Unemployment and Crime [*]

by

Kangoh Lee
Department of Economics
San Diego State University
5500 Campanile Drive
San Diego, CA 92182-4485
klee@mail.sdsu.edu

November 2009

Abstract

This paper analyzes the effect of an increase in the unemployment rate on the crime rate in a model where individuals choose to be a worker or a criminal. The effect depends on the apprehension rate. The effect of unemployment on crime tends to be negative at a lower apprehension rate, but positive at a higher one. Unemployment insurance generosity does not necessarily reduce the crime rate, and the effect of generosity on crime depends again on the apprehension rate.

Unemployment and Crime

1. Introduction

Microeconomic models of crime predict that an increase in the unemployment rate decreases the opportunity cost of crime, increasing the crime rate (Becker (1967) and Ehrlich (1973)). However, unlike this prediction, a large body empirical research on the issue has shown that the effect of an increase in the unemployment rate on the crime rate is positive but small, and sometimes insignificant, and sometimes even negative for some types of property crimes (for example, Long and Witte (1981), Levitt (1996), Entorf and Spengler (2000), Rafael and Winter-Ebmer (2001), Gould et al. (2002)).[1] The empirical relationship between unemployment and crime thus appears to be inconclusive at best. In response to this intriguing inconsistency between theory and empirical findings, sociologists proposed a new argument. In particular, Cantor and Land (1985) argue that an increase in unemployment could not only increase motivation for crime but also decrease opportunity for crime, making the effect of unemployment on crime ambiguous. However, there appears to be no attempt to formalize this type of trade-off in an economic framework, and this paper makes such an attempt in a simple model and provides a guidance for empirical studies.

All individuals work in the legal sector. Individuals differ in their earnings ability or wages when employed, but they may be unemployed with some probability. In addition, individuals can commit a crime, theft or transfer of income from a victim to a criminal. Criminals can be apprehended with some probability. If apprehended, criminals lose jobs. Individuals decide whether to be a criminal by comparing payoffs. The economic advantage of a worker (non-criminal) over a criminal is that the worker enjoys a full income from employment, as the worker will not be apprehended. The advantage of a criminal is that the criminal enjoys an additional income from theft. The advantage of a worker increases with earnings ability, but the advantage of a criminal is independent of earning ability. Thus, low-wage earners become criminals. When the probability of unemployment increases, it lowers the opportunity cost of becoming a criminal, the expected wage of the legitimate sector. At the same time, the reduced wages lower the return to crime, because a criminal steals from others' income. As a result, an increase in the unemployment rate may increase or decrease the crime rate. This

---

[1] Freeman (1999) provides a survey of the literature.

ambiguity may explain the inconclusive evidence on the relationship between unemployment and crime in the empirical literature.

The trade-off between the opportunity cost of crime and the return to crime depends on a number of parameters in the model. In particular, the trade-off hinges on the apprehension rate. An increase in the unemployment rate tends to decrease the crime rate at a lower apprehension rate, but it tends to increase the crime rate at a higher apprehension rate. The intuition is that a lower apprehension rate makes the return to crime greater and the opportunity cost smaller. Since an increase in the unemployment rate decreases both the return and the opportunity cost, it decreases the return to crime maximally and the opportunity cost minimally at a lower apprehension rate, discouraging crimes. A higher apprehension rate has the opposite effect on the relationship between unemployment and crime. This dependence of the comparative static result on the apprehension rate is consistent with extant empirical findings. In Gould et al. (2002), the effect of unemployment on crime when the apprehension rate is included as an independent variable in their regression differs from that when it is not included. In particular, the effects on some types of crimes become negative, as discussed below.

Given the role that the apprehension rate plays in determining the effect of unemployment on crime, the analysis considers the choice of the apprehension rate. An increase in the apprehension rate decreases the crime rate and hence benefits both workers and criminals (a criminal can be robbed by another criminal), because both of them keep more of their incomes due to a lower crime rate. An increase in the apprehension rate, however, additionally reduces the return to crime. Criminals thus desire a lower level of apprehension rate than workers. As a result, workers' desired level of the apprehension rate exceeds the efficient level when the planner cares about both workers' and criminals' welfare. If the planner cares only about workers' welfare, the opposite holds. The reason is that social welfare increases with the number of workers. The planner thus wishes to increase the number of workers by increasing the apprehension rate while each worker does not care about the well-being of those additional workers. As a result, the planner sets the apprehension rate at a level higher than workers desire.

When unemployment insurance is added, it does not qualitatively alter the relationship between unemployment and crime in that the relationship depends on the apprehension rate

in the same manner it did in the absence of unemployment insurance. The reason is that even with the presence of unemployment insurance, an increase in unemployment decreases both the opportunity cost of crime and the return to crime. While unemployment insurance does not change the relationship between unemployment and crime, unemployment insurance benefits, measured by the replacement rate, may serve as an instrument to reduce the crime rate. In particular, unemployment insurance generosity reduces the crime rate when the apprehension rate is high, but not when it is low. The intuition is that more generous benefits increase the expected incomes of all individuals, increasing the return to crime and the opportunity cost of crime. As a low apprehension rate magnifies the return to crime and reduces the opportunity cost, more generous benefits increase the return to crime maximally and increase the opportunity cost minimally, encouraging crimes at low apprehension rate. Generous benefits have the opposite effect on crimes at high apprehension rates.

A number of economic models of crime study unemployment in an environment where workers and firms are randomly matched to create a productive surplus (Burdett et al. (2003, 2004)), Engelhardt et al. (2008)). However, unemployment is endogenously determined in such search models, making it difficult to study a causal effect, found in the empirical literature on the issue. İmrohoroglŭ et al. (2000, 2004) considers an economic model of crime with apprehension and unemployment insurance, and unemployment and crime are again endogenously determined in their simulations. These papers provide important and useful insights into the issue under consideration and into economics of crime as well, but may not provide a guidance for empirical studies that estimate the effect of an increase in the unemployment rate on the crime rate.

The paper is organized as follows. The next section presents a simple model of crime that permits a comparative static analysis of the effect of unemployment on crime. Section 3 considers occupational choices between a worker and a criminal. Section 4 highlights the trade-off between the opportunity cost of crime and the return to crime, and demonstrates that the effect of unemployment on crime hinges on the apprehension rate. Section 5 relates the analysis to extant empirical findings. Section 6 discusses the choice of the apprehension rate. Section 7 extends the analysis to include unemployment insurance, and the last section offers a conclusion.

2. Setup

This section considers the simplest possible model that permits an intended comparative static analysis, the effect of unemployment on crime rates. The model will be extended to include unemployment insurance later. The model here is basically the same as known static models of crime in the literature (for example, İmrohoroglŭ et al. (2000, 2004), Persson and Siven (2007)), except the formulation of unemployment. The economy consists of a continuum of individuals. Individuals differ in their ability to earn as workers, denoted w, when employed in the legal sector of the economy. The difference in w may reflect different levels of human capital such as education or skills. An individual with earnings ability w may be called w for simplicity. The number of individuals is normalized to unity, and w is distributed according to a distribution function $F(w)$ over the support $[\underline{w}, \overline{w}]$ with $\underline{w} > 0$ and $f(w) = F'(w)$. A worker faces a possible loss of jobs, and enjoys no income when unemployed. Let $\phi p(w)$ denote the probability of w being unemployed. $\phi \in (0, 1]$ is a positive constant that enables a comparative static analysis of the effect of an increase in unemployment on the crime rates. An increase in ϕ is considered an increase in the unemployment rate. A crucial assumption is that $p'(w) < 0$, so that abler individuals are less likely to be unemployed. This assumption conforms to empirical findings that less-educated or low-skilled individuals face a greater chance of losing their jobs (Ashenfelter and Ham (1979), Nickell (1979), Kiefer (1985), Jackman et al. (1991), McKenna (1996)).

Everyone is assumed to work in the legal sector. This assumption is consistent with empirical findings that a good fraction of criminals are employed in the legal sector (Witte and Tauchen (1994), Grogger (1998), İmrohoroglŭ et al. (2004)). Each individual chooses to be a criminal or not. A criminal works in the legal sector and commits a crime. A noncriminal works only in the legal sector. Henceforth, a noncriminal will be called a 'worker.' A criminal's source of income, in addition to the legitimate activity, is theft. As common in the literature, the term 'theft' means a transfer of income from a victim to a criminal, representing property crimes (crimes driven by economic incentives), the focus of this paper. 'Theft' is also the standard way to model property crimes in the literature, including all the extant models of unemployment and crime.

The number of criminals represents the crime rate. To determine the number of criminals, the next section considers occupational choices that individuals make, a criminal or a

worker. Individuals compare the expected utility of a worker and that of a criminal when making occupational choices, and this section discusses the expected utilities.

The expected utility of a worker is considered first. As noted above, w earns no income with probability $\phi p(w)$, and earns w with probability $(1 - \phi p(w))$ by supplying her labor inelastically. A worker may encounter a criminal and loses a fraction θ of her income. That is, when they meet, the criminal robs the worker of a fraction θ of her income if not apprehended.[2] However, with probability α, the criminal is apprehended. In that case, the worker does not lose any income, as in İmrohoroglŭ et al. (2000).

