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# Search for a theory of organized crimes

Juin-Jen Chang [a], Huei-Chung Lu [b], Ping Wang [c,d,*]

[a] Academia Sinica, Taiwan, ROC
[b] Fu-Jen Catholic University, Taiwan, ROC
[c] Department of Economics, Washington University in St. Louis, Campus Box 1208, One Brookings Drive, St. Louis, MO 63130, USA
[d] NBER, USA

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ABSTRACT

Casual empirical observations reveal no systematic relationship between the overall crime rate and organized criminal activity. We develop a search-theoretic framework to study the interactions not only between formal labor and crime sectors but also between individual and organized crimes. In equilibrium, individual and organized criminals face different arrest risks, success rates, reward structures and outside options. We characterize agents' "occupational choices," the gang's hierarchical structure and the responses of unemployment, crime rates and crime composition to changes in labor-market conditions and crime-deterrence policies. We further assess the effectiveness of arrest versus punishment policies in deterring individual and organized crimes.



## 1. Introduction

During the post-WWII period, the rise in criminal activity has become a severe socioeconomic problem throughout the world. In 2008, six countries had extremely high overall crime rates (measured by total crime incidents per capita) that exceeded 5%, including the UK (as high as 10.6%), the Netherlands, Germany, Canada, France and South Africa, in order from high to low. In the same year, the overall crime rate in the U.S. was 3.9%, with the total of 11.9 million crime incidents being the highest number for any country in the world. In recent years, criminal activities have exhibited divergent trends across countries: while the overall crime rate in the U.S. has declined, the comparable figures in many European countries have risen. Of particular interest, there appears to be no systematic relationship between the overall crime rate and organized criminal activity.

Nowadays in Italy, the overall crime rate remains high (3.7%) and the top 4 or 5 mafia families continue to threaten Italian society. Although successes have been achieved in the fight against the Mafias since the early 1990s, many other crime groups have emerged, including Camorra in Campania and white-collar criminal networks in Apulia (Paoli, 2007). Similarly, the U.K. exhibits not only the highest overall crime rate but also very active organized crime.[1] While the overall crime rate in Japan is relatively low in comparison to that of Western countries (2.2%), followed by the traditional organized criminal

* Corresponding author at: Department of Economics, Washington University in St. Louis, Campus Box 1208, One Brookings Drive, St. Louis, MO 63130, USA. Tel.: +1 314 935 4236; fax: +1 314 935 4156.
*E-mail address:* pingwang@wustl.edu (P. Wang).

[1] In 2007–08, there were 2800 organized crime groups in the UK (almost three times more than had been previously divulged), which have been estimated to result in a social cost of at least £20 billion a year.

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syndicates (boryokudan), a new breed of Japanese gangs, e.g., known as Yakuza, is growing and is heavily involved in criminal activities (Kaplan and Dubro, 2003).[2] In the U.S., Howell et al. (2011) report that the overall crime rate has recently been falling sharply, but the prevalence of gang activity (in terms of the size of gang membership and the occurrence of serious gang-related crimes) is significantly elevated from 2001 to 2009.[3] Based on the Los Angeles Police Department's 2011 COMPSTAT crime report, the ratio of organized (gang-related) to individual (non-gang related) robberies rose from 0.180 in 2009 to 0.185 in 2010 but then fell to 0.152 in 2011. Additionally, while the numbers of crime incidents in Russia have fallen recently, the numbers of crimes committed by organized groups continue to rise.[4]

What are, then, “organized crimes” and why do such crimes concern both the public and policymakers? Organized crime has been considered to be a major threat to human security, impeding the social, economic, political and cultural development of societies worldwide. It is a multi-faceted phenomenon and has manifested itself in different activities, including, among other things, drug trafficking, trafficking in vehicles, trafficking in firearms, the smuggling of migrants, and money laundering, etc. In this paper, we shall focus on property-based crimes that are primarily driven by economic factors, under which we examine how such types of crimes may be committed by individuals (nongang-related) or by criminal organizations (gang-related).[5] That is, we will not differentiate crimes based on different types of activities (say, theft versus violent crimes), but based on different means of committing such crimes (namely, individual versus organized crimes). In particular, to shed light on the nature of organized crime, we shall focus on the gang-related crime that is committed with the collaboration of a group of gang members organized by a gang leader who coordinates the member soldiers' risky activities and enhances their prey returns.[6]

While criminal gangs tend to be less formally structured than syndicates, the recent observations indicate that gangs have become much more organized (Kinnes, 2000). The empirical finding by Bouchard and Spindler (2010) also shows that the gang's organizational structures are important for influencing their members' participation and criminal behavior. By studying the recent corporatist turn of criminal gangs, Levitt and Venkatesh (2000) and Venkatesh and Levitt (2000) find that drug-trafficking gangs have established a vertically hierarchical administrative system for retailing illegal drugs (in particular, see the organizational structure displayed in Fig. I of Levitt and Venkatesh, 2000 and similar charts for other types of U.S. criminal gangs in Mallory, 2007).[7] As stressed by Thornberry et al. (1993) and Bouchard and Spindler (2010), to understand why gang members may lead to more serious threats to a society, gangs' organizational structures and the dynamic evolution of their memberships must be the central focus.

While the work by Schelling (1967) was influential in shaping the Racketeer Influenced and Corrupt Organizations Act passed in 1970, it is surprising that economists since then have not played much of a role in providing rigorous analysis for policymakers toward understanding the economics of organized crimes. The aforementioned observations with regard to crimes lead to a number of questions that deserve our attention. What are the underlying driving forces leading to the different criminal activity outcomes in these countries? Why would the trends in individual and organized crimes be divergent over the past few decades? Could conventional labor-market or crime-deterrence policies be effective in reducing both individual and organized crimes? In order to address these questions, we construct a general equilibrium model of crimes with the following special features:

- We allow for dynamic interactions between a formal labor market and a crime sector where individuals can self-select into a particular category of occupation. Specifically, individuals make an “occupational choice,” determining whether to stay clean by working in the formal labor sector (as workers), or to commit less-serious individual crimes (as individual criminals), or to engage in more-serious organized crimes (as organized criminals or soldiers).
- We fully address an important but unexplored issue which is to differentiate between individual and organized criminal activities within a unified framework and hence to endogenously determine the “composition of crimes,” where

[2] Japan's low crime rates have been at the core of a number of important criminological studies. Kühne (1994) shows that Japan's overall crime rates are less than 1/4 of those in Germany, while organized crimes are rampant in Japan in contrast to fairly inactive criminal gang activities in Germany.

