World-wide Crime

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EEA – ESEM Barcelona 2023: 38th Meeting of the European Economic Association and 75th European Meeting of the Econometric Society

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Roadmap

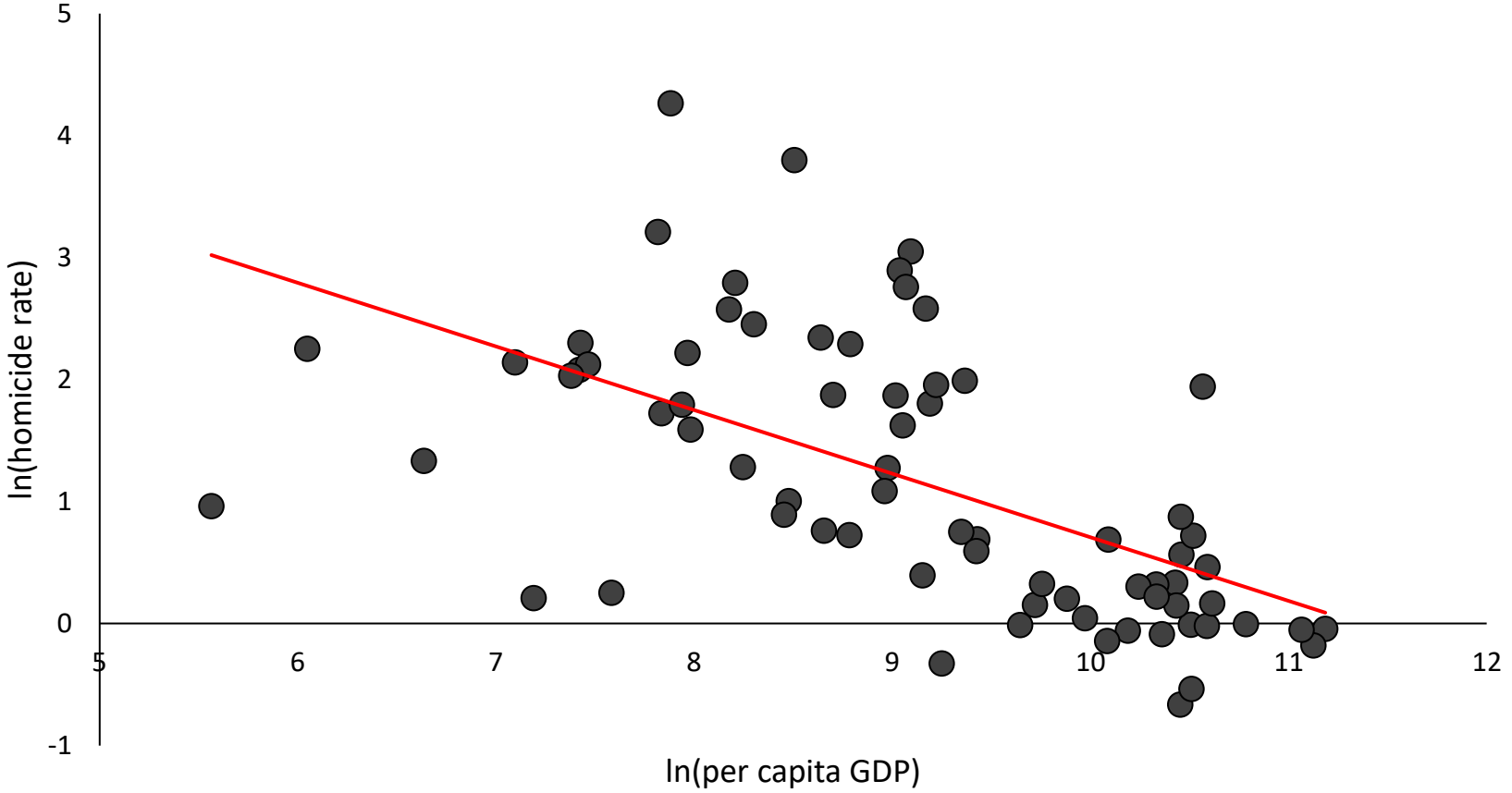
1. Motivation
2. A Search Model for Criminal Behavior
3. Theoretical Determinants of Crime Rates
4. Violent World-wide Crime: Empirical Results
5. Conclusions