To calculate the probabilities that an individual (a worker or criminal) encounters another (a worker or criminal), it is assumed that individuals are randomly matched, as in Roland and Verdier (2003), Burdett et. al. (2004), Huang et. al. (2004), and Persson and Siven (2007). Let m and n denote the number of criminals and the number of workers in the economy, respectively, that are endogenously determined later. It is assumed that a criminal can be robbed by another criminal, because criminals have no knowledge of their targets and randomly encounter targets. Unlike violent crimes such as murder, this assumption is reasonable for theft. The probability that any one, either a criminal or worker, meets a criminal, or that anyone is robbed is then $m/(m + n) = m$, given that the size of the population, $m + n$, equals unity. In an analogous manner, the probability that a criminal robs is $(n + m)/(m + n) = 1$, because a criminal can rob anyone, either a criminal or worker.

Apprehension of criminals is costly, and let $c(\alpha)$, an increasing and convex function, denote the cost of apprehending a criminal, with $c(0) = 0$ and $lim_{\alpha \to 1} c(\alpha) = \infty$. With m criminals, the total cost equals $mc(\alpha)$. The cost is financed by a proportional income tax, and the tax rate $t \in [0, 1]$ reads as

$$t = \frac{mc(\alpha)}{E},$$

$$E \equiv (1 - \alpha) \int_{criminals} (1 - \phi p(w)) w f(w) dw + \int_{workers} (1 - \phi p(w)) w f(w) dw,$$

because the identity of criminals and workers is not determined yet. E represents the aggregate income of the economy and the average income as well, given that the size of population is unity. In E, $(1 - \alpha)$ is multiplied by criminals' income, because they can work and earn income

---
[2]The parameter θ does not play any role in the analysis, but simply reflects the realism that a criminal is not necessarily able to steal 100% of a victim's income when the criminal meets a victim.

only when not apprehended.

Individuals are assumed to be risk neutral, and the expected utility of a worker with w reads as

$$u(w, m, \phi, \alpha, t, \theta) = [1 - m(1 - \alpha)\theta](1 - t)(1 - \phi p(w)),$$

because a worker loses the fraction $m(1 - \alpha)\theta$ of her disposable income, $(1 - t)(1 - \phi p(w))w$, when she meets a criminal and the criminal is not apprehended and the criminal steals the fraction θ. If an individual becomes a criminal, he earns in the legal sector and commits a crime. In addition to w, a criminal steals the fraction θ of the average income of all individuals if not apprehended. If apprehended, the criminal's utility is π, representing a minimum possible consumption or even disutility in monetary units from apprehension and punishment such as imprisonment. π thus can take a positive or a negative value. For a clear-cut result, π is assumed zero in the subsequent analysis although the implication of relaxing this assumption will be discussed. The expected utility of a criminal is then

$$v(w, m, \phi, \alpha, t, \theta, \pi) = (1 - \alpha)[(1 - m\theta)(1 - t)(1 - \phi p(w))w + \theta(1 - t)W] + \alpha\pi$$

$$= (1 - \alpha)(1 - t)[(1 - m\theta)(1 - \phi p(w))w + \theta \int_{\underline{w}}^{\overline{w}} (1 - \phi p(w))w f(w) dw],$$

where $\pi = 0$ as assumed above, and $W \equiv \int_{\underline{w}}^{\overline{w}} (1 - \phi p(w))w f(w) dw$ denotes the average income of all individuals. $(1 - \alpha)$ is multiplied by the terms in the squared brackets, because a criminal can earn income from the legal sector and steal from others only when not apprehended. Note that both a worker and a criminal (as a victim) are robbed of the same fraction, $m(1 - \alpha)\theta$, of their income from the legal sector.

3. Occupational Choice: A Worker or A Criminal

To maximize their expected utility, individuals choose to be a worker or a criminal, and let $\Omega(w, m, n, W, \phi, \theta)$ denote the difference in expected utility of an individual with w between being a worker and being a criminal, so that

$$\Omega(w, \phi, \alpha, t, \theta) \equiv u(w, m, \phi, \alpha, t, \theta) - v(w, m, \phi, \alpha, t, \theta) = (1 - t)\Psi(w, \phi, \alpha, \theta),$$

$$\Psi(w, \phi, \alpha, \theta) \equiv \alpha(1 - \phi p(w))w - (1 - \alpha)\theta \int_{\underline{w}}^{\overline{w}} (1 - \phi p(w))w f(w) dw. \tag{1}$$

Since the probability of unemployment decreases with w and a higher w earns more, the expected utility of a worker, $u(w, m, \phi, \alpha, t, \theta)$, increases with w. The expected utility of a

criminal, $v(w, m, \phi, \alpha, t, \theta)$, is also increasing in w, but at a slower rate, because of the factor $(1 - \alpha)$, as noted earlier. $\Omega(w, .)$ is thus increasing in w. That is, for $\alpha > 0$ and $t < 1$,

$$\frac{\Omega(w, \phi, \alpha, t, \theta)}{\partial w} = (1 - t)\alpha[1 - \phi p(w) - \phi p'(w)w] > 0.$$

This leads to the following result:

Proposition 1. *If w becomes a worker (criminal), $w' > (<) w$ also becomes a worker (criminal).*

The proposition has a simple intuition. The economic advantage of a worker over a criminal is that the worker enjoys a full income, as the worker will not be apprehended. That is, $(1-\alpha)$ is multiplied by a criminal's income but not by a worker's income. The advantage of a criminal is that the criminal enjoys an additional income from theft, $\theta(1-t)W$. The advantage of a worker, $(1-t)(1-\phi p(w))w - (1-\alpha)(1-t)(1-\phi p(w))w = (1-t)\alpha(1-\phi p(w))w$, increases with w, but the advantage of a criminal, $\theta(1-t)W$, is independent of w. Thus, an individual with a higher w is more likely to be a worker. This stratification result simply says that less-educated and low-skilled individuals are more likely to be criminals. While this result is derived from a stylized model, it is consistent with empirical findings that most crimes are committed by unskilled youth (Freeman (1996)), a group considered low-skilled individuals with low w in the model.

The proposition does not rule out the possibility that all individuals become workers (0% crime rate) or criminals (100% crime rate). To avoid these uninteresting and unrealistic cases, there must be a critical individual, denoted $w^* \in (\underline{w}, \overline{w})$, who is indifferent between being a worker and a criminal. To ensure the existence of such w^*, α must be restricted appropriately. At $\alpha = 0$, $\Psi(w, .) = -\theta \int_{\underline{w}}^{\overline{w}}(1 - \phi p(w))w f(w)dw < 0$ for all w. At $\alpha = 1$, $\Psi(w, .) = (1 - \phi p(w))w > 0$ for all w. In addition, $\partial \Psi(w, m, \phi, \alpha, \theta)/\partial \alpha = (1 - \phi p(w))w + \theta \int_{\underline{w}}^{\overline{w}}(1 - \phi p(w))w f(w)dw > 0$ for all w. Thus, there are two critical values of α, $\underline{\alpha}$ and $\overline{\alpha}$, such that for each $\alpha \in (\underline{\alpha}, \overline{\alpha})$ with $0 < \underline{\alpha} < \overline{\alpha} < 1$, there is $w^* \in (\underline{w}, \overline{w})$ that satisfies $\Psi(w^*, .) = 0$. As for t, at $\alpha = 0$, $c(0) = 0$ and hence $t = 0$. t increases with α for two reasons. In the numerator of t, $c(\alpha)$ increases with α, and the aggregate income E in the denominator decreases in α. As α approaches unity, $lim_{\alpha \to 1}c(\alpha) = \infty$ and $lim_{\alpha \to 1}t = 1$, as t cannot exceed unity. Thus, $t < 1$ and $(1 - t) > 0$ for $\alpha \in (\underline{\alpha}, \overline{\alpha})$ if $t(\overline{\alpha}) < 1$, and the sign of $\Omega(w, .)$ coincides with that of $\Psi(w, .)$. This result may be summarized as:

Proposition 2. *(i) There are $\underline{\alpha}$ and $\overline{\alpha}$, with $0 < \underline{\alpha} < \overline{\alpha} < 1$, such that for each $\alpha \in (\underline{\alpha}, \overline{\alpha})$, there is $w^* \in (\underline{w}, \overline{w})$ that satisfies $\Omega(w^*, .) = 0$ if $t(\overline{\alpha}) < 1$, (ii) $\lim_{\alpha \to \underline{\alpha}} w^* = \overline{w}$, and (iii) $\lim_{\alpha \to \overline{\alpha}} w^* = \underline{w}$.*

The proposition demonstrates that an interior occupational choice equilibrium exists unless the apprehension rate α is too small or too large. In such an equilibrium, some choose to be criminals while others choose to be workers. The intuition of the proposition is simple. A criminal works in the legal sector and earns income like a worker, and commits a crime and enjoys an additional income from theft if not apprehended. Thus, when a criminal is never apprehended or when $\alpha = 0$, it pays to be a criminal, and everyone chooses to be a criminal. As α increases, being a worker becomes attractive. As α reaches $\underline{\alpha}$, the highest income individual, $\overline{w}$, becomes indifferent between a worker and a criminal. As a result, w^* approaches $\overline{w}$, as in (ii). In an analogous manner, when $\alpha = 1$ and a criminal is apprehended with certainty, he enjoys $\pi = 0$, and is made worse off than if he were a worker. Thus, everyone wants to be a worker. As α decreases, being a criminal becomes attractive. As α falls to $\overline{\alpha}$ from unity, the lowest income individual, $\underline{w}$, becomes indifferent between a worker and a criminal, and w^* approaches $\underline{w}$, as in (iii). As a consequence, for $\alpha \in (\underline{\alpha}, \overline{\alpha})$, there is a critical individual $w^* \in (\underline{w}, \overline{w})$ that is indifferent between being a criminal and being a worker, as in (i).