[3] Based on the National Youth Gang Survey, only 23.9% of respondents report active youth gangs in their jurisdictions in 2001. Such figures continue to rise to 34.5% by 2009. Based on the National Gang Intelligence Center Report, all U.S. cities with 250 000 or more population reported criminal gang activities in 2008, where the total gang population was estimated to be about 900 000 in 2008, up from 700 000 in 2005. As stressed by Klein (1998) and Howell et al. (2011), recent data shows that while larger cities consistently exhibit the highest prevalence rates of gang activity, the gang activity in suburban areas also becomes much closer to that in urban areas.

[4] Salagaev et al. (2005) document that the problem of Russian gangs (particularly in Moscow and Kazan cities) is substantial in comparison with that of European gangs.

[5] In our paper, we do not model the property right protection or contract enforcement roles of some criminal organizations or the turf-war for controlling either access to markets or a particular territory. Of particular note, while the vast majority of individual crimes are property crimes, more than 30% of gang members' illegal activities pertain to property crimes (cf. Schneider, 2001). The New Jersey State Policy Gang Survey indicates that in 2010 more than half of the gangs were not associated with violent crimes of assault/homicide/kidnapping types, while 38% of them were involved in theft/burglary/robbery crimes.

[6] This is consistent with the organization theory of ethnographic gang studies (cf. Bouchard and Spindler, 2010), emphasizing that (i) organizational characteristics, such as the presence of a leader, hierarchy, and specific rules, are identified as an important feature of criminal gangs; (ii) the organization refers to the “work environment” of and the extent to which it is structured to facilitate crime and to reward members.

[7] By conducting interviews with and observing 15 heroin gangs, Mieczkowski (1986) points out that the modern operation of drug-selling for gangs, described as the “runner system,” is hierarchically and cooperatively organized with a group of criminals and clearly defined rules of duties and conduct. The runner system has largely replaced the traditional fixed-location strategy, known as the “dope pad” system, which was more loosely organized.

individual and organized criminals, in equilibrium, face different arrest risks, different success rates, different reward structures as well as different outside options.

- We explicitly model the hierarchical structure and the operation of the criminal organization, highlighting (i) the determination of the flow commission to gang members based on optimal revenue-sharing, (ii) the extent of the operating activeness, and (iii) the size of the gang. Given an organized gang, there are two important differences between individual and organized crimes. First, individuals within the criminal organization are complements. This gives rise to increasing returns to scale, which results in a higher robbery rate for organized crimes than individual crimes. Second, the gang offers some insurance to its soldiers and generates two layers of "risk-sharing effects". On the one hand, the gang provides its soldiers with an insurance against police arrests by paying the commission regardless of the arrest. On the other hand, the criminal organization can create (optimally) a wall to insulate some of its members by hiding them from being exposed to police detection.

In our paper, agents' dynamic interactions are conveniently modeled using the search-theoretic approach that allows for endogenous determination of victimization and crime success rates in a parsimonious manner, under which we are able to identify three interesting general-equilibrium effects. First, the individuals' *occupational choice* endogenizes the sizes of the labor market and both the individual and organized crime markets, which allow us to have a better understanding of the driving forces leading to the different criminal activity outcomes in an economy. Second, we show that, because of the *crime composition effect* driven by the occupational switch within the criminal sector, the population of a particular type of criminal may *rise* in response to a tightened crime deterrence policy. Third, because of the *risk-sharing effects* which affect the effective arrest risk facing each organized criminal, the equilibrium mass of searching soldiers in each active subdivision is adjusted adversely to crime deterrence policies. The resulting reduction in the effective arrest rate in turn diminishes the effects of these crime deterrence policies. The three general-equilibrium effects mentioned above lead to several unconventional comparative-static outcomes that may yield useful policy implications and empirically testable hypotheses.

By conducting analytical and numerical analyses, we obtain several findings of particular interest. First, under the optimal revenue-sharing scheme, a higher arrest rate raises the probability of dismantling a subdivision (gang set) and reduces the equilibrium commission to soldiers, whereas a higher nonpecuniary punishment leads to the opposite outcome because of the risk-sharing effect. Moreover, a more active gang's operation increases the mass of organized criminals, while a higher gang leader's internal power within the organization suppresses it. Furthermore, depending on the measurement, an increase in the gang leader's monopoly power may be associated with a smaller or a larger output of crime, which contradicts the conventional wisdom.

Second, due to the crime composition effect, the population of a particular type of criminal (in particular, individual criminals) may rise in response to a tightened crime deterrence policy (in particular, an arrest policy). Due to the occupational-choice channel, organized criminal activities are less responsive to formal labor market conditions than individual criminal activities. Thus, in response to a better labor-market condition, the economy-wide criminal activity falls whereas the proportion of more severe organized crimes rises. Third, while both crime deterrence policies have nonnegligible effects on the labor-market outcomes, the nonpecuniary punishment policy is not as effective as the arrest rate policy in overall crime reduction due to risk sharing within criminal organizations. Finally, in response to any labor-market, crime-policy and criminal organization changes, the unemployment and the overall crime rates are always positively related, corroborating the empirical facts. However, depending on the types of changes, the overall crime rate and the ratio of organized to individual criminals may exhibit a positive or a negative relationship.

### 1.1. Related literature

Since the pivotal studies by Becker (1968) and Ehrlich (1973), economists have begun to examine the individual agent's rational choice between legal and illegal activities in the face of different deterrence arrangements. Although the deterrence of organized crimes is perhaps the most prominent criminal policy agenda, the existing research on the economics of crimes has focused primarily on individual rather than organized crimes.[8]

As for individual crimes, in the recent literature dynamic general equilibrium frameworks have been used to characterize the individual agent's decision-making as to whether to engage in illegal activities. Economists have begun to study the interactions between the socioeconomic environment and the concomitant rate of individual crimes in dynamic general equilibrium, which has been stressed by Merlo (2001) as critical in modeling criminal behavior. For example, İmrohoroğlu et al. (2004) calibrate a general competitive equilibrium model of crime to explain why property crimes have declined over the past few decades, whereas Lochner (2004) studies the relationship between crimes and labor market outcomes. In a way that is more closely related to our paper, some recent studies model the interactions between the formal labor market and the crime sector using the search-theoretic approach. Burdett et al. (2003) address the interrelations between crime, inequality, and unemployment. By shedding light on the role of human capital, Huang et al. (2004) examine the relationships between crime, education and market wages. Engelhardt et al. (2008) quantitatively study the effects of

[8] The United Nations Convention Against Transnational Organized Crime established in December 2000 has devoted sizable resources for combating criminal gang activities and organized crimes.

various labor market and anti-crime policies by extending the conventional search models to allow agents to undertake formal labor and criminal activities simultaneously. All of these studies focus exclusively on individual crimes, leaving organized criminal activities unexplored.

