Time series or cross-section analysis

Graphs and descriptive statistics

Randomized experiment

Natural experiment (IV, regression discontinuity, diff-in-diff)

Panel data

~~Time series or cross section analysis~~

~~Graphs and descriptive statistics~~



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