Communities, Youth Crime, and Deterrence: A Quantitative Theoretic Analysis*

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Abstract

This paper develops a two-community, equilibrium model of property crime wherein the residential choices of households, the criminal decisions of youths, and the deterrence policies of communities are endogenously determined. I first characterize equilibrium at a fairly general level. I then calibrate the model to match characteristics of central cities and suburbs in U.S. metropolitan areas as measured in 1990, and examine the impact of earmarking an additional 100,000 police to central city police departments. In politico-economic equilibrium, this policy crowds-out locally financed central city police expenditures and has relatively little impact on the crime rate in either the central city or the suburbs. Most of its impact is reflected in a lower central city property tax rate, a higher net (of property tax) central city housing services price, and a reallocation of central city financed expenditures from law enforcement to education.

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1 Introduction

In an economy with multiple communities, government policies influence crime rates through a variety of channels. One important channel involves the impact of deterrence policy on the relative returns to legitimate versus illegitimate activities. Another important channel involves how such policies influence community composition through the residential choices of households.[1] Yet another important channel involves how local government policies will respond to central government interventions. These channels conspire to make the study of interjurisdictional crime policy a complex web. This paper takes a step toward untangling this web by developing a two-community model wherein the residential choices of households, the criminal decisions of youths, and the expenditure policies of local police departments and school districts are endogenously determined.

All of these channels were clearly at work when President Clinton's Community Oriented Policing Services (COPS) program was implemented between 1995 and 2000. The COPS program was designed to allocate $8.8 billion of federal grants so that local communities throughout the nation could hire 100,000 additional police officers during this period.[2] The idea was to target resources so that crime would be reduced throughout the nation, but especially in high-crime areas such as the inner cities where local law enforcement resources were thought to be inadequate. In implementing initiatives of this type, however, policymakers should be concerned about the connections mentioned above. A policy that favors a particular set of communities, for instance, could cause crime to spillover into neighboring communities, residents to relocate, and local governments in both low- and high-crime areas to adjust their own law enforcement spending as well. The complete impact of many state and federal crime-fighting policies can be assessed, therefore, only by accounting for all these channels.

In this paper, I develop a theoretical framework for examining this problem and report the results of a computational experiment specific to a stylized version of the COPS program. The model, which is laid out in section 2, integrates two influential and previously distinct lines of research. The first

[1] Recent empirical papers by Cullen and Levitt [7] and Glaeser and Sacerdote [29] emphasize the links between household mobility, community population size and crime rates.

[2] For a concise summary of the 1994 'Crime Bill' and the COPS program, see U.S. Department of Justice [56].

is the multiple-community literature that emphasizes how variation in the provision of local public goods interacts with households' choices of residential locations.[3] The second is the literature that deals with the equilibrium behavior of the criminal sector but abstracts from residential choices of households.[4] My work is similar to Epple and Platt [16] in terms of its focus on residential choice and voting behavior in a multiple-community setting where households differ in more than one respect. While their general analysis explicitly allows for many communities and mine considers only two, they do not incorporate a criminal sector. On the other hand, İmrohoroğlu et al. [33] use quantitative theory to study the link between aggregate property crime rates, law enforcement, and income redistribution in the context of a political economy model. Since their focus is on national aggregates, they abstract from issues involving multiple jurisdictions. Freeman et al. [25], Marceau [36], and Newlon [41] develop models with more than one community and mobile criminals, but abstract from the residential choices of households. My work provides a unified equilibrium framework for analyzing all of these elements of interjurisdictional crime policy in a multiple-community setting.[5]

The computational analysis, which is presented in section 3, offers a potential explanation for why urban crime rates have persistently exceeded those in suburban areas even though the national crime rate has decreased rapidly during the 1990s (see Figure 1). In this section, the COPS program is characterized as providing all of its resources to the high-crime central city. When local public policies are treated as exogenous to this federally-financed intervention, the simulated impact of the COPS program is a dramatic convergence of urban and suburban crime rates. In the more sophisticated en-

[3]A number of the key papers in this tradition include Benabou [3], de Bartolome [8], Ellickson [14], Epple, Filimon, and Romer [15], Epple and Platt [16], Epple and Romer [19], Fernandez and Rogerson ([22], [23]), Rose-Ackerman [43], Tiebout [48], and Westhoff [64].

[4]Included here are Balkin and McDonald [1], Boadway, Marceau and Marchand [4], Chiu and Madden [5], Deutsch, Hakim and Weinblatt [10], Ehrlich ([12],[13]), Fender [21], Freeman, Grogger and Sonstelie [25], Furlong [27], Glaeser, Sacerdote and Scheinkman [28], İmrohoroğlu, Merlo, and Rupert [33], Lacroix and Marceau [34], Marceau [36], Newlon [41], Sah [44], Usher ([61],[62]), and Zak [65]. A series of interesting early pieces on the economic analysis of interjurisdictional crime policy include Fabrikant [20], Hakim [31], Hakim, Ovadia, Sagi, and Weinblatt [32], Mehay [39], Shoup [46], and Weinblatt, Spiegel, Hakim and Benzion [63]. The seminal piece on the economics of crime is Becker [2].

[5]It is also reminiscent of Fernandez and Rogerson [23] in terms of using a community choice model for purposes of quantitative policy analysis.

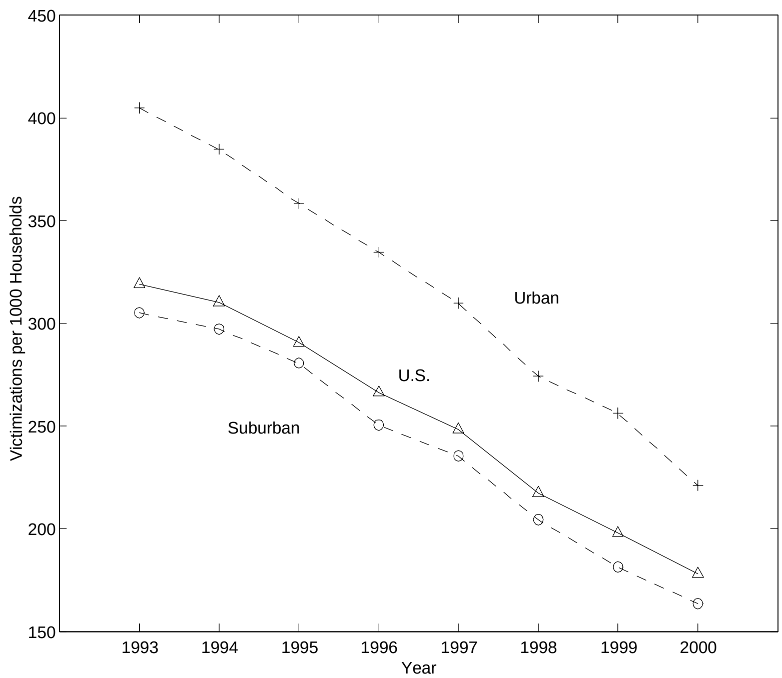

Figure 1: Property Crime in the U.S. (Source: U.S. Department of Justice [55, 1985-2000 Issues])

vironment where local public policies can respond to the COPS program, however, the federal intervention is largely undone by central city policy changes. In particular, central city voters respond to the federal augmentation of their own law enforcement resources by reducing their property tax burden and shifting the composition of their locally-financed spending towards public education. In the end, the spatial concentration of crime is essentially restored to its pre-COPS level. In this case, therefore, the ability of local governments to respond to federal- or state-level law enforcement initiatives proves critical to understanding the impact of crime policy.

Beyond the context of the COPS program, the theoretical and computational structure developed here offers a useful framework to analyze the interaction of federal, state and local government deterrence policies in an environment where both criminals and voters are rational decision makers. In the conclusion, I discuss a few of these more general insights and suggest some extensions of the work presented here.[6]

2 Model

The metropolitan area consists of many households and two communities. Each household has of one head and a fixed number (#) of youths. The mass of metropolitan households is normalized to one. Households are indexed by $i \in [0,1]$ and communities by $j \in \{1,2\}$. Heads differ by income, $y \in (0,\infty)$, and a taste parameter, $\upsilon \in (0,\infty)$.[7] Youth (productive) ability, $a \in (0,\infty)$, differs across households but is identical within households.[8] The i^{th} household has characteristics (y_i, υ_i, a_i), and the joint distribution of (y, υ, a) across households has cumulative density function (c.d.f.) F and probability density function (p.d.f.) f. Income per metropolitan household is denoted Y.

The aggregate (i.e., per metropolitan household) supply of housing services in j, denoted $\mathcal{H}_S\left(p_h^j; L^j\right)$, is a continuous, strictly increasing function of the net (of property tax) price of housing services, p_h^j, and an exogenous land factor, L^j.[9] Defining μ^j as the proportion (measure) of households residing in j, per household housing supply is given by

$$H_S\left(p_h^j; L^j\right) = \mathcal{H}_S\left(p_h^j; L^j\right)/\mu^j, \quad j = 1, 2 \tag{1}$$

whenever both communities are populated.

Public education and law enforcement are provided by communities, but these community-specific services are financed at both the metropolitan and

[6] Proofs of key results and a description of data sources are placed in appendices A and B. Additional appendices detailing the algorithm used to numerically solve for equilibria, the calibration of the computational model, and a sensitivity analysis for the quantitative results are available from me on request.

[7] Similar to Epple and Platt [16], I let heads differ in two respects — income and tastes — to generate equilibria that are not fully stratified by income. As emphasized in their paper, partial sorting by income more closely resembles the actual behavior of households in U.S. metropolitan areas.

[8] Since a will influence youths' returns to education (but not crime), it should not be interpreted merely as IQ. Rather, it is best to think of it as a complex amalgam of factors including certain types of intelligence, history and parental attitudes towards education.

[9] Epple et al.[15, p. 301] provide a microfoundation for this supply function. For brevity I merely posit its existence. I assume that housing market profits are captured by absentee landlords residing outside the model.

local levels. The metropolitan government raises tax revenue in proportion to income (tY), and distributes it as grants earmarked for public education and law enforcement to the local communities. The levels of these community-specific grants are exogenous to the model, representing an aggregation of state and federal expenditures which can be considered outside the control of any single community. Denoting these grants, measured in per household terms, by $\Gamma_E^j \geq 0$ and $\Gamma_L^j \geq 0$, the metropolitan government's budget constraint is given by

$$\mu^1 \left(\Gamma_E^1 + \Gamma_L^1\right) + \mu^2 \left(\Gamma_E^2 + \Gamma_L^2\right) = tY, \quad t \in [0,1]. \tag{2}$$

Local governments raise revenues using a proportional property tax $\tau^j \geq 0$. Local property tax revenues per j household are given by $\tau^j p_h^j H^j$ where H^j denotes housing services per j household. Assuming local governments must also balance their budgets, education and law enforcement expenditures per j household are respectively given by

$$G_E^j = \Gamma_E^j + \Delta^j \tau^j p_h^j H^j, \;\; G_L^j = \Gamma_L^j + \left(1 - \Delta^j\right) \tau^j p_h^j H^j, \;\; j = 1, 2, \tag{3}$$

where $\Delta^j \in [0,1]$ denotes the share of j's property tax revenues devoted to education. Both τ^j and Δ^j will be determined by majority voting.

Education quality in j, denoted Q^j, equals expenditure per student.[10] Letting n^j be the proportion of j youths choosing crime and assuming such youths do not attend school,

$$Q^j = \frac{G_E^j}{\#\left(1 - n^j\right)}. \tag{4}$$

The level of public safety in j is given by $\mathcal{S}^j \equiv \mathcal{S}\left(K^j\right)$ where $\mathcal{S}(\cdot)$ is a decreasing function of the crime rate, K^j (i.e., crimes per household in j).

2.1 Heads

Heads have preferences over consumption, c, housing, h, the quality of public education, Q, the level of public safety, $\mathcal{S}$, and other fixed community-level characteristics, denoted $\overline{M}$. The characteristics $\overline{M}$ can vary across communities, but are treated as exogenous to the model (e.g., an urban versus a suburban setting). The following assumptions restrict head preferences:

[10] This is a common assumption in the theoretical literature on education. See for instance Epple and Romano [17], Fernandez and Rogerson [23], and Glomm and Ravikumar [30].

Assumption 1 *Each head's preferences can be represented by a utility function*

$$U(b, M; \upsilon) \tag{5}$$

where

$$b \equiv u(c, h) \tag{6}$$

is a linearly homogenous function and

$$M \equiv M^{*}\left(Q, \mathcal{S}(K); \overline{M}\right) \equiv M\left(Q, K; \overline{M}\right). \tag{7}$$

Assumption 2 *(i) The utility function, $U(\cdot)$, is strictly increasing in b and M, the subutility function, $u(\cdot)$, is strictly increasing in c and h, and the subutility function $M(\cdot)$ is strictly increasing in Q and strictly decreasing in K; (ii) $U(\cdot)$ and $u(\cdot)$ strictly quasiconcave; (iii) $U(\cdot)$, $u(\cdot)$, and $M(\cdot)$ are twice continuously differentiable; and (iv) For any $c > 0$, $h > 0$, $\overline{c} \geq 0$, and $\overline{h} \geq 0$, $u(c, h) > \max\left\{u(\overline{c}, 0), u(0, \overline{h})\right\}$.*

The fundamental restrictions underlying Assumption 1 are that head preferences be weakly separable in (c, h), $\left(Q, \mathcal{S}, \overline{M}\right)$, and υ and homothetic in (c, h).[11] While these restrictions are stronger than those typically imposed in a general analysis, I justify them through the tractability they lend to my analysis. Henceforth, I refer to the composite commodities b and M as private goods and (community) amenities, respectively.