In the thin but growing literature on organized crimes, a criminal organization is modeled either as a monopolistic firm (or a non-coordinated group of firms owning some degree of monopoly power) or as a centralized quasi-government. The former branch of the literature is based purely on industrial organization aspects, regarding criminal activities as "social bads" in which the monopolistic market, by "producing" less "output" of crime, is considered to be better than a perfectly competitive one (cf. Buchanan, 1973; Reuter, 1985; Garoupa, 2000). In the latter branch of the literature, a criminal organization is defined as one competing and/or colluding with the government to monopolize a particular market in a given territory (cf. Grossman, 1995). These criminal organizations are usually regarded as protecting property rights and enforcing contracts when legitimate governments are not well-functioning. In this case, criminal organizations need not produce social bads. More recently, Chang et al. (2005) endogenize the size of a criminal organization and allow the soldiers' commission to depend on criminal abilities, which in turn affects the optimal law enforcement. Mansour et al. (2006) endogenize the formation of gangs and show that an increase in deterrence can increase crime-market competition, which raises the number of competing criminal gangs and the total illegal output. By contrast, our study takes an organizational view of gangs, focusing on intra- rather than inter-gang relationships in the illegal market. In Garoupa (2007), the criminal organization leader is modeled as the principal and the soldiers as agents in which the former makes costly investments to reduce the agents' arrest probability. In his model, agents work independently so that the likelihood of detection of one agent is independent from that of another and they are paid a fixed wage. By contrast, in our model organized crimes are made up of a collection of criminals and the arrest rate of one agent is related to that of other gang members in the same subdivision. Moreover, we endogenously determine the commission to gang members based on optimal revenue-sharing. In contrast with the entire literature, we allow for the general-equilibrium interactions between the formal labor market and the two different types of criminal activities, which is the central focus of our paper.

### 1.2. Individual versus organized crimes

Individual crimes are committed by individual agents and one criminal's arrest rate is largely independent of the behavior of others (putting aside a negative interdiction effect where a criminal is less likely to be arrested in a crowd). Since organized crimes are made up of a collection of criminals, the arrest rate facing each organized criminal increases with the mass of active soldiers in a specific subdivision. This gives rise to a *positive interdiction effect* in which an organized criminal is *ex ante* exposed to a higher arrest rate than an individual criminal. Moreover, organized crimes are structured by a hierarchy that runs a system of operations: the criminal organization can coordinate crimes by virtue of (i) the provision of crime technology to raise the soldiers' success rates and of organizational efficiency to increase the whole gang's revenues and (ii) the provision of insurance against the government's deterrence policies. If an individual criminal gets arrested, the crime spree ends. Because of the risk-sharing effect, organized crimes seemingly do not stop unless the whole organization is broken.

In the conventional studies on organized crimes, the criminal organization is viewed as a monopolistic firm that only imposes an entry fee on criminals to control the size of the crime market. Instead, we model the gang as an organized hierarchy with nonnegligible organizational costs.[9] In our model, the gang provides not only an environment that gives rise to increasing returns to scale in the robbery technology, but also an insurance against policy arrests for its soldiers via two layers of risk sharing (via a guaranteed commission regardless of the arrest and an insulation wall by hiding). These novel features of model setting enable us to differentiate more realistically between individual and organized crimes and to shed light on agents' self-selection behaviors (occupational choices) that endogenously determine the composition of crimes. Such an endeavor is crucial for explaining the divergent trends of individual and organized crimes.

To sum up, the main contribution of our paper is that it models the interactions between legal and illegal activities as well as the individual agent's rational choice between individual and organized criminal activities. Our paper complements conventional studies by highlighting the role of the occupational choice mechanism in understanding different criminal activity outcomes in the overall crime rate and the composition of crimes. We are also able to explain why conventional labor-market or crime-deterrence policies may not be effective in reducing both the level and the severity of crimes.

## 2. The model

We develop a general-equilibrium search-theoretic approach to the modeling of property-based crimes, including robbery, burglary, larceny-theft, motor vehicle theft, cyber theft, forgery, and drug trafficking. In addition to the law-enforcing government, the economy is populated by three distinct risk-neutral agents, namely households, firms and a central gang leader that run organized crimes. All agents are born and die at a common flow rate, $\delta > 0$, where the dead are replaced by identical new-born. All agents discount the future at a common rate $r > 0$ (inclusive of the death rate).

[9] Incorporating entry fees into our model does not alter our results.

There are two theaters of economic activities: the formal labor market and the criminal sector, where the latter consists of individual criminals and those belonging to organized criminal enterprises. Every household makes an optimal *occupational choice* between seeking a job in the formal labor market to become a worker and engaging in crimes either individually or under the shelter of the criminal organization. In the formal labor market, job seekers and vacancies are brought together through a stochastic matching technology. A similar matching phenomenon can also be used to describe the robbing activities in the crime market.

### 2.1. Households

All households are identical except for their disutility costs of committing crimes, which measure any psychological/real resource costs associated with committing crimes, or any social punishment as a result of involvement in criminal activities, or the minus of disutility costs of work in the formal labor market. Each household is endowed with an indivisible unit of labor that may be supplied inelastically. The total population of households is denoted by $\overline{N}$.

At each point in time, a household may be in one of two states: an unmatched "acquisition state" (seeking goods to hold in inventory and to ultimately consume) and a matched "consumption state" (seeking to derive utility by consuming goods currently held).[10] In the acquisition state, a worker augments goods holdings by using her labor endowment (the total mass is denoted as $U$). By contrast, a criminal augments goods holdings through theft (and through a self-employed job in the case of committing individual crimes). Upon committing an individual crime in the acquisition state, a criminal is by construction an active searcher (the total mass is $R^I$). Under a criminal organization, however, a soldier may be ordered by the central gang leader to be active (total mass denoted by $R^O$) or hidden (total mass denoted by $R^H$). Hidden criminals in the criminal organization are not subject to arrest.

