

Socially Optimal Crime and Punishment

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Inspira

Optimality of Public Security Policies

- ▶ What is the optimal public security policy?
 - ▶ How should punishments be set?
 - ▶ Are we over-punishing drug-related crimes?
 - ▶ How large should a police force be?
 - ▶ Should we "defund" the police?
- ▶ Questions such as these were the original motivations of the classic contributions to the economics of crime.
 - ▶ Beccaria (1764), Bentham (1789), Becker (1968), Stigler (1974), Ehrlich (1981).

Optimality of Public Security Policies

- ▶ Why come back to these questions?
 - ▶ Theoretical literature: mostly very stylized.
 - ▶ Conceptual and qualitative discussion of potential trade-offs.
 - ▶ Empirical literature: mostly reduced-form.
 - ▶ Analyses of effectiveness of marginal changes.

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 - ▶ How does increased harshness in sentencing affect the optimal size – and allocation – of police?

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- ▶ We do not share an accepted framework to analyze interactions across policies...
 - ▶ How does increased harshness in sentencing affect the optimal size – and allocation – of police?
- ▶ ...or equilibrium responses.
 - ▶ Through changes in behavior and in the equilibrium level of crime, policies always interact.

Summary

- ▶ The goal of this project is to develop a structural model to study the optimality of public security policies.
 - ▶ Theory incorporates trade-offs across different policies and equilibrium responses of crime in a "manageable" way.
 - ▶ Allow for analyses that would not be possible with reduced-form estimates or current theoretical models.
- ▶ We illustrate the potential use of this framework by performing a quantitative exercise using US data.
 - ▶ Focus on property crimes.
 - ▶ 2004 moments and well-identified estimates from empirical literature used to estimate parameters.
- ▶ Hopefully helps bridge the current gap between empirical and theoretical literatures on economics of crime.

Main Ingredients

- ▶ A public security policy is a combination of a size of the police force and an expected length of sentences.
- ▶ A policy affects criminal behavior by:
 - ▶ Making individuals afraid of punishment:
 - ▶ Deterrence.
 - ▶ Stopping incarcerated individuals from committing crimes:
 - ▶ Incapacitation.
 - ▶ Changing the labor market productivity upon release:
 - ▶ Recidivism.
 - ▶ Changing the number of active criminals and, therefore, the effectiveness of the public security policy:
 - ▶ Load.

Main Ingredients

- ▶ Social costs of crime include:
 - ▶ Utility loss from victimization.
 - ▶ Material losses associated with destruction of property and costs to engage in crime.
 - ▶ Expenditures on the public security system.
 - ▶ Utility and productivity losses from incarceration (including reduced future productivity).
- ▶ Framework can be used to analyze optimality of policies according to any welfare function over these dimensions.
 - ▶ Possibly also including other – "political" – constraints.
 - ▶ Fixed budget, non-increasing crime, etc.

Main Ingredients

- ▶ Needless to say, some important dimensions are left out:
 - ▶ Risk aversion.
 - ▶ No utility loss from exposure to risk of victimization, just from actual victimization.
 - ▶ Private change in behavior to avoid crime.
 - ▶ No change in individual behavior to reduce probability of victimization, just expenditures in public security.
 - ▶ Criminal capital.
 - ▶ No endogenous accumulation of criminal human capital, just human capital loss from incarceration.
 - ▶ No police bias, no wrongful convictions.