4. Unemployment and Crime Rates

The crime rate is measured by the number of crimes relative to the population.[3] The crime rate is m in the current setup, because the number of criminals equals m, and because the size of the population is unity. Alternatively speaking, as those individuals with $w < w^*$ become criminals, the number of criminals equals $F(w^*)$. Thus,

$$m(w^*) = F(w^*).$$

The critical individual w^* that satisfies $\Psi(w^*, .) = 0$ in (1) depends on the parameters of the model such as the apprehension rate α, and so does the crime rate $m(w^*)$. This observation is consistent with empirical findings that crime rates vary considerably across localities (Cook (2008)).

---

[3]For example, in the Uniform Crime Reports, crime rates are defined as the number of offenses per 100,000 inhabitants. In this simple static model, criminals are assumed to commit a crime only once, and the number of crimes equals the number of criminals.

For $\alpha \in (\underline{\alpha}, \overline{\alpha})$, the critical individual w^* is implicitly defined as a function of (ϕ, α) by

$$\Psi(w^*, \phi, \alpha) \equiv \alpha(1 - \phi p(w^*))w^* - (1 - \alpha)\theta \int_{\underline{w}}^{\overline{w}} (1 - \phi p(w))w f(w)dw = 0. \qquad (2)$$

Total differentiation of (2) gives

$$\frac{\partial w^*(\phi, \alpha)}{\partial \alpha} = -\frac{1}{K}[(1 - \phi p(w^*))w^* + \theta \int_{\underline{w}}^{\overline{w}} (1 - \phi p(w))w f(w)dw] < 0, \qquad (3)$$

$$\frac{\partial w^*(\phi, \alpha)}{\partial \phi} = \frac{1}{K}[\alpha p(w^*)w^* - (1 - \alpha)\theta \int_{\underline{w}}^{\overline{w}} p(w)w f(w)dw], \qquad (4)$$

where

$$K = d\Psi(.)/dw^* = \alpha(1 - \phi p(w^*) - \phi p'(w^*)w^*) > 0.$$

While the paper mainly concerns the effect of unemployment in (4), the effect of the apprehension rate in (3) also plays an important role in the subsequent analysis. (3) is negative, but the sign of (4) cannot be unambiguously determined.[4] Since $\partial m(w^*)/\partial z = f(w^*)(\partial w^*/\partial z), z = \phi, \alpha$, the sign of $\partial m(w^*)/\partial z$ coincides with that of $\partial w^*(\phi, \alpha)/\partial z$ in (3)-(4). These results are stated as:

Lemma 1. *(i) $\partial m(w^*)/\partial \alpha < 0$, and (ii) $\partial m(w^*)/\partial \phi > 0$ or < 0 (an increase in the apprehension rate decreases the crime rate, and an increase in the unemployment rate may increase or decrease the crime rate).*

The intuition of the comparative static results can be gained as follows. The crime rate is equivalent to the number of criminals in the economy. Given that all individuals with $w < w^*$ become criminals according to Proposition 1, a change in the parameters increases the crime rate if the change increases the incentive of the critical individual to be a criminal and hence increases the number of criminals. Thus, it suffices to study the effect of a change in the parameters on the behavior of the critical individual w^*. The opportunity cost of the critical individual to become a criminal equals the loss of earnings from the legal sector when apprehended, $\alpha(1 - \phi p(w^*))w^*$,[5] and the return to crime is the additional income from theft when not apprehended, $(1 - \alpha)\theta \int_{\underline{w}}^{\overline{w}} (1 - \phi p(w))w f(w)dw$.

---

[4]w^* depends also on θ, and obviously $\partial w^*/\partial \theta > 0$.

[5]More exactly, $\alpha(1 - \phi p(w^*))w^*$ represents the 'net' opportunity cost or the economic advantage of a worker over a criminal, as noted in the discussion of Proposition 1. The reason is that by becoming a criminal, the critical individual loses $(1 - \phi p(w^*))w^*$ from the legal employment but still keeps $(1 - \alpha)(1 - \phi p(w^*))w^*$ from the legal employment. Thus, the critical individual loses $\alpha(1 - \phi p(w^*))w^*$. Since this does not appear to create confusion, the term 'opportunity cost' will be used for simplicity.

An increase in the apprehension rate α increases the opportunity cost but decreases the return to crime. As a result, the crime rate decreases with the apprehension rate and $\partial m/\partial \alpha < 0$. This effect of an increase in the apprehension rate is not only intuitive, but also the most important factor that explains a significant decrease in the U.S. crime rate in 1990s (İmrohoroglŭ et al. (2004)). However, the effect of an increase in the unemployment rate on the crime rate is ambiguous. A higher unemployment rate decreases expected income of a worker, decreasing the opportunity cost of becoming a criminal. At the same time, the reduced incomes also lower the return to crime, because the return consists of a fraction θ of the average income of all individuals. As a consequence, an increase in unemployment may increase or decrease the crime rate. This ambiguity may in part explain why empirical evidence on the issue is inconclusive in the literature, as noted in the introduction.

To say more about the effect of an increase in the unemployment rate on the crime rate, $\alpha w^* = (1-\alpha)\theta \int_{\underline{w}}^{\overline{w}}(1-\phi p(w))wf(w)dw/(1-\phi p(w^*))$ is substituted from (2) into the numerator of (4) to obtain

$$
\begin{aligned}
\frac{\partial w^*(\phi, \alpha, \theta)}{\partial \phi} &= \frac{1}{K}[p(w^*)\frac{(1-\alpha)\theta \int_{\underline{w}}^{\overline{w}}(1-\phi p(w))wf(w)dw}{(1-\phi p(w^*))} - (1-\alpha)\theta \int_{\underline{w}}^{\overline{w}} p(w)wf(w)dw] \\
&= \frac{(1-\alpha)\theta}{K(1-\phi p(w^*))}[p(w^*)\int_{\underline{w}}^{\overline{w}}(1-\phi p(w))wf(w)dw - (1-\phi p(w^*))\int_{\underline{w}}^{\overline{w}} p(w)wf(w)dw] \\
&= \frac{(1-\alpha)\theta}{K(1-\phi p(w^*))}\int_{\underline{w}}^{\overline{w}}(p(w^*)-p(w))wf(w)dw.
\end{aligned}
\tag{5}
$$

To determine the sign of (5), let

$$
x(\alpha) \equiv \int_{\underline{w}}^{\overline{w}}(p(w^*)-p(w))wf(w)dw.
\tag{6}
$$

Since $lim_{\alpha \to \underline{\alpha}}w^* = \overline{w}$ from Proposition 1, and since $p(w)$ is decreasing in w, $lim_{\alpha \to \underline{\alpha}}p(w^*) = p(\overline{w}) < p(w)$ for all $w < \overline{w}$. Thus, $lim_{\alpha \to \underline{\alpha}}x(\alpha) < 0$. By an analogous argument, $lim_{\alpha \to \overline{\alpha}}x(\alpha) > 0$. In addition, $x'(\alpha) = \int_{\underline{w}}^{\overline{w}} p'(w^*)\frac{\partial w^*}{\partial \alpha}wf(w)dw > 0$, because $\partial w^*/\partial \alpha < 0$ from (3). Given that the sign of $\partial w^*/\partial \phi$ in (5) coincides with that of $x(\alpha)$ in (6), the following result can be stated:

Proposition 3. *There is a critical value of α, denoted $\alpha^* \in (\underline{\alpha}, \overline{\alpha})$, such that $\partial m(w^*)/\partial \phi \le (\ge) 0$ for $\alpha \le (\ge) \alpha^*$.*

The proposition demonstrates that the effect of unemployment on the crime rate depends on the magnitude of the apprehension rate α. As discussed in Lemma 1, an increase

in the unemployment rate decreases the opportunity cost of becoming a criminal and the return to crime as well. At a very low apprehension rate, such as α close to $\underline{\alpha}$, the return is maximized due to a lower chance of being apprehended. At the same time, the opportunity cost is minimized, because a worker loses more or keeps less of her expected income, as criminals are less likely to be apprehended. Thus, in this case, an increase in the unemployment rate decreases the opportunity cost minimally but decreases the return to crime maximally, reducing the crime rate and $\partial m / \partial \phi < 0$. At a very high apprehension rate, such as α close to $\overline{\alpha}$, the opposite holds, and an increase in the unemployment rate increases the crime rate and $\partial m / \partial \phi > 0$. In addition, as the apprehension rate α increases, the decrease in the opportunity cost gets larger, but the decrease in the return gets smaller, making it more likely that an increase in the unemployment rate increases the crime rate. Thus, there is a critical α below (above) which an increase in the unemployment rate decreases (increases) the crime rate.

