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OPTIMAL DETERRENCE, INEQUALITY AND THE JEAN-VALJEAN EFFECT

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ABSTRACT

Abstract This paper extends the Becker (1968)-Ehrlich (1973) model of crime to allow for government transfers. Using the Shapiro and Stiglitz (1984) model, it is shown that one can view deterrence as a tax on (criminal) labor supply. That in turn allows an integration of a crime model with a standard public finance model. Using King et al. (1988) preferences, it is shown that when individuals are needy or desperate the income effect may dominate the substitution effect. The is that policies undertaken with the intent of deterring crime may, unintuitively, lead to an increase in crime. This provides an alternative to to Becker (1968)'s explanation for persistent crime levels. The results are also consistent with recent research showing that extending social welfare programs can reduce crime. Finally, the policy that minimizes net social costs is characterized by a combination of deterrence and transfers to reduce inequality. This result illustrates how Posner (1973)'s criteria of wealth maximization can imply that reducing inequality is a part of optimal crime policy.

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OF THE INTENT OF PUNISHMENTS.

From the foregoing considerations it is evident, that the intent of punishments is not to torment a sensible being, nor to undo a crime already committed. Is it possible that torments, and useless cruelty, the instruments of furious fanaticism, or of impotency of tyrants, can be authorized by a political body? which, so far from being influenced by passion, should be the cool moderator of the passions of individuals. Can the groans of a tortured wretch recall the time past, or reverse the crime he has committed? The end of punishment, therefore, is no other, than to prevent others from committing the like offense. Such punishments, therefore, and such a mode of inflicting them, ought to be chosen, as will make strongest and most lasting impressions on the minds of others, with the least torment to the body of the criminal.

Chapter 12, Cesare Beccaria (1764)

1 Introduction

The law and economics movement provides a very useful way to organize many features of observed legal rules, including a framework for the empirical analysis of these rules. The success is not because economics is the "correct" way to think about the law, nor because it necessarily provides the best positive analysis of the law. Rather, the success lies in providing a simple and elegant framework within which one can organize vast, apparently unrelated bodies of law (Posner (1973)). The purpose of this paper is to show that one can extend a law and economics model of deterrence to incorporate inequality as part of a *positive* analysis of the law. Arriving at an allocation that maximizes welfare, as measured by the total output of society, entails allocating some resources to the least wealthy members of society. I shall show that this results from a standard "Marshallian" model of labor supply when the income effect dominates the substitution effect.

By labor supply, I mean the choice by an individual to engage in illegitimate or criminal activity that entails violating the rule of law.[1] Such activity is reduced by imposing a sanction on the

[1] The term "illegitimate" follows from Ehrlich (1973) who denotes any activity as illegitimate for which the social cost is higher than the private benefit to the individual. It is a criminal activity when societies decide that an activity should be sanctioned. I will follow the standard practice of calling all such activities "criminal", though as we shall see, the theory makes some predictions regarding which activities should be sanctioned, and which are "illegitimate"

individual. The standard literature on deterrence (Polinsky and Shavell (2000)) supposes that policies increasing deterrence always lead to a decrease crime. Becker (1968) makes the important point that the reason we do not observe perfect deterrence is due to the cost of enforcement - at an optimum the benefit of decreasing crime is less than the resulting increase in deterrence costs. I show that a second reason why deterrence is not perfect may because that deterrence policies may be ineffective, or in some cases counter productive.

This result follows from a sequence of observations. The first begins with a reframing of the standard deterrence model (Polinsky and Shavell (2000)). That model supposes that society sets up a system in which individuals engaged in criminal activity are caught with a fixed probability (P) followed by a sanction (f). Using the well known Shapiro and Stiglitz (1984) model, one can translate this risk of detection and sanction into a single, equivalent tax on criminal labor supply. The benefit of this translation is that one can the connect the effect of taxes on deterrence to the vast economics literature on labor supply (Blundell and Macurdy (1999)).

A focus of the labor supply literature is the measurement of the elasticity of labor supply with respect to wages.[2] This paper focuses upon non violent property crimes where the individual's goal is to earn income from criminal labor supply. I follow Becker (1968)-Ehrlich (1973) to view crime as activity whose compensation increases with the level of criminal activity. In the analytical section below it is shown that when individuals view deterrence as a tax, the elasticity of the level of crime with respect to deterrence is exactly the negative of the elasticity of labor supply.

Next, I place some structure upon individual preferences. Specifically, it is assumed that individuals have only two choices - crime or leisure that allows for a clean characterization of how changes in deterrence policy affect behavior.[3] I adapt the widely used King et al. (1988) preferences because they can capture the empirical fact that in many situations labor supply is wage inelastic - even if a wage changes over the business cycle, a person may choose to continue to supply the same number of hours.

and not sanctioned.

[2]Elasticity is used to measure the effect of wages on labor supply because it is independent of the unit used to measure labor and wages. Formally, the elasticity of labor supply with respect to wages is given by: $\epsilon_w =$ %Change in labor supply/%percentage change in wage.

[3]MacLeod and Rivera (2022) extends this case to one with several possible remunerative activities.

A convenient feature of these preferences is the stark implication for labor supply. Specifically, with these preferences one can capture the notion of need - a basic level of consumption, denoted by c^0, that the person views as necessary. Technically, when consumption approaches c^0, then the individual experiences extreme disutility.[4] I show that when an individual's basic needs cannot be met by the transfers they are receiving then, in the jargon of demand theory, the income effect is larger than then substitution effect, with the consequence that the elasticity of labor supply becomes negative. In this case, policies that increase deterrence also *increase* crime.

The result is intuitive. I call a person who must work to meet a basic consumption level a *needy* person. When deterrence increases, this leads to a fall in their wage from criminal activity, and consequently a fall in income. In order to meet basic needs in this case the individual must *increase* labor supply. Conversely, when a person is affluent, then they have sufficient resources to meet basic needs in the absence of working in the criminal labor market. In that case, policies to increase deterrence reduce crime.

These observations have some empirical implications that are consistent with the data. Most studies of labor supply find that it the wage elasticity of labor supply is positive, and hence the elasticity crime with respect to deterrence is negative (deterrence is effective). However, these results are the average over a large population of individuals. Empirical studies of deterrence find that the elasticities are typically small, or in some case even positive (see figure 2 in the concluding discussion). Moreover, Pencavel (2021) finds that early in the 20th century, when workers were much poorer, there is evidence of a negative wage elasticity, that in turn implies that policies to increase deterrence would increase crime.

More generally, cross country studies of crime show that high income inequality leads to more crime (Soares (2004)). In the United States there is recent careful work by Jácome (2020) showing that an increase in access to health services can lower crime among low income young men. Work by Deshpande and Meuller-Smith (2021); Deshpande (2016) provide direct evidence that reducing social security income to individuals at age 18 results in a significant increase in crime. There is also

[4] It is interesting to observe that general equilibrium theory, the foundation for modern mathematical economics, assumes that even in the absence of work an individual can survive - see Debreu (1959). Coate (1989) discusses the implications of this assumption in the context of famines.

popular evidence that individuals will work hard to attain a better standard of living. An example are the efforts of individuals to enter the United States to work (see Keefe (2010) for moving set of stories about individuals migrating from China to the United States).

Finally, there is the story of Jean Valjean, the hero in Victor Hugo's novel, *Les Miserables.* Jean Valjean is desperate and steals some bread to feed his sister's starving children. He does this even though the potential sanction is very large. When he is caught stealing, he must serve a 19 year sentence for the crime. The point of the novel is that Jean Valjean is not really a "criminal", but a person in a desperate situation. This is the phenomena that is captured when the income effect is larger that then substitution effect. In cases where sanctions no longer deter criminal behavior I call this the *Jean Valjean effect.*

For such situations society may be better served with policies of income support than with punitive sanctions. The final contribution of this paper is to derive the policy that minimizes social costs. It is shown that optimal policy towards criminal behavior is a combination of sanctions and transfers, whose size depends upon social cost of funds. The optimal transfer policy entails bringing needy individuals up to the same level of need or affluence.