Illustration of Potential Use

Policy Plane

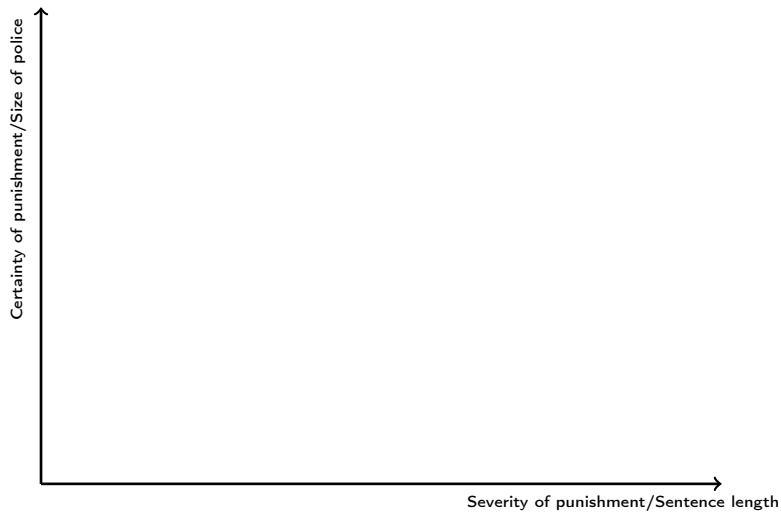


Illustration of Potential Use

- 2004 US policy on property crime

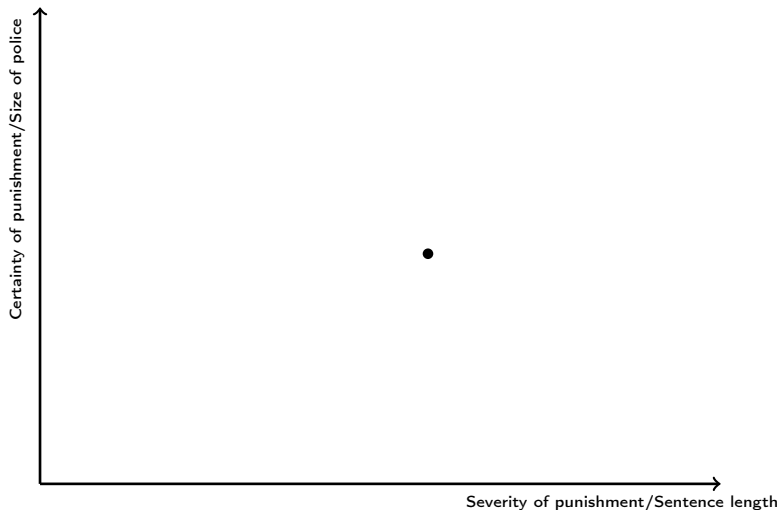
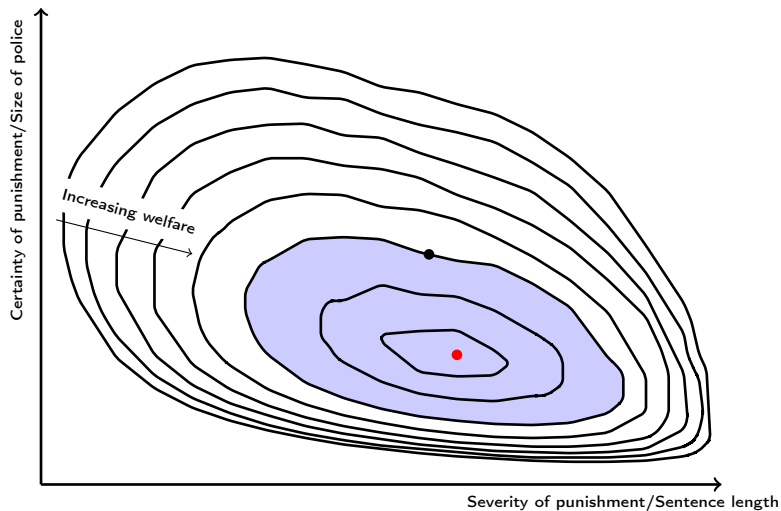


Illustration of Potential Use

- Welfare improving region
- Globally optimal policy



Literature

- ▶ From Beccaria (1764) to Becker (1968).
 - ▶ Followed by wide array of empirical evidence:
 - ▶ Grogger (1995), Levitt (1996, 2001), Di Tella and Schargodsky (2004), Lochner (2004), Buonanno and Raphael (2013), Mastrobuoni and Rivers (2017), etc.
- ▶ Recent structural work:
 - ▶ Imrohorglu et al. (2000), Burdett et al. (2003), Engelhardt et al. (2008).
 - ▶ Fella and Gallipoli (2014): incarceration vs. education.
 - ▶ No life-cycle of wages/crime, exogenous probability of arrest, no recidivism effect, no net loss from crime.
 - ▶ Welfare cost: transitory income risk from victimization and expenditures on prison system.
 - ▶ Fu and Wolpin (2018): expenditures on police.
 - ▶ No life-cycle of wages/crime, exog. public security technology, no recidivism effect, no net loss from crime, no incarceration.
 - ▶ Arbitrary welfare function over crime, size of the police (negatively), and arrests (positively).