Another way of seeing the proposition is to focus on the expression of $x(\alpha)$ in (6). Roughly speaking, an increase in the unemployment rate lowers the opportunity cost of crime for the critical individual, w^*, that is indifferent between being a criminal and a worker. Since the opportunity cost is expected employment and income from working, an increase in ϕ increases the probability of unemployment and hence decreases the opportunity cost by $p(w^*)$. An increase in the unemployment rate decreases the return to crime, the average income of all individuals. Since an increase in ϕ increases the unemployment rate by $p(w)$, it decreases the return by $p(w)$ for all w. Thus, given that $p(w)$ decreases in w, the return effect outweighs the opportunity-cost effect, and an increase in the unemployment rate decreases the crime rate, when w^* is high (so that $p(w^*)$ is small) or α is low with $\alpha < \alpha^*$. The opposite holds when w^* is low (so that $p(w^*)$ is large) or α is high with $\alpha > \alpha^*$.

Proposition 3 implies that as the apprehension rates would vary across jurisdictions or localities, the effects of an increase in the unemployment rate on the crime rate would also vary. The effect would be positive in some localities while it would be negative in others. This variation may explain the diverse effects, found in empirical studies mentioned in the introduction. In addition, this variation across localities means that the aggregate effect of unemployment on crime, based on an aggregate data such as a national data, may be insignificant, another finding in empirical studies.

As a final point, suppose that $\pi \neq 0$. Substituting $\alpha w^* = [(1-\alpha)\theta \int_{\underline{w}}^{\overline{w}} (1-\phi p(w))wf(w)dw +$

$\alpha\pi]/(1 - \phi p(w^*))$ from (2) into the numerator of (4), (5) becomes

$$\frac{\partial w^*(\phi, \alpha)}{\partial \phi} = \frac{1}{K(1 - \phi p(w^*))}[(1 - \alpha)\theta \int_{\underline{w}}^{\overline{w}} (p(w^*) - p(w))wf(w)dw + \alpha p(w^*)\pi].$$

Consider first the case with $\pi < 0$. At low values of α, $x(\alpha) < 0$ and hence the first term, $(1 - \alpha)\theta x(\alpha)$, inside the squared brackets is negative. The second term, $\alpha p(w^*)\pi$, is also negative with $\pi < 0$, making $\partial w^*/\partial\phi < 0$ for such low values of α, as in Proposition 3. However, at high values of α, the first term becomes positive. Since the second term is negative with $\pi < 0$, $\partial w^*/\partial\phi$ cannot be signed for high values of α. When $\pi > 0$, an analogous argument holds, and $\partial w^*/\partial\alpha > 0$ for high values of α, as in Proposition 3, but cannot be signed for low values of α.

5. Discussion

This section relates the analytical results in the previous section to extant empirical findings. While many papers have studied the relationship between unemployment and crime by adding various control variables such as ages and state dummy, only Gould et al. (2002) appears to include the apprehension rate as an independent variable. According to Table 2 in Gould et al. (2002), an increase in the arrest rate reduces the crime rate across all types of crimes driven by economic incentives: auto theft, burglary, larceny, and robbery.[6] Thus, the comparative static result, $\partial m(w^*)/\partial\alpha < 0$ in Lemma 1, is consistent with empirical findings in Gould et al. (2002).

As for the effect of an increase in the unemployment rate on the crime rate, unemployment has a positive effect on crime when the apprehension rate is not included as an independent variable in Table 1 of Gould et al. (2002). When it is included in Table 2, it reduces the magnitudes of the positive effects for burglary and robbery.[7] In addition, the effect becomes negative, and an increase in the unemployment rate decreases the crime rate for auto theft and larceny.[8] These empirical findings appear to suggest that the effect of unemployment on crime hinges on the apprehension rate, and the effect can be either positive or negative, as in Proposition 3.

6. Apprehension Rates

---

[6]The first three types of crimes are classified as property crime, but robbery is classified as violent crime in the official FBI crime statistics, Uniform Crime Reports.

[7]The coefficients on burglary and robbery decrease from 3.10 to 2.19 and from 2.12 to 0.39, respectively.

[8]The coefficients on auto theft and larceny become - .82 and -1.29, respectively.

Given the important role that the apprehension rate played in determining the effect of unemployment on crimes in the previous section, this section considers a choice of the apprehension rate. Consider a worker's choice of the apprehension rate that maximizes her expected utility

$$u(w, m, \phi, \alpha, t, \theta) = (1 - t)y_u(w),$$

$$y_u(w) \equiv [1 - m(1 - \alpha)\theta](1 - \phi p(w))w,$$

where the tax rate t reads as

$$t = \frac{m(w^*)c(\alpha)}{E},$$

$$E \equiv (1 - \alpha) \int_{\underline{w}}^{w^*} (1 - \phi p(w))wf(w)dw + \int_{w^*}^{\overline{w}} (1 - \phi p(w))wf(w)dw.$$

The first-order condition for an interior maximum of $u(w, .)$ is

$$\frac{du(w, .)}{d\alpha} = -\frac{dt}{d\alpha}y_u(w) + (1 - t)\frac{dy_u(w)}{d\alpha} = 0, \tag{7}$$

$$\frac{dt}{d\alpha} = \frac{1}{E^2}\{E[m(w^*)c'(\alpha) + f(w^*)c(\alpha)\frac{\partial w^*}{\partial \alpha}]$$

$$+ m(w^*)c(\alpha)[\int_{\underline{w}}^{w^*} (1 - \phi p(w))wf(w)dw + \alpha(1 - \phi p(w^*))w^*f(w^*)\frac{\partial w^*}{\partial \alpha}]\},$$

$$\frac{dy_u(w)}{d\alpha} = \theta[m - (1 - \alpha)f(w^*)\frac{\partial w^*}{\partial \alpha}](1 - \phi p(w))w > 0,$$

where recall that $m = m(w^*) = F(w^*)$. An increase in α does not necessarily increase the tax rate t, and $dt/d\alpha$ can be positive or negative. This occurs because an increase in α increases the cost of apprehending a criminal, but decreases the number of criminals ($\partial w^*/\partial \alpha < 0$). However, at an interior solution that satisfies $du(w, .)/d\alpha = 0$, it must be that $dt/d\alpha > 0$, because $dy_u(y)/d\alpha > 0$, as derived above. The first-order condition then states that at a worker's utility-maximizing choice of α, denoted α_u, the marginal cost resulting from the increased tax rate equals the marginal benefit from the increased disposable income.

For future reference, observe that the first-order condition (7) holds for all workers (for all $w \in [w^*, \overline{w}]$), because both y_u and $dy_u(w)/d\alpha$ include a common factor, $(1 - \phi p(w))w$, and because the factor can be dropped. That is, the condition (7) can be rewritten as

$$\frac{du(w, .)}{d\alpha} = 0 \implies -\frac{dt}{d\alpha}[1 - m(1 - \alpha)\theta](1 - \phi p(w))w + (1 - t)\frac{d}{d\alpha}[1 - m(1 - \alpha)\theta](1 - \phi p(w))w = 0$$

13

$$\implies (1 - \phi p(w))w \frac{d}{d\alpha} \{(1-t)[1 - m(1-\alpha)\theta]\} = 0. \tag{8}$$

A worker with a higher w enjoys a higher utility from a given apprehension rate α, as $u(w,.)$ increases in w at a given α. However, all workers prefer the same level of α, because their marginal benefit and the marginal cost of an increase in α both are proportional to their expected gross income, $(1 - \phi p(w))w$.

To compare the worker's choice with the efficient α, define social welfare of the economy as the sum of the utilities of workers and criminals,

$$S(\alpha) = \int_{\underline{w}}^{w^*} v(w, m, \phi, \alpha, t, \theta) f(w) dw + \int_{w^*}^{\overline{w}} u(w, m, \phi, \alpha, t, \theta) f(w) dw$$

$$= E - m(w^*)c(\alpha) = (1-t)E.$$

Evaluating $S'(\alpha)$ at the worker's choice α_u that satisfies (7), giving[9]

$$S'(\alpha)\mid_{\alpha=\alpha_u} = -\frac{dt}{d\alpha}E + (1-t)\frac{dE}{d\alpha}$$

$$= -\frac{1-t}{y_u(w)}\frac{dy_u(w)}{d\alpha}E + (1-t)\frac{dE}{d\alpha}$$

$$= \frac{1-t}{y_u(w)}[-\frac{dy_u(w)}{d\alpha}E + y_u(w)\frac{dE}{d\alpha}],$$

where the first equality uses (7). Since

$$\frac{dE}{d\alpha} = -\int_{\underline{w}}^{w^*}(1 - \phi p(w))wf(w)dw - \alpha(1 - \phi p(w^*))w^* f(w^*)\frac{\partial w^*}{\partial \alpha}$$

cannot be signed, the sign of $S'(\alpha)\mid_{\alpha=\alpha_u}$ is not obvious. However, as proved in the appendix, a simple calculation shows that $S'(\alpha)\mid_{\alpha=\alpha_u} < 0$ and hence $\alpha_S < \alpha_u$ with α_S maximizing $S(\alpha)$. The intuition of the inequality will be discussed below.

