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There is much discussion of the relationships between crime, inequality, and unemployment. We construct a model where all three are endogenous. We find that introducing crime into otherwise standard models of labor markets has several interesting implications. For example, it can lead to wage inequality among homogeneous workers. Also, it can generate multiple equilibria in natural but previously unexplored ways; hence two identical neighborhoods can end up with different levels of crime, inequality, and unemployment. We discuss the effects of anti-crime policies like changing jail sentences, as well as more traditional labor market policies like changing unemployment insurance. (JEL: D83, J64)

The economics of crime is obviously important. At the turn of the millennium 2.1 million people in the US were in prison or jail, rising to 6.3 million if we include those on probation or parole; to put this in perspective, 5.7 million people were unemployed. There is, of course, much work on the relationships between crime, unemployment, and inequality.[1] A novel feature of our study is that all three of these variables will be made endogenous using an equilibrium search model. This allows us to highlight various interactions among the variables (e.g., how crime affects the unemployment rate and vice-versa), and, more generally, to discuss some general equilibrium effects that seem to have been neglected in the literature. A key finding is that introducing criminal activity into otherwise standard models of the labor market can significantly affect the predictions of these models.

For example, once crime is incorporated, models that implied a single wage may now generate wage dispersion. Also, models that had a unique equilibrium can now generate multiple equilibria in natural but previously unexplored ways. A channel of multiplicity that we emphasize is this. Suppose there are lots of good (high wage) jobs available. Then workers are less inclined to criminal activity, and this makes it easier for a given firm to pay a wage high enough to keep its workers honest. This strategic interaction in wage setting yields multiple equilibria. Thus, two identical neighborhoods may end up with very different amounts of crime, which is interesting in light of recent empirical work (e.g. Edward L. Glaeser, Bruce Sacerdote and Jose A. Scheinkman 1996) that finds it is difficult to account for the high variance in crime rates.[2]

The paper is organized as follows. Section 1 presents the worker's problem taking wages as given. This provides a natural extension to the textbook job search model to incorporate crime. Section 2 analyzes wage setting. This shows how various types of equilibria with different crime rates can arise for different parameter values, and how sometimes multiple equilibria coexist, with different amounts of crime, inequality, and unemployment. In this section we also discuss the relation between our model and some related literature, including other models of wage dispersion, and the efficiency wage model; as we discuss, there is a sense in which one can tell an economic story that is very similar to the efficiency wage story, although the crime model does has some key differences both in assumptions and predictions. Section 3 discusses several extensions. Section 4 concludes.

I. Crime and Job Search

There is a $[0, 1]$ continuum of homogeneous workers and a $[0, N]$ continuum of homogeneous firms.[3] All agents are infinite lived and risk neutral. For now all we say about firms is that each posts a wage w that it is willing to pay to anyone. Let $F(w)$ be the distribution of wages posted. At any point in time workers are either employed (at some w), unemployed, or in jail. Let the numbers in each state be e, u, and n, and the payoff or value functions be $V_1(w)$, V_0, and J. Unemployed workers consume b and receive i.i.d. wage offers from F at rate λ_0. Employed workers consume w, receive i.i.d. offers from F at rate λ_1, and, in addition to leaving for endogenous reasons – e.g. they may change jobs or go to jail – are also laid off exogenously at rate δ. Jailed workers consume z, receive no offers until released, and are released into unemployment at rate ρ, which for simplicity is constant.

Employed (unemployed) workers also encounter opportunities to commit crimes at rate μ_1 (μ_0). A crime opportunity is a chance to steal some amount g that is fixed for now but will be endogenized below. Let $\phi_1(w)$ (ϕ_0) be the probability that an employed (unemployed) worker commits a crime given an opportunity. Let π be the probability of being caught and sent to jail, where for convenience, you are either caught instantly or not at all. Then the expected payoff from crime for an employed (unemployed) worker is $K_1(w)$ (K_0), where

$$K_0 = g + \pi J + (1 - \pi)V_0 \tag{1}$$

$$K_1(w) = g + \pi J + (1 - \pi)V_1(w). \tag{2}$$

Hence, the crime decision satisfies:

$$\phi_0 = \begin{cases} 1 & \text{if } V_0 - J < \frac{g}{\pi} \\ 0 & \text{if } V_0 - J > \frac{g}{\pi} \end{cases} \quad \text{and } \phi_1(w) = \begin{cases} 1 & \text{if } V_1(w) - J < \frac{g}{\pi} \\ 0 & \text{if } V_1(w) - J > \frac{g}{\pi} \end{cases} \quad (3)$$

Employed and unemployed workers also fall victim to crime at rate γ. Below we will close the model by relating γ to the endogenous decisions ϕ_0 and $\phi_1(w)$, but it facilitates the discussion to first present the case where γ is exogenous. This can be rationalized by saying that workers in the model commit crimes against agents in other neighborhoods but not in their own. Alternatively, crime could be "victimless" – there is no problem if $\gamma = 0$, or if we reinterpret $\gamma > 0$ as a tax. In any case, γ will be independent of ϕ_0 and $\phi_1(w)$ until Section 3. When victimized an employed (unemployed) worker suffers a loss $\ell_1(w)$ (ℓ_0). For now we set $\ell_1(w) = \ell_0 = \ell$ exogenously, but we also discuss how this can be generalized below.

Given the probability is 0 that two or more events – e.g. a crime and a job opportunity – occur simultaneously, Bellman's equation for an unemployed worker is

$$rV_0 = b - \gamma\ell + \mu_0\phi_0(K_0 - V_0) + \lambda_0 E_x \max\{V_1(x) - V_0, 0\}, \quad (4)$$

where r is the rate of time preference. In words, the flow return to being unemployed rV_0 equals instantaneous net income plus the expected value of receiving either a crime or job opportunity. Similarly,

$$rV_1(w) = w - \gamma\ell + \delta[V_0 - V_1(w)] + \mu_1\phi_1(w)[K_1(w) - V_1(w)]$$
$$+ \lambda_1 E_x \max\{V_1(x) - V_1(w), 0\} \quad (5)$$

$$rJ = z + \rho(V_0 - J) \quad (6)$$

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are Bellman's equations for an employed worker and for one in jail.