Upon obtaining the fruit of her labor (for example, a Diamond's (1984) coconut), a worker must wait for a judicious moment to consume it and thereby derive utility (for example, after she reaches a white sand beach). During this waiting period, she may be robbed of her fruit—in this case, she must return to the acquisition state and start the process over again. Thus, the noninstantaneous transition from the acquisition state to the consumption state is crucial for criminal activities to take place. For simplicity, we assume that all criminals are free from being robbed.[11] We denote the masses of workers, individual criminals and organized criminals in the consumption state as $E$, $Q^I$ and $Q^O$, respectively.

Let us denote the total mass of workers as $N$ and the fraction of criminals committing organized crime as $\Psi$. We can then summarize the division of the population as follows:

| Population | Total | Consumption state | Acquisition state |
|---|---|---|---|
| Workers | $N$ | $E$ | $U$ |
| Individual criminals | $(1-\Psi)(\overline{N}-N)$ | $Q^I$ | $R^I$ |
| Organized criminals | $\Psi(\overline{N}-N)$ | $Q^O$ | $R^O+R^H$ |

Accordingly, we have the following three population identities:

$$N=E+U,$$
$$(\overline{N}-N)(1-\Psi)=Q^I+R^I,$$
$$(\overline{N}-N)\Psi=Q^O+R^O+R^H. \quad (1)$$

It is convenient to denote the *fraction* of population of each "occupation" as $O$ (organized criminals), $I$ (individual criminals) and $W$ (workers). These fractions are to be determined by occupational choice in Section 3.2.1.

### 2.2. Firms

The role of firms in the formal sector is relatively passive. Each firm possesses a fixed-coefficient's technology that employs the labor services of one worker at a time and produces an output measured by $y>0$. To simplify our analysis, the wage offer is determined by a fixed wage rule: $w=\xi y$, where $0<\xi<1$.

### 2.3. The criminal organization

We focus on the hierarchical structure of a criminal organization—the operation of active subdivisions and the determination of soldier effort and commissions, relegating the implications of multiple competing gangs to Section 4.2 below.

[10] This structure is similar to the distinction between unemployed and employed states in labor search models. Due to market frictions, transition from one to another state is not instantaneous. This allows us to model matching and separation rates (job and crime matching rates as well as job separation, death and arrest rates) as flow arrival rates. In conventional canonical setups, such transitions between states are modeled in terms of probabilities. When the sizes of unmatched and matched pools and the matching rates are all endogenous, the conventional approach becomes much more cumbersome.

[11] We could allow criminals to become victims at a lower victimization rate without changing the main results.

A typical operation of a criminal organization involves avoiding full exposure to law enforcing agents. We model this important feature by assuming that the central gang leader divides the criminal organization into $n$ subdivisions (gang sets) with $m$ of them being active and $n-m$ of them being inactive (hidden). As documented in Spergel (1990, pp. 205–7) and Levitt and Venkatesh (2000) associate and peripheral gang members (or fringe members) could be active or inactive—they may be regular or irregular in their attendance at gang events or gatherings and some " floaters" may only arrange deals for weapons, drugs, or stolen property between gang sets and with others outside the gang, without direct involvement at the crime scene.[12] For an illustrative hierarchical structure of a typical criminal organization, the reader is referred to Figure 13-1 and the related discussion in Mallory (2007, Chapter 13), which particularly highlights the presence of "inactive cell members." In the benchmark setup, we allow the central gang leader to endogenously determine the number of active subdivisions for a given number of total subdivisions (we shall endogenize $n$ in Section 4.2 below).

Let $R_k^O$ be the number of soldiers in the $k$-th subdivision. By imposing symmetry, we have: $R^O = mR_k^O$; hence, $R_H = (n-m)/m \cdot R^O$ and $R^O + R^H = (n/m)R^O$. Let $\pi$ be the rate at which a particular criminal is caught and $P = 1-(1-\pi)^{R_k^O}$ denote the probability of the police dismantling a subdivision of the criminal organization with $R_k^O$ active soldiers. This implies that arresting one member of the subdivision leads to its dissolution. Thus, the overall success rate is calculated as: $\sum_{k=0}^{m}\binom{m}{k}P^k(1-P)^{m-k}(m-k) = 1-P$. As is evident, $P$ is increasing in the strength of law enforcement $\pi$.

In the conventional crime literature, it is assumed that a criminal's arrest rate is independent of the behavior of others. Sah (1991) considers that each criminal's interdiction rate is lower when more commit crimes. This negative interdiction effect is endogenized by Huang et al. (2004) using a general-equilibrium search framework with only individual crime activities. In our organized crime sector, we specifically model the fact that organized crimes are committed with the collaboration of more than one criminal. As a consequence, there exists a *positive* interdiction effect in which more searching soldiers in an active subdivision lead to a greater exposure for the subdivision to be detected and hence a higher effective risk (i.e., $P$ is increasing in $R_k^O$). This may be due to one soldier turning in another or due to the enforcer's tracing other criminals in the same gang set via the connections of the arrested soldier.

The presence of this positive interdiction effect implies that a soldier, by participating in an organized crime, is *ex ante* exposed to a higher arrest rate than an individual criminal ($P > \pi$). In reality, Milhaupt and West (2000) document that, in 1997 in Japan, members of criminal organizations are more likely than individual criminals to be arrested and prosecuted for crimes. Moreover, Reuter (1983) and Liddick (1999, p. 411) report that the arrest risks increase as more members are grouped together. This grouped risk is exactly what we call the positive interdiction effect. Since hidden criminals in the criminal organization do not have to face being arrested, the arrest rate facing each soldier increases with the number of active subdivisions and the mass of active soldiers. Thus, as the equilibrium mass of searching soldiers in each active subdivision is adjusted in the *opposite* direction to the crime deterrence policies, there is a *risk-sharing effect* that occurs via the endogenous reduction in the equilibrium arrest rate for organized crimes. In accordance with realistic observations, it is assumed that the central gang leader is never caught, as he has full power in deciding who (including himself) is to be hidden against crime detection even if some active subdivisions are dismantled.