1. Motivation

Motivation

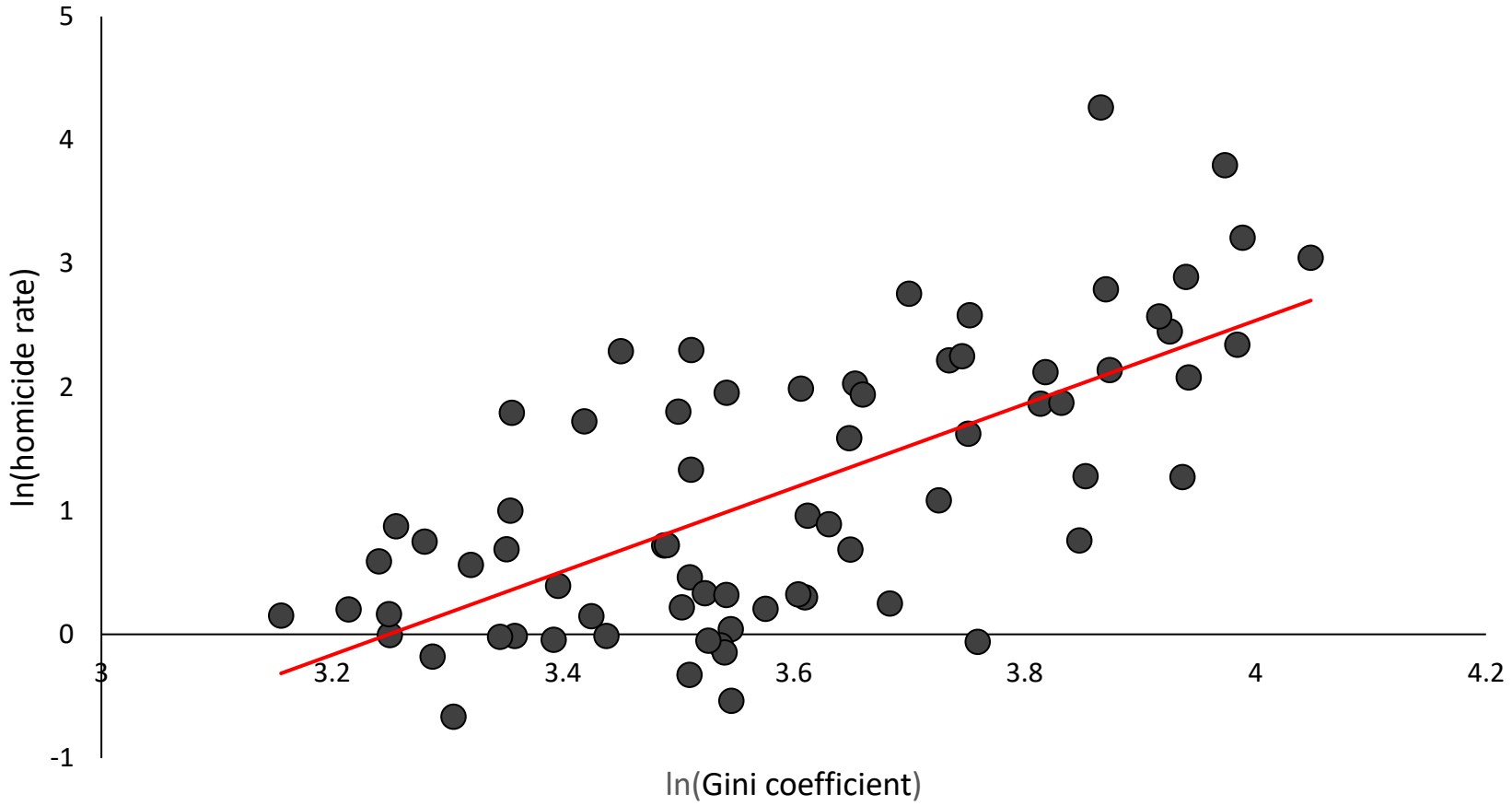
- Crime represents a **major policy concern** in most countries of the world
- It has **negative consequences for the well-being of citizens** and the **efficient performance of the economy**
- Crime rates **differ between countries and over time**
  - LAC and SSA are the regions with the highest incidence of violent crime in the world
- Countries also differ substantially in many dimensions that may matter for crime:
  - **Average income level, income inequality, average level of education, police force, and the probability of apprehension**

Cross-country correlation between homicide rate and per capita GDP



Note: data points represent long-term averages for each country included in the empirical section of this paper. The red line depicts statistical cross-country correlations estimated by OLS regression.

Cross-country correlation between homicide rate and Gini coefficient



Note: data points represent long-term averages for each country included in the empirical section of this paper. The red line depicts statistical cross-country correlations estimated by OLS regression.

Theoretical Models of Crime Behavior (1/2)

a) **Static Models:**

- **Becker (1968)**
  - Crime decision results from a rational decision based on static benefits and costs of the criminal act
  - A higher expected value of the loot incentivizes crime; a larger probability of being captured and more drastic punishment discourage crime
- **Stigler (1970) and Ehrlich (1973)**
  - Extend Becker's model by including some economic variables that affect crime incidence (education, labor wage)

Limitations: static ad-hoc models that do not model the mechanisms by which variables co-determine crime

Theoretical Models of Crime Behavior (2/2)

b) Dynamic Models:

- **Burdett et al. (2003, 2004)**
  - Propose a **dynamic general-equilibrium search model of crime and other illegal activities**
  - They model an environment where **unemployment, income inequality, and crime are simultaneously determined in equilibrium**, and analyze the effects of anti-crime policies
- **Huang et al. (2004)**
  - In a model similar to Burdett et al.'s, they add **individuals' schooling** decisions and derive the relationship between levels of educational attainment and crime

Limitations: dynamic models do not derive analytically the effects of economic variables and do not consider some restrictions (i.e., the government's budget constraint) on crime

Empirical Models of Criminal Behavior

- Empirical research on crime (most not based on models) has focused on **benefits and costs related to criminal actions (based on Becker's model)**. Studies identify the following as the main determinants of crime rates in the world:
  a) **Level and growth rate of income (-)** (Ehrlich, 1976; Fleisher, 1996; Kelly, 2000; Fajnzylber et al., 2001; Di Tella et al., 2010)
  b) **Income inequality (+)** (Ehrlich, 1973; Fajnzylber et al., 2002; Di Tella et al., 2010)
  c) **Educational level (-)**(Ehrlich, 1975; 1994; Soares, 2004; Lochner, 2010)
  d) **Unemployment rate (+)** (Ehrlich, 1973; Fougère et al., 2000)
  e) **Police force and severity of penalties (+/-)** (Levitt, 1996, 1997; Levitt, 1997; Lin, 2009; Mocan and Gittins, 2010)
  f) **Sociological and institutional factors: social capital** (Lederman et al., 2002), **demographic composition** (Fajnzylber et al., 2002, Saridakis, 2004; Feld and Bishop, 2012), **political system** (Lin, 2007)

This paper

This paper's objectives:

- Analyze theoretically and empirically the determinants of crime
- Develop a theoretical framework with closed-form solutions for a dynamic general-equilibrium search model of crime (and employment)
- Validate empirically theoretical model by testing for key determinants of homicide rates in a world-wide country panel
  - ➢ Based on econometric estimations of an empirical specification – that follows closely our theoretical model – for a world panel database