An interesting implication of this result is that it illustrates a situation where the reduction of inequality is part of a policy that maximizes social welfare based upon individual well being. A common critique of the law and economics approach to policy is the tendency to view inequality as outside the question of how best to design legal rules. For example, the Coase theorem (Coase (1960)) implies that the allocation of initial endowments does not affect the efficiency of a well functioning system of law.[5]

Kaplow and Shavell (2001)'s thoughtful analysis of welfare economics implies that "fairness", values incorporating interpersonal comparisons, should not be considered when determining the optimal allocation of resources. This might lead one to conclude that inequality is not a concern of law and economics. This paper shows there are situations where reducing inequality is part of a welfare maximizing system of legal rules. Moreover, this result does not rely upon notions of

[5] See Kaplow and Shavell (2001) for a modern discussion of inequality and welfare in the law and economics tradition.

fairness that make interpersonal comparisons.

2 Analytical Framework

This section provides a model of criminal labor supply that highlights the relationship between an individual's income, and the extent to which their behavior responds to incentives provided by the legal system. The model illustrates that even with stable preferences, variation in a person's need can lead to large variation in their response to deterrence. The approach follows Becker (1968) and Ehrlich (1973) in viewing crime as a labor supply problem, with the added twist that individuals vary in their needs. From this perspective the focus is upon activity that is mainly remunerative in nature, such as theft, fraud or drug dealing.

The extent to which a person allocates time to criminal activities depends upon the return. It is assumed that such activity earns a return of ω per unit of time. The activity is illegitimate because the social cost per unit of time, w^c is greater than the benefit, ω, to the individual. Hence, we simply call such activity "criminal activity". The level of crime is denoted by l. It is assumed that there is only one activity. This is a key assumption because it focuses attention how the *absence* of alternative sources of work can affect rational choice in unexpected ways. The case of several activities studied in MacLeod and Rivera (2022).

It is assumed that an individual has King et al. (1988) preferences. These preferences are widely used in macro-economics because they captures the fact that aggregate level labor supply is often wage inelastic. More precisely it is assumed:

$$\begin{aligned} U &= \text{Utility-from-Income} - \text{Cost-of-Effort}, \\ &= \log\left(c - c^0\right) - V\left(l\right), \end{aligned} \tag{1}$$

where l is criminal labor supply, the cost of effort satisfies $V'\left(l\right), V''\left(l\right) > 0$ for $l > 0$, and c is consumption. A person's need is given by c^0. In principle it can vary by individual and over time, but for this discussion it is assumed fixed. As we shall show presently, the choice of $\log\left(c - c^0\right)$ for utility is not arbitrary. It captures the notion that there is a minimum level of consumption that a person views at "necessary", and has the feature that $\lim_{c \to c_i} \log(c - c_i) = -\infty$. Second, it turns out that this functional form is unique among those that generate what economists call "inelastic labor supply".

It is also the case that we can use these preferences to capture variation in sensitivity of illegitimate labor supply to the "wage", w, the return per hour from criminal labor. Thus consumption takes the form:

$$c = w \times l + t.$$

Total labor income is given by $w \times l$, and t is non-labor income, such as transfers from savings or family. We define a person's net need as the amount of labor income needed to meet minimum consumption:

$$n^0 = c^0 - t^0.$$

This is the difference between their minimum consumption need and the amount of non-labor income a person is receiving. We say a person is "affluent" when need is negative, $n^0 < 0$. The superscript 0 indicates need before government transfers, while government or other third party transfers are simply denoted by t^g.

Finally, it is assumed that criminal activity leads to a potential fine, punishment or tax, τ, satisfying $\omega \geq \tau \geq 0$, where ω be the wage from criminal activity, and hence a person's net "wage" is:

$$w = \omega - \tau.$$

In the appendix it is shown that in a Shapiro and Stiglitz (1984) continuous time model one can transform the standard deterrence model of Becker, as generally used in the literature (see Polinsky and Shavell (2000)), into one where punishment is effectively a tax. The standard deterrence model supposes that a person committing a crime faces a probability of detection P, followed by the implementation of a sanction f. The probability that a person is detected depends upon the length of time engaged in the criminal activity. Letting $p = P/l$ be the flow probability of detection, as we show in the appendix, the effective "tax" on criminal activity is:

$$\tau = f \times p = f \times P/l.$$

In this model deterrence, τ, reduces the person's criminal wage w.

In order to have convenient closed form solutions it is assumed that $V(l) = l^2/2$. The qualitative features of this model will be the same as with a more general convex cost of effort function. Criminal labor supply is the level of activity that maximizes the individual's payoff as a function of the net wage, w, and need, n:

$$l^S(w,n) = \arg\max_{l \geq 0} \log(wl - n) - l^2/2. \tag{2}$$

In the appendix we show that the solution to this problem is a decreasing function of the ratio of transfers to the wage, we denote as *real need,* $N = \frac{n}{w}$:

$$l^S(w,n) = L\left(\frac{n}{w}\right) = L(N),$$

where labor supply as a function of real need can be shown to take the form:

$$L(N) = \left(N + \sqrt{N^2+4}\right) \Big/ 2.$$

We shall use the elasticities to measure how the effect of policy affects the level of illegitimate or criminal activity. The elasticity of activity with respect to wage is:

$$\begin{aligned} \epsilon_w(N) &= \frac{L'(N)}{L(N)} \frac{dN}{dw} \times w, \\ &= -\frac{L'(N)}{L(N)} N \end{aligned}$$

Both labor supply and this elasticity are illustrated in figure (1). Notice that the elasticity is negative for affluent individuals but positive for needy persons. As we shall show, then has a

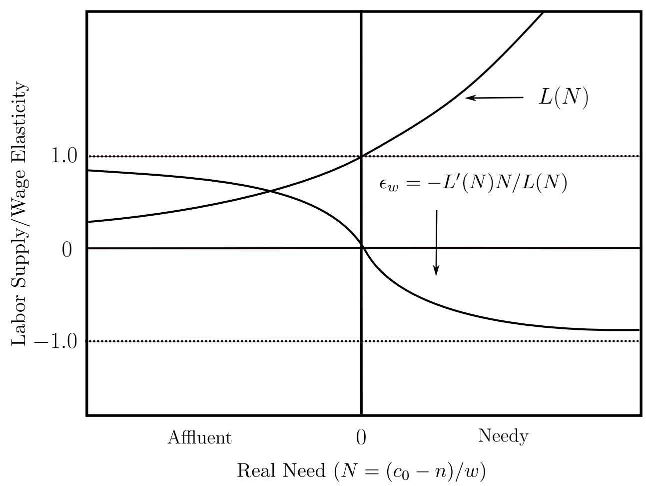

Figure 1: Illegitimate Labor/Crime as a Function of Need

significant implication for the effect on deterrence upon the level of criminal activity.