Road Map

- ▶ Introduction
- ▶ Model
 - ▶ Structure
 - ▶ Equilibrium
 - ▶ Welfare
 - ▶ The Public Security Technology
- ▶ Estimation
- ▶ Quantitative Exercises

Model: Basics

- ▶ Public safety policy: certainty and severity of punishment.
 - ▶ Severity of punishment: "sentence" length.
 - ▶ Certainty of punishment: probability of detection.
- ▶ Individuals: heterogeneous productivity, life-cycle wage profile.
 - ▶ Crime is a rational decision.
 - ▶ A mass of individuals considers committing crimes.
 - ▶ Individuals face an age-specific cost of committing crimes.
- ▶ Effects of incarceration: scarring and incapacitation.
 - ▶ Incarceration reduces productivity in the labor market.
 - ▶ Prisoners cannot commit crimes.
- ▶ Social planner's objective is to minimize total welfare loss from crime.
 - ▶ Not to minimize crime.

Model: Basics

- ▶ Discrete time.
- ▶ Linear utility on income.
- ▶ Agents are characterized by:
 - ▶ Age (indexed by t).
 - ▶ Propensity to commit crimes.
 - ▶ Productivity.

Model: Crime

- ▶ Crime: interaction between a dishonest and an honest agent.
 - ▶ Random encounters.
- ▶ Definition of a crime:
 - ▶ Financial transfer from victim to criminal.
 - ▶ Damage to the victim (material and/or psychological).
 - ▶ Cost paid by the criminal depending on age t .

Model: Crime

- ▶ v : aggregate crime rate.
- ▶ Crimes are detected with probability $p(v)$.
 - ▶ Take $p(v)$ as given for now, we come back to this later.
- ▶ Each individual sentence length is a r.v. with geometric distribution: expected value λ .
- ▶ An agent chooses each period whether to commit crimes.
 - ▶ Agents who engage in crime commit a random number of crimes until the end of the period, or until caught.
 - ▶ Exponential distribution of criminal opportunities within a period.

Model: Crime

- ▶ This process determines:
 - ▶ \bar{p} : probability of incarceration per period, conditional on committing crimes.
 - ▶ \bar{p} is a function of $p(v)$.
 - ▶ $\bar{\Pi}_t$: instantaneous net gain from crime for an agent at age t .
 - ▶ $\bar{\Pi}_t$ also a function of amount stolen and cost of committing a crime.

Model: State Transitions

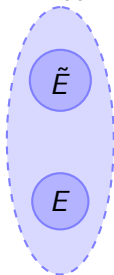


Model: State Transitions

Prison



Free

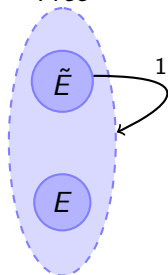


Model: State Transitions

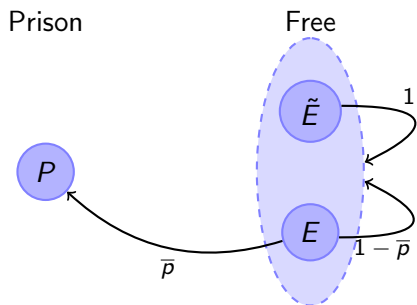
Prison



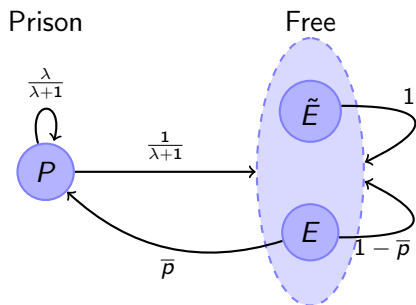
Free



Model: State Transitions



Model: State Transitions



- ▶ We focus on stationary state: aggregate quantities constant.

Model: Utility of Potential Criminals

- ▶ The instantaneous expected utility of an agent at age t in state s_t , with productivity w_t is:

$$\mathbb{E}[u(c_t)] = \begin{cases} w_t - f & \text{if } s_t = \tilde{E}, \\ w_t - f + \bar{\Pi}_t & \text{if } s_t = E, \\ b - f & \text{if } s_t = P. \end{cases}$$

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- ▶ Life-cycle dynamics of productivity:

$$w_{t+1} = \begin{cases} \gamma_t w_t & \text{if } s_t \in \{\tilde{E}, E\}, \\ \theta w_t & \text{if } s_t = P. \end{cases}$$

- ▶ $\gamma_t \geq 1$ and $\theta < 1$.
- ▶ With previous transitions, these determine the value functions.