Suppose alternatively that the planner maximizes the utilities of workers only,

$$Q(\alpha) = \int_{w^*}^{\overline{w}} u(w.,)f(w)dw = \int_{w^*}^{\overline{w}}(1-t)y_u(w)f(w)dw$$

$$= (1-t)[1 - m(1-\alpha)\theta]\int_{w^*}^{\overline{w}}(1 - \phi p(w))wf(w)dw.$$

---

[9]This first-order approach of course can be justified only when the maximization problems are concave in α. The condition unfortunately cannot be checked without detailed knowledge of the functions such as the shape of $f(w)$, and is assumed to hold.

Evaluating $Q'(\alpha)$ at α_u,

$$Q'(\alpha)\mid_{\alpha=\alpha_u} = \frac{d}{d\alpha}\{(1-t)[1-m(1-\alpha)\theta]\}\int_{w^*}^{\overline{w}}(1-\phi p(w))wf(w)dw$$

$$-(1-t)[1-m(1-\alpha)\theta](1-\phi p(w^*))w^*f(w^*)\frac{\partial w^*}{\partial \alpha}$$

$$= -(1-t)[1-m(1-\alpha)\theta](1-\phi p(w^*))w^*f(w^*)\frac{\partial w^*}{\partial \alpha} > 0.$$

The last equality follows from (8), and the inequality comes again from $\partial w^*/\partial\alpha < 0$. Thus, α_Q that maximizes $Q(\alpha)$ exceeds α_u. These results may be summarized as:

> **Proposition 4.** $\alpha_S < \alpha_u < \alpha_Q$ (A worker's choice of the apprehension rate exceeds the efficient level if social welfare considers the utilities of all individuals, and the opposite holds if social welfare considers the utilities of workers only).

The proof of the first inequality is in the appendix. To gain the intuition of the first inequality, rewrite the expected utility of a criminal as

$$v(w, m, \phi, \alpha, t, \theta) = (1-t)y_v(w),$$

$$y_v(w) \equiv (1-\alpha)[(1-m\theta)(1-\phi p(w))w + \theta\int_{\underline{w}}^{\overline{w}}(1-\phi p(w))wf(w)dw],$$

$$\frac{dy_v(w)}{d\alpha} = -[(1-m\theta)(1-\phi p(w))w + \theta\int_{\underline{w}}^{\overline{w}}(1-\phi p(w))wf(w)dw] - (1-\alpha)\theta f(w^*)\frac{\partial w^*}{\partial\alpha}(1-\phi p(w))w.$$

$dy_v(w)/d\alpha$ differs from $dy_u(w)/d\alpha$ in (7) in three respects.[10] First, an increase in the apprehension rate directly benefits workers, as they can keep more of their incomes, but directly hurts criminals, as they are less likely to keep their jobs and earn incomes. This difference is reflected in $\theta m(1-\phi p(w))w > 0$ of $dy_u(w)/d\alpha$ and $-(1-m\theta)(1-\phi p(w))w < 0$ of $dy_v(w)/d\alpha$. Second, an increase in the apprehension rate decreases crimes due to $\partial m(w)/\partial\alpha < 0$, enabling both workers and criminals to keep more of their earned income and indirectly benefiting both of them. However, since workers earn more incomes than criminals, such an increase in the apprehension rate benefits workers more than criminals. That is, the term, $-(1-\alpha)\theta f(w^*)\frac{\partial w^*}{\partial\alpha}(1-\phi p(w))w > 0$, is present in both $dy_u(w)/d\alpha$ and $dy_v(w)/d\alpha$, but the term in $dy_u(w)/d\alpha$ is larger because $(1-\phi p(w))w$ is larger for workers. Third, an increase in

---

[10]The intuition here of course is not exact but rough, because an increase in the apprehension rate increases the tax rate, reducing a worker's income more than a criminal's income. This tax effect makes a worker desire a lower apprehension rate. However, this tax effect turns out to be outweighed by the benefit effects discussed in the text.

the apprehension rate lowers the return to crime, as criminals are less likely to be able to steal from others, as reflected in $-\theta \int_{\underline{w}}^{\overline{w}}(1 - \phi p(w))wf(w)dw < 0$ of $dy_v(w)/d\alpha$ while it is absent in $dy_u(w)/d\alpha$. Taken together, workers desire an apprehension rate higher than criminals do. The planner cares both about workers and about criminals when choosing α, and the planner's choice should be lower than a worker's choice.

As for the second inequality, $\alpha_u < \alpha_Q$, even if all workers prefer the same level of α and even if the planner considers the utilities of only workers, the planner's choice of α still differs from a worker's choice of α. The reason is that an increase in α lowers w^*, increasing the number of workers. The planner takes into account the utility of these additional workers when choosing α, but an individual worker does not. Since social welfare increases with the number of workers or with the total gross income of workers ($Q(\alpha)$ increases with $\int_{w^*}^{\overline{w}}(1 - \phi p(w))wf(w)dw$), the planner that wishes to maximize social welfare desires to have more workers and to increase α, beyond the level that each worker chooses.

Assuming that $F(w^*) < 1/2$ and workers are a majority, α_u may be interpreted as a voting outcome. The proposition then shows that the voting outcome is not efficient. This inefficiency is obvious, especially when the planner considers the utilities of all individuals. Even when the planner considers the utilities of workers only, the voting outcome is not efficient, not because of a usual reason that the median income differs from the mean income. Rather the reason is that the planner wishes to have more workers in the economy.

7. Unemployment Insurance

This section assumes that an individual with w receives an unemployment insurance benefit of bw if unemployed, where $b \in (0, 1)$ is the replacement rate. To finance the benefits, individuals pay their taxes out of their earnings and unemployment insurance benefits.[11] The unemployment insurance program is assumed self-financing.

The expected utility of a worker with w in the previous section is then modified as

$$u(w, m, \phi, \alpha, \theta, t, b) = [1 - m(1 - \alpha)\theta](1 - t)(1 - \phi p(w) + b\phi p(w))w.$$

The difference from the previous section is that workers receive the benefits when unemployed

---

[11]Unemployment insurance benefits are taxed in practice. The fact that benefits are taxed incidentally simplifies the analysis and presentation. However, even if benefits are not taxed, it does not affect the analysis in an important way, but makes the presentation more complicated. An earlier version of this paper modeled unemployment insurance benefits as non-taxable.

and the tax rate is higher. The expected utility of a criminal becomes

$$v(w, m, \phi, \alpha, \theta, t, b) = (1 - \alpha)[(1 - m\theta)(1 - t)(1 - \phi p(w) + b\phi p(w))w$$

$$+ \theta \int_{\underline{w}}^{\overline{w}} (1 - t)(1 - \phi p(w) + b\phi p(w))w f(w)dw],$$

because criminals receive the unemployment insurance benefits and can steal from others only when not apprehended.

The difference in expected utility of an individual with w between being a worker and being a criminal reads as

$$\Omega(w, m, \phi, \alpha, \theta, t, b) = (1 - t)\Psi(w, m, \phi, \alpha, \theta, b),$$

$$\Psi(w, m, \phi, \alpha, \theta, b) \equiv \alpha(1 - \phi p(w) + b\phi p(w))w - (1 - \alpha)\theta \int_{\underline{w}}^{\overline{w}} (1 - \phi p(w) + b\phi p(w))w f(w)dw. \quad (9)$$

Differentiation of $\Omega(w, .)$ with respect to w gives, for $\alpha > 0$ and $t < 1$,

$$\frac{\partial \Omega(w, .)}{\partial w} = (1 - t)\alpha[1 - \phi p(w) + b\phi p(w) - (1 - b)\phi p'(w)w] > 0.$$

Thus, Proposition 1 continues to hold and the stratification result obtains.

To conduct a meaningful comparative static analysis, there must be $w^* \in (\underline{w}, \overline{w})$, as in the previous sections. At $\alpha = 0$, $\Psi(w, .) = -\theta \int_{\underline{w}}^{\overline{w}} (1 - \phi p(w) + b\phi p(w))w f(w)dw < 0$ for all w. At $\alpha = 1$, $\Psi(w, .) = (1 - \phi p(w) + b\phi p(w))w > 0$ for all w. In addition, $\partial\Psi(w, m, \phi, \alpha, \theta)/\partial\alpha = (1 - \phi p(w) + b\phi p(w))w + \theta \int_{\underline{w}}^{\overline{w}} (1 - \phi p(w) + b\phi p(w))w f(w)dw > 0$ for all w. Thus, there are two critical values of α, $\underline{\alpha}$ and $\overline{\alpha}$, such that for each $\alpha \in (\underline{\alpha}, \overline{\alpha})$, there is $w^* \in (\underline{w}, \overline{w})$ that satisfies $\Psi(w^*, .) = 0$.[12] Thus, if $t < 1$ for $\alpha \in (\underline{\alpha}, \overline{\alpha})$, Proposition 2 extends.