Conditional on her residential choice, a head with income y and tastes υ chooses (c, h) to maximize (5) subject to her budget constraint

$$c + ph \leq (1 - t - \phi)\, y, \quad c \geq 0, \quad h \geq 0, \tag{8}$$

where $p \equiv (1 + \tau)\, p_h$ is the gross (of property tax) price of housing services and

$$\phi = \phi(K) \in [0, 1 - t] \tag{9}$$

is the fraction of income she loses to theft. This fraction is increasing in the community crime rate, K.[12] Due to separability, this is achieved by

[11] Let $U^{*}(u^{*}, M; \upsilon)$ where u^{*} is homothetic. Then $u^{*} = \mathcal{M}(u)$ where $\mathcal{M}(\cdot)$ is an increasing function and u is linearly homogenous in (c, h). Thus $U(u, M; \upsilon) \equiv U^{*}(\mathcal{M}(u), M; \upsilon)$.

[12] Under this specification, every head in a community loses an identical fraction of income to theft. A natural motivation for this assumption is that ϕ represents the per income unit price of crime insurance in an actuarially fair insurance market with risk averse heads.

maximizing (6) subject to (8). Denote the resulting housing demand function by

$$\widehat{h} \equiv \widehat{h}\left(p, (1-t-\phi)\, y\right) \equiv \underset{h \in [0,(1-t-\phi)y/p]}{\arg\max}\; u((1-t-\phi)\, y - ph, h). \tag{10}$$

Lemma 1 *Given a community of residence, the optimal private goods bundle of a head with income y is*

$$\widehat{b} = y/p_b$$

where

$$p_b \equiv p_b\left(p, \phi\right) = 1/\left(u\left(1-pg\left(p\right), g\left(p\right)\right) \cdot \left(1-t-\phi\right)\right), \tag{11}$$

$g(\cdot)$ is an increasing function, and $p_b(\cdot)$ is increasing in both p and ϕ.

I refer to p_b as the price of private goods. From Lemma 1, a head with income y and tastes υ obtains the utility level

$$U\left(\widehat{b}, M; \upsilon\right) = U\left(y/p_b, M; \upsilon\right) \tag{12}$$

when residing in a community with amenity level M and private goods price p_b.[13] Consequently, head i prefers community 1 over community 2 if and only if

$$U\left(y_i/p_b^1, M^1; \upsilon_i\right) \geq U\left(y_i/p_b^2, M^2; \upsilon_i\right) \tag{13}$$

where $p_b^j \equiv p_b\left(p^j, \phi^j\right)$, $p^j \equiv \left(1+\tau^j\right) p_h^j$, $\phi^j \equiv \phi\left(K^j\right)$ and $M^j \equiv M\left(Q^j, K^j; \overline{M}^j\right)$.

This means that head residential choices can be completely characterized by indifference curves in the (M, p_b) plane with slopes

$$\begin{aligned} m\left(M, p_b; y, \upsilon\right) &\equiv \left.\frac{dp_b}{dM}\right|_{U(y/p_b, M;\upsilon)=\text{constant}} \\ &= \frac{\left(p_b\right)^2 U_2\left(y/p_b, M; \upsilon\right)}{y_i U_1\left(y/p_b, M; \upsilon\right)} > 0, \end{aligned} \tag{14}$$

where U_1 and U_2 denote partial derivatives. The following 'single-crossing' restrictions greatly facilitate the analysis:

[13] The crime rate K affects head utility in two ways. It affects p_b through its impact on ϕ. This captures the direct monetary cost of crime to a head. It also affects M through its impact on public safety, $\mathcal{S}$. Here the interpretation is one of the fear of victimization. As emphasized by Sah [44], the fear of crime itself can be an important determinant of individual well-being.

Assumption 3 *For each head with characteristics* (y, υ) *and all points* (M, p_b)*,*

$$\frac{\partial m\left(M, p_b; y, \upsilon\right)}{\partial y} > 0 \tag{15}$$

and

$$\frac{\partial m\left(M, p_b; y, \upsilon\right)}{\partial \upsilon} > 0. \tag{16}$$

Assumption 3 says that, other things equal, households with larger incomes (taste parameters) are, on the margin, more willing to sacrifice private goods, b, for amenities, M. As depicted in Figure 2, the head with a higher income (taste parameter) prefers the community offering the larger (M, p_b) — i.e., point 2 is preferred to point 1.[14] Without loss of generality, define the communities as follows:

Definition 1 *Community* 2 *offers higher amenities; i.e.,* $M^2 > M^1$*.*

Remark 1 *Clearly, if* $p_b^1 \geq p_b^2$*, no head will choose community* 1 *since each could obtain higher amenities and at least as much of the private good in community* 2*. Henceforth, I restrict my analysis to the interesting case where* $p_b^1 < p_b^2$*.*

The following proposition characterizes residential choices using a two-dimensional stratification result similar to Epple and Platt [16, Lemma 1, p. 28]:

Proposition 1 *Let*

$$\widehat{y}\left(\upsilon\right) \equiv \widehat{y}\left(\upsilon; M^1, p_b^1, M^2, p_b^2\right) : \Re^+ \rightarrow \Re^+ \tag{17}$$

[14] Denoting partial derivatives by subscripts and powers by superscripts, head i's indifference curve is globally concave if

$$\frac{p_b^2}{yU_1^3}\left[\left(U_2^2U_{11} - 2U_1U_2U_{12} + U_1^2U_{22}\right) + \frac{2p_bU_1U_2^2}{y}\right] < 0$$

for all points (M, p_b) in the positive real orthant. The term in parentheses is negative by strict quasiconcavity of U, but the overall expression is ambiguous in sign. Consequently, the curvature properties of these indifference curves are not pinned down at this level of generality.

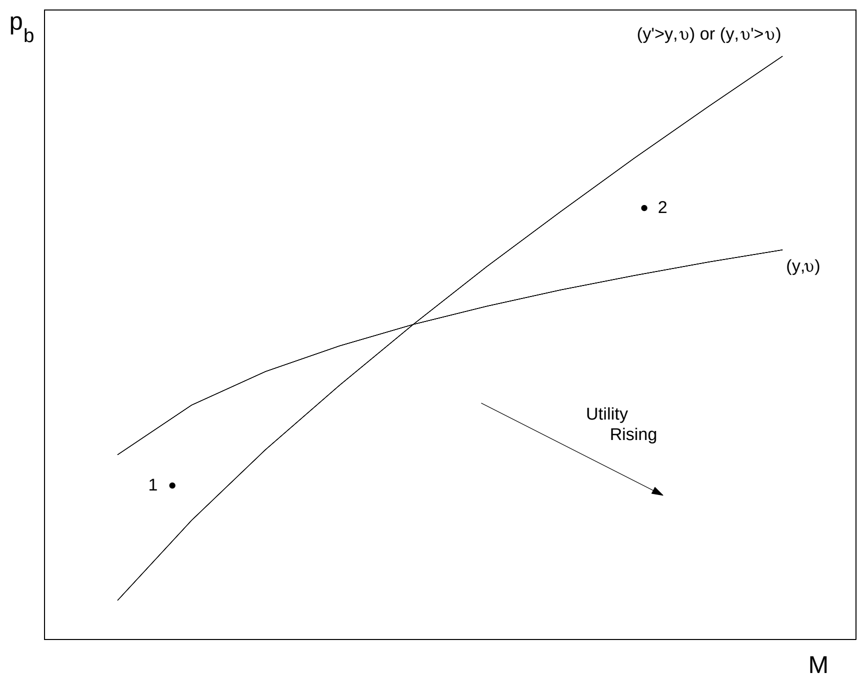

Figure 2: Head Indifference Curves

be such that, for each $\upsilon > 0$*,*

$$U\left(\widehat{y}(\upsilon)/p_b^1, M^1; \upsilon\right) \equiv U\left(\widehat{y}(\upsilon)/p_b^2, M^2; \upsilon\right). \tag{18}$$

Then ***(i)*** *a head with income* y *and taste parameter* υ *resides in community 2 if and only if* $y > \widehat{y}(\upsilon)$ *and* ***(ii)*** $\widehat{y}(\upsilon)$ *is strictly decreasing in* υ*.*

Figure 3 plots the residential boundary locus defined in Proposition 1.[15] Whenever the head income distribution has support over $\Re^+$, a necessary and sufficient condition for both communities to be occupied is that $\widehat{y}(\upsilon) \in (0, \infty)$ for some υ.

Using Proposition 1, the proportion of metropolitan households residing in each community is determined by

$$\mu^1 = \int_0^\infty \int_0^{\widehat{y}(\upsilon)} f_{y,\upsilon}(y, \upsilon) dy d\upsilon, \quad \mu^2 = 1 - \mu^1, \tag{19}$$

[15] The curvature properties of $\widehat{y}(\upsilon)$ are not pinned down at this level of generality.

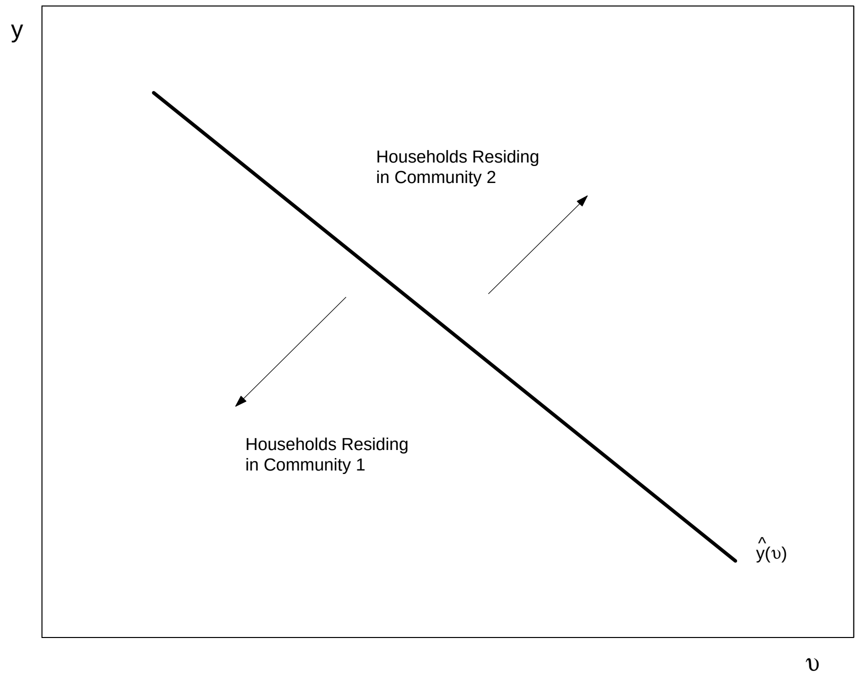

Figure 3: Residential Boundary Locus

where $f_{y,\upsilon}(y,\upsilon) \equiv \int_0^\infty f(y,\upsilon,a)\,da$ is the joint density of (y,υ). Per household community incomes are determined by

$$Y^1 = \frac{\int_0^\infty \int_0^{\widehat{y}(\upsilon)} y f_{y,\upsilon}(y,\upsilon) dy d\upsilon}{\mu^1}, \quad Y^2 = \frac{\int_0^\infty \int_{\widehat{y}(\upsilon)}^\infty y f_{y,\upsilon}(y,\upsilon) dy d\upsilon}{\mu^2}, \tag{20}$$

and the per household housing demand functions are

$$\begin{array}{c} H_D^1 = \int_0^\infty \int_0^{\widehat{y}(\upsilon)} \widehat{h}\left(p^1, \left(1 - t - \phi^1\right) y\right) f_{y,\upsilon}(y,\upsilon) dy d\upsilon / \mu^1, \\ H_D^2 = \int_0^\infty \int_{\widehat{y}(\upsilon)}^\infty \widehat{h}\left(p^2, \left(1 - t - \phi^2\right) y\right) f_{y,\upsilon}(y,\upsilon) dy d\upsilon / \mu^2. \end{array} \tag{21}$$

2.2 Youths

I assume that each youth resides in the community chosen by his head and that all crimes are committed by youths. This restriction lends a great deal of tractability to my analysis. Further, as documented in Table 1, youths

Crime Category	Age in Years		
	<18	**<21**	**<25**
Burglary	33.0	51.0	65.0
Larceny-Theft	30.0	44.0	56.0
Motor Vehicle Theft	43.3	61.8	74.5
Robbery	24.2	43.7	61.6

Table 1: Percentage of Arrests in the 1990 U.S.
Source: U.S. Department of Justice [60, 1990 Edition, Table 36]

account for a substantial portion of property-related crime arrests.[16]

Youths decide whether to become educated or become criminals (not both). Those choosing crime decide how to allocate offenses across communities. A youth in household i residing in community j (hereafter, youth ij) has preferences over income, I_{ij}, and an occupation cost (measured in utility points), κ_{ij}, given by

$$V\left(I_{ij}, \kappa_{ij}\right) = v\left(I_{ij}\right) - \kappa_{ij}$$

where $v(\cdot)$ is a strictly increasing function. If youth ij becomes educated, his income (earning potential) is

$$I_{ij} = I_{ij}^{e} \equiv I\left(Q^{j}, a_{i}\right), \tag{22}$$

where $I(\cdot)$ is strictly increasing in both Q^j and a_i. His occupation cost is a constant; i.e., $\kappa_{ij} = \kappa_{ij}^{e} \equiv \epsilon > 0$.[17] His utility from choosing education is

$$V_{ij}^{e} = v\left(I_{ij}^{e}\right) - \kappa_{ij}^{e} = v\left(I\left(Q^{j}, a_{i}\right)\right) - \epsilon. \tag{23}$$

If youth ij chooses crime, his income is

$$I_{ij} = I_{ij}^{c} \equiv r^{j}\lambda_{ij}^{j} + r^{-j}\lambda_{ij}^{-j}$$

[16]It also implies a link between the residential choices of heads and criminals. In my quantitative work below, I limit the analysis to estimates of crimes committed by youths aged less than 18 since these individuals will primarily reside where their heads do. I also examine the sensitivity of my results to different assumptions about the travel costs incurred by criminals. When travel costs are small, community of residence is immaterial from the criminal's perspective.