2. A Search Model of Crime Behavior

The model

- We develop a **dynamic general-equilibrium search model** to better understand the **determinants of crime rates**, based on Burdett et al. (2003, 2004)
- Our model is about **common crime**. As is the case of Burdett et al. (2003), our model is not well suited to analyze white-collar crime
- We extend Burdett et al. (2003) in four key dimensions:
  - An **exogenous police force**, which affects crime by lowering the opportunity to commit crime, raising the probability of being caught, and reducing the non-institutionalized population
  - The **government's budget constraint**, with an endogenous tax rate
  - A **Pareto distribution function of wages**, which includes location and Theil index parameters
  - We **derive analytically (obtaining closed-form solutions) the effects of key crime determinants on crime rates**

Agents

- The economy is populated by five classes of infinitely lived and risk neutral agents and the government:
  a) A [0, 1-α] continuum of **homogeneous workers**: **employed (e) at some wage w (e), unemployed (u), and jailed (n)**
  b) A continuum [0, α] of **homogeneous police officers** (not included in Burdett et al.)
  c) A continuum [0, N] of **homogeneous firms**. Firm post a wage that they are willing to pay workers, according to a F(w) cdf
- r is the rate of time preference

Job market dynamics

- **Unemployed workers:** (i) consume b (unemployment insurance paid by the government) and (ii) receive i.i.d. wage offers from F at rate λ
- **Employed workers:** (i) consume w, (ii) pay taxes at a rate t (not considered by Burdett et al.), (iii) receive i.i.d. wage offers from *F* at rate λ , and (iv) are laid off at rate δ
- **Jailed workers:** (i) consume z (a government transfer), (ii) receive no job offers until released, and (iii) are released into unemployment at rate ρ
- **Police officers:** (i) consume w_p (paid by the government) and their job is to prevent crime and capture criminals; (ii) hold their jobs indefinitely , and (iii) do not commit crime

Crime market dynamics (1/2)

- A **crime opportunity:** chance to steal some amount g>0
- e and u workers find **opportunities to commit crimes at rate $\mu(\alpha)$** (a function that decreases with the number of police officers; crime-prevention role of police)
- The **probability of being caught by police and sent to jail is $\pi(\alpha)$** (a function that increases with the number of police officers, crime-repression role of police)
- Let **$\phi(w)$ (ϕ_0) the probability that an e and u worker commits a crime** given an opportunity
- e and u workers also **fall victim to crime at an exogenous rate γ**. When victimized an e (u) worker suffers a loss equal to her wage or her unemploym. insur.: $l_1(w) = w$; $l_0 =$ b

Crime market dynamics (2/2)

- The value functions are $V_1(w)$, V_0 , J, and P for e, u, n, and police, respectively
- The expected pay-off from crime for an e (u) worker is $K_1(w)$ (K_0):

$$K_0 = g + \pi(\alpha)J + \big(1 - \pi(\alpha)\big)V_0$$

$$K_1 = g + \pi(\alpha)J + \big(1 - \pi(\alpha)\big)V_1(w)$$

- u worker commits a crime iff $K_0 > V_0$ and e worker commits a crime iff $K_1(w) > V_1(w)$:

$$\phi_0 = \begin{cases} 1 & if \quad V_0 - J < \dfrac{g}{\pi(\alpha)} \\ 0 & if \quad V_0 - J > \dfrac{g}{\pi(\alpha)} \end{cases} \qquad \phi_1(w) = \begin{cases} 1 & if \quad V_1(w) - J < \dfrac{g}{\pi(\alpha)} \\ 0 & if \quad V_1(w) - J > \dfrac{g}{\pi(\alpha)} \end{cases}$$

Flow-value functions

- The Bellman equation for **unemployed (u)** is:

$$rV_0 = b(1-\gamma) + \mu(\alpha)\phi_0(K_0 - V_0) + \lambda \mathrm{E}\left[\max_x\{V_1(x) - V_0, 0\}\right]$$

- The Bellman equation for **employed (e)** is:

$$rV_1(w) = w(1-\gamma)(1-t) + \mu(\alpha)\phi_1(w)\big(K_1(w) - V_1(w)\big) + \delta\big(V_0 - V_1(w)\big) + \lambda \mathrm{E}\left[\max_x\{V_1(x) - V_1(w), 0\}\right]$$