Workers need to decide whether to accept a job and whether to commit a crime. In terms of the first decision, first note from (5) that $V_1(w)$ is increasing in w. This implies that an employed worker will accept any outside offer above his current wage, and an unemployed worker will accept any $w \geq R$, where R is the *reservation wage* defined by $V_1(R) = V_0$. In terms of the crime decision, observe from (2) that $K_1(w) - V_1(w)$ is decreasing in w, and that $K_0 - V_0 = K_1(R) - V_1(R)$. The former observation implies workers are less likely to commit crimes when their wages are higher, and the latter implies the unemployed engage in crime iff workers employed at R do. Thus, if $\phi_0 = 0$ then $\phi_1(w) = 0$ for all w, and if $\phi_0 = 1$ then $\phi_1(w) = 1$ for $w < C$ and $\phi_1(w) = 0$ for $w \geq C$, where $C > R$ is the *crime wage* defined by $K_1(C) = V_1(C)$.[4] By (2), at $w = C$ the gain just equals the expected cost of crime, which is the chance of losing one's job and going to jail: $g = \pi [V_1(C) - J]$.

We now show how to solve for R and C. For the reservation wage, first equate (4) to (5) evaluated at $w = R$ and rearrange to yield

$$R = b + (\lambda_0 - \lambda_1) \Delta(R) + (\mu_0 - \mu_1) \phi_0 [g - \pi(V_0 - J)], \qquad (7)$$

where

$$\Delta(R) = \int_R^\infty [V_1(x) - V_1(R)] \, dF(x) = \int_R^\infty V_1'(x) [1 - F(x)] \, dx \qquad (8)$$

after integrating by parts. Consider first the case $\phi_0 = 0$, which means the last term in (7) vanishes. Then differentiate (5) and insert $V_1'(x)$ into $\Delta(R)$ to get

$$\Delta(R) = \int_R^\infty \frac{[1 - F(x)] \, dx}{r + \delta + \lambda_1 [1 - F(x)]}. \qquad (9)$$

Inserting (9) into (7) yields one equation in R. Indeed, in the case $\phi_0 = 0$, this is simply the *reservation wage equation* from the standard model, as summarized in Dale T. Mortensen (1986), for example.

Consider now the case $\phi_0 = 1$, which means $\phi_1(w) = 1$ iff $w < C$ for some $C > R$. The procedure leading to (9) now yields

$$\Delta(R) = \int_R^C \frac{[1 - F(x)]\,dx}{r + \delta + \mu_1\pi + \lambda_1[1 - F(x)]} + \int_C^\infty \frac{[1 - F(x)]\,dx}{r + \delta + \lambda_1[1 - F(x)]}. \quad (10)$$

Also, since the last term in (7) no longer vanishes, subtract (6) and (4) to get

$$V_0 - J = \frac{b - z - \gamma\ell + \mu_0 g + \lambda_0\Delta(R)}{r + \rho + \mu_0\pi}. \quad (11)$$

Inserting (11) and (10) into (7) yields the reservation wage equation when $\phi_0 = 1$. In this case we also need the *crime wage equation*. Using $g = \pi[V_1(C) - J]$ and (5),

$$C = z + \gamma\ell + (r + \delta)\frac{g}{\pi} + (\rho - \delta)(V_0 - J) - \lambda_1\Delta(C), \quad (12)$$

where $\Delta(C)$ is the function $\Delta(R)$ evaluated at $R = C$. Inserting (11) and (10) into (12) gives the desired result.

To summarize, one possible case is $K_0 - V_0 < 0$, which implies $\phi_0 = 0$ and $\phi_1(w) = 0$ for all w. The other possibility is $K_0 - V_0 > 0$, which implies $\phi_0 = 1$ and at least the unemployed commit crime, while the employed do iff $w < C$. Obviously worker behavior depends on $F(w)$; e.g., if $F(C) = 0$ no employed worker commits crime. When we endogenize F, it will depend on R and C, and we have a fixed point problem to be analyzed below. However, even taking F as given we think this is an interesting extension of the standard job search model, since it makes predictions about the effects of many variables on R and C, and

hence on unemployment and crime rates.[5] This is especially easy if $\mu_0 = \mu_1 = \mu$ and $\lambda_0 = \lambda_1 = \lambda$, since then (7) yields $R = b$, and we can focus on C.

In this case, one can show $\partial C/\partial z > 0$ and $\partial C/\partial \rho > 0$, e.g., so more "pleasant" or shorter jail terms raise C and make employed workers more likely to commit crime. Also, $\partial C/\partial \pi < 0$, so higher apprehension rates make them less likely to commit crime, and $\partial C/\partial \gamma > 0$, so higher victimization rates (or taxes) make them more likely, because this makes legitimate activity less attractive. Also, $\partial C/\partial \mu < 0$ at least if ρg is not too big, so more opportunities make workers less inclined to crime. Also, $\partial C/\partial b$ is proportional to $\rho - \delta$; intuitively, an increase in b makes legitimate employment more attractive, since things are not so bad even if you get laid off, but also makes crime more attractive, since things are not so bad upon release if you go jail, and the net effect depends on what happens faster, a layoff or release.

We now solve for steady state. We assume $w \geq R$ with probability 1, but we do not necessarily impose $\mu_0 = \mu_1 = \mu$ and $\lambda_0 = \lambda_1$ here. Then, if $\phi_0 = 0$ (no crime) we have $u = \delta/(\delta + \lambda_0)$ and $e = \lambda_0/(\delta + \lambda_0)$, exactly as in the standard model. If $\phi_0 = 1$ the labor market flows are shown in Figure 1, where e_L is the number of workers employed at $w < C$, $e_H = e - e_L$ is the number employed at $w \geq C$, and $\sigma = 1 - F(C)$ is the fraction of firms offering at least C. Solving for steady state yields

$$e_L = (1 - \sigma)\,\rho\delta\lambda_0/\Omega \qquad\qquad n = [(\delta + \mu_1\pi + \lambda_1\sigma)\,\mu_0 + \mu_1\lambda_0(1 - \sigma)]\,\pi\delta/\Omega$$

$$e_H = (\delta + \mu_1\pi + \lambda_1)\,\sigma\rho\lambda_0/\Omega \quad u = (\delta + \mu_1\pi + \lambda_1\sigma)\,\rho\delta/\Omega$$

$$\tag{13}$$

where Ω is the constant that makes $e_L + e_u + u + n = 1$.

The unemployment rate is $U = \frac{u}{1-n}$ and, in any equilibrium with $\phi_0 = 1$, the crime rate is $c = \frac{u\mu_0 + e_L\mu_1}{1-n}$, where we emphasize that we use the non-institutionalized population in the denominator. One can now derive the effects of different policy changes on these variables. For example, suppose we change z, b or γ in such a way that C falls, as discussed above. The only effect this has on (13) is to increase σ, and one can check that this reduces n, u, U, and c. Hence, anti-crime policies like harsher jail terms, changes in unemployment insurance, or neighborhood improvement programs to reduce victimization, given that they lower C, reduce the number in jail, the number unemployed, the unemployment rate, and the crime rate.