Active soldiers in the criminal organization encounter a victim at a flow rate $\beta^O e^{\varphi}$ at which they may steal goods $w$ (or the flow revenue from drug selling). While $\beta^O$ measures the exogenous robbery rate (or the flow probability of drug selling), the overall success rate is augmented by the effort (denoted by $e$) exerted by the foot soldier $e^{\varphi}$, where $\varphi \in (0,1)$ denotes a positive return to effort at a diminishing rate. Without loss of generality, we normalize the effort exerted to commit individual crimes to one and the associated effort cost to zero. Thus, the *additional* effort cost associated with organized criminal activities is given by $\kappa(e-1)$, where $\kappa > 0$. In the benchmark equilibrium, we shall choose $\kappa$ such that $e=1$, i.e., all agents exert the same effort regardless of the type of criminal activities.

Regardless of their status (active or hidden), all soldiers in the criminal organization are paid a flow commission of $b > 0$ at each point-in-time. This compensation scheme captures another layer of the *risk-sharing effect*. In practice, Reuter (1985) notes that the fringe benefits to compensate gang members include the maintained earnings in the event that they are arrested. Levitt and Venkatesh (2000) also report that to increase the loyalty to the organization and decrease the internal conflict within the criminal organization, the gang leaders may pay for their members who are apprehended—such benefits may even include expenses for lawsuits and payments to the family of a foot soldier who is killed. The presence of these two risk-sharing effects in essence raises the expected returns and reduces the *ex post effective* arrest risk associated with organized crimes, so the latter measure need *not* be higher than that associated with individual crimes.

Under the probability of dismantling a subdivision $P$, the revenue from organized criminal activity accrued by each active gang member is given by $A(1-P)\beta^O e^{\varphi} w$, where $A > 0$ measures the gang's organizational efficiency. A gang is "effective" only when $A > 1$, that is, it generates more revenue should the arrest rate and the foot soldier's effort be identical to the case of individual crimes. In reality, Siegel (2012, p. 295) documents that "professional thieves in the larger cities banded together into gangs to protect themselves, increase the scope of their activities, and help dispose of stolen goods." While Taylor (1990) argues that well-organized gangs can better market their illicit goods to make huge profits, Mieczkowski (1986)

[12] Klein (1968, p. 74) reports that during the 4 years of the Los Angeles Group Guidance Project, fringe members were charged with 40% fewer offenses than regular members in gang activity participation.

notes that drug trafficking gangs can improve their networking to gain a greater volume of sales.[13] All such organizational functions translate into a higher value of $A$ in our model.

Once the per active gang member revenue is specified, it is assumed that the central gang leader and the gang member will split it with a fixed percentage where a fraction of $\gamma$ goes to the central gang leader with the remainder $1-\gamma$ being divided equally among all foot soldiers. This simple revenue sharing scheme is realistic, and consistent with the literature. For example, Levitt and Venkatesh (2000) report that drug-selling gains are shared in fixed percentages between gang leaders and gang members. Mansour et al. (2006) assume equal shares of profits between criminal members of the criminal organization.[14] Because only $m$ of the $n$ subdivisions are active and all gang members are compensated regardless of their status, each foot soldier receives a flow commission of

$$b = \frac{m}{n}(1-\gamma)A(1-P)\beta^O e^{\varphi} w. \tag{2}$$

We next turn to the cost structure of the criminal organization. In addition to a variable operating cost $cR^O$ that is linear in the mass of active soldiers ($c>0$), the criminal organization also incurs a "fixed" operating cost $F>0$. Although $F$ is independent of the mass of active soldiers, we allow it to depend on the number of active and inactive subdivisions:

$$F(m) = (F_0+F_1)m^{\varsigma} + F_0(n-m)^{\varsigma}, \tag{3}$$

where $F_0>0$, $F_1>0$, and $\varsigma>1$. The dependence of $F$ on the number of subdivisions captures the organizational cost incurred by managing criminal hierarchies (as argued in the crime policy literature such as Gottschalk, 2008). In contrast with previous studies, we permit the cost of managing active subdivisions to be higher than managing hidden ones (as reflected by $F_1>0$). We further impose $\left(\underline{m}/(n-\underline{m})\right)^{\varsigma-1} > F_0/(F_0+F_1)$, where $\underline{m}$ is the lower bound of the number of active subdivisions. This regularity condition is imposed to ensure that activating more subdivisions is more costly.

We can now specify the central gang leader's point-in-time surplus as follows:

$$s = A(1-P)\beta^O e^{\varphi} w - c\cdot\sum_{k=1}^{m} R_k^O - b\cdot\sum_{k=1}^{n} R_k^O - F(m) = \left[A(1-P)\beta^O e^{\varphi} w - c - \frac{nb}{m} - \frac{F(m)}{R^O}\right]R^O = \left[\gamma A(1-P)\beta^O e^{\varphi} w - c - \frac{F(m)}{R^O}\right]R^O. \tag{4}$$

Note that, in addition to higher organizational costs, raising the extent of the gang's activeness $m$ may induce more individuals to join the criminal organization (and hence more active soldiers $R^O$ under a symmetry). The probability of the police dismantling a subdivision $P$ will thereby increase as a response. This implies that some extent of the hiddenness $m<n$ (risk sharing) could be optimal for the criminal organization (to be discussed in Section 3.3 later).

In addition to the determination of the size ($n$) and the extent of the activeness ($m$) of the criminal organization, there are two important decisions to be pinned down. On the one hand, an active soldier determines optimal effort such that his compensation net of effort cost is maximized. On the other hand, the central gang leader determines the optimal sharing rule ($\gamma$) that achieves the highest surplus. By selecting the sharing rule, the soldiers' incentives to join the organization are affected through which the central gang leader can achieve the surplus-maximizing mass of the members ($R^O+R^H$).[15] It is in this sense that $\gamma$ influences how large the organization will be and can hence be regarded as a measure of the monopoly power of the gang.

### 2.4. The government

The government performs two law enforcement functions: arresting and punishing criminals. For simplicity, we assume that punishment is nonpecuniary, in forms of disutility, and that arresting criminals incurs policing costs measured by $\nu\pi$. To balance its budget, the government finances the policing costs by levying a lump-sum tax $T$ on each employed worker. That is, the following government budget constraint must hold:

$$TE = \nu\pi. \tag{5}$$

### 2.5. Matching and population dynamics

Let $\mu$ denote the flow rate at which a worker locates a job in the formal labor market (job finding rate) and $\eta$ represent the flow rate at which a firm locates a worker (job recruitment rate). Since each job is filled by exactly one worker, it follows that

$$\mu U = \eta V = m_0 M(U,V), \tag{6}$$

where $m_0>0$ and $M$ is the matching technology governing the flow rate of contacts between the two parties; it is strictly increasing, strictly concave and homogeneous of degree one in $U$ and $V$, satisfying the Inada and boundary conditions (i.e., $M(0,V)=M(U,0)=0$).