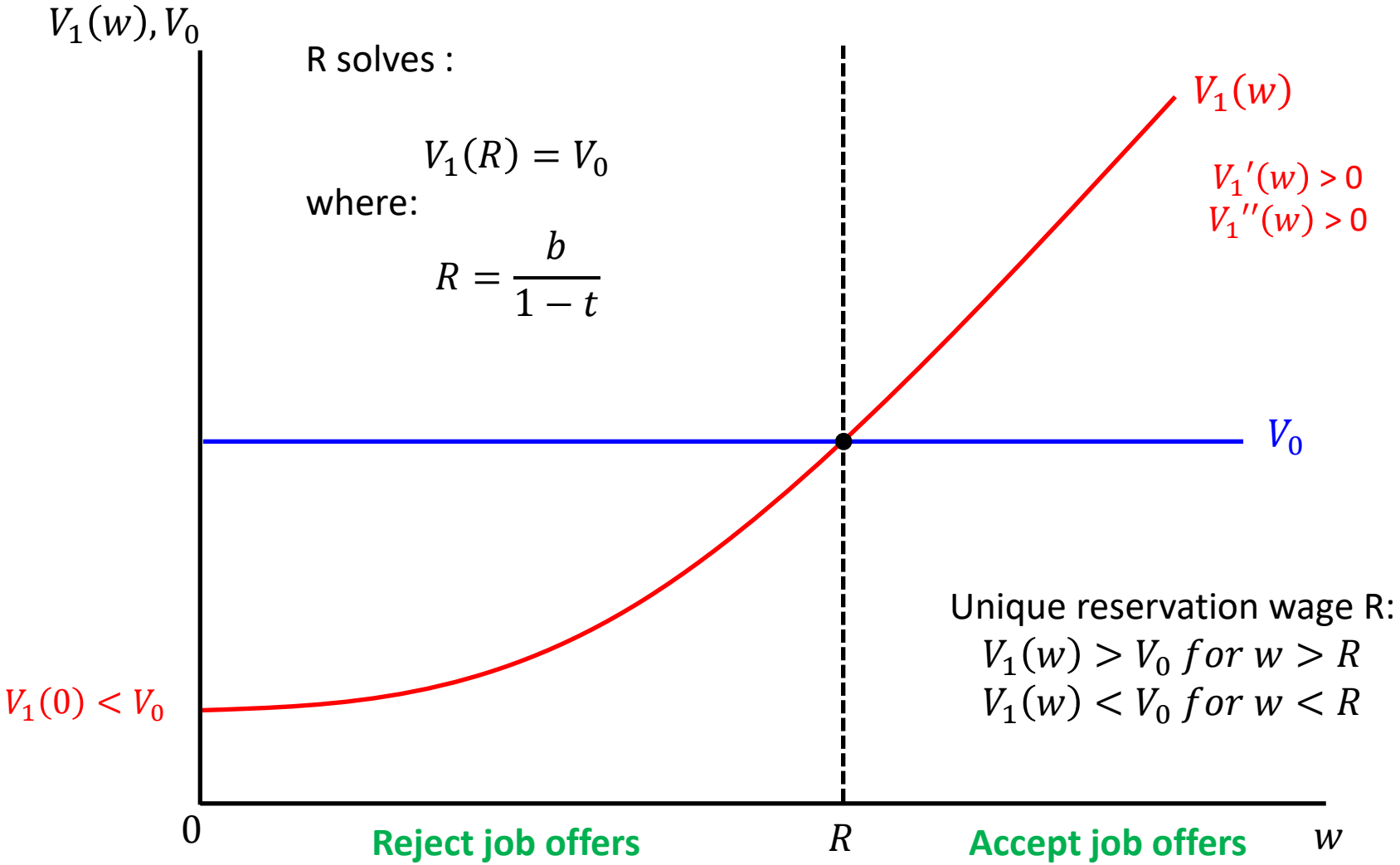
- The Bellman equation for **jailed (n)** is:

$$rJ = z + \rho(V_0 - J)$$

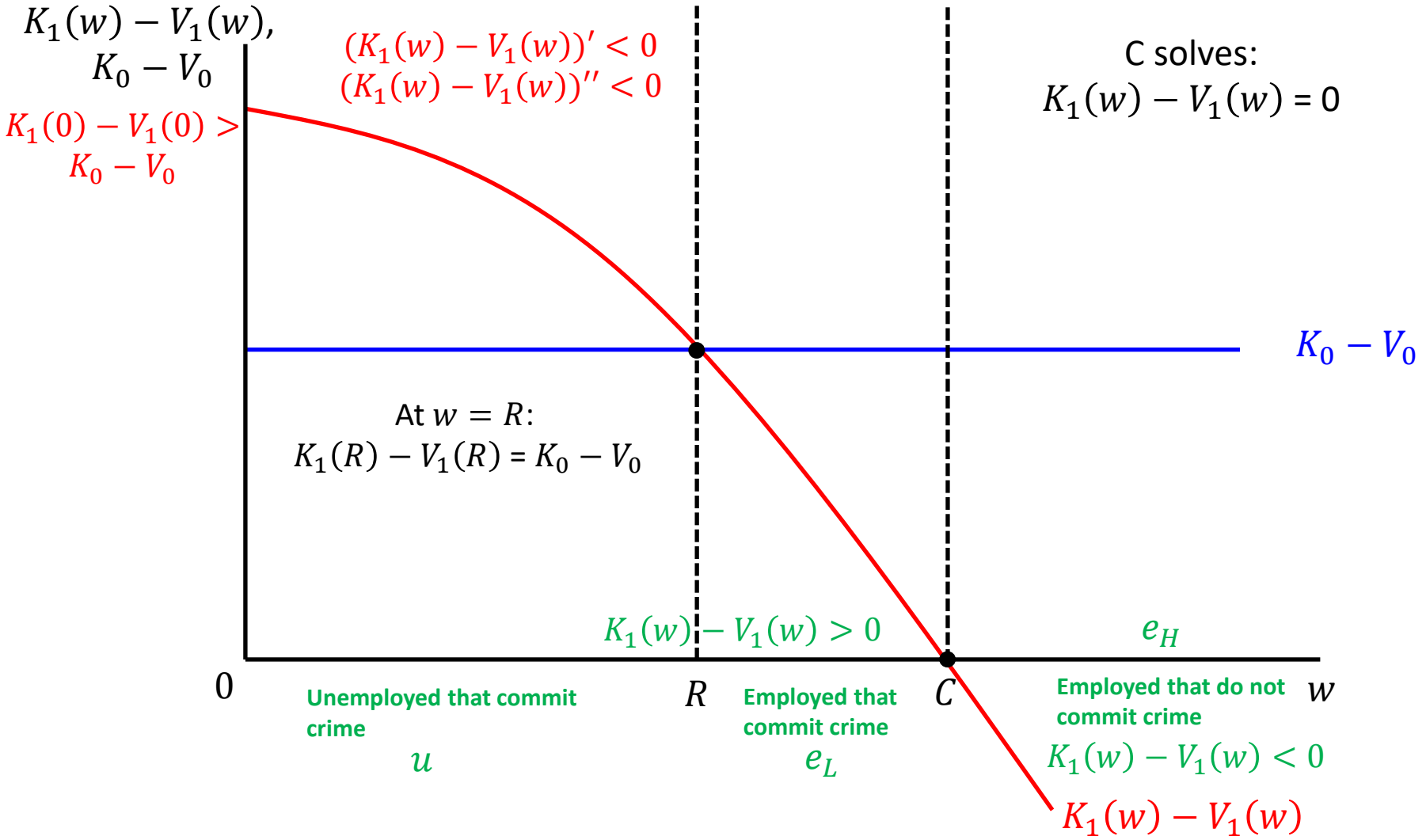
- The Bellman equation for **police (P)** is:

$$rP = w_p$$

Job decision

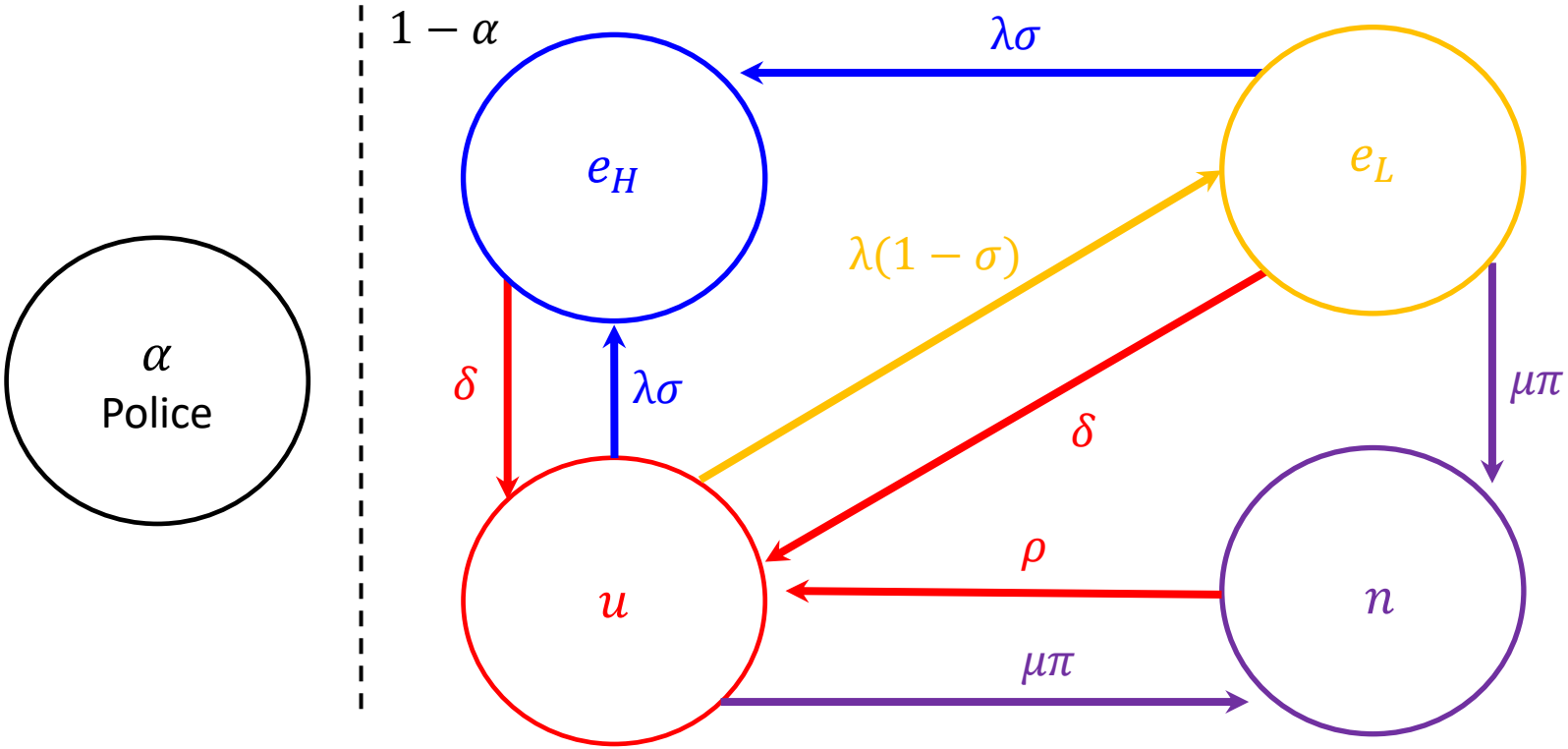


Crime decision



Economy flows

- Let $\sigma = 1 - F(C)$ be the fraction of firms offering at least C. We specify the following Pareto cdf for $F(w) = 1 - \left(\frac{R-\varphi}{w}\right)^{\beta}$ where φ is the location parameter and $\beta > 1$ is the Theil Index



Steady-state Equilibrium

- Let t^{ss} be the steady-state tax rate that satisfies the s.s. budget constraint:

$$t^{ss}\int_R^{\infty} w dF(w) = bu^{ss} + \alpha w_p + zn^{ss}$$

- In s.s. each variable satisfies $X_{t+1} - X_t = 0$, jobs are offered at $w \geq R$ with probability 1 and $\phi_0 = 1$. Then,

$$n^{ss} = \frac{(1-\alpha)(\delta + \mu(\alpha)\pi(\alpha) + \lambda)\mu(\alpha)\pi(\alpha)\delta}{\Omega} \qquad e_H^{ss} = \frac{(1-\alpha)(\delta + \mu(\alpha)\pi(\alpha) + \lambda)\rho\lambda\sigma}{\Omega}$$