We now derive the distribution of wages paid, say $G(w)$, which generally differs from the distribution of wages posted, $F(w)$. Consider first the case $\phi_0 = 1$. Let $F_L(w) = F(w|w < C)$ and $F_H(w) = F(w|w \geq C)$ be the conditional distributions of wages posted and let $G_L(w) = G(w|w < C)$ and $G_H(w) = G(w|w \geq C)$ be the conditional distributions of wages paid. Then one can derive[6]

$$G_L(w) = \frac{u}{e_L} \frac{\lambda_0 (1-\sigma) F_L(w)}{\delta + \mu_1\pi + \lambda_1\sigma + \lambda_1(1-\sigma)[1 - F_L(w)]} \tag{14}$$

$$G_H(w) = \frac{\lambda_0 u + \lambda_1 e_L}{e_{H.}} \frac{\sigma F_H(w)}{\delta + \lambda_1\sigma[1 - F_H(w)]}. \tag{15}$$

Eliminating u, e_L and e_H using (13),

$$G_L(w) = \frac{F_L(w)}{1 + k_L[1 - F_L(w)]} \text{ and } G_H(w) = \frac{F_H(w)}{1 + k_H[1 - F_H(w)]}, \tag{16}$$

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where $k_L = \frac{\lambda_1(1-\sigma)}{\delta+\mu_1\pi+\lambda_1\sigma}$ and $k_H = \frac{\lambda_1\sigma}{\delta}$. Given F and $\sigma = 1 - F(C)$, these are the conditional distributions of observed wages when $\phi_0 = 1$. The results when $\phi_0 = 0$ can be found by setting $\sigma = 1$.

One can derive the conditional densities by differentiating (16), and the unconditional density is given by $G'(w) = \frac{e_L}{e_L+e_H}G'_L(w)$ if $w < C$ and $G'(w) = \frac{e_H}{e_L+e_H}G'_H(w)$ if $w > C$. Using (13),

$$G'(w) = \begin{cases} \dfrac{\bar{k}_L F'(w)}{\{\delta + \mu_1\pi + \lambda_1[1 - F(w)]\}^2} & \text{if } w < C \\[3mm] \dfrac{\bar{k}_H F'(w)}{\{\delta + \lambda_1[1 - F(w)]\}^2} & \text{if } w > C \end{cases} \tag{17}$$

where $\bar{k}_L = \frac{\delta(\delta+\mu_1\pi+\lambda_1)(\delta+\mu_1\pi+\lambda_1\sigma)}{\delta+\mu_1\pi\sigma+\lambda_1\sigma}$ and $\bar{k}_H = \frac{\delta(\delta+\mu_1\pi+\lambda_1)(\delta+\lambda_1\sigma)}{\delta+\mu_1\pi\sigma+\lambda_1\sigma}$. Suppose we change z, ρ, γ or b so C falls from C_1 to C_0. As these parameters affect the wage density only through σ, it is relatively easy to see that $G'(w)$ shifts down for $w < C_0$ and for $w > C_1$ while it shifts up for $w \in (C_0, C_1)$. Hence, when the crime wage falls we end up with fewer workers in the tails of the distribution and more in the middle of the distribution. Therefore, anti-crime policies like those discussed above not only reduce crime and unemployment, they also reduce wage inequality.

One can perform other experiments, although some are more complicated. For example, an increase in μ_1 affects c, U and G directly, and also indirectly through C. In any case, we want to proceed to models where the wage offer distribution F is endogenous. It is well known that a model with on-the-job search generates wage dispersion even without crime (Burdett and Mortensen 1998). Therefore, in the next section we focus on the case of no on-the-job

search ($\lambda_1 = 0$), where the model without crime implies there must be a single wage; then we will be able to conclude that crime in and of itself can generate wage dispersion. The version with $\lambda_1 > 0$ is analyzed in detail in Burdett, Lagos and Wright (2002).

II. Wage Posting Equilibrium

As discussed, here we set $\lambda_1 = 0$ and $\lambda_0 = \lambda > 0$. Also, to reduce notation we set $\mu_0 = \mu_1 = \mu$, and assume that $\ell_1(w) = \ell_0 = g$; i.e. the loss from being victimized is independent of one's income and equal to the gain from crime. Until the next section we continue to assume γ is exogenous; again, one could say workers only victimize agents in other neighborhoods, or that crime is "victimless" and γ is a tax.[7] We assume each firm has linear technology with marginal product $p > b$, and posts a wage at which it hires all workers that it contacts. Each firm takes as given the wages of other firms as described by F, and worker behavior as described by (R, C). We assume firms maximize steady state profit.

Clearly, there will be at most two wages posted in equilibrium: each firm either posts R or C. To see this, first note that firms paying $w < R$ attract no workers, so they must post at least R. Suppose $\phi_0 = 0$. Then $\phi_1(w) = 0$ for all $w \geq R$, and any firm posting $w > R$ makes more profit posting R. Hence, if $\phi_0 = 0$ all firms post $w = R$ (a case of the well known result by Peter A. Diamond 1971). Now suppose $\phi_0 = 1$. Then $\phi_1(w) = 0$ iff $w \geq C$ for some $C > R$, and firms paying below C lose workers faster than those paying above C because their workers sometimes commit crime, get caught, and go to jail.

Still, any firm paying $w > C$ could make more profit if it reduced its wage to C, while any firm paying $w \in (R, C)$ could make more profit if it reduced its wage to R. Hence, $\phi_0 = 1$ implies all firms post either R or C.

So when $\phi_0 = 0$ all firms post R, and when $\phi_0 = 1$ the equilibrium offer distribution can be summarized by R, C, and the fraction σ posting C. In the latter case a firm posting R hires workers at rate $\lambda u / N$ (since the number of workers contacting a firm is λu and there are N firms per worker) and loses them at rate $\delta + \mu\pi$, so in steady state it has $L_R = \lambda u / (\delta + \mu\pi) N$ workers. Similarly, a firm posting C will have $L_C = \lambda u / \delta N$ workers. Steady-state profits are $\Pi_R = (p - R) L_R = (p - R) \lambda u / (\delta + \mu\pi) N$ and $\Pi_C = (p - C) L_C = (p - C) \lambda u / \delta N$. Profit maximization obviously implies

$$\sigma = \begin{cases} 1 & \text{if } \Pi_C > \Pi_R \\ 0 & \text{if } \Pi_C < \Pi_R \end{cases} \tag{18}$$

and wage dispersion $(0 < \sigma < 1)$ requires $\Pi_C = \Pi_R$. Also, given there are at most two wages posted, we write V_R and V_C for workers' value functions.