Total differentiation of $\Psi(w^*, .) = 0$ in (9) gives

$$\frac{\partial w^*(.)}{\partial \alpha} = -\frac{1}{K}[(1 - \phi p(w^*) + b\phi p(w^*))w^* + \theta \int_{\underline{w}}^{\overline{w}} (1 - \phi p(w) + b\phi p(w))w f(w)dw] < 0, \quad (10)$$

$$\frac{\partial w^*(.)}{\partial \phi} = \frac{(1 - b)}{K}[\alpha p(w^*)w^* - (1 - \alpha)\theta \int_{\underline{w}}^{\overline{w}} p(w)w f(w)dw], \quad (11)$$

$$\frac{\partial w^*(.)}{\partial b} = \frac{1}{K}[(1 - \alpha)\theta \int_{\underline{w}}^{\overline{w}} \phi p(w)w f(w)dw - \alpha\phi p(w^*)w^*], \quad (12)$$

---

[12]Since unemployment insurance is added in this section, critical values, w^* and $\underline{\alpha}$ and $\overline{\alpha}$, are different from those in the previous sections. However, for simplicity, the same notations will be kept whenever no confusion is created.

where

$$K = \frac{d\Psi(.)}{dw^*} = \alpha[1 - \phi p(w^*) + b\phi p(w^*) - (1-b)\phi p'(w^*)w^*)] > 0.$$

As in the previous sections, (10) is negative, but the signs of (11) and (12) cannot be unambiguously determined. Lemma 1 thus continues to hold although a new comparative static result, $\partial w^*/\partial b$, is added and its sign is ambiguous.

The subsequent analysis focuses on the two ambiguous comparative static results in (11) and (12). In an analogous manner to (5), $\partial w^*/\partial\phi$ can be rewritten as

$$\frac{\partial w^*(.)}{\partial\phi} = \frac{(1-b)(1-\alpha)\theta}{K(1 - \phi p(w^*) + b\phi p(w^*))} \int_{\underline{w}}^{\overline{w}} (p(w^*) - p(w))wf(w)dw$$

$$= \frac{(1-b)(1-\alpha)\theta}{K(1 - \phi p(w^*) + b\phi p(w^*))} x(\alpha), \tag{13}$$

where $\alpha w^* = (1-\alpha)\theta \int_{\underline{w}}^{\overline{w}}(1 - \phi p(w) + b\phi p(w))wf(w)dw/(1 - \phi p(w^*) + b\phi p(w^*))$ is substituted from $\Psi(w^*,.) = 0$ in (9). The sign of $\partial w^*/\partial\phi$ then coincides with the sign of $x(\alpha)$ in (6), and the following result can be stated:

Proposition 5. *There is a critical value of α, denoted $\alpha^* \in (\underline{\alpha}, \overline{\alpha})$, such that $\partial m(w^*)/\partial\phi \leq (\geq) 0$ for $\alpha \leq (\geq) \alpha^*$.*

The proposition does not differ qualitatively from Proposition 3, although the critical value of α would differ due to the addition of unemployment insurance, and the apprehension rate still plays the same role in determining the effect of an increase in the unemployment rate on the crime rate. Thus, the presence of the unemployment insurance program does not affect the nature of the comparative statics qualitatively. The main reason is that an increase in the unemployment rate decreases both the opportunity cost of crime and the return to crime regardless of whether the unemployment insurance program exists or not. In addition, at low values of the apprehension rate, the return decreases maximally while the opportunity cost decreases minimally. At high values of the apprehension rate, the opposite holds.

Using again $\Psi(w^*,.) = 0$ in (9), $\partial w^*/\partial b$ in (12) can be rewritten as

$$\frac{\partial w^*(.)}{\partial b} = \frac{(1-\alpha)\theta\phi}{K(1 - \phi p(w^*) + b\phi p(w^*))} \int_{\underline{w}}^{\overline{w}} (p(w) - p(w^*))wf(w)dw$$

$$= -\frac{(1-\alpha)\theta\phi}{K(1 - \phi p(w^*) + b\phi p(w^*))} x(\alpha). \tag{14}$$

18

The properties of $x(\alpha)$ in (6) imply the following result:

Proposition 6. *There is a critical value of α, denoted $\alpha^{**} \in (\underline{\alpha}, \overline{\alpha})$, such that $\partial m(w^*)/\partial b$ $\geq (\leq) 0$ for $\alpha \leq (\geq) \alpha^{**}$.*

The proposition demonstrates that the effect of unemployment insurance benefits, measured by the replacement rate b, on the crime rate depends on the magnitude of the apprehension rate α. The intuition of the result can be gained again by considering the effect of an increase in the replacement rate on the behavior of the critical individual with w^*. Since the opportunity cost of the critical individual to become a criminal is $\alpha(1 - \phi p(w^*) + b\phi p(w^*))$, an increase in b changes the critical individual's opportunity cost of crime by $\alpha\phi p(w^*)w^*$. The same increase in b changes the return to crime, the average income of all individuals, by $(1 - \alpha)\theta \int_{\underline{w}}^{\overline{w}} \phi p(w)wf(w)dw$. At a very low level of apprehension rate, such as α close to $\underline{\alpha}$, the expected return increases maximally due to a lower chance of being apprehended and due to the increased average income of all individuals. At the same time, the opportunity cost increases minimally. Thus, an increase in b in this case encourages crimes and $\partial w^*/\partial b > 0$. At a higher apprehension rate, the opposite holds, and an increase in the replacement rate discourages crimes and $\partial w^*/\partial b < 0$.

An implication is that unemployment insurance generosity does not necessarily discourage crimes. Rather, the effect of a generous benefit depends on the apprehension rate. With a high apprehension rate, a generous benefit is an effective measure to reduce crimes. However, with a low apprehension rate, a generous benefit increases crime. It is interesting to note that Burdett et al. (2003, 2004) also find, in a different model with job search, that the relationship between the replacement rate and the crime rate is complicated, depending on the parameter values of the model, and certainly is not monotonic.

Comparison of Proposition 6 and Proposition 5 reveals that the apprehension rate plays a key role in both Propositions but it has opposite effects. A low apprehension rate helps an increase in the replacement rate increase the crime rate in Proposition 6, but helps an increase in the unemployment rate decrease the crime rate in Proposition 5. This contrasting role of the apprehension rate simply comes from the observation that an increase in the replacement rate increases the return to crime while an increase in the unemployment rate decreases the return to crime. Since a low apprehension rate makes the return to crime larger, an increase

in the replacement rate increases the return maximally and hence encourages crimes while an increase in the unemployment rate decreases the return maximally and hence discourages crimes at a low apprehension rate.

As for the choice of the apprehension rate α, Proposition 4 continues to hold. The reason is that unemployment insurance increases expected income from $(1 - \phi p(w))w$ to $(1 - \phi p(w) + b\phi p(w))w$. However, these income terms are independent of α. The subsequent analysis focuses on another policy variable of interest, the replacement rate b.

Rather than comparing the levels of b chosen according to different objective functions, as in Section 6, this section discusses the difference between workers and criminals in terms of their choice of b. Such a discussion without a detailed analysis conserves space but still enables the comparison between a worker's choice of b and the efficient level, as the intuition of Proposition 4 suggested. A worker's choice of the replacement rate b maximizes

$$u(w, m, \phi, \alpha, \theta, t, b) = (1 - t)y_u(w),$$

$$y_u(w) \equiv [1 - m(1 - \alpha)\theta](1 - \phi p(w) + b\phi p(w))w,$$

where the tax rate t reads as

$$t = \frac{bU}{E + bU},$$

$$U \equiv (1 - \alpha) \int_{\underline{w}}^{w^*} \phi p(w)w f(w)dw + \int_{w^*}^{\overline{w}} \phi p(w)w f(w)dw.$$

In the numerator of the tax rate, t, the cost of apprehension, $m(w^*)c(\alpha)$, should be added, but is omitted in order to focus on unemployment insurance. The first-order condition for an interior maximum of $u(w, .)$ is

$$\frac{du(w, .)}{db} = -\frac{dt}{db}y_u(w) + (1 - t)\frac{dy_u(w)}{db} = 0, \tag{15}$$

$$\frac{dt}{db} = \frac{1}{(E + bU)^2}[EU + \alpha b w^* f(w^*)\frac{\partial w^*}{\partial b}(U(1 - \phi p(w^*)) - E\phi p(w^*))]$$

$$\frac{dy_u(w)}{db} = [\phi p(w)(1 - m(1 - \alpha)\theta) - (1 - \alpha)\theta f(w^*)\frac{\partial w^*}{\partial b}(1 - \phi p(w) + b\phi p(w))]w.$$

Neither dt/db nor $dy_u(w)/db$ can be signed, because $\partial w^*/\partial b > (<) 0$ for $\alpha < (>) \alpha^{**}$, as in Proposition 6. For the subsequent discussion, assume that $dt/db > 0$, in an analogous manner

20

to $dt/d\alpha > 0$ in the previous section, so that $dy_u(w)/db > 0$ at an interior solution.