[17]Since education is publicly provided, ϵ represents the effort involved in becoming educated. It is straightforward to let κ_{ij}^{e} depend on ability.

where r^j (r^{-j}) denotes the physical return — or loot — per offense committed inside (outside) his community of residence j, and λ_{ij}^j $\left(\lambda_{ij}^{-j}\right)$ denotes the offenses committed by ij inside (outside) his community of residence j.[18] His occupation cost is

$$\kappa_{ij} = \kappa_{ij}^c \equiv w_{ij} + S_{ij}.$$

The first component

$$w_{ij} = w\left(\lambda_{ij}^j, \lambda_{ij}^{-j}\right), \tag{24}$$

with $w(\cdot)$ an increasing function, represents the effort cost of committing offenses. The second component

$$S_{ij} = S\left(Z_{ij}^j + Z_{ij}^{-j}\right) \tag{25}$$

represents the sanction for criminal activities, where $S(\cdot)$ is an increasing function and Z_{ij}^ℓ is youth ij's conviction level for offenses committed in community ℓ, $\ell = 1, 2$. This formalizes the notion of severity of punishment. When the total conviction level, $Z_{ij}^j + Z_{ij}^{-j}$, realizes a larger value, the criminal receives a larger sanction. Since severity of punishment is determined primarily by laws written at the state/federal level and legal precedent, I assume the form of $S(\cdot)$ is exogenous from a community's perspective.

I assume the conviction levels $Z_{ij}^j \geq 0$ and $Z_{ij}^{-j} \geq 0$ are mutually independent continuous random variables.[19] The distribution function of Z_{ij}^ℓ is given by

$$F_Z\left(z; G_L^\ell, K^\ell, \lambda_{ij}^\ell\right) = \int_0^z f_Z\left(x; G_L^\ell, K^\ell, \lambda_{ij}^\ell\right) dx, \quad \ell = 1, 2,$$

where f_Z is the associated density function. Since the offenses considered here are primarily investigated by local police, I allow certainty of punishment to depend on community law enforcement expenditures and case-loads (i.e., crime rates). I formalize this by assuming that F_Z is strictly decreasing in G_L^ℓ and strictly increasing in K^ℓ. Consequently, a criminal who commits λ offenses in community ℓ is more likely to realize a large conviction level when community ℓ spends more on law enforcement or has a smaller crime rate.

[18] At this level of generality, more offenses can be thought of as more crimes, a more egregious crime or both.

[19] One can imagine interjurisdictional complementarities in law enforcement that might well argue for a positive dependence between Z_{ij}^j and Z_{ij}^{-j}. This generalization would be straightforward.

Similarly, I assume that F_Z is strictly decreasing in λ_{ij}^{ℓ} so that, given G_L^{ℓ} and K^{ℓ}, a criminal allocating a larger offense level to community ℓ is more likely to realize a larger conviction level in ℓ.[20]

Letting $f_{Z^{\ell}}(z,\lambda) \equiv f_Z\left(z;\lambda, G_L^{\ell}, K^{\ell}\right)$, $\ell = 1,2$,

$$\begin{aligned} ES_{ij} &\equiv ES\left(Z_{ij}^{j} + Z_{ij}^{-j} \middle| \lambda_{ij}^{j}, \lambda_{ij}^{-j}\right) \\ &= \int_0^{\infty}\int_0^{\infty} S\left(z^j + z^{-j}\right) f_{Z^j}\left(z^j; \lambda_{ij}^{j}\right) f_{Z^{-j}}\left(z^{-j}; \lambda_{ij}^{-j}\right) dz^j dz^{-j} \\ &\equiv ES^c\left(\lambda_{ij}^{j}, \lambda_{ij}^{-j}; G_L^j, K^j, G_L^{-j}, K^{-j}\right), \end{aligned} \tag{26}$$

denotes youth ij's expected sanction for a given offense allocation $\left(\lambda_{ij}^{j}, \lambda_{ij}^{-j}\right)$.[21] His expected utility from choosing crime given this allocation is

$$\begin{aligned} EV_{ij}^{c} &\equiv E\left[v\left(I_{ij}^{c}\right) - \kappa_{ij}^{c}\right] \\ &= v\left(r^j\lambda_{ij}^{j} + r^{-j}\lambda_{ij}^{-j}\right) - w\left(\lambda_{ij}^{j}, \lambda_{ij}^{-j}\right) - ES_{ij} \\ &\equiv EV^c\left(\lambda_{ij}^{j}, \lambda_{ij}^{-j}; r^j, G_L^j, K^j, r^{-j}, G_L^{-j}, K^{-j}\right). \end{aligned} \tag{27}$$

For technical convenience, I make the following assumption:

Assumption 4 *With respect to* $\left(\lambda_{ij}^{j}, \lambda_{ij}^{-j}\right) \geqq 0$, $EV^c(\cdot)$ *is a strictly concave and twice continuously differentiable function.*

If youth ij becomes a criminal, he chooses $\left(\lambda_{ij}^{j}, \lambda_{ij}^{-j}\right)$ to maximize (27) subject to (26) and

$$\left(\lambda_{ij}^{j}, \lambda_{ij}^{-j}\right) \geqq 0. \tag{28}$$

Under Assumption 4, this is a concave programming problem satisfying constraint qualification with Kuhn-Tucker conditions

$$\partial EV_{ij}^{c}/\partial\lambda_{ij}^{\ell} \leq 0, \quad \lambda_{ij}^{\ell} \geq 0, \quad \textit{and} \quad \lambda_{ij}^{\ell}\partial EV_{ij}^{c}/\partial\lambda_{ij}^{\ell} = 0, \quad \ell = 1,2.$$

[20] While the occupation of crime is a risky one, the uncertainty in this model comes through the conviction level but not income. In every year between 1985-1992, less than forty percent of reported stolen property in the U.S. was recovered (Federal Bureau of Investigation [60, 1985-92 Issues]). Due to underreporting of crime, the percentage actually recovered is likely considerably smaller.

[21] Depending on the particular choice of $f_Z(\cdot)$, the conviction level, Z_{ij}^{ℓ}, may or may not be bounded by the offense level, λ_{ij}^{j}. One justification for the absence of such a bound is that it is possible for criminals to be convicted of offenses more serious than those actually committed.

Since the optimal offense allocation depends on where the criminal lives (but not on household characteristics), I denote it by

$$\widehat{\lambda}_j^{\ell} = \widehat{\lambda}^{\ell}\left(r^j, G_L^j, K^j, r^{-j}, G_L^{-j}, K^{-j}\right), \quad \ell = 1, 2. \tag{29}$$

While 'corner solutions' (i.e., $\widehat{\lambda}_j^{j} = 0$ or $\widehat{\lambda}_j^{-j} = 0$) are a distinct possibility, a necessary condition for a criminal to commit offenses in both communities (i.e., for $\widehat{\lambda}_j^{j} > 0$ and $\widehat{\lambda}_j^{-j} > 0$) is given by

$$\frac{\partial w_{ij}/\partial \lambda_{ij}^{j} + \partial ES_{ij}/\partial \lambda_{ij}^{j}}{r^j} = \frac{\partial w_{ij}/\partial \lambda_{ij}^{-j} + \partial ES_{ij}/\partial \lambda_{ij}^{-j}}{r^{-j}}. \tag{30}$$

Equation 30 says that, whenever a criminal does commit offenses in both communities, he equates his expected occupation cost per physical return at the margin. Excepting knife-edge cases, this type of 'cross-hauling' behavior requires that either $w(\cdot)$ or $ES^c(\cdot)$, defined in (24) and (26), be nonlinear in λ_{ij}^{j} or λ_{ij}^{-j}. More intuitively, since the marginal physical return to offenses in j is constant at r^j, cross-hauling requires that the marginal expected occupation cost of committing offenses in community ℓ varies with the offense level, λ_{ij}^{ℓ}, for $\ell = 1$ or 2.

Youth ij's indirect expected utility from choosing crime is given by

$$\begin{aligned} \widehat{EV}_j^{c} &\equiv EV^c\left(\widehat{\lambda}_{ij}^{j}, \widehat{\lambda}_{ij}^{-j}; r^j, G_L^j, K^j, r^{-j}, G_L^{-j}, K^{-j}\right) \\ &\equiv \widehat{EV}^{c}\left(r^j, G_L^j, K^j, r^{-j}, G_L^{-j}, K^{-j}\right), \end{aligned} \tag{31}$$

and he becomes a criminal if and only if

$$v\left(I\left(Q^j, a_i\right)\right) - \epsilon < \widehat{EV}_j^{c}. \tag{32}$$

Within communities, the occupational choices of youths will be stratified by ability with the less able choosing crime. Proposition 2 formalizes this result:

Proposition 2 *Let*

$$a^j = a^j\left(Q^j, \widehat{EV}_j^{c}\right) \tag{33}$$

be the community specific ability level such that

$$\widehat{EV}_j^{c} = v\left(I\left(Q^j, a^j\right)\right) - \epsilon. \tag{34}$$

Then youth ij becomes a criminal if and only if $a_i < a^j$. Further, a^j is decreasing in Q^j and increasing in $\widehat{EV}_j^{c}$.

Remark 2 *Ceteris paribus,* $\widehat{EV}_j^c$ *is nondecreasing in* r^ℓ*, nondecreasing in* K^ℓ *and nonincreasing in* G_L^ℓ*, for* $\ell = 1, 2$*.*

Using Proposition 2, the proportion of youths participating in crime is determined by

$$n^j = F_a^j\left(a^j\right) \equiv \int_0^{a^j} f_a^j\left(a\right) da, \quad j = 1, 2, \tag{35}$$

where

$$f_a^1\left(a\right) = \frac{\int_0^\infty \int_0^{\widehat{y}(\upsilon)} f\left(y, \upsilon, a\right) dy d\upsilon}{\mu^1}, \quad f_a^2\left(a\right) = \frac{\int_0^\infty \int_{\widehat{y}(\upsilon)}^\infty f\left(y, \upsilon, a\right) dy d\upsilon}{\mu^2} \tag{36}$$

denote the marginal densities of youth ability in each community induced by the residential choices of heads.[22] The community crime rates are determined by

$$K^j = \#\left(\mu^j n^j \widehat{\lambda}_j^j + \mu^{-j} n^{-j} \widehat{\lambda}_{-j}^j\right) / \mu^j, \quad j = 1, 2. \tag{37}$$

2.3 Equilibrium

Equilibrium is defined in two parts. Throughout, let $\varphi \equiv (\tau^1, \Delta^1, \tau^2, \Delta^2)$ denote the local public policies and let $\xi \equiv (Q^1, p_h^1, K^1, Q^2, p_h^2, K^2)$ denote the local economic characteristics.[23]

2.3.1 Economic Equilibrium

In economic equilibrium, households are public policy takers.

Definition 2 *Given* φ*, an* ***economic equilibrium (EE)*** *satisfies the following conditions: (E1) The choices made by heads and youths are individually rational; (E2) The metropolitan and local governments balance their budgets; (E3) Housing markets clear; (E4) Income stolen from households equals loot confiscated by criminals; and (E5) Aggregate outcomes are consistent with individual behavior.*

[22] Since every household has the same number of youths, the proportion of youths in a community choosing crime is identical with the proportion of households in a community whose youths choose crime.

[23] All remaining endogenous variables can be written as functions of φ, ξ, and, implicitly, the exogenous metropolitan area characteristics (e.g., grants, the distribution of (y, υ, a), the housing supply functions, etc.).

Condition (*E1*) requires that heads choose (c,h) to maximize (5) subject to (8) and reside in the community maximizing (12). It also requires that youths choose crime if and only if (32) is satisfied and that those becoming criminals choose $\left(\lambda_{ij}^{j},\lambda_{ij}^{-j}\right)$ to maximize (27) subject to (28). Condition (*E2*) is satisfied when (2) and (3) hold. Condition (*E3*) requires that housing supply (1) equal housing demand (21) in each community. The materials balance condition (*E4*) requires

$$r^j=\phi^j Y^j/K^j,\qquad j=1,2. \tag{38}$$

The rational expectations consistency condition (*E5*) requires

$$\xi=\ddot{\xi}\left(\xi;\varphi\right), \tag{39}$$

where $\ddot{\xi}\left(\xi;\varphi\right)$ denotes the value ξ implied by (*E1*)-(*E4*) given φ and the forecasted value of ξ. Denote the solution to this fixed point problem by $\widehat{\xi}\left(\varphi\right)$.