Bellman's equations can now be simplified a lot. Consider the case $\phi_0 = 0$, which we call a *Type N* equilibrium (N for "no crime"). In this case, since all firms post R

$$rV_0 = b - \gamma g \tag{19}$$

$$rV_R = R - \gamma g, \tag{20}$$

where we have used $\ell = g$ (victim's loss equals criminal's gain). Now $V_0 = V_R$ implies $R = b$. This constitutes an equilibrium iff (3) holds – i.e., iff $V_0 - J \geq \frac{g}{\pi}$.

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Subtracting (19) and (6) we see that, given $r \cong 0$,

$$V_0 - J = \frac{b - z - \gamma g + \mu \phi_0 g + \lambda \sigma g / \pi}{\rho + \mu \pi \phi_0 + \lambda \sigma}. \tag{21}$$

Hence, $\phi_0 = 0$ is an equilibrium iff $b \geq \bar{b}$ where

$$\bar{b} = z + \gamma g + \rho g / \pi. \tag{22}$$

It will also follow from the analysis of other possible cases below that no other equilibrium can exist when $b > \bar{b}$.

We summarize the above discussion as follows, where to facilitate the presentation we ignore nongeneric cases like $b = \bar{b}$.

Proposition 1. A *Type N* equilibrium exists iff $b > \bar{b}$; if it exists it is unique.

Now consider $\phi_0 = 1$, which means the unemployed commit crime and the employed do at $w = R$ but not $w = C$. Bellman's equations become

$$rV_0 = b - \gamma g + \lambda \sigma (V_C - V_0) + \mu [g + \pi (J - V_0)] \tag{23}$$

$$rV_R = R - \gamma g + \mu [g + \pi (J - V_0)] \tag{24}$$

$$rV_C = C - \gamma g + \delta (V_0 - V_C). \tag{25}$$

We can solve these for the value functions given (R, C, σ), then insert the solutions into the reservation and crime wage equations, $V_0 = V_R$ and $V_C - J = g / \pi$, to get R and C as functions of σ and parameters,

$$R(\sigma) = b + \frac{\lambda \sigma}{\rho + \mu \pi + \lambda \sigma} (\bar{b} - b) \tag{26}$$

$$C(\sigma) = \bar{b} + \frac{\delta - \rho}{\rho + \mu \pi + \lambda \sigma} (\bar{b} - b), \tag{27}$$

where $\bar{b}$ was defined above in (22).

Given these solutions for $C(\sigma)$ and $R(\sigma)$, the profit differential across high- and low-wage firms $\Pi_C - \Pi_R$ is, after some algebra, proportional to

$$T(\sigma) = p - \bar{b} - \frac{(\rho^* - \rho)(\bar{b} - b)}{\rho + \mu\pi + \lambda\sigma} \tag{28}$$

where $\rho^* = \delta(\delta + 2\mu\pi)/\mu\pi$. Thus, when $\phi_0 = 1$ the possible equilibria are as follows. A *Type L* equilibrium (L for "low crime") has $\sigma = 1$ and requires $T(1) > 0$; in this case no employed workers, but only unemployed workers, commit crime. A *Type H* equilibrium (H for "high crime") has $\sigma = 0$ and requires $T(0) < 0$; in this case everyone commits crime. A *Type M* equilibrium (M for "medium crime") has $\sigma \in (0,1)$ and requires $T(\sigma) = 0$; in this case there is wage dispersion, and low wage workers commit crime while high wage workers do not.

To describe when these different equilibria exist, it is convenient to define

$$p_0(b) = \bar{b} + \frac{(\rho^* - \rho)(\bar{b} - b)}{\rho + \mu\pi} \tag{29}$$

$$p_1(b) = \bar{b} + \frac{(\rho^* - \rho)(\bar{b} - b)}{\rho + \mu\pi + \lambda}. \tag{30}$$

We will break things into two cases, $\rho > \rho^*$ and $\rho < \rho^*$, which determines the sign of $p_0(b) - p_1(b)$, $p_0'(b)$, $p_1'(b)$, and $T'(b)$.

Proposition 2. Assume $b < \bar{b}$ and $\rho > \rho^*$. Then $p_0 < p_1$, $p_j' > 0$, $T' < 0$ and

(a) if $p > p_1(b)$ there is a unique equilibrium and it is *Type L*;

(b) if $p < p_0(b)$ there is a unique equilibrium and it is *Type H*;

(c) if $p_0(b) < p < p_1(b)$ there is a unique equilibrium and it is *Type M*.

Proof. The results $p_0 < p_1$, $p_j' > 0$ and $T' < 0$ are obvious. Given $b < \bar{b}$ there is no *Type N* equilibrium by Proposition 1. Existence of the other equilibria is

easy: the conditions in (a), (b), and (c) are equivalent to $T(1) > 0$, $T(0) < 0$, and $T(0) > 0 > T(1)$, which means there is an equilibrium with $\sigma = 1$, $\sigma = 0$, and $\sigma \in (0, 1)$, respectively. Uniqueness follows from $T' < 0$. See Figure 2(i). ∎

Proposition 3. Assume $b < \bar{b}$ and $\rho < \rho^*$. Then $p_0 > p_1$, $p_j' < 0$, $T' > 0$ and

(a) if $p > p_0\,(b)$ there is a unique equilibrium and it is *Type L*;

(b) if $p < p_1\,(b)$ there is a unique equilibrium and it is *Type H*;

(c) if $p_1\,(b) < p < p_0\,(b)$ there are exactly equilibria, one *Type L*, one *Type H* and one *Type M*.

Proof. Everything is the same as the previous proof, except that in the case $\rho > \rho^*$ we have $T' > 0$, and so $T(0) < 0 < T(1)$ implies there are exactly 3 equilibria, one each with $\sigma = 1$ (*Type L*), $\sigma = 0$ (*Type H*), and $\sigma \in (0, 1)$ (*Type M*). See Figure 2(ii). ∎

INSERT FIGURE 2 ABOUT HERE

The set of equilibria are shown in (b, p) space in Figure 3 where panels (i) and (ii) correspond to the two cases $\rho > \rho^*$ and $\rho > \rho^*$. In either case, there is no crime if $b > \bar{b} = z + \gamma g + \rho g / \pi$ – e.g. if z is small (jail is bad), ρ is small (sentences are long), or π is big (crime is risky). When $b < \bar{b}$, at least the unemployed commit crime, and the employed do iff p is low. Intuitively, low p means firms are not willing to pay enough to keep their workers honest, while high p means they are willing, because then turnover is more costly. Another way to say it is this: an increase in p raises revenue faster at high wage firms than low wage firms, since the former have more workers, and so for large p all firms find it profitable to post C. Just how high p has to be to eliminate

crime depends on parameters, but also on beliefs, since there can be multiple equilibria (more on this below).