A criminal's choice of b maximizes

$$v(w, m, \phi, \alpha, \theta, t, b) = (1 - t)y_v(w)$$

$$y_v(w) \equiv (1 - \alpha)[(1 - m\theta)(1 - \phi p(w) + b\phi p(w))w + \theta \int_{\underline{w}}^{\overline{w}} (1 - \phi p(w) + b\phi p(w))wf(w)dw],$$

and the first-order condition is

$$\frac{dv(w, .)}{db} = -\frac{dt}{db}y_v(w) + (1 - t)\frac{dy_v(w)}{db} = 0, \tag{16}$$

$$\frac{dy_v(w)}{db} = (1 - \alpha)[\phi p(w)(1 - m\theta) - \theta f(w^*)\frac{\partial w^*}{\partial b}(1 - \phi p(w) + b\phi p(w))]w$$

$$+ (1 - \alpha)\theta \int_{\underline{w}}^{\overline{w}} \phi p(w)wf(w)dw.$$

Comparing (15) and (16), the following result can be stated:

> **Proposition 7.** If $\alpha \leq \alpha^{**}$, $b_v > b_u$ (A criminal desires a higher level of replacement rate than a worker).

The proof is in the appendix, and the intuition is discussed here. $dy_v(w)/db$ in (16) differs from $dy_u(w)/db$ in (15) in three respects. First, an increase in the replacement rate increases crimes due to $\partial m(w)/\partial b > 0$ when $\alpha < \alpha^{**}$, and both workers and criminals lose more of their earned incomes. However, since workers earn more incomes than criminals, such an increase in the replacement rate hurts workers more than criminals. That is, the term, $-(1 - \alpha)\theta f(w^*)\frac{\partial w^*}{\partial b}(1 - \phi p(w) + b\phi p(w))w < 0$, is present in both $dy_u(w)/db$ and $dy_v(w)/db$, but the term in $dy_u(w)/db$ is larger in absolute value because $(1 - \phi p(w) + b\phi p(w))w$ is larger for workers. Second, an increase in the replacement rate increases the return to crime, because a criminal steals income from everyone, and because an increase in b increases everyone's income. This effect of an increase in b is reflected in $(1 - \alpha)\theta \int_{\underline{w}}^{\overline{w}} \phi p(w)wf(w)dw > 0$ of $dy_v(w)/db$ while it is absent in $dy_u(w)/db$. These two effects make a criminal desire a higher replacement rate than a worker does. Third, an increase in b increases the disposable income of criminals and workers when unemployed, benefiting both workers and criminals. But it is ambiguous whether it benefits workers more or less than criminals, because the expected unemployment benefits, $b\phi p(w)w$, may be higher for workers or for criminals,[13] and because criminals can enjoy unemployment insurance benefits only when not apprehended. This ambiguity is reflected

---

[13]w is higher for a worker, but $p(w)$ is lower.

in the ambiguous relationship between $\phi p(\tilde{w})\tilde{w}(1 - m(1 - \alpha)\theta)$ and $(1 - \alpha)\phi p(\hat{w})\hat{w}(1 - m\theta)$ with $\tilde{w}$ and $\hat{w}$ denoting a worker's wage and a criminal's wage, respectively. Despite this third ambiguous effect, $dy_v(w)/db > dy_u(w)/db$ and criminals desire a higher replacement rate, because the first two effects turn out to outweigh the third ambiguous effect.

Contrary to the condition in the proposition, suppose that $\alpha > \alpha^{**}$, so that $\partial w^*/\partial b < 0$. In this case, the first effect above becomes positive, $-(1-\alpha)\theta f(w^*)\frac{\partial w^*}{\partial b}(1-\phi p(w)+b\phi p(w))w > 0$, and an increase in the replacement rate benefits both workers and criminals, because both workers and criminals can keep more of their earned incomes due to a lower crime rate. However, it benefits workers more, because a worker earns more income than a criminal. This first effect then makes a worker desire a higher replacement rate than a criminal. Thus, the first effect and the second effect work in opposite directions, making the relationship between b_v and b_u ambiguous.

Proposition 7 implies $b_u < b_S$, with b_S maximizing social welfare when the planner cares about workers and about criminals. As for the relationship between b_u and b_Q, with b_Q maximizing the utilities of workers, it depends on the magnitude of α. As in Proposition 6, the planner wants to increase the number of workers by lowering the crime rate. Thus, the planner will decrease b and desire a lower level of b than a worker does when $\alpha < \alpha^{**}$, and the opposite holds when $\alpha > \alpha^{**}$.

8. Conclusion

The paper has analyzed the relationship between unemployment and crime, and the analysis has demonstrated that the relationship is in general ambiguous. More importantly, the relationship depends on the apprehension rate. This result suggests that the effect of unemployment on crime would vary with enforcement policies and legal systems that differ across jurisdictions and cultures. Thus, it appears to be useful to include the apprehension rate in empirical analysis of the issue to shed a light on empirical studies. Many studies have examined the effects of apprehension on crime (for example, Levitt (1998), Glaeser and Sacerdote (1999), Kelly (2000)), but researchers have rarely related the effects of unemployment on crime to the apprehension rate.

References

Ashenfelter, O. and Ham, J., 1979, Education, Unemployment and Earnings, Journal of Political Economy 87, S99-S116.

Becker, G., 1968, Crime and Punishment: An Economic Approach, Journal of Political Economy 73 (1968) 169-217.

Burdett, K., R. Lagos, and R. Wright, 2003, Crime, Inequality, and Unemployment, American Economic Review, 93, 1764-1777.

Burdett, K., R. Lagos, and R. Wright, 2004, An On-The-Job Search Model of Crime, Inequality, and Unemployment, International Economic Review, 45, 681-706.

Cantor, D., and Land, K., 1985, Unemployment and Crime Rates in the Post-World War II United States: A Theoretical and Empirical Analysis, American Sociological Review, 50, 317-332.

Cohen, A., and Felson, M., 1979, Social Change and Crime Rate Trends: A Routine Activity Approach, American Sociological Review, 44, 588-607.

Cook, P., 2008, Assessing Urban Crime And Its Control: An Overview, NBER Working Paper, NO 13781.

Ehrlich, I., 1973, Participation in Illegitimate Activities: A Theoretical and Empirical Investigation, Journal of Political Economy, 81, 521-565.

Engelhardt, B., Rocheteau, G., and Rupert, P., 2008, Crime and the Labor Market: A Search Model with Optimal Contracts, Journal of Public Economics, 92, 1876-1891.

Entorf, H., and Spengler, H., 2000, Socioeconomic and Economic Factors of Crime in Germany: Evidence form Panel Data of the Germany States, International Review of Law and Economics, 20, 75-106.

Freeman, R., 1999, The Economics of, in Handbook of Labor Economics, Vol. 3, (chapter 52 in O. Ashenfelter and D. Card (Eds.), Elsevier Science.

Freeman, R., "Why do so many young American men commit crimes and what might we do about it?" Journal of Economic Perspectives 10, 1996, 25-42.

Glaeser, E., and Sacerdote, B., 1999, Why Is There More Crime in Cities, Journal of Political Economy, 107, S225-S258.

Grogger, J., "The Effect of Arrests on the Employment and Earnings of Young Men," Quarterly Journal of Economics, 110, 1995, 51-71.

Gould, E., Weinberg, B., and Mustard, D., 2002, Crime Rates and Local Labor Market Opportunities in the United States: 1979-1997, Review of Economics and Statistics, 84, 45-61.

Huang, C. C, D. Laing, and P. Wang, 2004, Crime and Poverty: A Search-Theoretic Approach, International Economic Review, 45, 909-938.

İmrohoroglŭ, A., Merlo, A., and Rupert, P., 2000, On the Political Economy of Income Redistribution and Crime, International Economic Review, 41, 1-25.

İmrohoroglŭ, A., Merlo, A., and Rupert, P., 2004, What Accounts for the Decline in Crime?, International Economic Review, 45, 707-729.

Jackman, R., Layard, R., and Nickell, S., 1991, Unemployment: Macro-economic Performance and the Labour Market (Oxford, Oxford University Press).

Kelly, M., 2000, Inequality and Crime, Review of Economics and Statistics, 82, 530-539.

Kiefer, N. M., 1985, Evidence on the Role of Education in Labor Turnover, Journal of Human Resources, 20, 445-452.

Levitt, S., 1996, The Effect of Prison Population Size on Crime Rates: Evidence from Prison Overcrowding Litigation, Quarterly Journal of Economics, 111, 319-352

Levitt, S., 1998, Why Do Increased Arrest Rates Appear to Reduce Crime: Deterrence, Incapacitation, or Measurement Error?, Economic Inquiry, 36, 353-372.

Long, S., and Witte, A., 1981, Current Economic Trends: Implications for Crime and Criminal Justice, 69-143 in K. Wright (Ed.), Crime and Criminal Justice in a Declining Economy. Cambridge, MA: Oelgeschlager, Gunn Hain.