2.3.2 Politico-Economic Equilibrium

Any politico-economic equilibrium (P-EE) is also an EE. As such, neither heads nor youths will want to alter their behavior in P-EE. However, I limit the sophistication of heads in their role as *voters* in certain respects. In particular, voters anticipate all aspects of economic equilibrium except household mobility.[24]

Treating residential choices under the forecasted value of φ as fixed, voters in j anticipate $\left(M^j,p_b^j\right)$ for each candidate (τ^j,Δ^j) holding (τ^{-j},Δ^{-j}) fixed. Denoting these anticipated values by $\left(\widetilde{M}^j,\widetilde{p}_b^j\right)$, the community possibilities set perceived by voters in j is given by

$$CPS^j\left(\varphi\right)\equiv$$
$$\left\{(\tau^j,\Delta^j):\left(\widetilde{M}^j\left(\tau^j,\Delta^j;\varphi\right),\ \widetilde{p}_b^j\left(\tau^j,\Delta^j;\varphi\right)\right),\ \forall\tau^j\geqq 0,\ \forall\Delta^j\in[0,1]\right\}. \tag{40}$$

Its community possibility frontier, $CPF^j\left(\varphi\right)$, is defined as the smallest value of $\widetilde{p}_b^j$ corresponding to each value of M^j in (40).

[24] The P-EE concept here is analogous to that used in Fernandez and Rogerson [23] who assume households move once and for all and then vote. In Epple and Romer [19], voters anticipate household mobility but ignore the adjustments of economic aggregates outside the home community.

Figure 4 plots an example of points in CPS^j for three different property tax rates. Each curve is generated by holding τ fixed and varying the composition parameter Δ over points between 0 and 1. For small values of Δ, education is receiving a small share of local revenues with law enforcement getting the remainder. With concave education and conviction technologies, the marginal product educational expenditures is relatively high while the opposite is true for law enforcement expenditures. Within this region, the increase in educational quality at the expense of law enforcement dominates any potential increases in the crime rate, and the level of amenities, M, increases.[25] Beyond a point, however, robbing the police to pay the educator causes the conviction rate to fall too much, beyond which increases in the crime rate outweigh any further gains in educational quality. Within this region, further increases in Δ are unproductive in the sense that M falls and p_b rises.

Figure 4 also shows that increasing the property tax rate, τ, makes it possible to obtain higher amenity levels, albeit at the cost of a higher price of private goods, p_b. The community possibility frontier, CPF^j, is the lower envelope of all such curves when varying both $\tau \geq 0$ and $\Delta \in [0, 1]$ on a continuum.[26]

The following formally defines P-EE:

Definition 3 *A* ***politico-economic equilibrium (P-EE)*** *is a quadruple* $\varphi = (\tau^1, \Delta^1, \tau^2, \Delta^2)$ *such that the following conditions are satisfied:* ***(P1)*** *Economic equilibrium attains under* φ*; and* ***(P2)*** *Holding* (τ^{-j}, Δ^{-j}) *and residential choices under* φ *fixed,* (τ^j, Δ^j) *is a majority winner in community* j*,* $j = 1, 2$*, when each voter* i *evaluates* (τ, Δ) *candidates using*

$$\widetilde{U}(\tau, \Delta; \varphi, y_i, \upsilon_i) \equiv U\left(\frac{y_i}{\widetilde{p}_b^j(\tau, \Delta; \varphi)}, \widetilde{M}^j(\tau, \Delta; \varphi); \upsilon_i\right). \tag{41}$$

I adapt Proposition 2 from Epple and Platt [16, p. 33] to provide sufficient conditions for the existence of a majority winning local public policy (τ^j, Δ^j):

[25] Indeed, the crime rate itself could also be falling due to the impact of educational quality on the crime participation rate.

[26] The behavior of these curves does of course depend on the level of education and police grants being given to a community. For instance, if the police grant were very large, increases in Δ could uniformly increase amenities. Similarly, for high property tax rates, Laffer-type behavior could occur so that further increases in τ could lead to lower amenities at some levels of Δ.

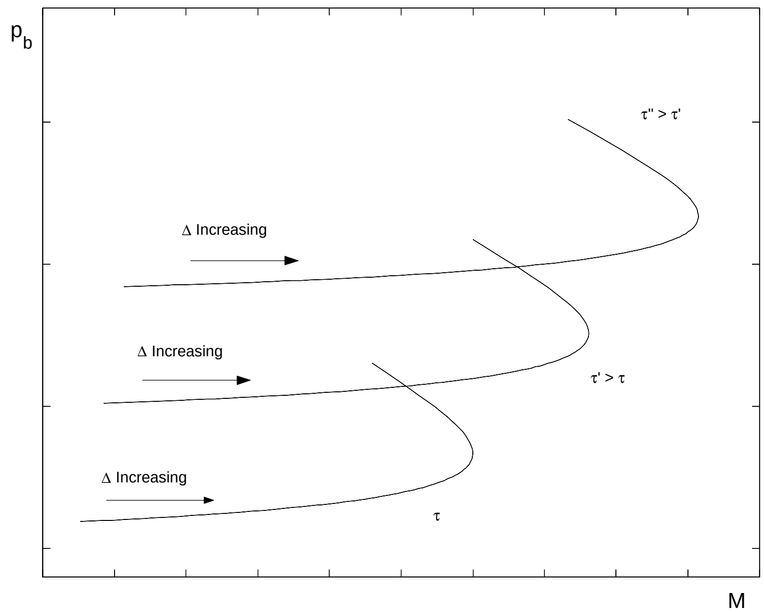

Figure 4: Community Possibilities

Proposition 3 *Let* $\varphi^* = \left(\tau^{1^*}, \Delta^{1^*}, \tau^{2^*}, \Delta^{2^*}\right)$ *be a forecast of local public policies. If there exist functions* $y^j(\upsilon) : \Re^+ \rightarrow \Re^+$ *for* $j = 1, 2$ *such that*

$$\begin{aligned}
&(i) \quad \forall \tau \geq 0,\ \forall \Delta \in [0,1],\ \ \forall \upsilon \geq 0,\ \ j = 1, 2, \\
&\qquad \widetilde{U}\left(\tau^{j^*}, \Delta^{j^*}; \varphi^*, y^j(\upsilon), \upsilon\right) \geq \widetilde{U}\left(\tau, \Delta; \varphi^*, y^j(\upsilon), \upsilon\right), \\
&(ii) \quad \int_0^\infty \int_0^{\min\left\{y^1(\upsilon), \widehat{y}(\upsilon)\right\}} f_{y,\upsilon}(y, \upsilon)\, dy d\upsilon \geq 0.5\mu^1, \quad \textit{and} \\
&(iii) \quad \int_0^\infty \int_{\widehat{y}(\upsilon)}^{\max\left\{y^2(\upsilon), \widehat{y}(\upsilon)\right\}} f_{y,\upsilon}(y, \upsilon)\, dy d\upsilon \geq 0.5\mu^2,
\end{aligned}$$

then φ^* *is a P-EE.*

The problems facing the existence of majority voting equilibria when the policy space is multidimensional are well known (e.g., McKelvey [38]). The approach often taken in such cases is to put additional structure on the voting process (e.g., Shepsle [45]), although I do not find this to be necessary in my analysis.[27]

[27] My notion of P-EE in Definition 3 corresponds Shepsle's [45, Theorem 2.1, p. 37]

3 Computational Experiment

The model developed in section 2 can be applied to study a number of important crime policies at a fairly rich level of detail. Here I examine one such policy — the COPS program. The COPS program authorized 8.8 billion dollars to finance 100,000 additional local police officers between 1995-2000 (U.S. Department of Justice [56]). Measured in 1990 dollars, this amounts to roughly \$100 per household.[28] Although a nationwide initiative, its intent was to focus resources on high crime communities, particularly inner cities. While there is much debate as to whether this actually occurred, I choose to avoid this quagmire.[29] Rather, I examine a polar (and seemingly most favorable to central city crime-fighting) case where all the resources are devoted to central city police departments.

In sections 3.1 and 3.2, I develop a quantitative version of the model introduced in section 2. In section 3.3, I use this model to examine the impact of the COPS program.

3.1 Functional Forms

Here I posit explicit functional forms for the relationships introduced in section 2. Since the literature on the appropriate choice of functional forms is sparse, my guiding principle is to choose forms that are common to quantitative analyses, readily admit to empirical interpretation of the parameters, and/or lead to tractable results.

I begin by assuming that household characteristics are distributed according to

$$(\ln y, \ln v, \ln a)' \sim N_3(\mathbf{m}, \mathbf{\Sigma}) \tag{42}$$

where $\ln(\cdot)$ is the natural logarithm, $N_3(\cdot)$ is the trivariate normal distribution, $\mathbf{m} = (m_y, m_v, m_a)'$, and $vech(\mathbf{\Sigma}) = \left(s_y^2, s_{yv}, s_{ya}, s_v^2, s_{va}, s_a^2\right)'$. The multivariate lognormal distribution is a natural starting point that leads to

preference-induced equilibrium. When it exists, it is identical to his *structure-induced equilibrium.* In my quantitative analysis below, the median voter in any one policy direction turns out to be the median voter in every policy direction.

[28]There were 99,627,000 U.S. HHs in 1995 (U.S. Department of Commerce [51, 1995 Issue]), and the ratio of the 1995 to 1990 Consumer Price Index equaled 1.166 (Council of Economic Advisors [6, 2000 Edition, Table B-58]).

[29]See, e.g., Stephen Glass, "Anatomy of a Policy Fraud," *New Republic*, Nov. 17, 1997.

fairly tractable results.[30]

I assume that community housing supply per metropolitan household is given by

$$\mathcal{H}_S(p_h; L) = Lp_h^{\varrho}, \quad \varrho > 0, \tag{43}$$

where ϱ is the price elasticity of housing supply. This specification is common to the multiple-community literature (e.g., Epple et al. [15] and Fernandez and Rogerson [23]).

The fraction of head income lost to theft is given by

$$\phi = \phi(K) = \min\{\eta_0 K^{\eta_1}, (1-t)\}, \quad \eta_0 > 0, \ \ \eta_1 > 0. \tag{44}$$

While I know of no studies relating the fraction of household income stolen to the crime rate, this specification is parsimonious, reasonably flexible, and can be estimated from available data.

I parameterize head preferences using

$$U(b, M; v) = \frac{1}{1-\omega}\left(b^{1-\omega} + vM^{1-\omega}\right), \ \ \omega > 1, \tag{45}$$

where

$$b \equiv u(c,h) = \left(c^{1-\sigma} + \delta h^{1-\sigma}\right)^{\frac{1}{1-\sigma}}, \quad \sigma > 0, \ \ \delta > 0 \tag{46}$$

and

$$M \equiv M\left(Q, K; \overline{M}\right) = \overline{M} \cdot \left(Q^{1-\alpha} + dK^{\alpha-1}\right)^{\frac{1}{1-\alpha}}, \quad \overline{M} > 0, \quad \alpha > 0, \quad d > 0. \tag{47}$$

The specifications for $U(\cdot)$ and $u(\cdot)$ are common to quantitative analyses. By restricting $\omega > 1$ in (45), I ensure that Assumption 3 is satisfied. As formalized in Corollaries 1 and 2 below, these specifications prove to be quite useful from a computational perspective.

Corollary 1 (to Proposition 1) *A head with income y and taste parameter v lives in community 2 (i.e., the community with larger M) if and only if*

$$x > \frac{\frac{1}{\omega-1}\left(\left(p_b^2\right)^{\omega-1} - \left(p_b^1\right)^{\omega-1}\right)}{\frac{1}{1-\omega}\left(\left(M^2\right)^{1-\omega} - \left(M^1\right)^{1-\omega}\right)} \equiv \widehat{x}\left(M^1, p_b^1, M^2, p_b^2\right) \tag{48}$$

[30] The bivariate lognormal distribution was used by Epple and Romano [18] to model the distribution of household incomes and youth abilities in a quantitative analysis of education vouchers with public and private schools.

where

$$x \equiv y^{\omega-1}v, \tag{49}$$

$$p_b^j \equiv p_b\left(p^j, \phi^j\right) = \frac{\left(\frac{p^j}{\delta}\right)^{\frac{1}{1-\sigma}}\left(p^j + \left(\frac{p^j}{\delta}\right)^{\frac{1}{\sigma}}\right)^{\frac{\sigma}{\sigma-1}}}{1-t-\phi^j}. \tag{50}$$

Corollary 2 (to Proposition 3) *In each community j, the head with the median value of* (49)*, denoted x_{med}^j, is that community's median voter.*

From Corollary 2 and (41), a necessary condition for an interior P-EE (i.e., one with $\tau^j > 0$ and $\Delta^j \in (0,1)$) is

$$\begin{array}{l} x_{med}^j \cdot \left(M^j\right)^{-\omega}\left(p_b^j\right)^{2-\omega} = \frac{\partial \widetilde{p}_b^j\left(\tau^j,\Delta^j;\varphi\right)/\partial\tau^j}{\partial \widetilde{M}^j\left(\tau^j,\Delta^j;\varphi\right)/\partial\tau^j} \\ x_{med}^j \cdot \left(M^j\right)^{-\omega}\left(p_b^j\right)^{2-\omega} = \frac{\partial \widetilde{p}_b^j\left(\tau^j,\Delta^j;\varphi\right)/\partial\Delta^j}{\partial \widetilde{M}^j\left(\tau^j,\Delta^j;\varphi\right)/\partial\Delta^j} \end{array}, \quad j = cc, sub. \tag{51}$$

Next consider the parameterization for the problem facing youths. I assume that youth preferences over income are given by

$$v\left(I_{ij}\right) = I_{ij}. \tag{52}$$

This substantially reduces the computational burden involved in the criminal optimization problem, and a linear specification is perhaps not so unpalatable since youth preferences are specified directly over income.