<center>INSERT FIGURE 3 ABOUT HERE</center>

To say more about the properties of the different equilibria, first solve $T(\sigma) = 0$ explicitly for σ in the *Type M* equilibrium,

$$\sigma^* = \frac{(\rho^* - \rho)\left(\bar{b} - b\right) - (\rho + \mu\pi)\left(p - \bar{b}\right)}{\lambda\left(p - \bar{b}\right)}. \tag{31}$$

This can be inserted into (26) and (27) to get R and C as functions of parameters in the *Type M* equilibrium. To get R and C in *Type L* or H equilibrium, set $\sigma = 1$ or $\sigma = 0$. The equilibrium wage correspondence is shown in Figure 4. The cases are: $\rho < \delta$ which implies $\partial C/\partial b < 0$, and also implies $\rho < \rho^*$ which means we have multiple equilibria for some b, as shown in panel (i); and $\rho > \delta$ which implies $\partial C/\partial b > 0$ and has two subcases, either $\rho < \rho^*$ or $\rho > \rho^*$, which means either multiplicity or uniqueness, as shown in panels (ii) and (iii). Note that our statements about $\partial C/\partial b$ refer to *Type L* and H equilibria, as R and C are actually independent of b in *Type M* equilibrium. Also notice C and R can be higher in *Type L* than *Type H* equilibrium, or vice-versa. Also notice $C - R$ decreases with b, reaching 0 at $\bar{b}$ when we enter a *Type N* equilibrium.

<center>INSERT FIGURE 4 ABOUT HERE</center>

We can also solve for the steady state, and then for the unemployment and crime rates.[8] Using superscripts to indicate the equilibrium (e.g. U^N is the unemployment rate in *Type N* equilibrium), it can easily be shown that

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$U^N = U^L < U^M < U^H$ and $c^N < c^L < c^M < c^H$. Hence, across equilibria the crime and unemployment rates move together, although of course we cannot say one causes the other. In terms of inequality we have: in both *Type N* and *Type H* equilibria everyone earns b; in *Type L* equilibrium all employed workers earn $C(1) > b$; and in *Type M* equilibrium a fraction σ^* earn $C(\sigma^*)$ while the rest earn $R(\sigma^*)$, where $b < R(\sigma^*) < C(\sigma^*)$. Notice workers prefer a low or medium crime equilibrium to no crime – at least, holding victimization constant – since it is the possibility of crime that makes some firms offer a premium wage to keep their workers honest. Crime does not help workers in a high crime equilibrium, however, where firms give up trying to keep them honest and simply pay $w = R = b$.

It is worth discussing multiplicity further. Notice that multiple equilibria can only arise here when ρ is relatively small – i.e. jail sentences are relatively long – since we need $\rho < \rho^*$ to get $T' > 0$. It would not work if, say, we only fired criminals (this case is captured by letting $\rho \to \infty$, which from Proposition 3 implies uniqueness). More substantively, multiplicity is interesting because it implies that two otherwise identical neighborhoods can end up in very different situations, say one in a *Type L* equilibrium where all employed workers earn $C > b$ and there is little crime or unemployment, and the other in a *Type H* equilibrium where all workers earn b and there is lots of crime and unemployment. It is the fact that there are high-wage jobs available in the first neighborhood that deters people from crime, and it is the fact that people are less inclined to commit crime that makes it profitable for firms to pay the relatively high wage

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C. This source of multiple equilibrium seems new; clearly, it can only arise in models with endogenous wage setting.

In terms of policy implications, consider for example a change in b. First suppose that $\rho < \rho^*$ as in panel (ii) of Figure 3, so that $p_j(b) < 0$, where $p_0(b)$ and $p_1(b)$ are defined in (29) and (30). Then for a range of p, as b rises we move from a high crime to a low crime equilibrium with an intervening interval where multiple equilibrium exist. Alternatively, if $\rho < \rho^*$ so that $p_j(b) > 0$, as in panel (i) in Figure 3, then for a range of p as b rises we move from low to medium to high crime. Hence, the effect on crime of an increase in b depends critically on parameter values. Although of course b in the model is meant to capture many things, including the value of leisure, other nonmarket activity, and so on, to the extent that at least part of b includes unemployment insurance, the conclusion is that changes in unemployment insurance can have fairly complicated effects on crime and the labor market.

As another example, suppose we make jail worse by reducing z. Then when we redraw the existence regions in the Figure, the following happens: given (b, p), if we were in a *Type L* equilibrium we can switch to a *Type N* equilibrium; if we were in a *Type M* equilibrium we can switch to a *Type N* or *L* equilibrium; and if we were in a *Type H* equilibrium we can switch to *Type N*, *L* or *M* equilibrium. In all cases, crime can only fall. Changes in the other policy variables can be similarly analyzed. The point is that even though things get a little complicated with multiple equilibria, some fairly straightforward policy predictions come out of the model.

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We close this section with a few comments on some labor literature. First, there is a connection between our framework and efficiency wage theory, such as Carl Shapiro and Joseph E. Stiglitz (1984). In their model, paying strictly above the reservation wage keeps workers from shirking, while here it keeps them from crime, which affects profit through turnover since criminals sometimes get caught and go to jail. In this sense the models are similar. However, standard efficiency wage models have a unique equilibrium and all firms pay the same wage, while here we can have multiple equilibria and we can have wage dispersion.[9] Also related is the James W. Albrecht and Bo Axell (1984) model, which generates wage dispersion by assuming workers are heterogenous with respect to b. In that model, posting a higher w increases a firm's inflow of new workers, while here it decreases a firm's outflow of workers. Still, in both models the advantage of a higher w is that the firm will have more workers, which is offset by a lower profit per worker.

III. Extensions

In the previous section we took the victimization rate γ to be constant. While this can be justified, we now endogenize γ by equating it to the crime rate c, which seems interesting for its own sake and also allows us to identify a new source of multiplicity. If $\phi_0 = 0$ then $c = 0$; if $\phi_0 = 1$ then $c = \frac{(u + e_L)\mu}{1 - n}$ and $\gamma = c$ implies

$$c = c(\sigma) = \frac{[\delta + \mu\pi + (1 - \sigma)\lambda]\delta\mu}{(1 - \sigma)\delta\lambda + (\delta + \mu\pi)(\delta + \lambda\sigma)}. \tag{32}$$

The method of analysis is the same as before except we replace γ by c.

