E C O N O M I C S   B U L L E T I N

Crime timing

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Abstract

This note develops a dynamic model of crime that determines the conditions under which it is optimal for a criminal to delay commission of a crime rather than committing it immediately. It also examines the optimal enforcement strategy in this context. We derive two results. The first is that it might be optimal to postpone a crime that is profitable now if its benefit increase quickly enough in the future and that a crime that is not yet optimal might become so in the future. The second is that it is optimal to underdeter crime.

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Crime Timing

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Abstract: *This note develops a dynamic model of crime that determines the conditions under which it is optimal for a criminal to delay commission of a crime rather than committing it immediately. It also examines the optimal enforcement strategy in this context. We derive two results. The first is that it might be optimal to postpone a crime that is profitable now if its benefit increase quickly enough in the future and that a crime that is not yet optimal might become so in the future. The second is that it is optimal to underdeter crime.*

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1. Introduction

This note considers a potential criminal contemplating committing a crime. Individuals have to decide whether they commit the crime now or later. The aim of the paper is to answer the following problem: at what point it is optimal to commit a crime and which are the consequences for the enforcement authority? We employ a model in which individuals may postpone the crime. Individuals commit the crime once.

There are other dynamic models of crime, but we depart from them in the sense that they consider repeat offenses. The papers (Davis, 1988; Polinsky and Shavell, 1998; Baik and Kim, 2001; Emons, 2003 and 2004) ask the question whether the decreasing sanction scheme maximizes social welfare. Agents may commit the crime several times. The closer paper to ours is Engelen (2004). He establishes an analogy between real option and criminal behavior and applies it to restricting illegal insider trading. He concludes that it may then be optimal to wait some time before committing the crime.

Our results invalidate the simple net expected payoff rule as it is commonly shown in the economic theory of criminal behavior (for surveys, see Polinsky and Shavell, 2000 and Garoupa, 1997). Because previous models ignore the ability of postpone the crime, they miss the possibility for the authority to induce individuals to commit the crime earlier or later in order to maximize the social welfare. Our framework is a richer model than the conventional analysis of crime, which is a special case of our model. We show that it might be optimal to postpone a crime that is profitable now if its benefit increase quickly enough in the future. We also show that a crime that is not yet optimal might become so in the future. In this framework, we show that some under deterrence is optimal.

Section 2 describes the model. Section 3 derives the individual's decision of whether and when to commit the crime. Section 4 derives some enforcement policy implications. Section 5 concludes. All proofs are in the appendix.

2. The Model

In the model, risk neutral individuals contemplate whether to commit a crime immediately or later. Each individual is identified by the benefit he would obtain from committing the offense, $b \in [0, B]$. The crime causes harm, h. We suppose that $h < B$, that is, not every offense is socially undesirable. We consider a model with an infinite number of periods $t = 0, 1, ...$ and continuous discount rate ρ.

At $t = 0$, individuals must decide whether to commit the crime immediately or later. Individuals who commit the crime are detected with some probability, p, and fined, f. So, the game ends. If individuals decide to wait, then the benefit increases at the rate α, i.e. it becomes $be^{(\alpha-\rho)t}$. Let us gives some examples of crimes that change in value over time. Taxpayers may wait that their earnings become high to "forget" a source of income in their declaration. Thieves may wait that the safe deposit makes full before assaulting it. Managers may wait that free cash flow increases before diverting it. You can also think about insider trading case (see Engelen (2004) for a more detailed analysis). The insider possesses a non public information about a firm that can influence the price of a security. He can commit the crime immediately, i.e. trade on this inside information before the information becomes public and the stock price changes. But it can be valuable to postpone the trade even if it is profitable immediately. For instance, the insider can wait until liquidity is high enough since as liquidity increases his gain increases. Or he can wait to collect more information, which will increase the potential gains of the crime.

A crime is defined by the benefit it provides and the harm it causes. Harm and benefit are related. Consequently when the benefit increases, the harm increases. The harm done increases throughout time at the rate γ. In order to derive some tractable results we assume that $\gamma < \rho$.

We consider first the decision of individuals whether to commit the crime immediately or later. Clearly, individuals' strategies are the following. First, individuals can decide not to commit the crime. The expected payoff is zero. Second, individuals can decide to commit the crime at $t = 0$. In that case, the expected payoff is:

$$F^0 = b - pf \tag{1}$$

Third, individuals can decide to wait. Therefore, this strategy yields an expected payoff:

$$F^t = be^{(\alpha-\rho)t} - pfe^{-\rho t} \tag{2}$$

Remark that when $\alpha > \rho$, waiting longer to commit the crime would always be a better policy and the optimum would not exist. Consequently, from now on we consider the case when $\alpha < \rho$. There will be a critical benefit above which individuals will commit the crime immediately and below which they commit the crime later. The critical benefit is defined by the probability of detection, the level of sanction and the growth rates.

Proposition 1 *Define* $\overline{b} = \frac{\rho}{\rho-\alpha}pf$.