Elasticities are widely used in labor economics because they provide a unit free measure of how changes in the wage result in change in labor supply. The percentage change in illegitimate labor is equal to the elasticity of labor supply as a function of deterrence times the percentage change in deterrence:

$$\%\Delta l \approx \epsilon_w \times \%\Delta w,$$

where ϵ_w is the elasticity of labor supply with respect to deterrence. Notice that a deterrence $\Delta\tau$ corresponds a change $-\Delta w$ in the wage. This implies that the impact on illegitimate labor and crime from an increase in deterrence is given by:

$$\%\Delta l \approx -\epsilon_w \times \Delta\tau / w$$

where $w = \omega - \tau$ is the individual's net wage from criminal activity. The sign of this elasticity depends upon whether or not the individual is needy. In particular, for needy individuals, increasing deterrence *increases* the supply of illegitimate or criminal labor. The elasticity we have computed here is known as the Marshallian elasticity - it combines both the substitution effect and the income effect. The substitution effect is the extent to which a person reduces labor supply given the wage, holding utility fixed. This is always positive - an increase in the wage, or decrease in deterrence always increases labor supply. In contrast, the income effect is always negative - increasing income holding the wage fixed reduces labor supply. Thus, if one increases the wage, this has a positive effect due to substitution, but also a negative effect on labor supply due to the fact that increasing the wage increases income. When the size of the income effect is greater than the substitution effect this gives rise to what is known as the backward bending labor supply curve. What is convenient about King et al. (1988) utility is that need, $n^0 = c^0 - t^0$, completely determines whether or not the income effect dominates the substitution effect.

In addition to deterrence, transfers that affect need are an alternative policy instrument that can affect the level of illegitimate activity. When the government provides a transfer t^g this has the following effect on labor supply:

$$\%\Delta l \approx \epsilon_t \times \%\Delta t,$$

where:

$$\begin{aligned}\epsilon_t &= \frac{\partial l}{\partial t}\frac{t}{l}, \\ &= -t^g \times \frac{L'(N)}{I(w,N)} < 0,\end{aligned}$$

and $I(w,N) = L(N) \times w$ is the total income from illegitimate or criminal labor. In this case $\epsilon_t < 0$, and hence increasing transfers *always* decreases the level of crime. In contrast, if a person is needy, then deterrence simply exacerbates their needs, leading to more criminal behavior. In particular, holding need constant, a person with a lower wage income will be more responsive to a transfer.

2.1 Optimal Policy

This section derives the optimal level of deterrence and transfer for an individual. It is assumed that the social cost of criminal labor is given by:

$$\mathscr{C} = MC(\tau)\, l(\tau, t^g) + \lambda t^g, \tag{3}$$

where the marginal cost of crime per unit of criminal activity is:

$$MC(\tau) = (w^c - (\omega - \tau) + D(\tau)).$$

The social cost of illegitimate labor is w^c. Increasing deterrence reduces the individual's income and hence imposes a social cost that is measured by the income loss due to deterrence, $(\omega - \tau)\, l(\tau, t^g)$. Government transfers, t^g, are socially costly at the rate $\lambda > 0$, which in the public finance literature typically assumed to be approximately 0.3.[6] Finally, following Becker (1968), it is assumed that increasing deterrence is costly and this cost is given by $D(\tau)$, which is assumed to be differentiable and satisfy:

$$D(0) = D'(0) = 0, D'' > 0, \lim_{\tau \to \omega} D(\tau) = \infty. \tag{4}$$

This cost implies that perfect deterrence is impossible, and hence, as in Becker (1968), there will always be some criminal activity. Following Polinsky and Shavell (2000), I proceed by asking what interventions minimize the social cost of crime. More precisely, it is assumed that government chooses a policy $P = (\tau, t^g)$, the level of deterrence and transfers to the individual, that minimize costs:

$$\min_{\tau \in [0,\omega], t^g \geq 0} \mathscr{C}(\tau, t^g)$$

where:

$$\mathscr{C}(\tau, t^g) = MC(\tau)\, L\left(\frac{n^0 - t^g}{\omega - \tau}\right) + \lambda t^g,$$

[6] See Laffont and Tirole (1993).

and $L\left(\frac{n^0-t^g}{\omega-\tau}\right)$ is labor supply as a function of real need. The assumption that lump taxation is not possible is represented by the requirement $t^g \geq 0$. Finally, the individual's utility as a function of the choice variables is given by:

$$\begin{aligned} u(\tau, t^g) &= \log\left(w\left(L(N) - N\right)\right) - V\left(L(N)\right), \\ &= \log(w) + \log\left(L(N) - N\right) - V\left(L(N)\right), \end{aligned}$$

where, as above, the net criminal wage is $w = \omega - \tau$, and real need is given by $N = \frac{n^0-t^g}{\omega-\tau}$.

In the appendix the first order condition for optimal deterrence are derived. The first result is that when person is needy, the wage elasticity is negative, $\epsilon_w < 0$, which in turn implies that increasing deterrence (lowering the wage from crime) *increases* crime. Hence, in that case it is optimal to have *no deterrence:* $\tau^* = 0$. In other words, some crime by needy individuals is tolerated. When a person is affluent, the wage elasticity is positive and the first order condition for deterrence is:

$$\tau^* = \omega \frac{\epsilon_{MC}(\tau^*)}{\epsilon_w(\tau^*) + \epsilon_{MC}(\tau^*)}, \tag{5}$$

where the elasticity of social cost with respect to deterrence is:

$$\epsilon_{MC}(\tau^*) = \frac{dMC(\tau)}{d\tau} \times \frac{\tau}{MC(\tau)}.$$

If individuals are very wage elastic (ϵ_w is large), then a small amount of deterrence has a large effect on crime. Thus, τ^* is correspondingly smaller. Holding the cost of crime fixed, this implies that it is optimal to have less deterrence for more affluent individuals (whose wage elasticity is higher - see figure 1).

The first order condition for the optimal transfer is:

$$L'\left(\frac{n^0 - t^{g*}}{\omega - \tau^*}\right) = \lambda \times \frac{\omega - \tau^*}{MC(\tau^*)}.$$

Since $L' > 0$, when the social cost of funds is sufficiently low, then regardless of need this implies that is optimal to have a positive transfer. More precisely, let

$$\bar{\lambda}(\tau^*) = MC(\tau^*) L'\left(\frac{n^0}{\omega - \tau^*}\right) \frac{1}{\omega - \tau^*} > 0.$$

Whenever $\lambda < \bar{\lambda}(\tau^*)$ it is optimal to have a transfer $t^{g*} > 0$.

2.2 Aggregate Policy

The analysis of the previous section highlights the point that optimal compliance entails the use of both deterrence and transfers. It also requires the policy to be tailored to the characteristics of the individual. In practice the characteristics of the individual are typically observed imperfectly. However, consistent with the public finance literature, it is assumed that transfer policies can be means tests. In contrast, consistent with the norm in criminal law, it is assumed that while criminal penalties can vary with the crime, they do not normally vary with the characteristics of the person (all individuals are equal before the law).

The aggregate analysis begins with a population of individuals who vary by their need, $n^0 \in \Re$, given by a distribution $f\left(n^0\right) > 0$. It is assumed the one can tailor transfer policy to a person's need. Hence, authorities choose a transfer function $t^g\left(n^0\right) \geq 0$. It is further assumed that deterrence τ is chosen to be independent of type. The available policy choices are formally given by $P = \left\{\tau, t^g\left(n^0\right)\right\} \in \mathscr{P} = [0, \omega] \times \mathscr{N}$, where $\mathscr{N}$ is the set of functions determining need with positive transfers:

$$\mathscr{N} = \{\tau^g : \Re \to \Re_+\}.$$

The optimal policy is the solution to:

$$\min_{P \in \mathscr{P}} \mathscr{C}(P) = \min_{P \in \mathscr{P}} \int_{-\infty}^{\infty} \left\{ MC(\tau) L\left(\frac{n^0 - t^g\left(n^0\right)}{\omega - \tau}\right) + \lambda t^g\left(n^0\right) \right\} f\left(n^0\right) dn^0 \tag{6}$$

The fact that the cost function is convex in the transfer, continuous and bounded above ensures that there is a cost minimizing solution. The solution is detailed in the appendix. I proceed with the determination of the optimal transfer, $t^{g*}\left(\tau, n^0\right)$, given a level of deterrence τ, and then derive the optimal level of deterrence.