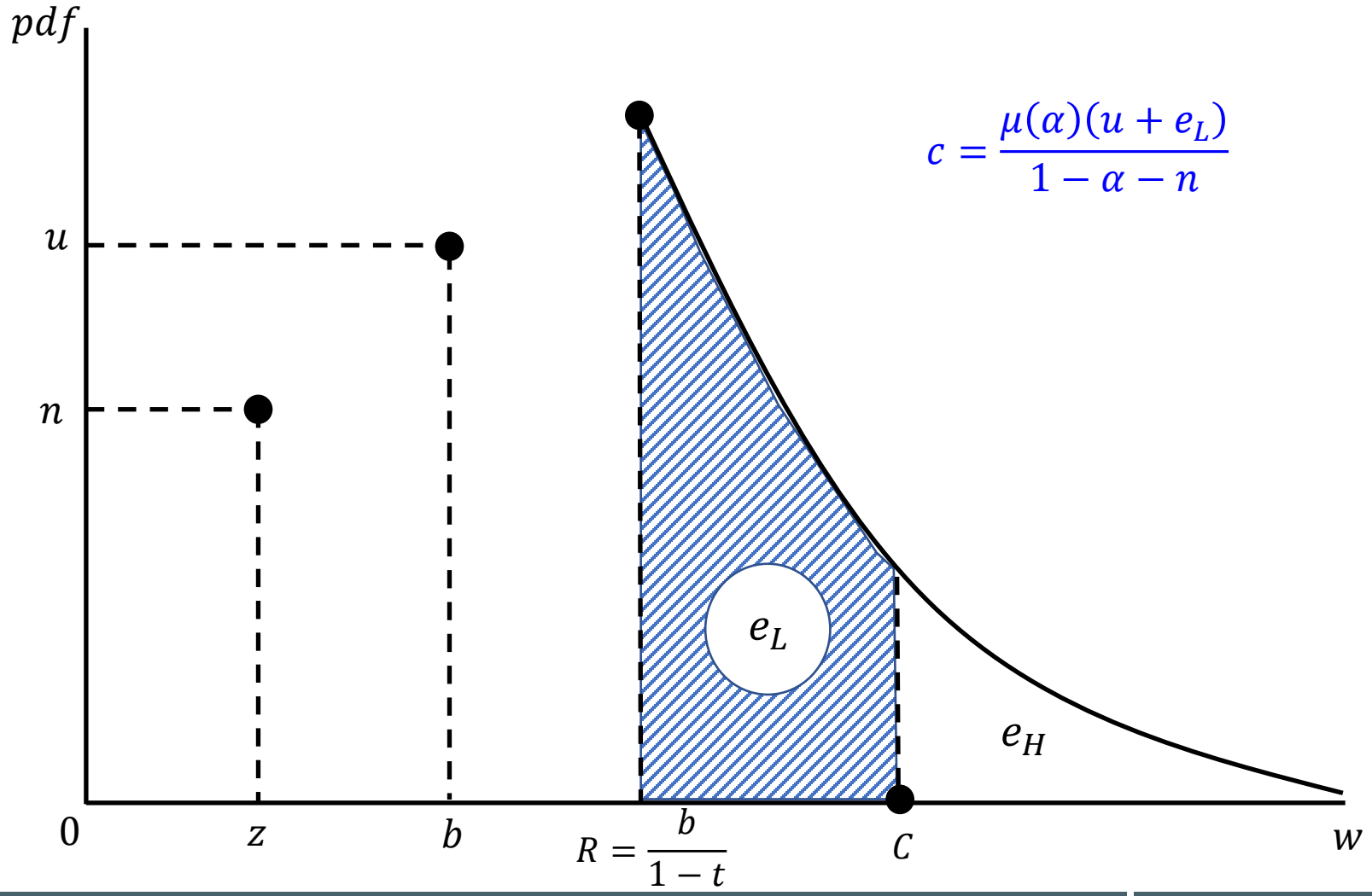
$$u^{ss} = \frac{(1-\alpha)(\delta + \mu(\alpha)\pi(\alpha) + \lambda\sigma)\rho\delta}{\Omega} \qquad e_L^{ss} = \frac{(1-\alpha)(1-\sigma)\rho\delta\lambda}{\Omega}$$

- The s.s. crime rate is:

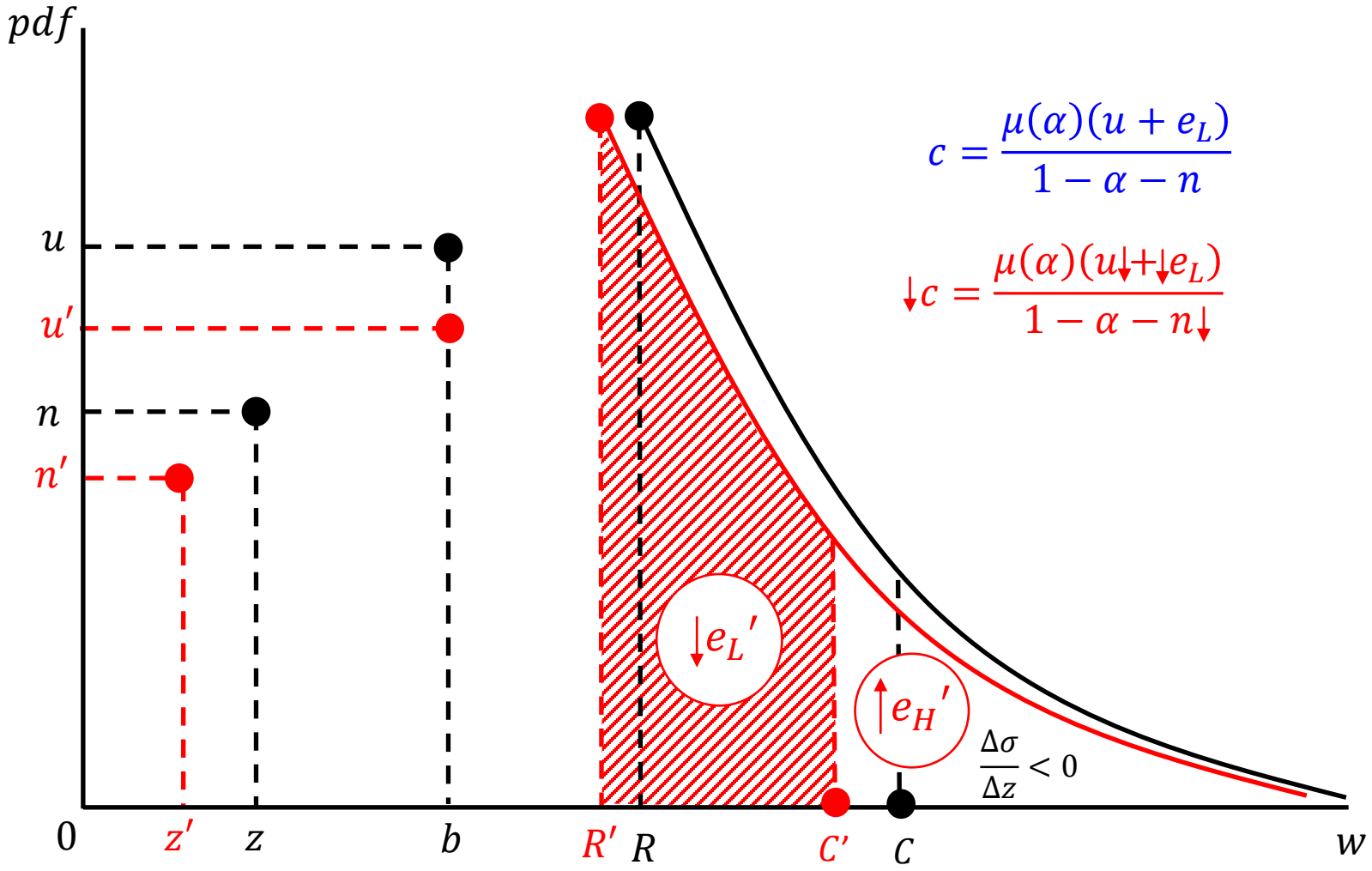
$$c^{ss} = \frac{\mu(\alpha)(u^{ss} + e_L^{ss})}{1-\alpha-n^{ss}} = \frac{\mu(\alpha)\delta}{\delta + \lambda\sigma}$$

3. Theoretical Determinants of Crime Rates

An example: effects of more severe criminal penalties (lower z)



An example: effects of more severe criminal penalties (lower z)



Theoretical Determinants of Crime Rates (partial derivatives in the paper)

Determinant	Exogenous Variable	Description	Effect on crime rates	Explanations
Severity of penalties	Lower z	More severe criminal penalties (lower consumption of jailed individuals)	Negative	More severe penalties discourage criminal action due to lower consumption in prison, reducing the expected profit from committing crime. These effects are amplified by an endogenous lower tax rate
	Lower ρ	Longer sentences	Negative	Longer sentences lower criminal action due to higher time in prison, lowering the expected profit from committing crime. These effects are amplified by a lower tax rate
Inequality	Higher β	Higher Theil Index in F(w)	Positive	Higher inequality generates less probability of obtaining better wages in the labor market. This is amplified by a higher tax rate
Average Income	Higher φ	Higher expected wage	Negative	A distribution with a higher expected wage generates a higher probability of obtaining a better wage. This is amplified by a lower tax rate
Police	Higher α	Higher proportion of police officers	Ambiguous	More police officers make it harder to commit crime and more likely to be caught (discouraging crime). This effect is compensated by a higher endogenous tax rate to finance more police officers, which makes it more costly to be unemployed or employed (promoting crime)
Unemployment	Higher b	Higher unemployment benefits	Positive	Higher unemployment benefits incentivize being unemployed, which increases the crime rate. This is amplified by a higher tax rate

4. Violent World-wide Crime: Empirical Results

Empirical Specification (1/2)

- We use the following dynamic model with unobserved country-specific effects:

$$Y_{i,t} = \gamma Y_{i,t-1} + \theta' X_{i,t} + \eta_i + \varepsilon_{i,t}$$

- The dependent variable Y is the crime rate, X is the set of independent variables, γ is the regression coefficient of the lagged dependent variable, θ is a vector of regression coefficients, η_i is a country-specific factor (which could be correlated with explanatory variables), and $\varepsilon_{i,t}$ is the error term
- Subscripts i and t denote country and time period, respectively

Empirical Specification (2/2)

- **Core model**
  - **Dependent variable:** the crime rate (c) is measured by the national intentional homicide rate defined as ratio to inhabitants
  - **Independent variables:**
    - For the average wage level ($\overline{w} + \varphi$) we use per capita GDP
    - For wage dispersion (β) we use the Gini coefficient
    - For unemployed workers (u) we use the unemployment rate
    - For a measure of police (α) we use the ratio of the number of police officers to inhabitants
- **Extended model**
  - **Additional independent variables:**
    - For an extreme proxy of the negative of this net transfer ($z \to -\infty$) we use a country dummy for the death penalty
    - For a country feature that reflects more profitable crime opportunities we use a country dummy for prevalence of drugs
    - For a key determinant of the average wage level ($\overline{w} + \varphi$) we add educational attainment as a measure of human capital

Data

- **Sample criteria:** sample determined by
  - quality of available UNODC crime data
  - availability of at least three consecutive observations
- **Data structure:** quinquennial data
- **Period coverage:** 1974-2018
- **World panel sample:**
  - 68 countries
  - Sample includes at least 2 countries in each regional category according to IMF classification. There are 33 AE, 15 LAC, 10 EDE, 5 EDA, 3 MECA, and 2 SSA