Model: Utility of Potential Criminals

state at age t (F ou P)

$$V_t^S(w)$$

↑
age

↑
productivity at age t

Model: Utility of Potential Criminals

state at age t (F ou P)

$$\begin{array}{c} \downarrow \\ V_t^S(w) \\ \begin{array}{c} \uparrow \\ \text{age} \end{array} \quad \begin{array}{c} \uparrow \\ \text{productivity at age } t \end{array} \end{array}$$

- ▶ Value function for a **free** individual:

$$V_t^F(w) = w - f + \max\{U_{\text{non-crime}}, U_{\text{crime}}\},$$

where

$$U_{\text{non-crime}} = \beta V_{t+1}^F(\gamma_t w)$$

and

$$U_{\text{crime}} = \bar{\Pi}_t + (1 - \bar{p})\beta V_{t+1}^F(\gamma_t w) + \bar{p}\beta V_{t+1}^P(\gamma_t w).$$

Model: Utility of Potential Criminals

state at age t (F ou P)

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- ▶ Value function for an individual in **prison**:

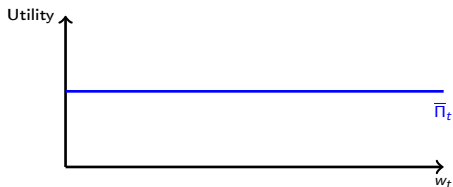
$$V_t^P(w) = b - f + \frac{\lambda}{\lambda + 1} \beta V_{t+1}^P(\theta w) + \frac{1}{\lambda + 1} \beta V_{t+1}^F(\theta w).$$

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 - ▶ Welfare
 - ▶ The Public Security Technology
- ▶ Estimation
- ▶ Quantitative Exercises

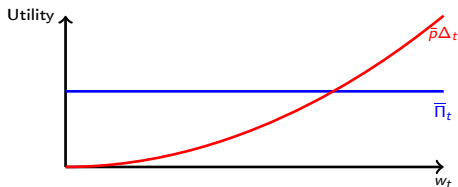
Model: Individual Choice

- ▶ Characterization of individual choice (for given crime rate ν):
 - ▶ Expected gain from crime: $\bar{\Pi}_t$.



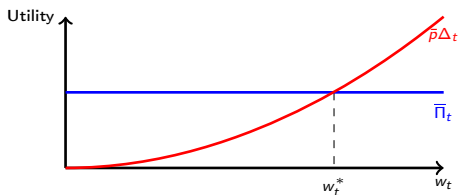
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 - ▶ Expected gain from crime: $\bar{\Pi}_t$.
 - ▶ Expected losses from crime:
 - ▶ Probability $(1 - \bar{p})$: 0.
 - ▶ Probability \bar{p} : difference Δ_t between starting next period free or in prison.



Model: Individual Choice

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 - ▶ Probability $(1 - \bar{p})$: 0.
 - ▶ Probability \bar{p} : difference Δ_t between starting next period free or in prison.
 - ▶ For each age t , there is a cut-off productivity w_t^* .
 - ▶ Using backward induction we determine w_t^* down to $t = 0$



Model: Equilibrium

- ▶ Rational expectations equilibrium:
 - ▶ Individual decision describes behavior for an aggregate crime rate v^* .
 - ▶ We have to find the equilibrium crime rate v^* consistent with individual decisions.

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Model: Welfare

- ▶ Policy choice is a triplet (k, λ, f) :
 - ▶ k : expenditures on police protection.
 - ▶ With the crime rate v , determines the detection probability:
 $p = p(v, k)$.
 - ▶ λ : average sentence length.
 - ▶ Constant cost κ per prisoner/period.
 - ▶ f : lump-sum tax to finance public security policy.
 - ▶ Government runs a balanced budget.

Model: Welfare

- ▶ Welfare maximization problem can be framed in terms of choice (k, λ) .
 - ▶ We use the utilitarian metric, but any other could be used.
 - ▶ Welfare loss from crime is given by:

$$\begin{aligned} & \text{direct losses from criminal event} \\ & + \underbrace{\text{prison expenditures} + \text{police expenditures}}_{\text{PSP's financial costs}} \\ & + \underbrace{\text{freedom deprivation} + \text{HK depreciation}}_{\text{Criminals' losses}}. \end{aligned}$$

- ▶ This total cost is what "accounting methodology" from literature on costs of crime tries to estimate.
 - ▶ But what is relevant is how it responds to changes in policy.