The legitimate income (earning potential) of youths is

$$I\left(Q,a\right) = \beta_0 Q^{\beta_1} a, \quad \beta_0 > 0, \ \beta_1 > 0. \tag{53}$$

This specification has the virtue of parsimony, and lends itself easily to empirical interpretation.

I assume that the effort cost of criminal activity is given by

$$w\left(\lambda_{ij}^j, \lambda_{ij}^{-j}\right) = \gamma\lambda_{ij}^j + \gamma^*\lambda_{ij}^{-j}, \quad \gamma^* \geq \gamma \geq 0. \tag{54}$$

Under (54), offenses committed outside the home community are at least as costly as those committed inside the home community. The bulk of evidence in the criminology literature suggests that most crimes are committed close to home, and 'travel costs' have traditionally been used as a reasonable explanation for this spatial pattern of criminal activity (e.g., Fabricant [20] and Newlon [41]).

The sanction for criminal activity is given by

$$S\left(Z_{ij}^{j}+Z_{ij}^{-j}\right)=\frac{s}{2}\left(Z_{ij}^{j}+Z_{ij}^{-j}\right)^{2},\quad s>0, \tag{55}$$

which, as is standard in the literature, implies a convex relationship between the sanction and the total conviction level.

The conviction level of criminal i residing in j when he commits λ_{ij}^{ℓ} offenses in community ℓ obeys

$$Z_{ij}^{\ell}\sim exponential\left(\pi^{\ell}\lambda_{ij}^{\ell}\right) \tag{56}$$

where, momentarily suppressing superscripts,

$$\pi=\min\left\{\theta_0 G_L^{\theta_1}K^{\theta_2},1\right\},\qquad \theta_0>0,\ \ \theta_1>0,\ \ \theta_2<0. \tag{57}$$

Under this specification,

$$EZ_{ij}^{\ell}=\pi^{\ell}\lambda_{ij}^{\ell}\quad \text{and}\quad var\left(Z_{ij}^{\ell}\right)=\left(\pi^{\ell}\lambda_{ij}^{\ell}\right)^{2}\qquad \ell=1,2,$$

so that π^{ℓ} is the anticipated conviction rate for offenses committed in community ℓ.[31]

Assuming Z_{ij}^{1} and Z_{ij}^{2} are statistically independent, the expected utility of a criminal living in j becomes

$$\begin{aligned}EV_{ij}^{c}&=\left(r^{j}-\gamma\right)\lambda_{ij}^{j}+\left(r^{-j}-\gamma^{*}\right)\lambda_{ij}^{-j}\\&\quad-\tfrac{s}{2}\left(\left[\pi^{j}\lambda_{ij}^{j}+\pi^{-j}\lambda_{ij}^{-j}\right]^{2}+\left(\pi^{j}\lambda_{ij}^{j}\right)^{2}+\left(\pi^{-j}\lambda_{ij}^{-j}\right)^{2}\right)\end{aligned} \tag{58}$$

which is strictly concave in $\left(\lambda_{ij}^{j},\lambda_{ij}^{-j}\right)$. Taken as a whole, the forms chosen in (52), (54), (55), and (56) have the benefit of simplifying the criminal's offense allocation problem to one of a quadratic program subject to nonnegativity constraints. Additionally, criminals have an incentive to diversify their offense allocation since, in so doing, they can reduce their expected sanction, defined in (26), by trading-off the expected total conviction rate, $E\left(Z_{ij}^{j}+Z_{ij}^{-j}\middle|\lambda_{ij}^{j},\lambda_{ij}^{-j}\right)$, with its variance, $var\left(Z_{ij}^{j}+Z_{ij}^{-j}\middle|\lambda_{ij}^{j},\lambda_{ij}^{-j}\right)$. Consequently, the necessary condition for cross-hauling provided in (30) does not reduce to a knife-edge case.

[31] Since police resources and caseloads should only directly impact the probability of arrest, I treat the probability of conviction given arrest as fixed, absorbing it into the constant θ_0 in (57).

3.2 Benchmark Equilibrium

In the benchmark equilibrium, I identify the central city (denoted *cc*) as the low M community — i.e., community 1 — and the suburbs (denoted *sub*) as the high M community — i.e., community 2. The metropolitan area is denoted by *met*.

The quantitative model of section 3.1 contains the 35 parameters displayed in Table 2. Several of these parameters are fixed a priori via normalizations and assumptions. In particular, I assume grants are distributed equally in per household terms (i.e., $\Gamma_E^{cc} = \Gamma_E^{sub}$ and $\Gamma_L^{cc} = \Gamma_L^{sub}$). The total metropolitan land factor, $L^{cc}+L^{sub}$, and $\overline{M}^{cc}$ are each normalized to one. Following Epple and Romano [18], I set $s_a = s_y$ so that, under (53), the earning potential of youths is proportional to head income. I then set $m_a = -s_a^2/2$ to normalize ability per metropolitan youth to one. The parameter β_0 in (53) was then chosen so that earning potential per metropolitan youth equals income per metropolitan household when evaluated in benchmark equilibrium. I also set $\gamma = 0$ and $\gamma^* = 1$ in (54) to produce $\widehat{\lambda}_{cc}^{sub} > 0$ and $\widehat{\lambda}_{sub}^{cc} = 0$ in both the benchmark equilibrium and the policy experiment.[32] I set the elasticity of substitution between private goods and amenities to equal 0.5 (i.e., $\omega = 2$).[33] The remaining 25 parameters were chosen to approximately match the 27 quantities displayed in Tables 3 and 4 in the benchmark equilibrium. Figure 5 depicts the benchmark P-EE in the (M, p_b) plane.

Some interesting characteristics of the benchmark equilibrium are reported in Table 5, columns '**B**' of section 3.3 below. The benchmark equilibrium is broadly consistent a number of stylized facts for metropolitan areas: (i) Property-related crime rates and youth crime participation rates are higher in cities than suburbs (i.e., $K^{cc} > K^{sub}$ and $n^{cc} > n^{sub}$); (ii) Cities tax property at a higher rate and allocate a larger share of their property tax collection to law enforcement than suburbs (i.e., $\tau^{cc} > \tau^{sub}$ and $\Delta^{cc} < \Delta^{sub}$); (iii) Cities have lower income per household than suburbs (i.e., $Y^{cc} < Y^{sub}$) but stratification by income is incomplete (Epple and Platt [16]); (iv) Large urban areas spend more per household on law enforcement (i.e., $G_L^{cc} > G_L^{sub}$), but provide less deterrence in terms of arrest probabilities — i.e., $\pi^{cc} < \pi^{sub}$ (Glaeser and Sacerdote [29]); and, (v) Criminals commit most

[32] This ensures that my results are not driven by suburban criminals preying on the central city.

[33] The principal quantitative results are not sensitive to the choice of $\gamma^* = 1$ or $\omega = 2$. Results are available from me on request.

Household Dist'n	$(m_y, m_v, m_a)' = $ (3.4617,0.8053,-0.2223)' $\left(s_y^2, s_{vy}, s_{ay}, s_v^2, s_{av}, s_a^2\right)' =$ $(0.6668^2$,-0.3997,0.1779,0.6444^2,-0.0291,$0.6668^2)'$
Youths / household	$\# = 0.684$
Grants / household	Education: $\Gamma_E^{cc} = \Gamma_E^{sub} = 1.5727$ Law Enforcement: $\Gamma_L^{cc} = \Gamma_L^{sub} = 0.0891$
Housing Supply	Land Factors: $L^{cc} = 0.3884,\ L^{sub} = 0.6116$ Price Elast. of Housing Supply: $\varrho = 0.5$
Exog. Amenities	$\overline{M}^{cc} = 1,\ \overline{M}^{sub} = 1.3448$
Head Pref's	Elast. of Subst. b/w $b$and MParm: $\omega = 2$ Elast. of Subst. b/w c and hParm: $\sigma = 1.5832$ Elast. of Subst. b/w Q and MParm: $\alpha = 0.972$ Housing and Pub. Safety Share Parms: $\delta = 0.0431,\ d = 0.1506$
Youth Pref's	Cost of Educating: $\epsilon = 3.474$ Cost per Local Offense: $\gamma = 0$ Cost per Exported Offense: $\gamma^* = 1$
Technologies	**Conviction Rate** Scale Parameter: $\theta_0 = 0.0251$ Elast. of Conv. Rate w.r.t. G_L: $\theta_1 = 0.305$ Elast. of Conv. Rate w.r.t. K: $\theta_2 = -0.4085$ **Sanction per Conv.**: $s = 34.8765$ **Theft** Scale Parameter: $\eta_0 = 0.0082$ Elast. of Fraction Stolen w.r.t. K: $\eta_1 = 0.295$ **Earnings from Educ.** Scale Parameter: $\beta_0 = 29.8636$ Elast. of Earnings w.r.t. Q: $\beta_1 = 0.1911$

Table 2: Parameters

	Model	**Data**
Ratio of CC to MET Land Area (L^{cc})	0.3884	0.3884
Youths per household $(\#)$	0.684	0.684
Income per household (Y)	39.806	39.805
Median household Income	31.871	31.870
$corr\left(\ln y, \ln I\left(Q, a\right)\right)$	0.4	0.4
Elasticity of Youth Earning Potential. w.r.t. Q (β_1)	0.1911	0.1911
Price Elasticity of Housing Supply (ϱ)	0.5	0.5
Price Elasticity of Housing Demand	-0.7	-0.7
Ratio of h Exp. to $(h+c)$ Exp.	0.15	0.15
Met Gov't Share of Education Rev.	0.531	0.529
Met Gov't Share of Law Enf. Exp.	0.276	0.274
Elasticity of π w.r.t. Law Enf. Exp. (θ_1)	0.305	0.305
Elasticity of Fraction Stolen w.r.t. Crime Rate (η_1)	0.295	0.295
Return per Crime	1.213	1.210
Crimes per Criminal	10.94	11

Table 3: Metropolitan Characteristics Matched in Benchmark Equilibrium
(Monetary Figures in thousands of 1990 dollars.)

	Model	**Data**
CC Income per household (Y^{cc})	33.906	33.948
SUB Income per household $\left(Y^{sub}\right)$	43.900	43.856
CC Median household Income	25.947	26.052
SUB Median household Income	35.402	36.038
CC Education Exp. per Pupil (Q^{cc})	4.215	4.232
SUB Education Exp. per Pupil $\left(Q^{sub}\right)$	4.556	4.569
CC Law Enf. Exp. per household (G_L^{cc})	0.404	0.406
SUB Law Enf. Exp. per household $\left(G_L^{sub}\right)$	0.267	0.269
CC Conviction Rate (π^{cc})	0.0355	0.0353
SUB Conviction Rate $\left(\pi^{sub}\right)$	0.0428	0.0427
CC Crimes per household (K^{cc})	0.218	0.221
SUB Crimes per household $\left(K^{sub}\right)$	0.101	0.102

Table 4: Local Characteristics Matched in Benchmark Equilibrium
(Monetary Figures in thousands of 1990 dollars.)

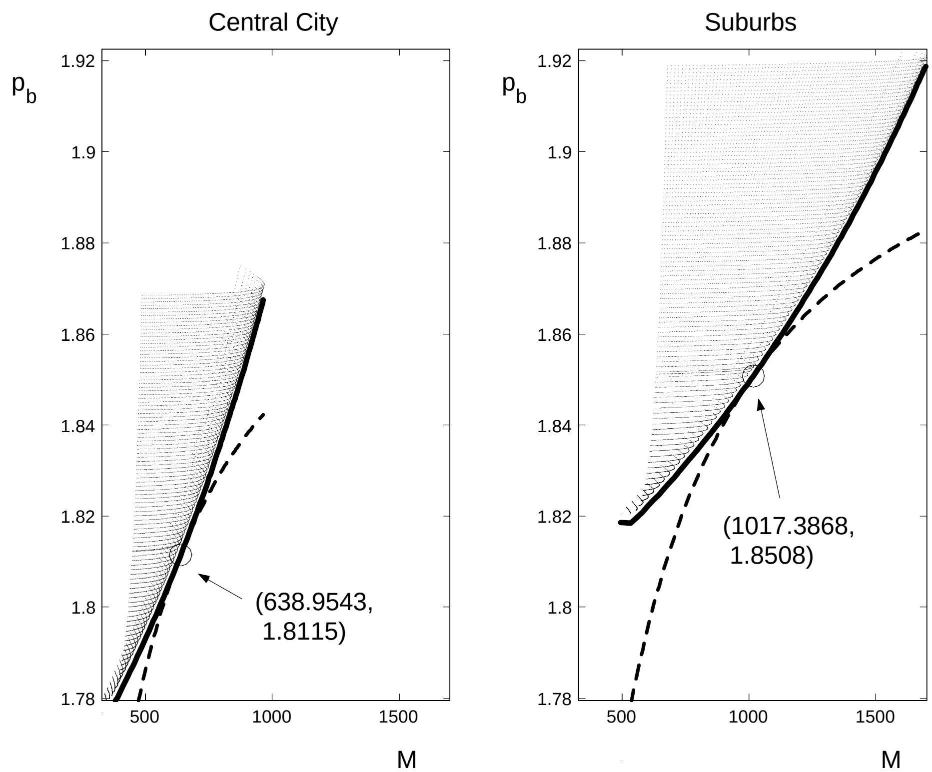

Figure 5: Benchmark Politico-Economic Equilibrium (Community Possibilities Set = Shaded Region; Community Possibilities Frontier = Solid Line, Indifference Curve of Median Voter = Dashed Line)

offenses in their communities of residence (i.e., $\widehat{\lambda}_j^j > \widehat{\lambda}_j^{-j}$).