Definitions and Sources of Variables used in Regression Analysis

Variable	Definition and Construction	Source
Log homicide rate	Log of the count of deaths purposely inflicted by other persons, per 100,000 inhabitants. Count of homicides reported by the United Nations Office on Drugs and Crime (UNODC) and population reported by the World Bank	UNODC, Homicide Statistics (2019), United Nations Surveys on Crime Trends and the Operations of Criminal Justice Systems (various issues), and World Bank database
Log per capita GDP	Log of the ratio between the series "GDP, PPP (constant 2017, international $)" and "Population" reported by the World Bank, thousands of dollars	World Development Indicators (World Bank)
Income concentration or inequality	Gini index	World Development Indicators (World Bank) and Deininger and Squire (1996)
Educational attainment	Average years of schooling of the population aged 25 and above	UNESCO (2017)
Unemployment rate	Reported by the World Bank	World Development Indicators (World Bank)
Log police rate	Log of the count of police personnel per 100,000 inhabitants. Count of police personnel reported by UNODC and population reported by the World Bank	UNODC, Homicide Statistics (2019), UN Surveys on Crime Trends and the Operations of Criminal Justice Systems (various issues), and World Bank database
Death penalty	Dummy for countries where the death penalty is legal (1) or not (0)	Amnesty International. List of Abolitionist and Retentionist Countries
Drug prevalence	Dummy for countries classified as major illicit drug-producing and/or drug-transit countries (1) or not (0)	U.S. Department of State, Bureau of International Narcotics and Law Enforcement Affairs, International Narcotics Control Strategy Report, various issues

Estimation Method

- **Two Step Dynamic System GMM:** we adopt the GMM estimator in its dynamic system version, which performs jointly regressions in levels and in first differences
  - All independent variables are treated **as potentially endogenous**, using their first and second lags as internal instruments
  - **Specification tests:** we perform the Hansen test for the null hypothesis of overall validity of instruments and the Arellano and Bond test for first and second-order serial correlation of errors
  - We present results with and without the Windmeijer correction
- **Robustness check:** we report regression results for alternative estimation models
  - We perform **cross-section estimation (Between Estimator)**, **Pooled OLS Estimator**, and **Instrumental Variable Fixed Effect Estimator (IV-FE)**

Estimation Results for Homicide Rates

	Dependent variable: log of homicide rate				
Explanatory Variables	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**
Lagged dependent variable	0.930*** (0.013)	0.841*** (0.345)	0.888 *** (0.018)	0.886 *** (0.015)	0.847 *** (0.022)
Log per capita GDP	-0.212*** (0.011)	-0.272** (0.137)	-0.105*** (0.015)	-0.421*** (0.022)	-0.096** (0.021)
Income Concentration	0.077*** (0.033)	0.108*** (0.033)	0.011*** (0.002)	0.046*** (0.002)	0.007** (0.002)
Unemployment Rate	-0.006*** (0.002)	-0.017 (0.040)	-0.010*** (0.003)	0.010 (0.011)	-0.006* (0.003)
Log Police Rate	0.050** (0.026)	0.127** (0.067)	-0.003 (0.050)	0.294*** (0.061)	0.107** (0.045)
Death Penalty			-0.054** (0.026)	-0.020 (0.061)	0.019 (0.028)
Drug Prevalence				0.486*** (0.170)	0.130*** (0.070)
Educational Attainment					0.005 (0.007)
Constant	0.000 (0.013)	-0.143 (0.179)	-0.121 (0.124)	-0.071 (0.131)	0.362 (0.195)
Time dummy	Yes	Yes	Yes	Yes	Yes
Country dummy	Yes	Yes	Yes	Yes	Yes
Observations	364	364	364	364	364
Countries	68	68	68	68	68
Specification tests (p-values)					
Hansen test	0.694	0.929	0.911	0.845	0.493
Serial correlation:					
(i) First order	0.017	0.005	0.018	0.017	0.018
(ii) Second order	0.355	0.623	0.306	0.331	0.342

Note: statistical significance levels are denoted by *** (1%), ** (5%), and *(10%). Column (1) presents results without the Windmeijer correction and columns (2)-(5) present results using the Windmeijer correction.

Robustness Check for our Core Model Results

Explanatory Variables	Dependent variable: log of homicide rate			
	(1) Cross-section	(2) Pooled OLS	(3) IV – Fixed Effects	(4) GMM
Lagged dependent variable		0.890***	0.464***	0.841***
		(0.025)	-0.078	-0.345
Log per capita GDP	-0.432***	-0.074***	-0.386**	-0.272**
	-0.035	(0.018)	-0.187	-0.137
Income Concentration	0.058***	0.009***	-0.009	0.108***
	-0.005	(0.003)	-0.01	-0.033
Unemployment Rate	0.001	-0.005	-0.005	-0.017
	-0.009	(0.005)	-0.007	-0.04
log Police Rate	0.242**	0.029	0.134**	0.127**
	(0.078)	(0.034)	(0.067)	(0.067)
Observations	68	364	364	364
Countries	68	68	68	68

Notes: statistical significance levels are denoted by *** (1%), ** (5%), and *(10%).

5. Conclusions

Conclusions

- This paper **analyzes theoretically and empirically the determinants of crime**
- We develop a **dynamic general equilibrium search model based on Burdett et al. (2004)**, which we extend by introducing: (i) an exogenous police force, (ii) the government's budget constraint, (iii) a cdf for wages that includes location and Theil index parameters, and (iv) we derive analytically the effects of the key crime determinants on crime rates
- We **estimate a dynamic model of homicide rates, for a panel of 68 AE and EMDEs for the 1974-2018 period** (largest crime database used to date in crime research)
- The **empirical results provide evidence in favor of our model of criminal behavior**

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