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Model: The Public Security Technology

- ▶ A theory of socially optimal crime and punishment has to deal with the definition of the public security technology.
 - ▶ $p(v, k)$, the probability of detecting a crime, as a function of:
 - ▶ k , police expenditures; and
 - ▶ v , the aggregate crime rate.
 - ▶ Previous literature assumes an arbitrary functional form.
 - ▶ Ehrlich (1973), Imrohoroglu et al. (2000), Fu and Wolpin (2018).

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 - ▶ Ehrlich (1973), Imrohoroglu et al. (2000), Fu and Wolpin (2018).
- ▶ But this object is not purely a technology.
 - ▶ It is the result of the behavior of police and criminals.
- ▶ We model explicitly the interaction between police and criminals to derive an endogenous public security technology.
 - ▶ Ferraz (2019) derives a similar function under much more general conditions.

Model: The Public Security Technology

- ▶ Police and Thieves Game:
 - ▶ There are police patrols (PP) deployed over some region.
 - ▶ Crimes close to a PP are more likely to be detected.
 - ▶ Criminals face uncertainty on the PP locations.
 - ▶ Number of PP is increasing on police expenditures.
 - ▶ Each arrest implies a cost for the criminal justice system.
 - ▶ Choices:
 - ▶ Police: locations of PP's to maximize arrests.
 - ▶ Thieves: locations of crimes to minimize prob. of arrest.

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 - ▶ Choices:
 - ▶ Police: locations of PP's to maximize arrests.
 - ▶ Thieves: locations of crimes to minimize prob. of arrest.
- ▶ Equilibrium in the police and thieves game leads to:

$$p(v, k) = 1 - \frac{L^W(\zeta_2 v e^{-\zeta_1 k + \zeta_2 v})}{\zeta_2 v}.$$

- ▶ Conditional on number of criminals and PP's.
 - ▶ L^W is the Lambert-W function.

Model: The Public Security Technology

- ▶ In the model: game police and criminals play each period, conditional on criminal and investment decisions.
- ▶ Micro-founded $p(v, k)$ respects all desirable properties, differently from arbitrary functions used by previous literature:
 - ▶ p is differentiable.
 - ▶ $p(v, \cdot)$ is strictly increasing in k .
 - ▶ $p(v, \cdot)$ is strictly concave in k .
 - ▶ $p(v, k) \rightarrow 0$ when $k \rightarrow 0$.
 - ▶ $p(v, k) \rightarrow 1$ when $k \rightarrow \infty$.
 - ▶ $p(\cdot, k)$ is decreasing in v .
 - ▶ Number of apprehensions, $vp(\cdot, k)$, is strictly increasing in v .

Road Map

- ▶ Introduction
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Data

- ▶ Property crime: robbery, larceny (>50 \$), burglary, auto-theft.
- ▶ Benchmark: US, 2004 (roughly constant prison population).
- ▶ Sources:
 - ▶ Official figures: NCVS, NCRP, CPS, Survey of Inmates in State and Federal Correctional Facilities, NLSY97, Sourcebook of Criminal Justice Statistics, CJEEE, United States Life Tables .
 - ▶ Empirical literature: Cohen (2000), Grogger (1995), Abrams and Rohlfs (2007), Levitt (1996), Levitt (2002), Fella and Gallipoli (2014).

Functional Forms and External Parameters

- ▶ Cost of committing a crime linear on age: b^C, c^C .
- ▶ Individuals retire (or are released from prison) at age 65 and earn a one-shot αw .
- ▶ Earnings: age profile and dispersion at age 18 from CPS.
- ▶ Parameters/exogenous variables from the literature:

Parameter	Value	Description
Time unity	1 year	
β	0.95 per year	discount rate (Fella and Gallipoli, 2014)
α	11.38	US 2004 Life Tables
λ_{2004}	17.8 months	average sentence length (BJS, 2004)
θ	0.91	Depreciation of HK in prison (Grogger, 1995)
z	848 dollars	average transfer per crime (Cohen, 2000, NCVS)
d_V	600 dollars	average damage per crime (Cohen, 2000, NCVS)
κ	26,000 dollars	cost per prisoner (CJEE, 2004, BJS)
k_{2004}	24 \$bn	police expenditures on property crimes (BJS, 2004)
M_0	540,000 (15%)	potential criminals (Sampson and Laub, 2003)