The first order condition for optimal need is found by differentiating the interior of (6), to get:

$$L'\left(\frac{n^0 - t^g\left(n^0\right)}{\omega - \tau}\right) = \frac{\lambda\left(\omega - \tau\right)}{MC\left(\tau\right)}. \tag{7}$$

We know that $L' < 1$, hence if the social cost of funds is too high $\left(\lambda \geq \frac{MC(\tau)}{\omega - \tau}\right)$, it is not optimal to have government transfers. When the social cost w^c of the illegitimate activity is sufficiently high, then it is always optimal have some transfer. What is of particular interest in (7) is that optimal need for those receiving a transfer does not depend upon a person's need n^0. This implies that all individuals who receive a transfer must have the same real need post transfer. Let $\bar{n}\left(\tau\right)$ be the unique solution to:

$$L'\left(\frac{\bar{n}\left(\tau\right)}{\omega - \tau}\right) = \frac{\lambda\left(\omega - \tau\right)}{MC\left(\tau\right)}.$$

This is the optimal level of need when individuals receive a transfer. When an individual has need less than $\bar{n}\left(\tau\right)$ then achieving this would require a lump sum tax that is not allowed. Hence, the optimal level of need corresponding to the optimal transfer $t^g\left(\tau, n^0\right) = n^0 - \bar{n}\left(\tau\right)$ is:

$$n^*\left(\tau, n^0\right) = \begin{cases} \bar{n}\left(\tau\right), & n^0 \geq \bar{n}\left(\tau\right), \\ n^0, & n^0 \leq \bar{n}\left(\tau\right). \end{cases} \tag{8}$$

For those individuals with need less than $\bar{n}\left(\tau\right)$ there is no transfer. Hence, when there are individuals that are involved in costly criminal activities, it may be optimal, as a matter of optimal enforcement of legal rules, to transfer resources to these persons! This illustrates the point that one cannot cleanly distinguish equity policy from the social cost minimizing policy. What is particularly interesting is that this model can be viewed as providing a rational choice foundation for the Rawlsian social welfare function. Economists interpret his theory as one that maximizes the well being of the worst off members of society, consistent with the optimal allocation predicted by this model.[7]

[7] Rawls (1971)

The next step is to determine how the transfer affects optimal deterrence. From (8) we can compute labor supply at the optimal transfer:

$$L^S(\tau) = \int_{-\infty}^{\bar{n}(\tau)} L\left(n^0/(\omega-\tau)\right) f\left(n^0\right) dn^0 + L\left(\bar{n}(\tau)/(\omega-\tau)\right)\left(1-F\left(\bar{n}(\tau)\right)\right). \tag{9}$$

The first term is labor supply from affluent individuals who do not receive a transfer, while the second term term is the labor supply from needy individual who all have the same level of need after transfers. In the appendix the average elasticity of criminal labor supply is derived:

$$\hat{\epsilon}_w(\tau) \equiv \left\{ \int_{-\infty}^{\bar{n}(w)} \epsilon_w\left(\tau, n^0\right) h\left(n^0\right) dn^0 - G(\tau) L\left(\frac{\bar{n}(\tau)}{\omega-\tau}\right) \epsilon_w\left(\tau, \bar{n}(\tau)\right) \right\} \Big/ L^{S*}(\tau).$$

This is the mean elasticity of labor supply for each level of need weighted by the total criminal activity (number of individuals times labor supply), and then divided by total criminal labor supply. This in turn results in exactly the same expression for optimal deterrence for one person, except we now use average elasticity:

$$\tau^* = \omega \frac{\epsilon_{MC}(\tau^*)}{\hat{\epsilon}_w(\tau^*) + \epsilon_{MC}(\tau^*)}. \tag{10}$$

As before, when the wage elasticity is negative ($\hat{\epsilon}_w(\tau^*) < 0$) then it is optimal to have no deterrence ($\tau^* = 0$). It is assumed that there are both needy and affluent individuals. Hence whether or not there should be deterrence depends upon the relative proportions of needy and affluent individuals in the economy.

Any activity for which the social cost is higher than the private return ($w^c > \omega$) is illegitimate. We call an illegitimate activity a *crime* whenever it is optimal to have strictly positive deterrence ($\tau^* > 0$). Thus this simple model provides conditions under which an activity should be deemed a crime, along with the level of resources to be allocated to reduce crime:

Proposition 1. *Assuming a unique solution to the optimal deterrence policy, an illegitimate activity*

$(w^c > \omega)$ *should be criminalized with a positive level of deterrence if:*

$$\hat{\epsilon}_w(0) > \left(\frac{1}{w^c/w - 1}\right) > 0. \tag{11}$$

Thus a necessary condition for criminalizing an activity is that the average wage elasticity of criminal labor supply is positive. An interesting implication of this result is that even though it may be optimal to have deterrence, in jurisdictions where individuals are very needy, the policy may be ineffective, in which case we observe informal non-enforcement of the law. It is also the case that when the social cost of an illegitimate activity is sufficiently high and the labor elasticity is positive, then condition (11) will be satisfied. In this case a positive level of deterrence is optimal. Presumably, jaywalking in New York City is tolerated because the private benefit is large relative to the social cost of jay walking.

3 Discussion

I began with observation is that one can use the Shapiro and Stiglitz (1984) model to reinterpret the standard model of deterrence as a tax on criminal income. This reinterpretation follows directly from the Becker (1968)-Ehrlich (1973) approach that views crime and illegitimate activity as a form of labor supply. This allows one to integrate the theory of deterrence into standard models of public finance and the extensive literature on taxation and labor supply (Blundell and Macurdy (1999),Moffitt (2002) and Chetty (2012)).

Second, I explore the consequence of deterrence as a tax using an extension of King et al. (1988) preferences, a model of labor supply that is widely used in macro-economics. A feature of the model is that the elasticity of labor supply can be cleanly parameterized as a function of non-labor income. Specifically, individuals are defined as "needy" if they must earn wage income in order to meet basic consumption needs, while affluent individuals are those for whom this is not the case. What is particularly nice about King et al. (1988) preferences is that this distinction maps cleanly onto situations where the income effect is either larger or smaller than the substitution effect.

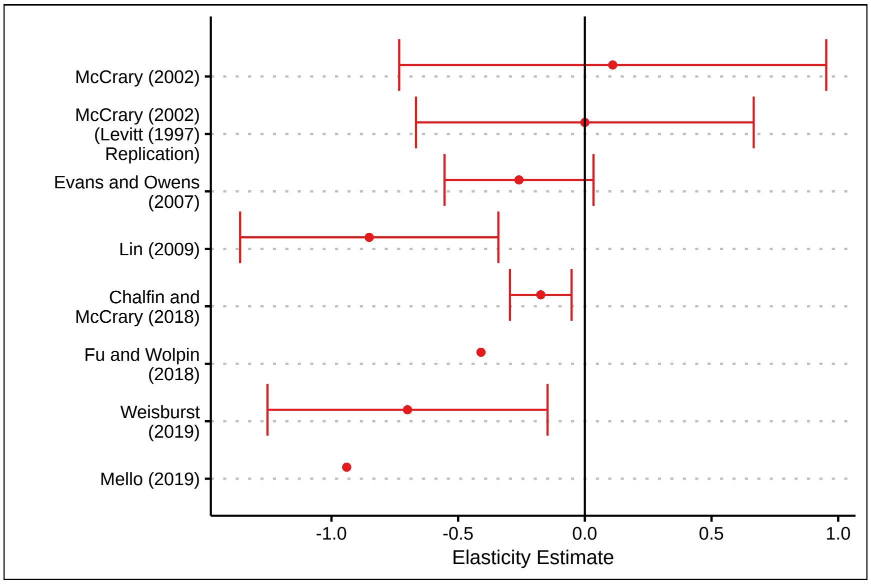

Figure 2: Effect of Deterrence on Crime
Sources: Levitt (1997); McCrary (2002); Chalfin and McCrary (2018); Evans and Owens (2007); Lin (2009); Fu and Wolpin (2017); Weisburst (2019); Mello (2019)

For needy individuals, the income effect dominates. This means that when wages fall, needy individuals work harder to keep up with their consumption needs. In more technical jargon, the wage elasticity of labor supply is negative. For the average worker in the United States today this is not typical (Blundell and Macurdy (1999)). However, Pencavel (2021) documents evidence of a negative wage elasticity early in the twentieth century, when workers were much less wealthy. This in turn implies a positive elasticity with respect to deterrence - increasing deterrence increases crime. Though, this may not be the standard assumption in the deterrence literature, there is evidence that this is relevant, even today.