- *if* $b \in \left(0, \overline{b}\right)$, *individuals commit the crime at* $T^* = \frac{1}{\alpha}\log\left[\frac{\rho pf}{(\rho-\alpha)b}\right] > 0$.
- *if* $b \in \left[\overline{b}, +\infty\right)$, *individuals commit the crime at* $t = 0$.

Proof. The value of the crime opportunity assuming he commits the crime at some arbitrary future time T is $F^T = be^{(\alpha-\rho)T} - pfe^{-\rho T}$. Maximizing F^T with respect to T gives the following first order condition (the second order condition is satisfied) which implies $T^* = \max\left\{\frac{1}{\alpha}\log\left[\frac{\rho pf}{(\rho-\alpha)b}\right], 0\right\}$. We have $T^* = 0$ for $\frac{\rho pf}{(\rho-\alpha)b} \leq 1$ which gives $\overline{b} = \frac{\rho}{\rho-\alpha}pf$. ■

First, if the benefit is superior to the critical benefit $\overline{b}$, then it is optimal to commit the crime immediately since the benefit of waiting is less than its cost because of discounting. Second, if the benefit is inferior to the critical benefit $\overline{b}$, then individuals must wait to increase their benefit enough. Actually, the discounted benefit increases at a factor $e^{(\alpha-\rho)t}$, whereas the discounted expected punishment increases by a smaller factor $e^{-\rho t}$. In other terms, there are situations in which it is preferable to delay the crime and this even if the gain from doing so exceeds the expected punishment in the first period.

Let us now turn to the enforcement problem. The enforcement authority's aim is to maximize social welfare through the choice of the fine for the crime, f. The sanction is monetary and socially costless to impose. Social welfare is the sum of the benefits obtained by individuals less the harm done. The level of the fine does not affect social welfare directly because we assume that fines are socially costless to impose.

Given the individuals' decision of committing the crime now or later, the social welfare is:

$$SW = \int_0^{\bar{b}} \left(e^{(\alpha-\rho)T^*(b)}b - e^{(\gamma-\rho)T^*(b)}h\right) g(b)\, db + \int_{\bar{b}}^{B} (b-h)\, g(b)\, db \tag{3}$$

The first term is the impact on social welfare of those individuals who decide to wait. The second term is that of those individuals who choose to commit a crime at $t = 0$. Note that fines being pure monetary transfers, their level f does not enter the social welfare impact of any given individual. However, it affects social welfare through its impact on the threshold $\bar{b}$. That is, the level of fines affects the individuals' behavior.

The optimal enforcement policy is defined in the following proposition:

Proposition 2 *The optimal fine is* $f^* = \frac{h}{p}\left(1 - \frac{\alpha\gamma}{(\rho+\alpha-\gamma)\rho}\right)$. *Some degree of underdeterrence is optimally desirable.*

Proof. Maximizing the social welfare over f gives the optimal fine. Knowing that T^* depends on f, the optimal fine must satisfy:

$$\begin{aligned} &\frac{\rho}{\rho-\alpha}p\left(e^{(\alpha-\rho)T^*(\bar{b})}\bar{b} - e^{(\gamma-\rho)T^*(\bar{b})}h\right) g(\bar{b}) + \frac{\rho}{\rho-\alpha}p\left(h-\bar{b}\right) g(\bar{b}) \\ &+ \int_0^{\bar{b}} \left((\alpha-\rho)\, e^{(\alpha-\rho)T^*(b)}b - (\gamma-\rho)\, e^{(\gamma-\rho)T^*(b)}h\right) g(b)\, db \frac{1}{\alpha f} = 0 \end{aligned} \tag{4}$$

Since $T^*\left(\bar{b}\right) = 0$, (4) becomes

$$\int_0^{\bar{b}} \left((\rho-\gamma)\, e^{(\gamma-\rho)T^*(b)}h - (\rho-\alpha)\, e^{(\alpha-\rho)T^*(b)}b\right) g(b)\, db = 0 \tag{5}$$