The youth crime participation rate (n^j) is more than 13 times higher in central cities than suburbs. This is due in large part to the fact that the legitimate earning potential of central city youths ($19,869) is substantially smaller than that that for suburban youths ($53,597), which is in turn due to both higher education quality as well as a 'better' distribution of youth abilities in the suburbs.[34] While suburban youths are far less likely to choose crime, the few who do offend more intensively than their central city coun-

[34] Glaeser and Sacerdote [29] argue that a sizeable component of the urban crime premium is due to cities attracting crime prone individuals. My analysis provides one explanation for this phenomenon based on Tiebout sorting of households.

terparts (i.e., $\lambda_{sub}^{sub} + \lambda_{sub}^{cc} > \lambda_{cc}^{cc} + \lambda_{cc}^{sub}$) even though, since $\gamma^* > r^{cc}$, suburban criminals commit no offenses in the central city (i.e., $\lambda_{sub}^{cc} = 0$). Consequently, the central city crime rate, K^{cc}, is only about twice as large as the suburban crime rate, K^{sub}, even though more households reside in the suburbs (i.e., $\mu^{sub} > \mu^{cc}$). Finally, even though central cities spend more per household on law enforcement, the central city conviction rate, π^{cc}, is lower than its suburban counterpart, π^{sub}, due to the more demanding case-load facing central city police departments.[35]

3.3 Impact of the COPS Program

I now assume the metropolitan government raises an additional \$100 per metropolitan household in income tax revenue over its benchmark collections and earmarks all these additional resources to central city police departments. Measuring dollars in thousands, the law enforcement grant per suburban household, Γ_L^{sub}, remains fixed at its benchmark level of 0.0891, while that for the central city, Γ_L^{cc}, increases from 0.0891 to $0.0891 + 0.1/\mu^{cc'}$, where $\mu^{cc'}$ is the equilibrium population size of the central city under the new regime.

In the benchmark equilibrium, grants per metropolitan household were $\$1,661.8$ dollars, with central cities and suburbs each receiving $\$1,572.7$ per community household for education and \$89.1 per community household for law enforcement.[36] The income tax rate balancing the metropolitan government budget was $t = 0.0417$. When the new policy is implemented, grants per metropolitan household rise to $\$1,761.8$ and the budget balancing income tax rate becomes 0.0443.

The equilibrium outcomes for a number of important variables are displayed in Table 5. For purposes of comparison, results are reported for both EE (see Definition 2) and P-EE (see Definition 3).

Consider first the economic equilibrium (columns '**EE**' in Table 5) where the property tax rates τ^j and the budget compositions Δ^j remain fixed at their benchmark levels. Since the COPS program makes the central city relatively more attractive to heads, its population increases from a benchmark level of $\mu^{cc} = 0.4096$ to 0.415. On average, the migrating households have head incomes and youth abilities higher (lower) than those in the benchmark

[35] The importance of this congestion effect is emphasized in Ehrlich [13], Freeman et al. [25], and Newlon [41].

[36] Grants per metropolitan household are $\mu^{cc}(\Gamma_E^{cc} + \Gamma_L^{cc}) + \mu^{sub}(\Gamma_E^{sub} + \Gamma_L^{sub})$.

	CC			SUB		
	B	**EE**	**P-EE**	**B**	**EE**	**P-EE**
Grants	1.6618	1.9028	1.9022	1.6618	1.6618	1.6618
Γ_E^j (to Educ.)	1.5727	1.5727	1.5727	1.5727	1.5727	1.5727
Γ_L^j (to L.E.)	0.0891	0.3301	0.3295	0.0891	0.0891	0.0891
Prop. Tax. Rev.	1.4990	1.5034	1.3141	1.7117	1.7046	1.7084
$\Delta^j \tau^j p_h^j H^j$ (to Educ.)	1.1840	1.1874	1.2316	1.5333	1.5270	1.5328
$(1-\Delta^j)\, \tau^j p_h^j H^j$ (to L.E.)	0.3151	0.3160	0.0825	0.1783	0.1776	0.1756
Gov't. Exp.	3.1608	3.4062	3.2163	3.3735	3.3664	3.3702
G_E^j (on Educ.)	2.7567	2.7601	2.8043	3.1060	3.0997	3.1055
G_L^j (on L.E.)	0.4042	0.6461	0.4120	0.2674	0.2667	0.2647
t (Income Tax Rate)	0.0417	0.0443	0.0443	0.0417	0.0443	0.0443
x_{med} (median voter)	58.220	58.355	58.380	81.400	81.556	81.585
τ^j (Property Tax Rate)	0.3416	0.3416	0.2880	0.2759	0.2759	0.2768
Δ^j (local spending comp.)	0.7898	0.7898	0.9372	0.8958	0.8958	0.8972
Y^j (Income per household)	33.906	33.965	33.976	43.900	43.949	43.958
μ^j (Share of Met. households)	0.4096	0.4150	0.4160	0.5904	0.5850	0.5840
p_h^j (Net Housing Price)	2.7773	2.8070	2.8796	3.2974	3.2683	3.2630
H^j (Housing per household)	1.5801	1.5680	1.5844	1.8812	1.8901	1.8917
$p_h^j H^j$ (Prop. Tax Base)	4.3886	4.4015	4.5622	6.2031	6.1774	6.1728
Q^j (Per Pupil Educ. Exp.)	4.2151	4.2093	4.2852	4.5561	4.5464	4.5548
Average Youth Ability	0.5054	0.5059	0.5056	1.3432	1.3506	1.3522
Youth Earning Potential	19.869	19.883	19.938	53.597	53.868	53.954
r^j (Return per Offense)	0.8135	1.0869	0.8298	1.8085	1.8134	1.8063
π^j (Conviction Rate)	0.0355	0.0484	0.0360	0.0428	0.0428	0.0426
n^j (Criminals / Youth)	0.0439	0.0413	0.0433	0.0033	0.0032	0.0032
λ_{cc}^j (CC Crim. Off. Alloc.)	7.2673	5.1271	7.1868	3.3220	3.4744	3.3337
λ_{sub}^j (SUB Crim. Off. Alloc.)	0.0000	0.0000	0.0000	14.1702	14.2067	14.2833
$\mu^j K^j$ (Crimes / Met. household)	0.0893	0.0602	0.0885	0.0598	0.0591	0.0594
K^j (Crimes per household)	0.2181	0.1449	0.2126	0.1013	0.1011	0.1017

Table 5: Impact of the COPS Program
(Notes: Columns 'B' are the benchmark values; Columns 'EE' are the economic equilibrium values maintaining the benchmark local public policies; Columns 'P-EE' are the politico-economic equilibrium values; All monetary Figures are measured in thousands of 1990 Dollars.)

central city (suburbs). Consequently, income per household, Y^j, and average youth ability rise in both communities.

The net inflow of households to the central city increases aggregate housing demand there and decreases it in the suburbs. The central city net housing price, p_h^{cc}, rises, per household housing, H^{cc}, falls, and the per household property tax base, $p_h^{cc}H^{cc}$, rises, with the opposite happening in the suburbs. With the property tax rates, τ^j, held fixed at their benchmark levels, property tax collections, $\tau^j p_h^j H^j$, rise in the central city and decline in the suburbs. With spending compositions, Δ^j, also held fixed, the result is that both central city law enforcement expenditures per household, G_L^{cc}, and education expenditures per household, G_E^{cc}, rise — with G_L^{cc} increasing substantially due to the increased grant — whereas both suburban law enforcement and education expenditures, G_L^{sub} and G_E^{sub}, decline slightly.

The increased spending on central city law enforcement makes central city offenses less attractive to criminals. This has two effects. First, central city youths choosing crime after the policy reform operate less intensively in the central city and more intensively in the suburbs (i.e., λ_{cc}^{cc} falls from 7.2673 to 5.1271 and λ_{cc}^{sub} rises from 3.322 to 3.4744). Due to stronger central city law enforcement and the sorting-induced improvement in the central city ability distribution, the central city crime participation rate declines from n^{cc} = 0.0439 criminals per youth to 0.0413. Accounting for alterations on both these margins, central city criminals now commit fewer total crimes in *both* the central city and the suburbs (i.e., $\mu^{cc}\#n^{cc}\lambda_{cc}^{cc}$ and $\mu^{cc}\#n^{cc}\lambda_{cc}^{sub}$ each fall).[37]

With fewer crimes committed in the central city and suburbs by central city criminals and a sorting-induced increase in income per household, Y^j, the return per offense rises in both central city and the suburbs (i.e., both r^{cc} and r^{sub} rise). The higher suburban return per offense combined with an essentially unchanged conviction rate, π^{sub}, causes suburban criminals to commit crimes slightly more intensively in the suburbs (i.e., λ_{sub}^{sub} rises from 14.1702 to 14.2067). At the same time, the sorting-induced improvement in

[37] Defining $\#^j$ as youths per j household, the number of youths per metropolitan household is $\#^{met} = \mu^{cc}\#^{cc} + \mu^{sub}\#^{sub}$. Since every household has # youths, $\#^{met} = \#^{cc} = \#^{sub} = \#$. Abbreviating 'households' by 'HHs', $\mu^j\#n^j\lambda_j^\ell$ is

$$\frac{\text{HHs in } j}{\text{HHs in } met} \times \frac{\text{Youths in } j}{\text{HHs in } j} \times \frac{\text{Criminals in } j}{\text{Youths in } j} \times \frac{\substack{\text{Crimes in } \ell \\ \text{per } j\text{Criminal}}}{\text{Criminals in } j}.$$

the suburban ability distribution causes the suburban youth crime participation rate, n^{sub}, to decline slightly, even though, due to lower education quality and more lucrative returns per offense, the occupation of crime has become relatively more attractive for suburban youths (i.e., the cut-off ability level a^{sub} defined in proposition 2 rises relative to its benchmark level).

Accounting for the alterations in the behavior of both central city and suburban youths, crimes per metropolitan household, $\mu^j K^j$, fall in each community. With substantially fewer crimes and a slightly larger population, the central city crime rate declines substantially from a benchmark level of $K^{cc} = 0.2181$ to 0.1449 crimes per household. While the population size in the suburbs, μ^{sub}, declines relative to its benchmark, suburban crimes per metropolitan household, $\mu^{sub} K^{sub}$, falls more. Consequently, the suburban crime rate also declines, albeit slightly, from its benchmark of $K^{sub} = 0.1013$ to 0.1011 crimes per household. Due to the changes in both law enforcement expenditures and departmental case-loads, the central city conviction rate increases from its benchmark level of $\pi^{cc} = 0.0355$ to 0.0484 convictions per crime while the suburban conviction rate, π^{sub}, remains about constant. In the aggregate, the COPS program causes the metropolitan-wide crime rate, $\mu^{cc} K^{cc} + \mu^{sub} K^{sub}$, to decline substantially from its benchmark level of 0.1491 to 0.1193.

Next consider the politico-economic equilibrium (columns '**P-EE**' in Table 5) where local governments adjust their contributions to education and law enforcement spending as dictated by majority rule within each community.[38] The most striking aspect of this analysis is that the central city government substantially offsets the metropolitan government's policy initiative by reducing its property tax rate from a benchmark of $\tau^{cc} = 0.3416$ to the new level of 0.288. At the same time, it increases the share of its locally financed education expenditures from a benchmark level of $\Delta^{cc} = 0.7898$ to the post-reform level of 0.9372. In stark contrast to EE (where local public policies were held fixed at their benchmark levels), central city law enforcement expenditures now rise only slightly from a benchmark level of $G_L^{cc} =$ 404.2 to 412 dollars per household.

Further, due the resulting change in the composition of the central city

[38]Figure 6 depicts P-EE in the (M, p_b) plane. The community possibilities frontier shifts back in *both* communities due to the increased income tax rate, t. Clearly, heads are worse-off under the COPS program. This welfare assessment, however, ignores potential windfall gains to central city land/housing owners. It further abstracts from a progressive income tax.