Thus, in the previous section we have $\phi_0 = 0$ when $b > \bar{b} = z + \gamma g + \rho g / \pi$,

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and the same is true here except the relevant threshold is endogenous,

$$\bar{b} = \hat{b}[\gamma(\sigma)] = z + \gamma(\sigma)g + \rho g/\pi, \tag{33}$$

where $\gamma(\sigma) = 0$ if $\phi_0 = 0$ and $\gamma(\sigma) = c(\sigma)$ if $\phi_0 = 1$. Notice $c'(\sigma) < 0$, and $\hat{b}(0) < \hat{b}[c(1)] < \hat{b}[c(0)]$. Hence, if agents believe we are in a *Type N* equilibrium the threshold is low, if they believe we are in a *Type L* equilibrium it is high, etc. This leads to the following result, the proof of which we omit since it simply involves checking when $\phi_0 = 0$ a best response.[10]

Proposition 4. A *Type N* equilibrium exists iff $b \geq \hat{b}(0)$; it is unique if $b > \hat{b}[c(0)] = \hat{b}(\mu)$.

Now consider equilibria with $\phi_0 = 1$. Let $\hat{T}$ be the generalized version of T, defined in (28), with $\bar{b}$ replaced by $\hat{b}[\gamma(\sigma)]$,

$$\hat{T}(\sigma) = p - \hat{b}[c(\sigma)] - \frac{(\rho^* - \rho)\{\hat{b}[c(\sigma)] - b\}}{\rho + \mu\pi + \lambda\sigma}. \tag{34}$$

Equilibrium implies $\sigma = 1$ if $\hat{T}(1) > 0$, $\sigma = 0$ if $\hat{T}(0) < 0$, and $\hat{T}(\sigma) = 0$ if $\sigma \in (0, 1)$. We begin the analysis of this case under the parameter restriction $\rho^* = \rho$. This allows us to focus on the impact of endogenizing γ, because it implies $\hat{T}(\sigma)$ would be constant if γ were fixed (with $\rho = \rho^*$, as σ rises both C and R rise but $\Pi_C - \Pi_R$ remains constant, eliminating strategic interaction in wage setting). Hence, if we find multiple equilibria here it is unambiguously because γ is endogenous. Once this point has been made, we will then relax $\rho^* = \rho$ and argue that the key economic results are in fact robust.

We report the results in several steps that apply to progressively higher values of b. For each range of b we give existence and uniqueness/multiplicity

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results for different values of p.

Proposition 5. Let $\rho = \rho^*$ and suppose $b < \hat{b}(0)$. Then,

   (a) if $p > \hat{b}[c(0)]$ there is a unique equilibrium and it is *Type L*;

   (b) if $p < \hat{b}[c(1)]$ there is a unique equilibrium and it is *Type H*;

   (c) if $\hat{b}[c(1)] < p < \hat{b}[c(0)]$ there are exactly equilibria, one *Type L*, one *Type H* and one *Type M*.

Proof. Since $b < \hat{b}(0)$ we have $\phi_0 = 1$ (recall the previous footnote). Now the existence of *Type L*, *H*, and *M* equilibria simply means finding conditions such that $\hat{T}(0) \geq 0$, $\hat{T}(1) \leq 0$, and $\hat{T}(0) < 0 < \hat{T}(1)$, respectively. These conditions are exactly those in (a), (b), and (c). Moreover, $\rho = \rho^*$ implies $\hat{T}' > 0$, which guarantees uniqueness of an equilibrium of any type. ∎

While the restriction $\rho = \rho^*$ is useful for demonstrating that multiplicity here is due to the endogeneity of γ, it is not actually used in the proof except to guarantee that $\hat{T}$ is monotone. In fact, $\hat{T}$ is monotone $\forall \rho \leq \rho^*$, and indeed, by continuity, also for some $\rho > \rho^*$. Hence, the key results apply much more generally.[11] For ρ very big, however, $\hat{T}$ can be nonmonotone. In this case things are slightly more complicated; e.g. even if $\hat{T}(0) > 0$ as in case (a) of the Proposition, we still know there must either be an equilibrium with $\sigma = 1$ or $\sigma \in (0,1)$ but we cannot be sure of which, and there could be one of each or multiple *Type M* equilibria (imagine the right panel of Figure 2 with T nonmonotone). But if the point is to show the existence of multiple equilibria and wage dispersion, we do not require any restriction on ρ. Again, $\rho = \rho^*$ is assumed mainly to show multiplicity can be due exclusively to endogenous γ.

Having established this, we return to the case $\rho = \rho^*$ and take up the results for a different range of b (things generalize here as in the previous paragraph to $\rho \neq \rho^*$).

Proposition 6. Let $\rho = \rho^*$ and suppose $\hat{b}(0) < b < \hat{b}[c(1)]$. Then all the equilibria in Proposition 5 exist under the same conditions, plus a *Type N* equilibrium.

Proof. Since $\hat{b}(0) < b$ it has already been established that *Type N* equilibrium exists. Since $b < \hat{b}[c(1)]$ the unemployed will choose $\phi_0 = 1$ for any $c(\sigma) \geq c(1)$. The rest of the argument is the same as Proposition 5. ∎

Finally we consider what happens for b larger than $\hat{b}[\gamma(1)]$ but still below $\hat{b}[\gamma(0)]$.

Proposition 7. Let $\rho = \rho^*$ and suppose $\hat{b}[\gamma(1)] < b < \hat{b}[\gamma(0)]$. Then,

(a) if $p > \hat{b}[\gamma(0)]$ there is a unique equilibrium and it is *Type N*;

(b) if $p < \hat{b}[\gamma(0)]$ there are exactly equilibria, one *Type N*, one *Type H* and one *Type M*.