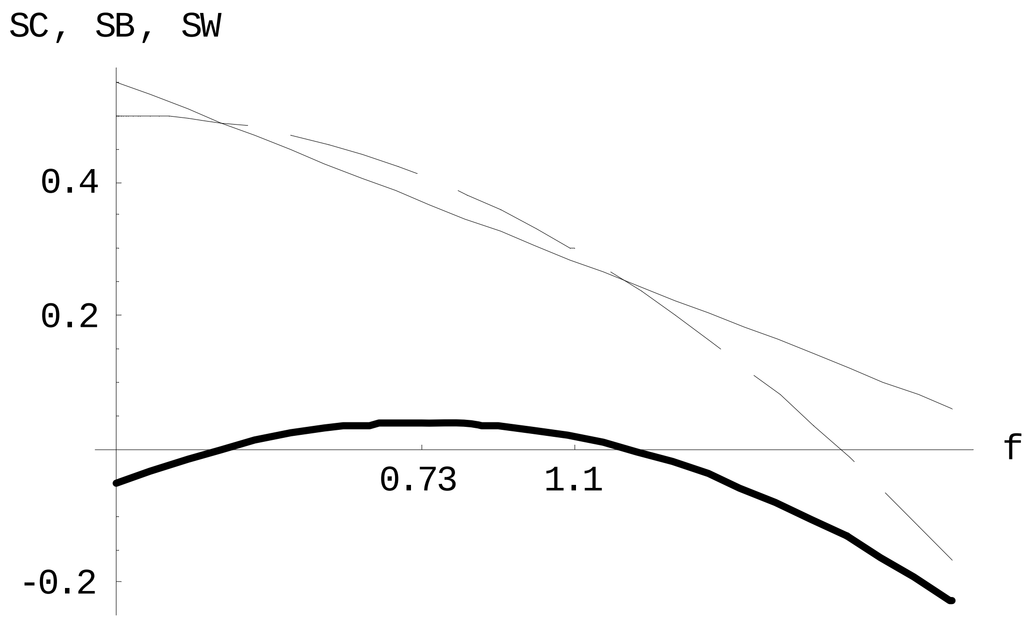
Since $e^{(\alpha-\rho)T^*(b)} = \left(\frac{(\rho-\alpha)b}{\rho p f}\right)^{\frac{\rho-\alpha}{\alpha}}$, $e^{(\gamma-\rho)T^*(b)} = \left(\frac{(\rho-\alpha)b}{\rho p f}\right)^{\frac{\rho-\gamma}{\alpha}}$ and $g(b)$ does not depend on b, (5) becomes

$$(\rho-\gamma)\, h \int_{b^-}^{\bar{b}} \left(\frac{(\rho-\alpha)\, b}{\rho p f}\right)^{\frac{\rho-\gamma}{\alpha}} db - (\rho-\alpha) \int_{b^-}^{\bar{b}} \left(\frac{(\rho-\alpha)\, b}{\rho p f}\right)^{\frac{\rho-\alpha}{\alpha}} b db = 0 \tag{6}$$

Which gives $pf = h\left(1 - \frac{\alpha\gamma}{(\rho+\alpha-\gamma)\rho}\right) < h$ since $\gamma < \rho$. ■

The intuition is the following. The optimal sanction depends only on the parameters that define the social costs (h, γ, ρ and α through T^* and $\bar{b}$). Suppose that $T^* = 0$ then we find the standard result $f^* = \frac{h}{p}$, i.e. perfect deterrence. The optimal sanction ensures that the criminals internalize the social costs they cause. If the crime in the future becomes valuable $T^* > 0$, this implies that the social costs are increasing and so the authority has to change the optimal sanction. If the authority increases the optimal sanction then it induces the criminals to postpone their crime, which in turn increases the social costs. At the opposite decreasing the optimal sanction induces the criminals to act earlier and so, decreases the social costs. Since fines are pure monetary transfers, it becomes optimal to urge some crimes by undertaking underdeterrence. This involves leaving some positive gains from crime. This underdeterrence result holds for all possible values of the parameters α and γ[1].

Numerical example: take the following parameters' values $B = 1$, $h = 0.55$, $\rho = 0.1$, $\alpha = 0.05$, $\gamma = 0.06$ and $p = 0.5$. In this case, the criminal delays his crime for $b < 0.733$. The fine which ensures perfect deterrence is $f = \frac{h}{p} = 1.1$. The following graphic shows that this fine is not optimal. The optimal one is $f^* = 0.73$.



The dotted line represents the social costs, i.e. SC $= \int_0^{\bar{b}} e^{(\gamma-\rho)T^*(b)} h db + \int_{\bar{b}}^1 h db$; the tight line represents the social benefits, i.e. SB $= \int_0^{\bar{b}} e^{(\alpha-\rho)T^*(b)} b db + \int_{\bar{b}}^1 b db$ and the tick line represents the social welfare.

3. Conclusion

[1] Assuming that α and/or γ can be different in some periods would not affect qualitatively our results. For example, in the periods in which the crime is more attractive (higher α), then the social costs is higher and so, the expected optimal sanction has to be lesser to take into account these periods.

This paper develops a dynamic model of crime that determines the conditions under which it is optimal for a criminal to delay commission of a crime rather than committing it immediately. It also examines the optimal enforcement strategy in this context. The paper derives two main results. The first is the fairly obvious result that it may be optimal to wait even if committing the crime now would yield a positive net expected benefit. The second is that enforcers should under-deter crime to induce offenders to commit crimes now rather than later. Note that when authorities have two policy instruments to maximize social welfare: the enforcement expenditures to detect offender and the fine, we find the well-known result from static models of crime: underdeterrence is greater.

Further understanding of how and why the net benefit from crime increases over time may aim at describing the behavior of potential criminal. We suspect that information acquisition may be an important explanation. In this way, we could introduce the possibility of learning of benefit or the probability of detection between the periods. For example, individuals might obtain information about the actual value of the probability of detection by investigating and spending time to determine the actual number of cameras' monitoring, guards,...

Another natural extension is to consider a setup where individuals can commit repeat offenses.

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