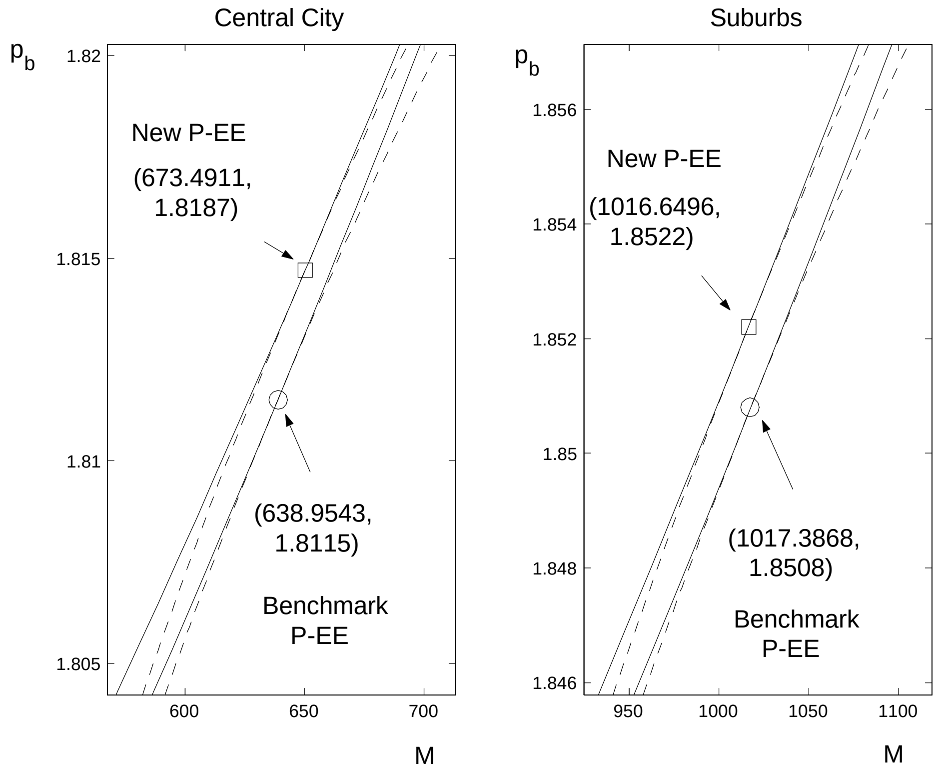

Figure 6: Politico-Economic Equilibrium with Increased Law Enforcement Grant to Central City (CPFs are solid lines, Indifference curves of median voters are dashed lines)

government's spending, Δ^{cc}, the increased grant to central city law enforcement actually causes central city educational expenditures, G_E^{cc}, to rise more than law enforcement expenditures, G_L^{cc}. The central city crime rate still falls from its benchmark level, but it does so only slightly (i.e., K^{cc} falls from 0.2181 to 0.2126 crimes per household). The suburban crime rate now rises slightly from a benchmark of $K^{sub} = 0.1013$ to 0.1017 crimes per household. In the aggregate, the metropolitan-wide crime rate, $\mu^{cc}K^{cc} + \mu^{sub}K^{sub}$, now declines only slightly from its benchmark level of 0.1491 to 0.1478 crimes per household.

These results highlight the striking differences between the policy conclusions drawn from a more 'naive' analysis that ignores the response of local public policies versus one that incorporates such responses. In a series of sensitivity analyses, I have found the principal conclusions presented here to be robust to alternative calibrations.[39]

4 Conclusion

While this paper has focused on one particular policy (the COPS program), I also believe it provides some more general insights with regard to interjurisdictional crime policies. First, as several papers have pointed out, strengthening law enforcement in one community can cause crime to 'spillover' into neighboring communities (e.g., Mehay [39], Weinblatt et al.[63], Deutsch et al. [10], Friedman et al. [26], de Meza and Gould [9], Freeman et al. [25], Marceau [36], and Newlon [41]). My analysis indicates that the impact of such spillovers on community crime rates is complex. While strengthening deterrence in one community does indeed create incentives for criminals to reallocate their offenses to other communities, such adjustments on this intensive margin are balanced by reductions on the extensive margin of crime participation. Put differently, criminals offend more intensively in the community with constant police spending but there are also fewer criminals. The net effect on the crime rates of neighboring communities is, at a general level, ambiguous.

Second, while strengthening deterrence in one community makes it more attractive to residents of other communities, the impact of the policy can be substantially capitalized into the net housing prices. A welfare accounting of such policies should thereby incorporate potential gains to land/home-owners.

Third, when local public policies are deemed responsive, intervention by a centralized government can substantially crowd-out locally financed expenditures. In an economy with multiple public projects, this can occur not only because local property tax collections fall, but also since the composition of local spending across projects can change. Interestingly, my model provides a tractable way of studying this issue, which involves more than one policy dimension, in the context of preference-induced majority voting equilibrium.

For purposes of tractability, the analysis in this paper has abstracted from a number of issues. An obvious, albeit potentially important, extension would be to include several communities instead of just two. A more subtle, though

[39] Results are available from me on request.

also potentially important, issue involves voter sophistication. In particular, sophisticated voters would anticipate the migration that different local public policies might generate. I believe that my theoretical framework can be expanded to accommodate both these settings, although the computational issues involved would become more challenging.

I have also made an important abstraction regarding the criminal sector. In particular, it is only the young who commit crime in my model. While youths constitute an important component of the general crime problem, relaxing this assumption is an important avenue of future research.

A Proofs

Proof of Lemma 1. Due to homotheticity, (10) can be written as

$$\widehat{h} = \widehat{h}\left(p, (1-t-\phi)\, y\right) = g\left(p\right) \cdot (1-t-\phi)\, y$$

where $g(p)$ is a strictly decreasing function. The private goods consumption of a head with income y is then

$$\begin{aligned} \widehat{b} &= u\left((1-t-\phi)\, y - p\widehat{h}, \widehat{h}\right) \\ &= u\left((1-pg\left(p\right)) \cdot (1-t-\phi)\, y, g\left(p\right) \cdot (1-t-\phi)\, y\right). \end{aligned}$$

Since u is linearly homogenous, this becomes

$$\widehat{b} = u\left(1-pg\left(p\right), g\left(p\right)\right) \cdot (1-t-\phi)\, y$$

where $u\left(1-pg\left(p\right), g\left(p\right)\right)$ is decreasing in p (since $\widehat{b}$ is itself an indirect utility function). Consequently, $\widehat{b} = y/p_b$ with

$$p_b \equiv p_b\left(p, \phi\right) \equiv 1/\left[u\left(1-pg\left(p\right), g\left(p\right)\right) \cdot (1-t-\phi)\right],$$

which is increasing in both p and ϕ. ■

Proof of Proposition 1. Begin with part (i). By definition, a head with income $\widehat{y}(v)$ and taste parameter v is indifferent between communities 1 and 2. This means that she has an indifference curve in the (M, p_b) plane intersecting both (M^1, p_b^1) and (M^2, p_b^2). Holding v fixed, (15) tells us that the slope of this indifference curve rises as income does. Since utility rises to the southeast in the (M, p_b) plane (see Figure 2), the result follows immediately.

Next consider part (ii). Differentiate (18) with respect to υ to obtain

$$\frac{d\widehat{y}}{d\upsilon} = \frac{U_3\left(\widehat{y}/p_b^2, M^2; \upsilon\right) - U_3\left(\widehat{y}/p_b^1, M^1; \upsilon\right)}{\frac{U_1\left(\widehat{y}/p_b^1, M^1; \upsilon\right)}{p_b^1} - \frac{U_1\left(\widehat{y}/p_b^2, M^2; \upsilon\right)}{p_b^2}} \tag{59}$$

where subscripts on U here denote partial derivatives. From the definition of $\widehat{y}$ and (16),

$$U\left(\widehat{y}/p_b^1, M^1; \upsilon+\varepsilon\right) \lesseqgtr U\left(\widehat{y}/p_b^2, M^2; \upsilon+\varepsilon\right) \Longleftrightarrow \varepsilon \gtreqless 0$$

Using (18) and dividing through by $\varepsilon \neq 0$ yields

$$\begin{aligned} & \frac{U\left(\widehat{y}/p_b^1, M^1; \upsilon+\varepsilon\right) - U\left(\widehat{y}/p_b^1, M^1; \upsilon\right)}{\varepsilon} \\ < \quad & \frac{U\left(\widehat{y}/p_b^2, M^2; \upsilon+\varepsilon\right) - U\left(\widehat{y}/p_b^2, M^2; \upsilon\right)}{\varepsilon}. \end{aligned}$$

Taking limits as $\varepsilon \to 0$ produces

$$U_3\left(\widehat{y}/p_b^1, M^1; \upsilon\right) < U_3\left(\widehat{y}/p_b^2, M^2; \upsilon\right).$$

Consequently, the numerator of (59) is positive. Similarly, using the definition of $\widehat{y}$ and (15), arguments analogous to those above yield

$$\begin{aligned} & \frac{U\left(\frac{\widehat{y}+\varepsilon}{p_b^1}, M^1; \upsilon\right) - U\left(\widehat{y}/p_b^1, M^1; \upsilon\right)}{\varepsilon} \\ < \quad & \frac{U\left(\frac{\widehat{y}+\varepsilon}{p_b^2}, M^2; \upsilon\right) - U\left(\widehat{y}/p_b^2, M^2; \upsilon\right)}{\varepsilon} \end{aligned}$$

for $\varepsilon \neq 0$. Taking limits as $\varepsilon \to 0$, it follows that

$$\frac{\partial U\left(\widehat{y}/p_b^1, M^1; \upsilon\right)}{\partial y} < \frac{\partial U\left(\widehat{y}/p_b^2, M^2; \upsilon\right)}{\partial y}$$

or, equivalently,

$$U_1\left(\widehat{y}/p_b^1, M^1; \upsilon\right)/p_b^1 < U_1\left(\widehat{y}/p_b^2, M^2; \upsilon\right)/p_b^2.$$

Consequently, the denominator of (59) is negative and, therefore, (59) itself is negative. ■

Proof of Proposition 2. The result that a youth living in community j chooses crime if and only if $a_i < a^j$ follows immediately since (23) is strictly increasing in ability while (31) independent of ability. The result that a^j is decreasing in Q^j follows from the fact that (23) is increasing in Q^j (since youth earning potential, $I(Q,a)$, depends positively on Q) while (31) is independent of Q^j. That a^j is increasing in $\widehat{EV}_j^c$ follows immediately from (32). ■

Proof of Proposition 3. Let Ω^{j^*} denote the economic equilibrium set of voters in community j with measure μ^{j^*} when the local public policy forecast is $\varphi^* = (\tau^{1^*}, \Delta^{1^*}, \tau^{2^*}, \Delta^{2^*})$, and let $(\tau^{j^*}, \Delta^{j^*})$ deliver the point

$$\left(M^{j^*} \equiv \widetilde{M}^j\left(\tau^{j^*}, \Delta^{j^*}; \varphi^*\right),\ p_b^{j^*} \equiv \widetilde{p}_b^j\left(\tau^{j^*}, \Delta^{j^*}; \varphi^*\right)\right)$$

in the (M, p_b) plane of Figure 7.[40] For all voters in j with characteristics $(y, \upsilon) = (y^j(\upsilon), \upsilon)$, let this point $\left(M^{j^*}, p_b^{j^*}\right)$ maximize (5) among the set of points (M, p_b) in community j's possibility set, $CPS^j(\varphi^*)$. Clearly there cannot exist any point (M, p_b) in j's $CPS^j(\varphi^*)$ that lies in region C of Figure 7 since the existence of such a point would violate condition (i) of Proposition 3. From equation (15) in Assumption 3, we know that, for fixed υ, indifference curves in the (M, p_b) plane increase as income does. Consequently, all households with tastes υ and income $y > y^j(\upsilon)$ prefer $\left(M^{j^*}, p_b^{j^*}\right)$ to any point (M, p_b) in region A of Figure 7. Combining this with condition (ii) — for community 1 — or condition (iii) — for community 2 — of Proposition 3 implies that at least one half the voters in community j prefer $\left(M^{j^*}, p_b^{j^*}\right)$ to any other point in region A of Figure 7. Analogously, all households with a given υ and $y < y^j(\upsilon)$ prefer $\left(M^{j^*}, p_b^{j^*}\right)$ to any point (M, p_b) in region B of Figure 7. Combining this with condition (ii) — for community 1 — or condition (iii) — for community 2 — of Proposition 3 implies that at least one half the voters in community j prefer $\left(M^{j^*}, p_b^{j^*}\right)$ to any other point in region B of Figure 7. Therefore, point $\left(M^{j^*}, p_b^{j^*}\right)$ garners at least half the vote in binary comparisons against all other candidate policies in community j's possibility set $CPS^j(\varphi^*)$. ■

[40] This proof does not rely on the curvature properties of either the voter indifference curves or the community possiblities frontier.

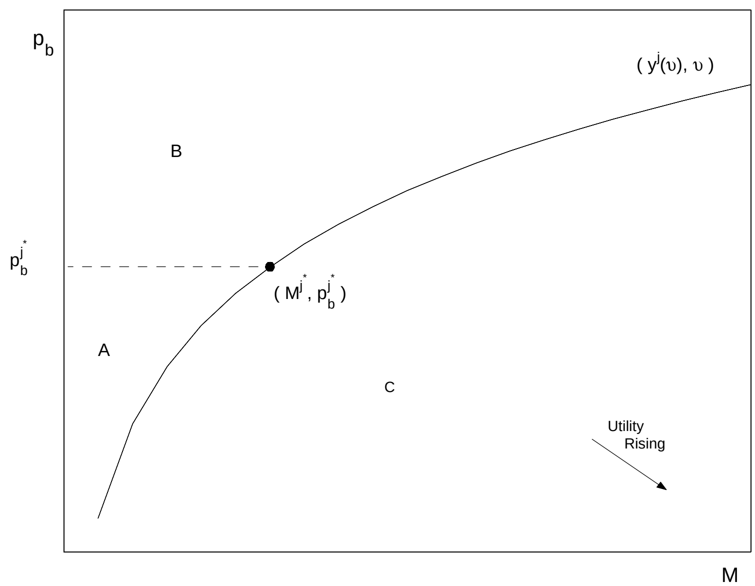

Figure 7: Used in Proof of Proposition 3

Proof of Corollary 1. Since $M^2 > M^1$ by Definition 1, focus on the interesting case where $p_b^2 > p_b^1$. (Otherwise, community 1 is empty.) Using (13) and (45), a head with income y and taste parameter υ chooses community 1 if and only if

$$\frac{1}{1-\omega}\left(\left(y/p_b^1\right)^{1-\omega}+\upsilon\left(M^1\right)^{1-\omega}\right)\geq\frac{1}{1-\omega}\left(\left(y/p_b^2\right)^{1-\omega}+\upsilon\left(M^2\right)^{1-\omega}\right).$$

For $\omega > 1$, this is equivalent to

$$y<\widehat{y}\left(\upsilon\right)=\left(\frac{\frac{1}{\omega-1}\left(\left(p_b^2\right)^{\omega-1}-\left(p_b^1\right)^{\omega-1}\right)}{\frac{1}{1-\omega}\left(\left(M^2\right)^{1-\omega}-\left(M^1\right)^{1-\omega}\right)}\right)^{\frac{1}{\omega-1}}\upsilon^{\frac{1}{1-\omega}}, \qquad (60)$$

which is the residential boundary locus defined in Proposition 1. Raising both sides to the power $(\omega-1)$ and multiplying through by υ delivers (48).