Proof. Since $\hat{b}(0) < \hat{b}[\gamma(1)] < b$ it has already been established that *Type N* equilibrium exists. The restriction in (a) is equivalent to $\hat{T}(0) > 0$, and $\hat{b}[c(1)] < b$ implies that the unemployed choose $\phi_0 = 0$ if $\gamma = c(1)$, so an equilibrium of *Type L* cannot exist. Hence the *Type N* equilibrium is unique under the conditions in (a). Next, note that $b < \hat{b}[c(0)]$ implies the unemployed choose $\phi_0 = 1$ if $\gamma \geq c(0)$. This together with the condition in (b), which is equivalent to $\hat{T}(0) < 0 < \hat{T}(1)$, implies an equilibrium of *Type H* exists if $p < z + \rho g/\pi + \mu g$. To finish the proof of (b), we construct a *Type M*

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equilibrium. First note that $\hat{T}(0) < 0 < \hat{T}(1)$ implies there exists a unique σ satisfying $\hat{T}(\sigma) = 0$, or equivalently, satisfying $p = z + \rho g/\pi + c(\sigma)g$. Finally, the unemployed set $\phi_0 = 1$ because $b < \hat{b}[c(\sigma)] = z + \rho g/\pi + c(\sigma)g = p$, and therefore an equilibrium of *Type M* exists. ∎

The results are illustrated in Figure 5. With γ fixed, this figure (or equivalently Figure 3 with $\rho = \rho^*$) would look very different: there would be an exogenous $\bar{b}$ such that $b > \bar{b}$ implies the unique equilibrium is *Type N*, and $b < \bar{b}$ implies the unique equilibrium is *Type L* if $p > \bar{b}$ and *Type H* if $p < \bar{b}$. Hence, equilibrium wage dispersion and multiple equilibria here are due to endogenous victimization. The economic intuition is simple: if you live in a neighborhood with lots of crime then life on the street, while still better than jail, is not that great, and this makes you more inclined to commit crime. This effect seems very general, and should be relevant in any model where crime is endogenous.[12]

<center>INSERT FIGURE 5 ABOUT HERE</center>

While there are many other ways one could extend things, we briefly mention just two. First, instead of firms posting wages, suppose w is determined by bargaining. One could use the generalized Nash solution where workers have any bargaining power $\theta \in [0, 1]$, but for simplicity we set $\theta = 1$, which implies $w = p$. Second, we endogenize the return to crime by setting $\ell_0 = \alpha b$, $\ell_1(w) = \alpha w$, and $g = \alpha \omega$ where $\omega = \frac{ep + ub}{e + u}$ is the expected income of a victim. Hence, the victim's loss ℓ and the perpetrator's gain g are both a fraction α of the former's income. We continue to endogenize $\gamma = c$, but for simplicity we set $\mu_0 = 0$ and $\mu_1 = \mu$ so that we only have to determine $\phi = \phi_1(p)$ and not ϕ_0. Bellman's equations

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are now

$$rV_0 = (1 - \alpha\gamma)b + \lambda(V_1 - V_0) \tag{35}$$

$$rV_1 = (1 - \alpha\gamma)p - \delta(V_1 - V_0) + \mu\phi[\alpha\omega - \pi(V_1 - J)]. \tag{36}$$

We can easily solve for steady state and the endogenous $\gamma = \frac{\mu\lambda\phi}{\delta+\lambda+\mu\pi\phi}$ and $\omega = \frac{\lambda p+(\delta+\mu\pi\phi)b}{\delta+\lambda+\mu\pi\phi}$ in terms of ϕ. To determine ϕ we check the sign of $V_1 - J - \frac{\alpha\omega}{\pi}$, which, after some algebra, is proportional to $S(\phi) = A + B\phi$ where A and B depend on the underlying parameters.[13] Equilibrium implies $\phi = 0$ if $S(0) > 0$, $\phi = 1$ if $S(0) < 0$, and $S(\phi) = 0$ if $\phi \in (0, 1)$. One can show that, given b, for low p we have a unique equilibrium with $\phi = 1$, for high p we have a unique equilibrium with $\phi = 0$, and for intermediate p we can either have an equilibrium with $\phi \in (0, 1)$ or all three equilibria. Although the model cannot generate wage dispersion, since $w = p$ for all workers, it can generate multiple equilibria with different crime and unemployment rates, and equilibria where some workers commit crime while others do not. So at least some of the key results are robust to various changes in modeling assumptions.

IV. Conclusion

We have developed a search equilibrium framework that can be used to analyze the interrelations between crime, unemployment, and inequality. An equilibrium model is essential to analyze feedbacks that can lead to multiplicity. Search theory was used because it not only generates unemployment and inequality endogenously, it also allows us to incorporate criminal opportunities and victimization in a natural way. The framework is a rich but still very

tractable extension of the standard search model. We found that introducing crime generates several interesting effects, including novel sources of wage dispersion and multiple equilibria. The model has many implications for the effects of policy and other variables on crime, unemployment, wages, etc. Of course, the model is simple, but it can easily be extended in many ways.

For example, one can analyze wage posting equilibria with on-the-job search. One can also include endogenous search effort, an entry (or location) decision, and heterogeneity. With heterogeneous agents, presumably some never engage in crime while others always do; we focused on a representative marginal worker who may or may not engage in crime, depending on his employment status and wage, and also on general economic conditions. It would also be good to try to explain lower offer arrival rates for those previously convicted of a crime, which may be hard in the current set up but perhaps not in a version with heterogeneity and private information. One could also consider workers who steal directly from their employers. This all seems feasible, but we thought it best to work out the simple model first. The main messages – say, about multiplicity and wage dispersion – should survive these extensions, and the tools we developed – say, for deriving the endogenous wage distribution G from any offer distribution F – will still be useful.

Multiple equilibria are relevant given that otherwise similar cities or neighborhoods can seem to end up with very different crime rates. One of our channels for multiplicity is quite simple: if you live in a neighborhood with lots of crime, the relative returns to legitimate activity are low, and this encourages crime.

The channel working through wage setting is more subtle, but we think that it is not empirically implausible. There is certainly evidence that youth crime *is* sensitive to labor market conditions, including unemployment rates and wages (e.g., Jeff Grogger 1998 and Eric D. Gould, Bruce A. Weinberg and David B. Mustard 2002). It is not hard to believe that some employers in some neighborhoods are concerned with turnover resulting from potential criminal activity by their employees, although we do not have hard evidence on this. In any case, concerning multiplicity the main point is merely that when local labor market conditions are good the incentive for crime is reduced, and this makes it relatively easy to maintain good labor market conditions.

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Footnotes

1. A small sample would include Gary S. Becker (1968), Raaj K. Sah (1991), Alexander Tabarrok (1997), John Fender (1999), and Ayse İmrohoroğlu, Antonio Merlo and Peter Rupert (1999, 2000); see Samuel Cameron (1988) and Richard B. Freeman (1996) for surveys. Chien-Chieh Huang, Derek Laing, and Ping Wang (2002) is a recent contribution that is quite related to what we do.

2. We also explore the following channel of multiplicity: when the crime rate falls the relative benefits to legitimate activity increase, reducing the incentive to be a criminal. We neglect other sources of multiplicity (e.g. congestion in law enforcement) that are discussed elsewhere.