Figure (2) reports some elasticities for property crime with respect to deterrence. For the most part the point estimates are negative, consistent with the standard assumption in the deterrence literature. Even though the point estimates are generally negative, they have large error bars. The fact that they are *average* elasticities ($\hat{\epsilon}$ in the formal model), suggests that many of the *individual* elasticities are likely to be positive.[8]

This approach has other empirical implications. The link between income and a person's re-

[8] See also the work of Donohue and Wolfers (2005) on the deterrence effect of the death penalty.

sponsiveness to deterrence is consistent with the observation that crime is higher in low income areas, and higher in jurisdictions with higher inequality (Soares (2004)). As mentioned above, the recent work by Deshpande and Meuller-Smith (2021), Deshpande (2016) and Jácome (2020) show that increasing the quality of social programs can also reduce crime. This evidence is consistent with standard labor supply models that predicts a negative effect of transfers on labor supply.

Though the theory here is static, it can be viewed as a behavioral model. The key point is that individuals are likely to vary in their needs over time, that in turn is predicted to lead to variation in crime. In addition, as Lochner (2007) shows, holding fixed the level of deterrence, a person's perception of deterrence can vary, that in turn leads to individual variation in the rate of offending. Ouss and Peysakhovich (2015) provide some additional evidence on how the response to deterrence can vary over time and by individual. This approach may form an interesting extension to the literature on behavioral law and economics (Jolls et al. (1998); Zamir and Teichman (2018)).

Another example comes from Levitt (2004). He points out that a large fraction of the increase in crime during the 1980s was due to the crack cocaine epidemic. Taking crack cocaine can lead to a distortion in preferences, and a need to obtain funds to support one's addiction. There is an extensive empirical literature linking drug use to criminal behavior (see DeBeck et al. (2007) and Long et al. (2014)). Allen (2005) finds evidence that some of the criminal behaviors of drug addicts are the result of once off acts of desperation to satisfy an addiction.

The approach is also related to other areas of law and economics. In an important paper, Arlen (1994) makes the point that deterrence may have unanticipated countervailing effects on corporations who commit a tort, or some other form of malfeasance. Arlen points out that the effectiveness of corporate liability depends upon the available information. An increase in corporate liability may lead to *lower* monitoring of illegitimate or tortuous activities by the corporation, that in turn may result in a higher level of corporate crime and malfeasance. Arlen and Kraakman (1997) extend this result to show that the problem is made worst by the fact that the government cannot optimally deter individuals unless companies both detect and self-report (and cooperate). Arlen and MacLeod (2005) also point out that corporations have an incentive to move liability to judgment proof independent contractors, thus reducing the effectiveness of deterrence.

The fact that criminals can be viewed as judgment proof independent contractors forms a primary justification for the use of incarceration (Posner (1973)). However, as Lee and McCrary (2017) point out, the incentive effects of incarceration are complex. First, incarceration is intended to be unpleasant, and hence it is intended to have a first order deterrent effect. Second, incarceration results in the incapacitation of individuals engaged in crime, and hence mechanically reduces crime. Levitt (2004) documents that incapacitation was an important factor in crime reduction during the 1980s.

Finally, the time spent incarcerated results in a loss of legitimate employment experience. This is particularly costly for young offenders. As Farber (1999) documents, labor market experience when young results in large wage increases. Given that contact with the criminal just system tends to start when people are young, incarceration delays entry into the formal labor market, reducing future income. Moreover, incarceration results in a criminal record that can reduce post incarceration employment opportunities (Aizer and Doyle (2015), Agan and Starr (2018), Doleac and Hansen (2020)).

Ouss (2020) has some very interesting evidence on the social costs of incarceration. She finds that when the cost of incarceration is moved from a US state to the counties this results in a sharp reduction of in sentence length. However, this does not result in an increase in arrests, suggesting that incarceration policy in the US may not be optimal.

Section (2.2) shows that optimal crime policy entails transfers to the most needy individuals to equalize the well being of the neediest individuals in society. The result does not depend upon making interpersonal comparisons of well being, but follows from a standard, utilitarian, law and economics model in which the optimal allocation is the one that minimizes total social cost. The result is reminiscent of Rawls (1971)'s theory of justice that provides a moral argument for society to help the most disadvantaged. The result illustrates the point that one does not need to rely upon fairness arguments to justify income redistribution.

It does imply that one does need to move beyond standard law and economics models that assume markets are relatively complete, with market imperfections rectified with appropriate taxes or fines. Specifically, when the income effect is larger than the substitution effect in criminal labor supply, then optimal crime policy entails the coordination of deterrence with social transfers. There is a growing body of empirical evidence on how transfers can reduce crime. The challenge is to design institutions that allow better coordination of policy choices between different branches of government. This paper makes the point that one can use standard labor supply models to assess the policy options, given the variation of individual responses to deterrence, and the fact that some some crimes are acts of desperation.

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A Appendix

A.1 Notation

Here is list of notation for reference. We will use these identities when convenient to reduce notation. In particular $N = \frac{n^0 - t^g}{\omega - \tau}$, where t^g is the government transfer is used frequently.

- Criminal activity: l
- Criminal wage: ω
- Marginal social cost of crime: $w^c > \omega$.
- Need: $n = c^0 - t$
- Return from crime: ω

- Deterrence: $\tau = w - \omega$
- Net return from crime: $w = \omega - \tau$
- Non-labor income: t^0 (private), t^g (government) (superscipt 0 is initial endowment)
- Real need is need in labor hours: $N = \frac{n}{\omega - \tau} = \frac{n}{w}$
- Utility is:

$$
\begin{aligned}
U &= \log\left(\left(\omega - \tau\right) l - n^0\right) - V\left(l\right), \\
&= \log\left(\left(\omega - \tau\right)\left(l - \frac{n^0}{\omega - \tau}\right)\right) - V\left(l\right), \\
&= \log\left(\left(\omega - \tau\right)\left(l - N^0\right)\right) - V\left(l\right).
\end{aligned}
$$

- Cost of effort: $V\left(l\right) = l^2/2$
- Criminal labor supply as function of real need: $L\left(N\right) = \arg\max_{l \geq 0}\left(\log\left(\left(\omega - \tau\right)\left(l - N\right)\right) - V\left(l\right)\right)$
- Wage elasticity of labor supply: $\epsilon_w\left(\tau, t^g\right) = -L'\left(\frac{n^0 - t^g}{\omega - \tau}\right)\frac{n^0 - t^g}{(\omega - \tau)L} \in (-1, 1)$
- Marginal social cost of crime: $MC\left(\tau\right) = \left(w^c - \left(\omega - \tau\right) + D\left(\tau\right)\right)$
- Elasticity of marginal social cost with respect to deterrence: $\epsilon_{MC}\left(\tau\right) = \frac{dMC(\tau)/d\tau}{MC(\tau)} \times \tau = \frac{(1 + D'(\tau)) \times \tau}{(w^c - (\omega - \tau) + D(\tau))} \geq 0$

A.2 Deterrence as a Tax

The purpose of this section is to show that the penalty in the standard deterrence model is equivalent to a tax on the criminal market wage. In the Becker model of deterrence, when an individual chooses to offend she faces a probability P of a sanction f (see footnote 16 of Becker (1968)). We can translate this into a flow of offenses using the Shapiro and Stiglitz (1984) model.