Estimation: Parameters

- ▶ 6 parameters to estimate:

Parameter	Interpretation
b^C, c^C	cost of committing a crime linear on age
ν	average number of crime opportunities per year
b	consumption equivalent of being in prison
ζ_1, ζ_2	public security technology parameters

Estimation: Moments

- ▶ We use 21 moments:
 - ▶ Age distribution of prison inflow (NCPR): 15.
 - ▶ Number of property crimes (NCVS): 1.
 - ▶ Number of prisoners for property crimes (NCPR): 1.
 - ▶ Value of 90 days of freedom (Abrams and Rohlfs, 2007): 1.
 - ▶ % of 18-19 year-olds committing crimes (NLSY): 1.
 - ▶ Police and incarceration elasticities (Levitt, 1996 and 2002): 2.

Estimation: Results

- ▶ 2-stage GMM, assuming diagonal variance-covariance matrix.

Parameter	Estimation	Unit
b^C	0.20 (0.0080)	hundreds of dollars/year
c^C	3.27 (0.3741)	hundreds of dollars
ν	10.08 (0.6512)	opportunities/year
b	82.94 (8.1641)	hundreds of dollars/year
ζ_1	0.969 (0.023)	
ζ_2	0.918×10^{-6} (0.420×10^{-6})	

Estimation: Targeted Moments

Moment	Data	Model
Inflow 18-24	39.5 (4.3)	36.0
Inflow 25-34	26.4 (3.7)	32.3
Inflow 35-44	22.0 (1.9)	23.0
Inflow 45+	12.1 (2.9)	8.7
Crime level	15032 (433)	15068
Value of Freedom	62.2 (37.4)	63.2
% criminals 18-23	3.00 (0.61)	3.16
Prisoners	509.7 (0.0235)	505.9
Elast. Police	-0.50 (0.24)	-0.58
Elast. Prisoners	-0.26 (0.12)	-0.28

Estimation: Untargeted Moments

Moment	Data	Model
% Prisoners 18-24	22.2	25.6
% Prisoners 25-34	33.6	35.5
% Prisoners 35-44	27.2	25.2
% Prisoners 45+	17.0	13.7
Avg # crimes/year for active criminals	7.3	9.0
Lifetime prob. of jail (%)	1.8-2.3	1.8

Road Map

- ▶ Introduction
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- ▶ Estimation
- ▶ Quantitative Exercises
 - ▶ Main Results
 - ▶ Political Constraints
 - ▶ Effect Decomposition

Quantitative Exercises: Optimal Policy

- ▶ Comparison of optimum to 2004 policy.

	Optimum	$\Delta\%$ of 2004
Average time in prison	22.3 mth	25.3
Expenditures on police	18.8 \$bn	-21.7
Expenditures on PSP	33.1 \$bn	-11.0
Number of crimes	16.9 mi	11.9
Total loss	62.9 \$bn	-1.6

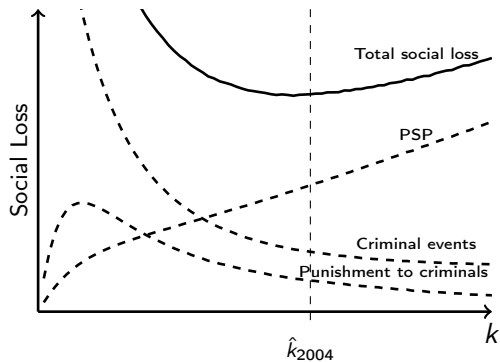
- ▶ Despite increase in prison population, roughly constant number of individuals going through prison at some moment in life.
 - ▶ Remember: we only consider property crime, 20% of total inmate population in early 2000s.

Quantitative Exercises: Decomposition of Welfare Gains

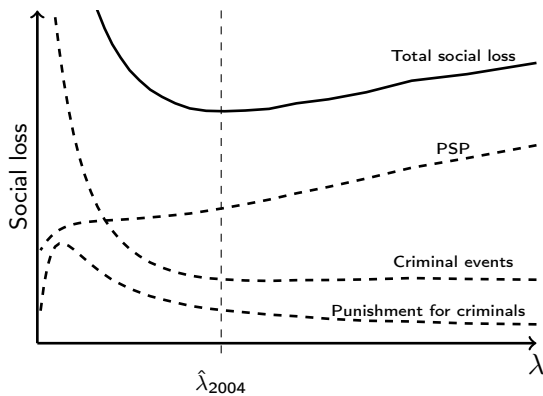
- ▶ The only source of welfare gains is the reduction in police expenditures.
- ▶ Still, it compensates all other dimensions of losses.