Martin, J., 1996, Measures of Replacement Rates for the Purpose of International Comparisons: A Note, OECD Economic Studies, 2,99-115.

McKenna, C., 1996, Education and the Distribution of Unemployment, European Journal of Political Economy, 12, 113-132.

Nickell, S., 1979, Education and Lifetime Patterns of Unemployment, Journal of Political Economy, 87, S117-S131.

Persson, M., and C. H. Siven, 2007, The Becker Paradox and Type I versus Type II Errors in the Economic of Crime, International Economic Review, 48, 211-233.

Raphael, S., and Winter-Ebmer, R., 2001, Identifying the Effects of Unemployment on Crime, Journal of Law and Economics, 44, 259-283.

Roland, G., and T. Verdier, Law Enforcement and Transition, European Economic Review, 47, 669 - 685.

Verdier, T., and Zenou, Y., 2004, Racial Beliefs, Location, and the Cause of Crime, International Economic Review, 45, 731-760.

Witte, A., and Tauchen, H., "work and Crime: An Exploration Using Panel Data," Public Finance, 49, 1994, 155-167.

Appendix

proof of Proposition 4.
Using the expressions for $dE/d\alpha$ and $dy_u(w)/d\alpha$, it can be shown that $-\frac{dy_u(w)}{d\alpha}E + y_u(w)\frac{dE}{d\alpha}$ has the same sign as

$$-E\theta m - [1 - m(1-\alpha)\theta] \int_{\underline{w}}^{w^*} (1 - \phi p(w))wf(w)dw$$

$$+f(w^*)\frac{\partial w^*}{\partial \alpha}[E\theta(1-\alpha) - (1 - m(1-\alpha)\theta)\alpha(1 - \phi p(w^*))w^*],$$

because both $y_u(w)$ and $dy_u(w)/d\alpha$ include a factor of $(1 - \phi p(w))w$ and the factor can be dropped without affecting the sign. The first line is obviously negative. Given that $\partial w^*/\partial \alpha < 0$, the second line is also negative, because the terms in the squared brackets turn out to be positive as follows. E can be rewritten as

$$E = \int_{\underline{w}}^{\overline{w}} (1 - \phi p(w))wf(w)dw - \alpha \int_{\underline{w}}^{w^*} (1 - \phi p(w))wf(w)dw.$$

By the definition of w^* in (2), $E(1-\alpha)\theta$ can be rewritten as

$$E(1-\alpha)\theta = \alpha(1 - \phi p(w^*))w^* - (1-\alpha)\theta\alpha \int_{\underline{w}}^{w^*} (1 - \phi p(w))wf(w)dw$$

$$> \alpha(1 - \phi p(w^*))w^* - (1-\alpha)\theta\alpha F(w^*)(1 - \phi p(w^*))w^*$$

$$= \alpha(1 - \phi p(w^*))w^* - (1-\alpha)\theta\alpha m(1 - \phi p(w^*))w^*$$

$$= [1 - m(1-\alpha)\theta]\alpha(1 - \phi p(w^*))w^*,$$

where the inequality follows because $(1 - \phi p(w))w$ increases in w, and the next equality uses $F(w^*) = m(w^*) = m$ by the definition of m. Thus, $E\theta(1-\alpha) - (1 - m(1-\alpha)\theta)\alpha(1 - \phi p(w^*))w^* > 0$, as claimed.

proof of Proposition 7.
Substitution of $dt/db = (1-t)(dy_u(w)/db)/y_u(w)$ into (16) from (15) gives

$$\frac{dv(w,.)}{db}\Big|_{b=b_u} = -\frac{dt}{db}y_v(w) + (1-t)\frac{dy_v(w)}{db}$$

$$= -\frac{1-t}{y_u(w)}\frac{dy_u(w)}{db}y_v(w) + (1-t)\frac{dy_v(w)}{db},$$

which has the same sign as

$$B \equiv -y_v(w)\frac{dy_u(w)}{db} + \frac{dy_v(w)}{db}y_u(w)$$

$$= -[(1-\alpha)(1-m\theta)(1 - \phi p(\hat{w}) + b\phi p(\hat{w}))\hat{w} + (1-\alpha)\theta \int_{\underline{w}}^{\overline{w}} (1 - \phi p(w) + b\phi p(w))wf(w)dw]$$

26

$$[(1 - m(1-\alpha)\theta)\phi p(\tilde{w}) - (1-\alpha)\theta f(w^*)\frac{\partial w^*}{\partial b}(1 - \phi p(\tilde{w}) + b\phi p(\tilde{w}))]\tilde{w}$$

$$+[1 - m(1-\alpha)\theta](1 - \phi p(\tilde{w}) + b\phi p(\tilde{w}))\tilde{w}$$

$$[(1-\alpha)(1-m\theta)\phi p(\hat{w})\hat{w} - (1-\alpha)\theta f(w^*)\frac{\partial w^*}{\partial b}(1-\phi p(\hat{w})+b\phi p(\hat{w}))\hat{w}+(1-\alpha)\theta\int_{\underline{w}}^{\overline{w}}\phi p(w)wf(w)dw],$$

where $\hat{w} \in (\underline{w}, w^*)$ and $\tilde{w} \in (w^*, \overline{w})$ represent a criminal's wage and a worker's wage, respectively. Rearranging terms and simplifying them, B becomes

$$B = (1-\alpha)(1-m\theta)[1 - m(1-\alpha)\theta](p(\hat{w}) - p(\tilde{w}))\phi\hat{w}\tilde{w}$$

$$-(1-\alpha)\theta f(w^*)\frac{\partial w^*}{\partial b}(1-\phi p(\hat{w})+b\phi p(\hat{w}))\hat{w}(1-\phi p(\tilde{w})+b\phi p(\tilde{w}))\tilde{w}[(1-m(1-\alpha)\theta)-(1-\alpha)(1-m\theta)]$$

$$-[1 - m(1-\alpha)\theta]\phi p(\tilde{w})\tilde{w}(1-\alpha)\theta\int_{\underline{w}}^{\overline{w}}(1 - \phi p(w) + \phi p(w))wf(w)dw$$

$$+(1-\alpha)\theta f(w^*)\frac{\partial w^*}{\partial b}(1 - \phi p(\tilde{w}) + b\phi p(\tilde{w}))\tilde{w}\alpha(1 - \phi p(w^*) + b\phi p(w^*))w^*$$

$$+[1 - m(1-\alpha)\theta](1 - \phi p(\tilde{w}) + b\phi p(\tilde{w}))\tilde{w}(1-\alpha)\theta\int_{\underline{w}}^{\overline{w}}\phi p(w)wf(w)dw.$$

The fourth line uses the fact that $(1-\alpha)\theta\int_{\underline{w}}^{\overline{w}}(1 - \phi p(w) + \phi p(w))wf(w)dw = \alpha(1 - \phi p(w^*) + b\phi p(w^*))w^*$ by the definition of w^* that satisfies $\Psi(w^*,.) = 0$ in (9). Noting that the terms inside the squared brackets of the second line reduce to α, B can be rewritten as

$$B = (1-\alpha)(1-m\theta)[1 - m(1-\alpha)\theta](p(\hat{w}) - p(\tilde{w}))\phi\hat{w}\tilde{w}$$

$$+(1-\alpha)\theta f(w^*)\frac{\partial w^*}{\partial b}(1-\phi p(\tilde{w})+b\phi p(\tilde{w}))\tilde{w}[\alpha(1-\phi p(w^*)+b\phi p(w^*))w^* - \alpha(1-\phi p(\hat{w})+b\phi p(\hat{w}))\hat{w}]$$

$$+[1 - m(1-\alpha)\theta](1-\alpha)\theta\phi\tilde{w}\int_{\underline{w}}^{\overline{w}}(p(w) - p(\tilde{w}))wf(w)dw$$

The first line is positive, because a criminal's earnings ability is lower than a worker's and $\hat{w} < \tilde{w}$, and because $p(\hat{w}) > p(\tilde{w})$. The second line is positive if $\alpha \le \alpha^{**}$ and $\partial w^*/\partial b > 0$, because a criminal's earnings ability is lower than the critical individual and $\hat{w} < w^*$, and because $(1 - \phi p(\hat{w}) + b\phi p(\hat{w}))\hat{w} < (1 - \phi p(w^*) + b\phi p(w^*))w^*$. The third line is also positive if $\alpha \le \alpha^{**}$, because $x(\alpha) = \int_{\underline{w}}^{\overline{w}}(p(w^*) - p(w))wf(w)dw < 0$ or equivalently $-x(\alpha) = \int_{\underline{w}}^{\overline{w}}(p(w) - p(w^*))wf(w)dw > 0$ when $\alpha \le \alpha^{**}$, and hence because $\int_{\underline{w}}^{\overline{w}}(p(w) - p(\tilde{w}))wf(w)dw > 0$, given that $\tilde{w} > w^*$ and $p(\tilde{w}) < p(w^*)$.

If $\alpha > \alpha^{**}$, the second line becomes negative, and the third line can be positive or negative. Given that the first line is still positive, B cannot be unambiguously signed.