[13] Hagedorn's (1994) empirical result suggests a positive relationship between gang organization and profitability.

[14] Although Garoupa (2007) models the members' compensation in the form of a fixed wage for the sake of simplicity, he notes that in an illegal enterprise most agents are rewarded with a percentage of the illegal gains.

[15] In practice the gang leader's control over fringe members is somewhat weak. As pointed out by Spergel (1990), some peripheral members may just join for a short period of time—days or weeks. So it is proper to assume that the gang leader controls the membership of the organization only via the compensation scheme and the operating structure of the organization.

Denote by $\beta^I$ ( $<\beta^O e^\varphi$) the flow rate at which an individual criminal encounters a victim and by $\alpha$ the victimization rate at which a worker loses her fruit to a criminal. The "matching" behavior in the criminal sector, including individual and organized crimes, is governed by

$$\alpha E = \beta^I \cdot R^I + \beta^O e^\varphi \cdot R^O. \tag{7}$$

That is, the flow crime rate can be measured by either the flow rate at which workers are victimized or the flow rate at which criminals succeed.

At the flow rate $\mu$, workers acquire jobs and move from the acquisition state to the consumption state. Workers exit the consumption state by successfully consuming the fruits of their labor at rate $\lambda$, or by death at rate $\delta$, or by becoming the victims of crime at rate $\alpha$. Thus, the population of workers at the consumption state evolves according to

$$\dot{E} = \mu U - (\lambda + \delta + \alpha)E. \tag{8}$$

Similarly, individual (resp. organized) criminals enter the consumption state after successfully committing a robbery $\beta^I$ (resp. $\beta^O e^\varphi$) and exit the state $Q^I$ (resp. $Q^O$) either by consuming $\lambda$ or by death $\delta$. These considerations yield

$$\begin{aligned} \dot{Q}^I &= \beta^I R^I - (\lambda + \delta)Q^I, \\ \dot{Q}^O &= \beta^O e^\varphi R^O - (\lambda + \delta)Q^O. \end{aligned} \tag{9}$$

In the steady state, $\dot{E} = \dot{Q}^j = 0$ $(j = I, O)$, which gives the relationships between the populations in the acquisition and the consumption states.

### 2.6. Asset values

We next turn to setting up the asset values facing each type of agent. Basically, the flow value achieved by each agent is equal to the instantaneous utility plus the expected incremental value from changing states.

We denote the households' values by $J_i$, using the subscript $i$ to label the corresponding state: $U$ (searching workers), $E$ (employed workers), $R^I$ (searching individual criminals), $Q^I$ (succeeding individual criminals), $R^O$ (searching organized criminals) and $Q^O$ (succeeding organized criminals). Here, the term "success" refers to successfully robbing a victim rather than escaping from the police.

The flow values of workers from job search and occupying the consumption state are given by

$$\begin{aligned} rJ_U &= \mu(J_E - J_U), \\ rJ_E &= \lambda w - T + (\lambda + \alpha)(J_U - J_E), \end{aligned} \tag{10}$$

where a searching worker has no instantaneous utility but an employed worker may enjoy the fruit of her labor at rate $\lambda$ upon paying the lump-sum tax.

Concerning individual criminals, we note that in addition to what they obtain from committing an individual crime, they can utilize their remaining time to earn self-employed income measured by $aw$, where their self-employment income to formal-sector wage ratio $a$ is exogenously given.[16] We further denote $\phi^I = (1+a)(1-\pi)$ as the gross rate of return from committing an individual crime and $z$ as the disutility from nonpecuniary punishment. The flow values from committing individual crimes in the acquisition and consumption states can therefore be specified as

$$\begin{aligned} rJ_{R^I} &= \beta^I (J_{Q^I} - J_{R^I}), \\ rJ_{Q^I} &= \phi^I \lambda w - \pi z + \lambda(J_{R^I} - J_{Q^I}). \end{aligned} \tag{11}$$

Again, a searching individual criminal has no instantaneous utility, whereas a succeeding one receives an expected outcome of $(1-\pi)w$ from committing an individual crime and an expected self-employment income $(1-\pi)aw$ (which can be enjoyed at rate $\lambda$), but may suffer a loss if he is caught (the expected disutility is captured by $\pi z$).

In contrast with individual crimes, being a soldier in a criminal organization is a full-time job regardless of the current status (active or hidden). By being caught, a soldier will suffer a higher nonpecuniary punishment than an individual criminal, due to his causing more severe damage and his higher likelihood of repeating offenses, where the incremental punishment is measured by $\sigma z$, $\sigma > 0$. Thus, the flow values of an organized criminal in the acquisition and consumption states are, respectively,

$$\begin{aligned} rJ_{R^O} &= \beta^O e^\varphi (J_{Q^O} - J_{R^O}), \\ rJ_{Q^O} &= \lambda[\phi^O w - \kappa(e-1)] - P(1+\sigma)z + \lambda(J_{R^O} - J_{Q^O}), \end{aligned} \tag{12}$$

where the gross return is simply: $\phi^O = b/w$.

**Remark.** In our model, all stolen goods are seized by police before reaching the consumption state when the criminals are arrested. One may extend the model, by assuming that only a fraction $1-\rho$ of stolen goods are seized by police. Then,

[16] The consideration of part-time individual criminals is consistent with the specification of conventional models of crimes, such as Becker (1968) and Ehrlich (1973).

under $e=1$, we have

$$rJ_{Q^I} = [(1-\pi)(1+\alpha)+\pi\rho]\lambda w - \pi z + \lambda(J_{R^I}-J_{Q^I}),$$
$$rJ_{Q^O} = [(1-P)+P\rho]\frac{m}{n}(1-\gamma)A\beta^O\lambda w - P(1+\sigma)z + \lambda(J_{R^O}-J_{Q^O}).$$

All of our results remain qualitatively unchanged as long as the net penalty is positive, that is

$$\rho < \min\left\{1, \frac{(1+\sigma)}{\frac{m}{n}(1-\gamma)A\beta^O}\right\}\cdot\frac{z}{\lambda w}.$$