All sources	1
Public Safety	
Total	4
Police	5.2
Prison	-1.2
Crime	-2.1
Criminals	
Total	-0.9
Freedom deprivation	0.2
HK depreciation	-1.1

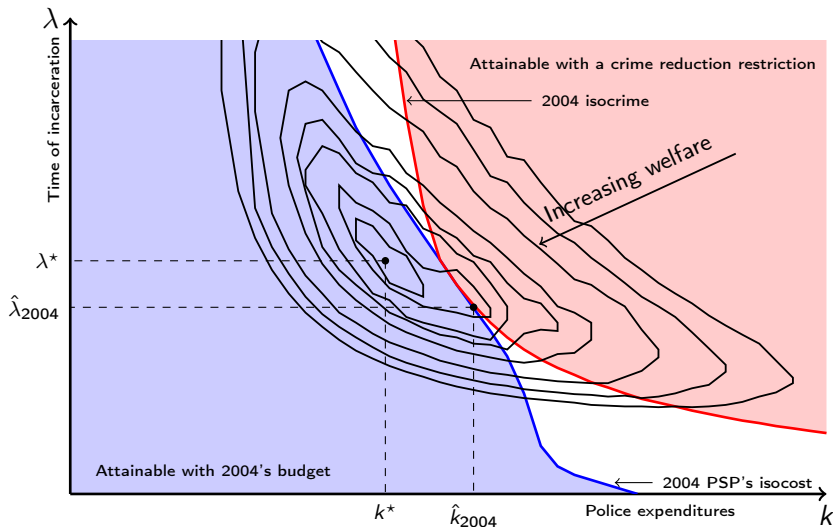
Quantitative Exercises: Changing only Police Expenditures k



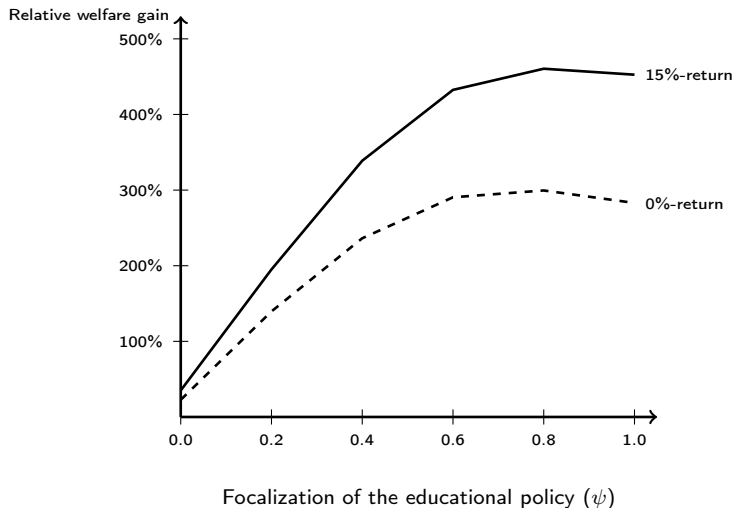
Quantitative Exercises: Changing only Sentences λ



Results: Policy Choices under Alternative Constraints



Results: Reallocation of PS Expenditures to Education



- ▶ Additional welfare gain with possibility of PSP defunding to fund education (excluding direct gains from education).

Conclusion

- ▶ Manageable quantitative model that incorporates various dimensions of crime.
- ▶ Equilibrium, dynamics, and interactions across different policies turn out to be important.
- ▶ Some novel components in the theoretical analysis:
 - ▶ Endogenous public security technology.
 - ▶ Life-cycle of income with HK depreciation from incarceration.
 - ▶ Endogenous selection into crime.
 - ▶ Load effect.
 - ▶ Three dimensions of policy.
- ▶ We map classical empirical effects – deterrence, incapacitation, and recidivism – onto their theoretical counterparts.
- ▶ Framework also useful to shed light on potential trade-offs across public security and social policies.