3. Assuming homogeneity makes it clear that equilibrium wage dispersion is generated by the option to commit crime, and not by ex ante heterogeneity; however, allowing for heterogeneity is empirically relevant and not very hard. One should interpret the representative agent in our model as a marginal type in the real world: although there may be some people who will always, or will

never, engage in criminal activity, we are interested in those who may, or may not, depending on individual and neighborhood economic conditions.

4. Notice our tie-breaking rules always go the "right" way: agents accept a job when $w = R$ and forego crime when $w = C$. This must be so in equilibrium when wages are endogenous.

5. It is useful to derive results for an arbitrary F distribution, and not only for the one that comes out of the wage-posting equilibrium in the next section, because the equilibrium F depends critically on some details of the environment (e.g., whether we allow on-the-job search). Moreover, it is possible to derive any F as an equilibrium under some assumptions – simply assume firm-specific productivity and use bargaining rather than wage posting. So while it can be important to model wages explicitly, it can also be interesting to analyze things for an arbitrary F.

6. Given $w \geq R$, for any $w < C$ the number of workers employed at a wage no greater than w is $G_L(w) e_L$. The distribution $G_L(w)$ evolves through time according to

$$\frac{d}{dt} G_L(w) e_L = \lambda_0 (1 - \sigma) F_L(w) u$$
$$- \{\delta + \mu_1 \pi + \lambda_1 \sigma + \lambda_1 (1 - \sigma) [1 - F_L(w)]\} e_L G_L(w).$$

Setting the time derivative to 0 yields (14). A similar method yields (15).

7. We also assume $V_0 \geq J$, which holds iff $b \geq z + \gamma g - (\mu \pi + \lambda \sigma) \frac{g}{\pi}$; otherwise unemployed agents would volunteer for jail.

8. For the record, the steady states are

$$
\begin{array}{lll}
e_L^L = 0 & e_L^M = \frac{\delta\lambda\rho(1-\sigma^*)}{\Sigma} & e_L^H = \frac{\rho\lambda}{(\rho+\mu\pi)(\delta+\lambda+\mu\pi)} \\[2mm]
e_H^L = \frac{\lambda\rho}{\lambda\rho+\delta(\rho+\mu\pi)} & e_H^M = \frac{\lambda\rho(\delta+\mu\pi)\sigma^*}{\Sigma} & e_H^H = 0 \\[2mm]
u^L = \frac{\delta\rho}{\lambda\rho+\delta(\rho+\mu\pi)} & u^M = \frac{\delta\rho(\delta+\mu\pi)}{\Sigma} & u^H = \frac{\rho(\delta+\mu\pi)}{(\rho+\mu\pi)(\delta+\lambda+\mu\pi)} \\[2mm]
n^L = \frac{\delta\mu\pi}{\lambda\rho+\delta(\rho+\mu\pi)} & n^M = \frac{[\delta+\mu\pi+(1-\sigma^*)\lambda]\delta\mu\pi}{\Sigma} & n^H = \frac{\mu\pi}{\rho+\mu\pi}
\end{array}
$$

where the superscript indicates the type of equilibrium, and Σ is the constant that makes $e_L^M + e_H^M + u^M + n^M = 1$.

9. Whether one can augment efficiency wage theories in a simple way to generate multiplicity and wage dispersion is an open question. In those models an agent caught shirking loses his job but is not sent to jail, and recall that jail is needed for multiplicity. As an aside, note that this aspect of our model (jail) also helps to avoid a well known problem in the efficiency wage literature, which is that when a worker is caught shirking the firm really has no incentive to follow through with the threat of firing him. Here the relevant threat is enforced by the criminal justice system.

10. Let ϕ_0 be the best response to any Φ_0, given γ. We know $\phi_0 = 0$ iff $V_0 - J \geq g/\pi$, where in general

$$
V_0 - J = \frac{b - z - \gamma g + \mu\Phi_0 g + \lambda\sigma g/\pi}{\rho + \mu\pi\Phi_0 + \lambda\sigma}.
$$

Therefore, letting $B(\gamma, \sigma, \Phi_0) = z + \gamma g - \mu g\Phi_0 + (\rho + \mu\pi\Phi_0)g/\pi$ we have:

$$
\phi_0 = \begin{cases} 0 & \text{if } b \geq B(\gamma, \sigma, \Phi_0) \\ 1 & \text{if } b < B(\gamma, \sigma, \Phi_0) \end{cases}
$$

Since $\gamma = 0$ and $\sigma = 1$ in a *Type N* equilibrium, it exists iff $b \geq B(0, 1, 0) = \hat{b}(0)$. Moreover, since $c(0) = \mu$, if $b \geq B(\mu, 0, 1) = \hat{b}[c(0)]$ then $\phi_0 = 0$ even if everyone else were a criminal, and so the *Type N* equilibrium is the unique possibility.

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11. The statement of the Proposition would have to be amended slightly if $\rho \neq \rho^*$ since then the thresholds for p would not simply be the constants $\hat{b}[c\,(1)]$ and $\hat{b}[c\,(0)]$, but rather functions $\hat{p}[b, c\,(1)]$ and $\hat{p}[b, c\,(0)]$, where

$$\hat{p}[b, c\,(\sigma)] = \hat{b}[c\,(\sigma)] - \frac{(\rho^* - \rho)\,\{\hat{b}[c\,(\sigma)] - b\}}{\rho + \mu\pi + \lambda\sigma}.$$

When $\rho = \rho^*$, $\hat{p}[b, c\,(\sigma)]$ does not depend on b; this explains why in Figure 5 below the lines delineating the regions are horizontal (compare with Figure 2).

12. Endogenous γ implies an additional channel for multiplicity if we assume a victim's loss is an increasing function of his income, say $\ell_1(w)$ with $\ell'_1 > 0$. Now a fall in γ induced by an increase in σ allows firms to reduce C relative to R – i.e. $\partial C/\partial\gamma > \partial R/\partial\gamma > 0$. In this case crime acts like a proportional tax, and an increase in σ is like a reduction in the tax rate, which benefits high-wage more than low-wage workers. Hence, with a increase in σ it is once again relatively cheaper to pay C and a strategic interaction in wage setting reappears.

13. For the record, setting $r \cong 0$ and normalizing $b = 0$ to reduce the clutter, we have $A = [(\delta + \lambda)(\rho + \lambda)\pi - \rho(\delta + \rho + \lambda)\alpha\lambda]\,p - \pi(\delta + \lambda)^2\,z$ and $B = \mu\pi(\pi - \alpha\lambda)(\rho + \lambda)\,p - \pi(\delta + \lambda)(\delta + \lambda + \mu\pi)z$.