Let $\Pi_F$ and $\Pi_V$ denote the firms' filled and vacant values, respectively. Upon paying the wage to the matched worker, a firm gains an instantaneous profit of $y-w$. Thus, its flow unfilled value and its filled value, respectively, are given by

$$r\Pi_V = \eta(\Pi_F - \Pi_V),$$
$$\Pi_F = y - w + \Pi_V = (1-\xi)y + \Pi_V. \tag{13}$$

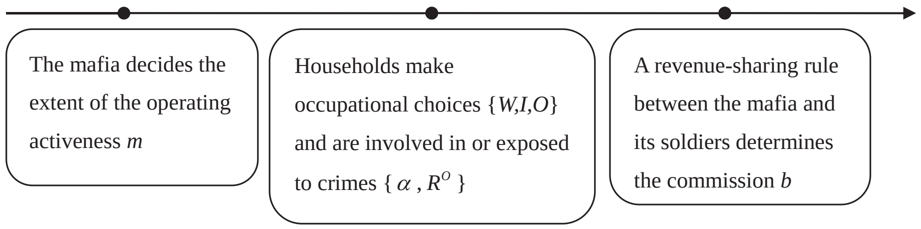
Finally, we denote the central gang leader's value and outside option as $\Pi_M$ and $\underline{\Pi}$, respectively. The gang leader's incremental value must equal the point-in-time surplus:

$$\Pi_M - \underline{\Pi} = s. \tag{14}$$

For simplicity, we assume that the gang leader's outside option, $\underline{\Pi}$, is exogenously given.[17]

### 2.7. The timeline

In the following chart, we summarize the sequence of actions in three separate stages:




Time line

To ensure subgame perfection, we shall solve the corresponding optimizing decisions backward, to which we now turn.

## 3. Optimization and equilibrium analysis

In this section, we solve the flow commission under organized crimes, followed by the determination of crime-market matching as well as the households' occupational choice, and then by the gang leader's decision on the operating activeness.

### 3.1. Flow commission to organized criminals

An active soldier determines optimal effort to maximize the flow value (that is, the flow commission $b$ net of the effort cost):

$$\max_e \frac{m}{n}(1-\gamma)A(1-P)\beta^O e^{\varphi} w - \kappa(e-1),$$

which yields

$$e^* = \left[\frac{\varphi\frac{m}{n}(1-\gamma)A(1-P)\beta^O w}{\kappa}\right]^{1/(1-\varphi)}. \tag{15}$$

Thus, the more efficient and active the criminal organization is or the lower the arrest rate is, the greater the effort an active soldier will exert. From this expression, it is easily seen that we can choose $\kappa$ such that $e=1$.

[17] In practice, such an outside option captures the gang leader's value from using his endowments/resources for other purposes. The value of the outside option may be used to justify why there is only one gang in the jurisdiction under consideration.

Given the soldier's effort obtained above, the central gang leader determines the optimal sharing rule to maximize the surplus:

$$\max_{\gamma}\left[\gamma A(1-P)\beta^{O}\left[\frac{\varphi\frac{m}{n}(1-\gamma)A(1-P)\beta^{O}w}{\kappa}\right]^{\varphi/(1-\varphi)}w-c-\frac{F(m)}{R^{O}}\right]R^{O},$$

which is equivalent to $\max_{\gamma}\gamma(1-\gamma)^{\varphi/(1-\varphi)}$, implying

$$\gamma^{*}=1-\varphi. \tag{16}$$

That is, the revenue share to the central gang leader rises when the extent of the return to the soldier's effort decreases. The returns to scale parameter $\varphi$ is therefore inversely related to the relative internal power of the central gang leader, which also captures the "monopoly power" of the gang in the criminal sector. Intuitively, by providing a greater revenue share to foot soldiers, the central gang leader's share is lower but the total revenue rises as a result of greater effort induced by the higher commission.

Denote $b_1$ as the lowest commission for a potential organized criminal to serve as a soldier for the gang (such that $J_{R^O}=J_{R^I}$) and $b_2$ as the highest commission that the central gang leader is willing to offer (such that $\Pi_M=\underline{\Pi}$). We impose:

**Assumption 1** (*Active Organized Crime Participation*). $\Pi_M>\underline{\Pi}$ and $J_{R^O}>J_{R^I}$. This assumption implies that both the gang leader and potential organized criminals are actively participating. This is assumed throughout because organized crimes are the focus of our paper. We can then characterize the revenue-sharing outcome.

**Proposition 1** (*Flow Commission to Organized Criminals*). *Under Assumption1, the flow commission to organized criminals is given by*

$$b^{*}=\left\{\left(\frac{\varphi}{\kappa}\right)^{\varphi}\left[\frac{m}{n}\varphi A(1-P)\beta^{O}w\right]\right\}^{1/(1-\varphi)}\in(b_1,b_2),$$

*where*

$$b_1\equiv\frac{1}{1-\varphi}\left[\frac{\beta^{I}(r+\lambda+\beta^{O}e^{*\varphi})}{\beta^{O}e^{*\varphi}(r+\lambda+\beta^{I})}(\phi^{I}w-\frac{\pi z}{\lambda})+\frac{P(1+\sigma)z}{\lambda}-\kappa\right]$$

*and*

$$b_2\equiv\frac{m}{n}\left[A(1-P)\beta^{O}e^{*\varphi}w-c-\frac{F(m)}{R^{O}}\right].$$

*The flow commission to organized criminals possesses the following properties*:

(i) *while the flow commission is lower in response to a higher arrest rate, it is irresponsive to nonpecuniary punishment*;
(ii) *the flow commission is larger if the criminal organization is more efficient and active, the robbery success rate is higher, or the returns to scale of the soldier's effort are greater.*

**Proof.** All proofs are relegated to the Appendix.

As we will see, this commission sharing effect and the upper and lower bounds of the flow commission are crucial for the households' occupational choice and the effectiveness of crime deterrence policies. □

### *3.2. Occupational choice and matching*

Recall that households are heterogeneous only in their disutility costs of committing crimes, which capture any psychological or real resource costs, or social punishment, or the minus of disutility costs of legal work. We capture this heterogeneity by $d$, where $d$ is assumed, for analytic convenience, to be uniformly distributed over [0, 1]. The discussion of such disutility costs goes back to the now classic pieces by Becker (1968) and Ehrlich (1973). As pointed out by Levitt and Venkatesh (2000), it is difficult to reconcile the behavior of gang members using a prototypical economic model without assuming nonstandard preferences or considering social/nonpecuniary factors of gang participation. By introducing heterogeneous disutility costs of committing crimes, Conley and Wang (2006) are able to obtain much more diverse patterns of individual crimes across space and over time.