Suppose that the individual has a single illegitimate activity and that effort in that activity is given by a constant l per unit of time, resulting in illegitimate income of $\omega \times l$ per unit of time.

Time is divided into small intervals of length $\Delta > 0$. During a period Δ, we can suppose that the probability of detection is given by $P = p \times l$. This is a Poisson parameter, so with an higher level of activity the individual faces a higher probability of detection. When caught, a penalty f is paid. Let us suppose that the individual's discount rate is r and that the process is stationary. Thus, individual utility solves the following dynamic program:

$$U_t = \Delta \left(p \times l \times u \left(\omega l - f - n \right) + \left(1 - p \times l \right) u \left(\omega l - n \right) \right) + e^{\Delta r} U_{t+\Delta}. \tag{12}$$

The stationary process assumption implies $U_{t+\Delta} = U_t$, and we have:

$$\begin{aligned} \frac{1 - e^{-\Delta r}}{\Delta} U_t &= u \left(\omega l - n \right) + \gamma l \left(u \left(\omega l - f - n \right) - u \left(\omega l - n \right) \right), \\ &\approx u \left(\omega l - n \right) - \gamma l f \frac{du \left(\omega l - n \right)}{dc}, \\ &\approx u \left(\omega l - \gamma l f - n \right) \\ &= u \left(\left(\omega - \gamma f \right) l - n \right). \end{aligned}$$

We can now let $\tau = pf$ define the flow level of deterrence, or the tax on cime. Letting $\Delta \to 0$ then we get:

$$\begin{aligned} rU_t &= u \left(\left(\omega - pf \right) l - n \right) - V_i \left(l_i \right) \\ &= u \left(\left(\omega - \tau \right) l - n \right) - V_i \left(l_i \right). \end{aligned}$$

Since multiplying utility by a constant does not change preferences, this expression corresponds to the static model 1 with wage $w = \omega - \tau$ and flow utility given by log consumption less effort costs.

A.3 Optimal Labor Supply

Problem (2) is concave and hence interior solutions are characterized by the first order condition:

$$\frac{w}{(wl - n)} = l,$$

from which it follows:

$$l\left(l-n/w\right)-1=0, \tag{13}$$
$$l^2-\frac{n}{w}l-1=0.$$

The solution to this begins by defining *real need* as $N=\frac{n}{w}$. This allows us to write labor supply as:

$$L\left(N\right)=\frac{N\pm\sqrt{N^2+4}}{2}.$$

Since $l\geq 0$ and the square root term is larger than N it follows that the unique solution is:

$$L\left(N\right)=\left(N+\sqrt{N^2+4}\right)\Big/2.$$

Observe that $L\left(0\right)=1$, $\lim_{N\to-\infty}L\left(N\right)=0$, $\lim_{N\to\infty}L\left(N\right)=\infty$.

Taking into account that N can be negative or positive implies that the derivative is given by:

$$\begin{aligned}\frac{dL}{dN}&=\left(1+\frac{N}{\sqrt{N^2+4}}\right)\Big/2\\&=\begin{cases}\left(1+\left(1+4/N^2\right)^{-1/2}\right)\Big/2, & N>0\\ 1/2, & N=0\\ \left(1-\left(1+4/N^2\right)^{-1/2}\right)\Big/2, & N<0\end{cases}\end{aligned}$$

Thus:

$$\lim_{N\to\infty}\frac{dL}{dN}=1 \tag{14}$$
$$\lim_{N\to0}\frac{dL}{dN}=\frac{1}{2}$$
$$\lim_{N\to-\infty}\frac{dL}{dN}=0 \tag{15}$$

The second derivative is given by:

$$L''(N) = \frac{2}{(N^2+4)^{3/2}} > 0.$$

The elasticity of labor supply with respect to real need is:

$$\begin{aligned}\epsilon_N(N) &= \frac{L'(N)N}{L} \\ &= \frac{\left(1+\frac{N}{\sqrt{N^2+4}}\right)}{\left(N+\sqrt{N^2+4}\right)} \times N \\ &= \frac{\left(N+\frac{N^2}{\sqrt{N^2+4}}\right)}{\left(N+\sqrt{N^2+4}\right)}. \end{aligned} \tag{16}$$

From the last line is follows that:

Proposition 2. *The elasticity of labor with respect to wage is $\epsilon_w = -\epsilon_N$. It satisfies:*

$$\begin{aligned}\lim_{w\to\infty} \epsilon_N(w) &= -1, \\ \lim_{w\to 0} \epsilon_N(0) &= 0, \\ \lim_{w\to -\infty} \epsilon_N(w) &= 1.\end{aligned}$$

Observe:

$$\begin{aligned}\epsilon_w &= \frac{dl}{dw}\frac{w}{L} \\ &= L'(N)\frac{dN}{dw}\frac{w}{L} \\ &= -L'(N)\frac{n}{w^2}\frac{w}{L}, \\ &= -L'(N)\frac{N}{L} \\ &= -\epsilon_N \lesseqgtr 0.\end{aligned}$$

When $N = 0$ (16) is zero. Next, when $N > 0$ we have:

$$\epsilon_N(N) = \frac{N\left(1+\frac{N}{\sqrt{N^2+4}}\right)}{N\left(1+\sqrt{1+4/N^2}\right)}.$$
$$= \frac{\left(1+\frac{N}{\sqrt{N^2+4}}\right)}{\left(1+\sqrt{1+4/N^2}\right)}.$$

From this it follows that $\lim_{N\to\infty}\epsilon_N(N) = \frac{1+1}{1+1} = 1$. For $N < 0$, we can let $x = -N > 0$ and let $x \to \infty$. Thus we have:

$$\epsilon_N(x) = \frac{\left(-x+\frac{x^2}{\sqrt{x^2+4}}\right)}{\left(-x+\sqrt{x^2+4}\right)}$$
$$= \frac{\left(-1+\frac{x}{\sqrt{x^2+4}}\right)}{\left(-1+\sqrt{1+4/x^2}\right)}.$$

Notice that the term on top is negative for $x > 0$ ($\frac{x}{\sqrt{x^2+4}} < 1$), while the term on the bottom is positive, and hence $\lim_{x\to\infty}\epsilon_N(x) = -1$. From this we obtain the limits in the proposition. For the rest of the appendix, we define elasticity in terms of deterrence and need. We set:

$$\epsilon(\tau, n) \equiv -\frac{dl}{dw}\frac{n}{\omega-\tau}$$

A.4 Cost Minimizing Problem

The optimal social cost of illegitimate labor is the solution to:

$$\min_{\tau\in[0,\omega],t^g\geq 0}\mathscr{C}(\tau, t^g) = \min_{\tau\in[0,\omega],t^g\geq 0}\left(w^c-\omega+\tau+D(\tau)\right)L\left(\frac{n^0-t^g}{\omega-\tau}\right)+\lambda t^g,$$
$$= \min_{\tau\in[0,\omega],t^g\geq 0} MC(\tau)\,L\left(\frac{n^0-t^g}{\omega-\tau}\right)+\lambda t^g$$

where $w^c > 0$ is the marginal social cost of illegitimate labor, and

$$MC(\tau) = (w^c - \omega + \tau + D(\tau)),$$

is the total marginal cost of the illegitimate activity that takes into account individual welfare and cost of deterrence. The cost of deterrence is assumed to be differentiable with $D(0) = D'(0) = 0, D'' > 0$. It is further assumed that perfect deterrence is very costly, namely:

$$\lim_{\tau \to \omega} D(\tau) = \infty$$

We proceed by considering optimal deterrence in the absence of transfers and the the general case.