The form for p_b given in (50) is confirmed as follows: Under (46), the head's housing demand function in (10) becomes

$$\widehat{h}\equiv\widehat{h}\left(p,\left(1-t-\phi\right)y\right)=g\left(p\right)\left(1-t-\phi\right)y$$

where

$$g(p) = 1/\left(p + (p/\delta)^{\frac{1}{\sigma}}\right).$$

Using this with (11) and (46) delivers the result (following some algebra). ■

Proof of Corollary 2. Under (45), the slope in (14) for a head with income y and taste parameter υ becomes

$$m_i = M^{-\omega} p_b^{2-\omega} x \tag{61}$$

with x given by (49). Since (61) is monotonic in the head characteristic index, x, voter preferences satisfy single-crossing in the (M, p_b) plane. Using arguments similar to Epple and Romer [19, Proposition 2], the policy in CPS^j that maximizes (41) for the voter with characteristic index x_{med}^j is a majority winner in community j.[41] ■

B Data

This appendix describes how I constructed the data in Tables 3 and 4.

B.1 Metropolitan-Wide Quantities

- **Ratio of Central City to Metropolitan Land Area**: In 1990, central places inside urbanized areas occupied 60,215.2 squared kilometers, whereas the urban fringe accounted for 94,837.1 squared kilometers (U.S. Department of Commerce [49, Table 10]). The ratio of squared kilometers of land area in central places to central places plus the urban fringe is 0.3884 ($= L^{cc}$).[42]

- **Youths per Household**: In 1990 US metropolitan areas, 25.3% of the population was under the age of 18 years and the ratio of population

[41] More formally, the functions

$$y^j(\upsilon) = \left(\frac{x_{med}^j}{\upsilon}\right)^{\frac{1}{\omega-1}}, \quad j = 1, 2,$$

will satisfy conditions (i)-(iii) of Proposition 3.

[42] I believe this is a more appropriate measure than the ratio of land area in central cities to metropolitan areas since considerable portions of metropolitan areas are often not urbanized/developed.

to households was 2.704 (U.S. Department of Commerce [50, Tables 1 and 2 with my calculations]). The estimated number of youths per metropolitan household is $0.253\,(2.704) \simeq 0.684$ (= #).

- Metropolitan-wide **Income per household** and **Median household Income**: In 1990 U.S. metropolitan areas, income per household was $39,805 and median household income was $31,870 (U.S. Department of Commerce [51, 1990 Edition, Table 2]).

- **Correlation between the log of head income and the log of youth (legitimate) earning potential** $[corr\,(\ln y, \ln I\,(Q,a))]$: Solon [47] and Zimmerman [66] agree that the best point estimate of the correlation between father's income and son's income is 0.4 $(= s_{ya}/\,(s_y s_a))$.

- **Elasticity of Youth Earning Potential with respect to Education Quality**: After reviewing the literature, Fernandez and Rogerson [23, p. 821] suggest 0.1911 $(= \beta_1)$ as a reasonable measure of the elasticity of mean earnings with respect to education expenditures.

- **Price Elasticity of Housing Supply** and **Demand**: Reviewing the empirical literature based on U.S. urban housing markets, Quigley [42] suggests estimates of 0.5 $(= \varrho)$ and -0.7, respectively.

- **Ratio of h Expenditures to $(h + c)$ Expenditures**: Fernandez and Rogerson [23, p. 820] report that the ratio of annual aggregate housing expenditures to aggregate expenditures on consumption (including housing) averaged 0.15 between 1960-1990.

- **Metropolitan Government's Share of Education Revenues and Law Enforcement Expenditures**: In the 1990 U.S., state and federal governments accounted for 52.9% of elementary and secondary education revenues (U.S. Department of Education [53, Table 39]) and 27.4% of police expenditures (U.S. Department of Justice [57, Table 3 with my calculations]).

- **Elasticity of the Conviction Rate with respect to Law Enforcement Expenditures**: Based on the FBI felony crime index, Ehrlich [11, p. 557] estimates the elasticity of the conviction rate with respect to law enforcement expenditures to be 0.305 $(= \theta_1)$.

- **Elasticity of Fraction Stolen with respect to the Crime Rate**: I estimate this elasticity by constructing a series of 30 annual observations on the fraction of income stolen by dividing the reported value of property stolen (U.S. Department of Justice [60, 1962-91 Editions with my calculations] by nominal gross domestic product (Council of Economic Advisors [6, 1992 Edition, Table B-1]) in each year from 1962-1991. I also constructed a series for property-related crime rates (burglary, larceny, motor vehicle theft, and robbery) over the same period. I could not reject the null hypothesis of a unit root at the 0.05 level in the logarithm of either series individually based on Dickey-Fuller t-tests. Johansen's λ_{trace} statistic rejected the null hypothesis of no cointegration at the 0.05 level. I then regressed the logarithm of fraction stolen on a constant and the logarithm of the property-related crime rate using Phillips and Hansen's fully modified least squares estimator. My point estimate was 0.295 ($= \eta_1$).[43]

- **Return per Crime**: The reported loss per burglary, larceny, motor vehicle theft, and robbery in the 1990 U.S. equaled $1,210 (U.S. Department of Justice [60, 1990 Edition, Table 19 with my calculations]).

- **Crimes per Criminal**: Marvell and Moody [37, p. 112] estimate the number of crimes per criminal in the U.S. to be about 11.[44]

B.2 Community-Specific Quantities

- **Income per Household and Median Household Income**: In 1990 U.S. metropolitan areas, mean and median household income in central cities were $33,948 and $26,052, while for places inside metropolitan areas but outside central cities these data were $43,856 and $36,038 ([51, 1990 Edition, Table 2]).

- **Education Expenditures Per Pupil**: In a study combining the National Center for Education Statistics (NCES) database with 1990 Cen-

[43] The augmentation orders for the Dickey-Fuller tests and the lag length for the VAR in Johansen's test were determined using a model selection criterion. The bandwidth for the Phillips-Hansen estimator was also chosen based on the data. Details are available from me on request.

[44] In the criminology literature, the number of crimes per criminal is dubbed 'Lambda'. As Freeman [24, p. 28] points out, there is considerable debate as to the correct value of Lambda.

sus demographic data mapped by the NCES to school district boundaries, Thomas B. Parrish and Christine S. Hidiko (U.S. Department of Education [52, Table II-6]) report evidence on K-12 public education expenditures U.S. central cities and suburbs. For academic year 1991-92, they found that per pupil general education revenues were $\$4,476$ for central city school districts and $\$4,833$ for suburban school districts.[45] In 1990, 1991, and 1992, the consumer price index (CPI-U, 1982-4=100) was 130.7, 136.2, and 140.3, respectively (Council of Economic Advisors [6, 2000 Edition, Table B-58]). The ratio of the 1990 CPI-U to the average of the 1991 and 1992 CPI-Us was about 0.9454. Deflating to 1990 dollars yields

$$\begin{aligned} \$4,476 \times 0.9454 &\simeq \$4,232 \text{ per pupil (central cities)}, \\ \$4,833 \times 0.9454 &\simeq \$4,569 \text{ per pupil (suburbs)}. \end{aligned}$$

- **Law Enforcement Expenditures per Household**: In 1993, U.S. police departments serving populations with at least 250,000 residents spent \$166 per resident while those serving populations with 10,000-50,000 residents spent \$110 per resident (U.S. Department of Justice [58, Table 10 with my calculations]). The ratio of 1990 to 1993 consumer price indices is about 0.9045 (Council of Economic Advisors [6, 2000 Edition, Table B-58]). Treating the bigger departments as central cities, measuring in 1990 dollars, and converting to per household terms, I estimate police expenditures to be

$$\begin{aligned} \$166 \times 0.9045 \times 2.704 &\simeq \$406 \text{ per household (central cities)}, \\ \$110 \times 0.9045 \times 2.704 &\simeq \$269 \text{ per household(suburbs)}. \end{aligned}$$

- **Conviction Rates**: Since not all crimes are reported to police, I decompose the per crime probability of arrest and conviction as

$$\Pr\{Re \;\&\; Ar \;\&\; Co\} = \Pr\{Re\}\Pr\{Ar|\, Re\}\Pr\{Co|\, Re, Ar\}$$

[45] They place metropolitan school districts into two categories: (i) Urban/central cities which consist primarily of school districts inside central cities, and (ii) Suburban/metropolitan which consist primarily of school districts outside central cities and inside metropolitan areas. These aggregated figures can, of course, mask substantial differences within individual metropolitan areas. For example, see Fernandez and Rogerson [22].

where Re indicates that a crime is reported, Ar indicates the criminal is arrested, and Co indicates the criminal is convicted. I assume that $\Pr\{Re\}$ and $\Pr\{Co|\, Re, Ar\}$ are identical across communities. Based on the 1990 U.S. victimization survey, the proportion of property-related crimes reported is estimated to be 0.3606 (U.S. Department of Justice [55, 1990 Edition, Table 101 with my calculations]).[46] The proportion of reported property-related crimes cleared by arrest equaled 0.1571 for cities with populations of 250,000 or more versus 0.1900 for suburban areas (U.S. Department of Justice [60, 1990 Edition, Table 20 with my calculations]).[47] The proportion of property-related crime arrests resulting in a guilty plea or conviction in 1988 was 0.6236 for five major US cities (U.S. Department of Justice [59, Table 1 with my calculations]).[48] Based on these, I estimate the conviction rates as

$$0.3606\,(0.1571)\,(0.6236) \simeq 0.0353 \quad \text{(central cities)},$$

$$0.3606\,(0.1900)\,(0.6236) \simeq 0.0427 \quad \text{(suburbs)}.$$

- **Crimes per Household**: In 1990, police departments in cities with 250,000 population or more recorded 9,211.6 burglaries, larcenies, motor vehicle thefts, and robberies per 100,000 population, while those in suburban areas recorded 4,238.2 ([60, 1990 Edition, Table 14 with my calculations]). Using the ratio of population to households 2.704 cited above, reported property-related crimes per household are

$$\begin{aligned} 9{,}211.6/100{,}000 \times 2.704 &\simeq 0.2491 \quad \text{(central cities)}, \\ 4{,}238.2/100{,}000 \times 2.704 &\simeq 0.1146 \quad \text{(suburbs)}. \end{aligned}$$

  Similar to Meyers [40], I correct for underreporting in the FBI data by dividing reported crime rates by the previously cited NCVS based estimate of 0.3606 for the probability that a property-related crime is

[46] This is based on the National Criminal Victimization Survey's (NCVS) definitions of crimes of theft, burglary, household larceny, motor vehicle theft, and robbery.

[47] This is based on the FBI's definitions of burglary, larceny, motor vehicle theft, and robbery. Both the NCVS and FBI define robbery as a violent (as opposed to property) crime. I include it under the rubric of 'property-related' crimes.

[48] This calculation is based on the crime categories of burglary, larceny, stolen property (which includes stolen automobiles), and robbery. I omitted arrests involving diversions/referall since the disposition of such cases was not yet determined. When calculating convictions, I included both arrests resulting in guilty pleas and trial convictions.

reported.[49] The resulting estimates of crimes per household are 0.6908 for central cities and 0.3178 for suburbs. Since all crime in my model is committed by youths, I also formed an estimate of central city and suburban crime rates due to criminals aged less than 18 years. Following Levitt [35], I assume the ratio of youth arrests to total arrests is a good estimator of the proportion of crimes committed by youths.[50] In 1990, individuals under 18 years of age accounted for 33.0% of burglary arrests, 30.0% of larceny arrests, 43.3% of motor vehicle theft arrests, 24.2% of robbery arrests, and 32.1% of these property-related crimes as a whole (U.S. Department of Justice [60, 1990 Edition, Tables 2 and 36 with my calculations]). My estimate of property-related crimes per household committed by youths in 1990 central cities and suburban areas were

$$\begin{aligned} 0.6908 \times 0.321 &\simeq 0.221 \quad \text{(central cities)}, \\ 0.3178 \times 0.321 &\simeq 0.102 \quad \text{(suburbs)}. \end{aligned}$$

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[49] Instead of adjusting the FBI crime rates for underreporting, I could have simply used the NCVS victimization rates available for central cities and suburbs. I chose not to do this since the victimization rates are based on where the victim resides, not necessarily where the crime occured.

[50] This will overestimate youth crime if youths are more likely to be arrested than adults and vice-versa. Data constraints leave few working alternatives, especially given my focus on property-related crimes. Of these, only in the case of robbery, which is technically a violent crime, is the victim likely to observe the offender.

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