Optimal Deterrence with No Transfers ($t^g = 0$)**:**

The first order condition is:

$$\frac{d\mathscr{C}}{d\tau} = MC(\tau) L'\left(\frac{n^0}{\omega - \tau}\right) \frac{n^0}{(\omega - \tau)^2} + L\left(\frac{n^0}{\omega - \tau}\right) \times \frac{dMC(\tau)}{d\tau} = 0. \tag{17}$$

We can use the expression for the wage elasticity of labor and the elasticity of MC with respect to deterrence:

$$\begin{aligned} \epsilon_{MC}(\tau) &= \frac{\frac{dMC(\tau)}{d\tau}}{MC(\tau)}\tau, \\ &= \frac{(1 + D'(\tau))}{(w^c - (\omega - \tau) + D(\tau))} \times \tau > 0. \end{aligned}$$

We suppose that this elasticity is increasing with deterrence (since $D(\tau) \to \infty$ as $\tau \to \omega$). We can rewrite the first order condition (17) as:

$$-\epsilon_w(\tau) / (\omega - \tau) + \epsilon_{MC}(\tau) / \tau = 0. \tag{18}$$

Hence if the optimal level of deterrence satisfies $\omega > \tau > 0$ then we have:

$$\frac{\epsilon_w(\tau^*)}{\epsilon_{MC}(\tau^*)} = \left(\frac{\omega}{\tau^*} - 1\right) \geq 0.$$

Since $\epsilon_{MC}(\tau^*) \geq 0$, a necessary condition for positive deterrence is that $\epsilon_w > 0$, namely that the person be affluent. Re-arranging we get:

$$\tau^* = \omega \frac{\epsilon_{MC}(\tau^*)}{\epsilon_w(\tau^*) + \epsilon_{MC}(\tau^*)} \in [0, \omega] \tag{19}$$

Thus we have:

Proposition 3. *If a person is needy, then it is never optimal to have a positive level of deterrence* $(\tau^* = 0)$*. A positive level of deterrence is cost minimizing if and only if the marginal social cost of labor satisfies* $w^c > \bar{w}^c > \omega$*, where:*

$$\bar{w}^c = \omega\left(1 + \frac{1}{\epsilon_w(0)}\right).$$

Moreover, for affluent persons, the optimal level of deterrence rises with the social marginal cost of illegitimate labor w^c*.*

Proof. When a person is needy then the elasticity of labor supply is negative. Hence (17) cannot be satisfied and some deterrence in not optimal. Increasing w^c decreases the elasticity of MC without affecting labor supply. This combined with the monotonicity of elasticity with respect to deterrence implies τ^* increases with w^c. Expression (18) can be written as follows:

$$\tau^* \frac{\epsilon_w(\tau^*)}{\epsilon_{MC}(\tau^*)} = \omega - \tau^*,$$

$$\epsilon_w(\tau^*) \times \frac{(w^c - (\omega - \tau) + D(\tau))}{(1 + D'(\tau))} = \omega - \tau^*.$$

Setting $\tau^* = 0$ in this expression defines $\bar{w}^c$ via:

$$\epsilon_w(0) \times (\bar{w}^c - \omega) = \omega,$$

yielding the desired result. Notice that for needy persons $\epsilon_w(0) < 0$, and hence $\bar{w}^c > \omega$ is a necessary condition for positive deterrence. □

Optimal Transfers

Consider the optimal provision of transfers given that the government is choosing an optimal level of deterrence τ^*. By the envelope theorem we can ignore the effect of transfers on the optimal τ^*. The first order condition for the optimum transfer is:

$$\frac{d\mathscr{C}}{dt^g}(\tau^*, t^g) = -MC(\tau^*) L'\left(\frac{n^0 - t^g}{\omega - \tau^*}\right)\frac{1}{\omega - \tau^*} + \lambda.$$

Thus the first order condition is given by:

$$L'\left(\frac{n^0 - t^{g*}}{\omega - \tau^*}\right) = \lambda \times \frac{\omega - \tau^*}{MC(\tau^*)}. \tag{20}$$

The second term is the cost of funds times the return to crime over the marginal social harm of crime. Since $L' > 0$ for all levels of real need we have:

Proposition 4. *If the cost of funds satisfies:*

$$\lambda \geq \bar{\lambda}(\tau^*) = MC(\tau^*) L'\left(\frac{n^0}{\omega - \tau^*}\right)\frac{1}{\omega - \tau^*},$$

then no transfer is optimal. However if $\lambda < \bar{\lambda}(\tau^*)$ then it is optimal to provide a transfer to the individual to lower crime.

Proof. Observe that the left hand side of (20) is strictly monotonic in t^g since $L'' > 0$, from which the result follows. □

A.5 Aggregate Policy

We begin with a population of individuals who only vary by their need, $n^0 \in \Re$, with distribution $f\left(n^0\right) > 0$. It is assumed the one can tailor transfer policy to a person's need. Hence, it is assumed that the authorities choose transfers $t^g\left(n^0\right) \geq 0$ Given that all individuals are equal before the law, it is further assumed that deterrence, and hence the net wage, $w = \omega - \tau$, is chosen independent of type. As assumed above, lump sum taxation ($t^g < 0$) is not possible. The optimal policy is thus the solution to:

$$\min_{\{\tau\in[0,\omega],t^g(n^0)\geq 0\}} \mathscr{C}\left(\tau, t^g\left(n^0\right)\right) = \min_{\{\tau\in[0,\omega],t^g(n^0)\geq 0\}} \int_{-\infty}^{\infty} MC\left(\tau\right) L\left(\frac{n^0 - t^g\left(n^0\right)}{\omega - \tau}\right) + \lambda t^g\left(n^0\right) f\left(n^0\right) dn^0. \tag{21}$$

where the first term is the integral of social cost of crime with respect to need, and the second term is the social cost of the transfers to the needy. The fact that the cost function is continuous and bounded above ensures that there is a cost minimizing solution. We proceed by first fixing the level of deterrence, τ, and determining the optimal transfer, $t^g\left(n^0, \tau\right)$, as a function of a person's need.

Step 1- Optimal transfer given τ:

Ignoring for the moment the non-negativity contraint on t^g, one has the first order condition:

$$MC\left(\tau\right) L'\left(\frac{n^0 - t^g\left(n^0\right)}{\omega - \tau}\right) / \left(\omega - \tau\right) + \lambda = 0 \tag{22}$$

Thus in the absence of constraints, real need $\frac{n^0 - t^g\left(n^0\right)}{\omega - \tau}$ is *independent* of individual need, n^0. Let $\bar{N}\left(\tau\right)$ be the unique solution (when it exists) to:

$$L'\left(\bar{N}\left(\tau\right)\right) = \frac{\lambda\left(\omega - \tau\right)}{MC\left(\tau\right)} \tag{23}$$

The solution has the follow properties.

Proposition 5. *There is a unique solution to (23), $\bar{N}(\tau)$ that is need independent if an only if:*

$$MC(\tau)/(\omega-\tau) > \lambda. \tag{24}$$

If this is not satisfied, no transfer is optimal given deterrence τ. When it is satisfied, then the unique optimal transfer that solves equation (6), $t^g(n^0)$, satisfies:

$$t^g\left(n^0\right) = \begin{cases} n^0 - \bar{n}(\tau), & \text{if } n^0 \geq \bar{n}(\tau), \\ 0, & \text{if not.} \end{cases}$$

where

$$\bar{n}(\tau) = (\omega-\tau)\bar{N}(\tau)$$

is the cutoff need below where there are no transfers.

Proof. The proof is straightforward and follows from the uniqueness of the cutoff $\bar{n}(\omega-\tau)$ when it exists. □

Step 2:

The next step is to determine the optimal level of deterrence, assuming that transfers are set optimally. Given optimal transfer policy, the optimal cost of deterrence as a function of deterrence τ is given by:

$$\mathscr{C}(\tau, t^{g*}(\tau)) = MC(\tau) L^{S*}(\tau) + \lambda T^{g*}(\tau), \tag{25}$$

where

$$L^{S*}(\tau) = \int_{-\infty}^{\bar{n}(\tau)} L\left(n^0/(\omega-\tau)\right) f\left(n^0\right) dn^0 + G(\tau) L\left(\frac{\bar{n}(\tau)}{\omega-\tau}\right),$$

is the labor supply given deterrence τ under the optimal transfer policy. The number of individuals receiving a transfer is

$$G(\tau) \equiv (1 - F(\bar{n}(\tau))),$$

where $F(n^0)$ is the cumulative distribution function for the density $f(n^0)$. Post-transfer all the individuals receiving a transfer choose the same level of crime, $L\left(\frac{\bar{n}(\tau)}{\omega-\tau}\right)$. The second term in (25) is the total cost of the transfers to needy individuals under the optimal transfer policy:

$$\begin{aligned} T^g(\tau) &= \int_{\bar{n}(\tau)}^{\infty} \left\{n^0 - \bar{n}(\tau)\right\} f\left(n^0\right) dn^0 \\ &= \int_{\bar{n}(\tau)}^{\infty} n^0 f\left(n^0\right) dn^0 - \bar{n}(\tau) G(\tau), \\ &= Need^{expost} - Need^{exante}. \end{aligned}$$

Under the hypothesis that transfers are chosen optimally, the envelope theorem implies that first order condition is found by taking the partial derivative with respect to deterrence:

$$\frac{\partial MC(\tau)}{\partial \tau} L^{S*}(\tau) + MC(\tau) \frac{\partial L^{S*}(\tau)}{\partial \tau} + \lambda \frac{\partial T^g(\tau)}{\partial \tau} = 0. \tag{26}$$

The envelope theorem implies that the derivative with respect to real need, $\bar{N}$, will be zero, and hence we can ignore the effect of deterrence on the cutoff when evaluating the first order conditions. Thus we have:

$$\begin{aligned} \frac{\partial MC(\tau)}{\partial \tau} &= \left(1 + D'(\tau)\right) > 1, \\ \frac{\partial L^{S*}(\tau)}{\partial \tau} &= \int_{-\infty}^{\bar{n}(\tau)} L'\left(n^0/(\omega-\tau)\right) \frac{n^0}{(\omega-\tau)^2} f\left(n^0\right) dn^0 + G(\tau) L'\left(\frac{\bar{n}(\tau)}{\omega-\tau}\right) \frac{n(\tau)}{(\omega-\tau)^2}, \\ \frac{\partial T^g(\tau)}{\partial \tau} &= 0, \end{aligned}$$

where we have abused notation somewhat to suppose that the partial derivatives indicate a derivative that ignores the effect of deterrence on the transfer via $\bar{N}(\tau)$.

The effect of deterrence on labor supply can be written in the form:

$$\begin{aligned}
\frac{\partial L^{S*}(\tau)}{\partial \tau} &= \frac{1}{(\omega-\tau)} \int_{-\infty}^{\bar{n}(\tau)} \frac{L'\left(n^0/(\omega-\tau)\right)}{L\left(n^0/(\omega-\tau)\right)} \frac{n^0}{(\omega-\tau)} L\left(n^0/w\right) f\left(n^0\right) dn^0 \\
&\quad + L\left(\frac{\bar{n}(\tau)}{\omega-\tau}\right) G(\tau) \frac{L'\left(\frac{\bar{n}(\tau)}{\omega-\tau}\right)}{L\left(\frac{\bar{n}(\tau)}{\omega-\tau}\right)} \frac{\bar{n}(\tau)}{(\omega-\tau)^2} \\
&= -\frac{1}{(\omega-\tau)} \int_{-\infty}^{\bar{n}(w)} \epsilon_w\left(\tau, n^0\right) h\left(n^0\right) dn^0 - \frac{L\left(\frac{\bar{n}(\tau)}{\omega-\tau}\right)}{\omega-\tau} \epsilon_w\left(\tau, \bar{n}(\tau)\right) \\
&= \left\{ \int_{-\infty}^{\bar{n}(w)} \epsilon_w\left(\tau, n^0\right) h\left(n^0\right) dn^0 - G(\tau) L\left(\frac{\bar{n}(\tau)}{\omega-\tau}\right) \epsilon_w\left(\tau, \bar{n}(\tau)\right) \right\} / (\omega-\tau) \\
&= -\hat{\epsilon}_w(\tau) / (\omega-\tau),
\end{aligned}$$

where $h\left(n^0\right) = L\left(n^0/(\omega-\tau)\right) f\left(n^0\right)$ is the density of criminal activity by individuals with need n^0. The term in brackets is the The elasticity $\hat{\epsilon}_w(\tau)$ is the average elasticity over the distribution of distribution of criminal activity weighted by the total crime carried out at each level of need $\bar{n}(\tau)$.

We can normalize by the total crime and set:

$$\hat{\epsilon}_w(\tau) \equiv \left\{ \int_{-\infty}^{\bar{n}(w)} \epsilon_w\left(\tau, n^0\right) h\left(n^0\right) dn^0 - G(\tau) L\left(\frac{\bar{n}(\tau)}{\omega-\tau}\right) \epsilon_w\left(\tau, \bar{n}(\tau)\right) \right\} \Big/ L^{S*}(\tau).$$

If there is an interior solution, the first order conditions imply that the optimal level of deterrence τ^* will satisfy:

$$\frac{\partial MC(\tau)}{\partial \tau^*} - MC(\tau)\, \hat{\epsilon}_w(\tau^*) / (\omega-\tau^*) = 0. \tag{27}$$

Following a similar argument to the single person case, we get an equation for the optimal deterrence that is the same formula as the one above, except now we are using the population mean elasticity:

$$\tau^* = \omega \frac{\epsilon_{MC}(\tau^*)}{\hat{\epsilon}_w(\tau^*) + \epsilon_{MC}(\tau^*)} \in [0, \omega]. \tag{28}$$

An application of this analysis is to delineate which activities should be criminalized:

Proposition 6. *Assuming a unique solution to the optimal deterrence policy, an illegitimate activity*

$(w^c > \omega)$ *should be criminalized with a positive level of deterrence if:*

$$\hat{\epsilon}_w(0) > \left(\frac{1}{w^c/w - 1}\right) > 0. \tag{29}$$

Proof. An activity should not be deterred if increasing deterrence above zero decreases social costs. This will occur if:

$$\frac{\partial MC(0)}{\partial \tau} L^{S*}(0) + MC(0) \frac{\partial L^{S*}(\tau)}{\partial \tau} + \lambda \frac{\partial T^g(0)}{\partial \tau} < 0.$$

This implies:

$$\frac{\frac{\partial MC(0)}{\partial \tau}}{MC(0)} - \frac{\hat{\epsilon}_w(0)}{\omega} < 0,$$

or:

$$\frac{1}{w^c - \omega} - \frac{\hat{\epsilon}_w(0)}{\omega} < 0,$$

which implies the result. □

This implies two corollaries:

Corollary 7. *If the wage elasticity is negative with optimal transfers, then it is optimal to set* $\tau^* = 0$.

Transfers have the effect of reducing need and hence increasing the wage elasticity. However, even with transfers if the number of individuals in need after transfer is sufficient large, then the wage elasticity can be negative. In that case no deterrence is optimal.

Corollary 8. *With a sufficiently high social cost, it will be optimal to have some deterrence.*

This results follows from the fact that as social cost rises, so does the benefit of a transfer. Eventually, the wage elasticity will be positive at $\tau = 0$, and with a sufficient high social cost of crime, (29) will be satisfied.