In our economy, we model two types of criminals, individual and organized. The disutility cost borne by a type-$d$ household is thus specified to depend on the types of crimes committed: $q^{j}\cdot d$, where $j=O, I$. It is reasonable to consider that committing crimes secretly (individual) is different from committing them in a group (organized). In our paper, we assume $q^O > q^I$, that is, committing organized crimes leads to stronger moral condemnation than committing individual crimes. This assumption is consistent with criminology studies. For example, Esbensen and Huizinga (1993) note that communities label people as troublesome as the public perceives them to be gang members and gang members suffer from stronger social sanctions, such as social disapproval, ridicule, peer pressure, and ostracism.

A household's type is entirely private information, which cannot be verified or used to alter the revenue-sharing outcome. It, however, plays a role in determining the household's occupational choice. Given the exogenous distribution of disutility costs and with all the value functions specified above, agents with different disutility costs will sort endogenously into different occupation categories, namely the formal sector of the workforce, individual criminal activities and organized criminal activities.

#### 3.2.1. *Occupational choice*

By taking the disutility costs of committing crimes into account, we redefine the corresponding values and utilize (10)–(12) to obtain the following net asset values:

$$\tilde{J}_U(d) = J_U = \frac{\mu(\lambda w - T)}{r(r+\lambda+\mu+\alpha)},$$
$$\tilde{J}_{R^I}(d) = J_{R^I} - q^I \cdot d = \frac{\beta^I(\phi^I \lambda w - \pi z)}{r(r+\lambda+\beta^I)} - q^I \cdot d,$$
$$\tilde{J}_{R^O}(d) = J_{R^O} - q^O \cdot d = \frac{\beta^O e^{*\varphi}\{\lambda[b^* - \kappa(e^* - 1)] - P(1+\sigma)z\}}{r(r+\lambda+\beta^O e^{*\varphi})} - q^O \cdot d. \quad (17)$$

These net values are plotted against the households' types $d$ (see Fig. 1). It is obvious that while $\tilde{J}_U(d)$ is independent of $d$, $\tilde{J}_{R^I}(d)$ and $\tilde{J}_{R^O}(d)$ are decreasing in $d$ with the latter steeper than the former (since $q^O > q^I$). There are two important critical points: one

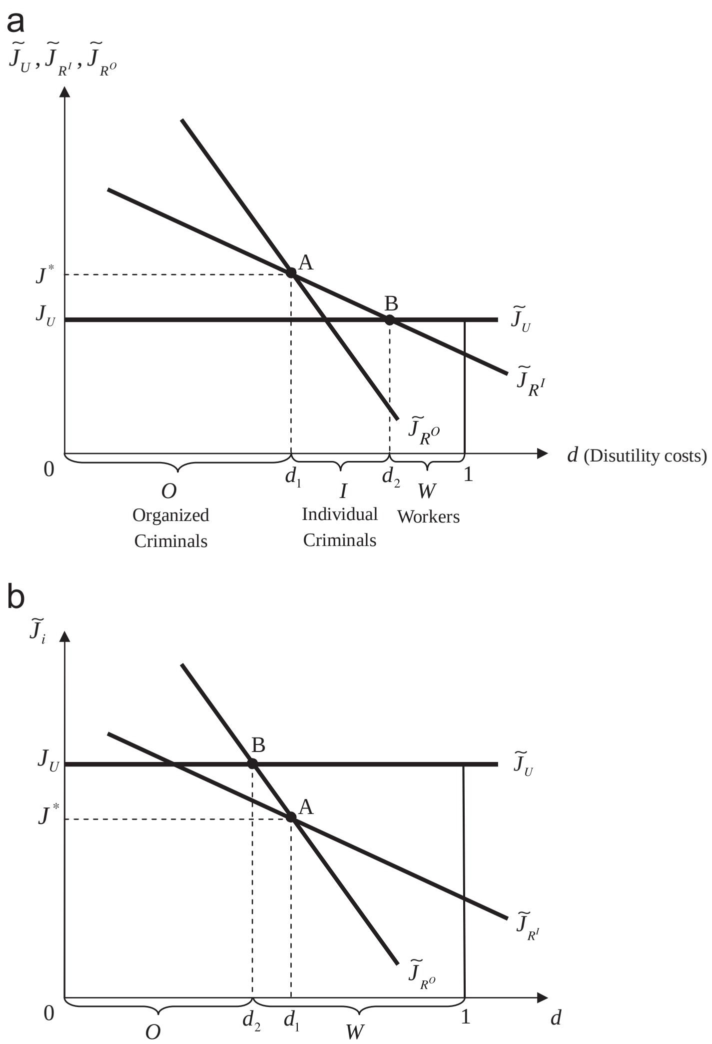



**Fig. 1.** Occupational choice: case I (a) and case II (b).

denoted by $d_1$ satisfying $\tilde{J}_{R^O}(d)=\tilde{J}_{R^I}(d)$ and another denoted by $d_2$ satisfying $\tilde{J}_{R^I}(d)=\tilde{J}_U(d)$ (corresponding to points $A$ and $B$, respectively, in Fig. 1).

From (17), we obtain

$$d_1=\frac{1}{r(q^O-q^I)}\left\{\frac{\beta^O e^{*\varphi}\{\lambda[b^*-\kappa(e^*-1)]-P(1+\sigma)z\}}{r+\lambda+\beta^O e^{*\varphi}}-\frac{\beta^I(\phi^I\lambda w-\pi z)}{r+\lambda+\beta^I}\right\},$$
$$d_2=\frac{1}{rq^I}\left[\frac{\beta^I(\phi^I\lambda w-\pi z)}{r+\lambda+\beta^I}-\frac{\mu(\lambda w-T)}{r+\lambda+\mu+\alpha}\right]. \tag{18}$$

Clearly, we must have $d_1<1$ and $d_2<1$, since otherwise there will be no workers and criminals will have nothing to steal. We will rule out the case with $d_2<0$ under which no one commits crimes. Moreover, we can show that under Assumption 1, $d_1>0$. Thus, we are left with two cases: (i) $d_1<d_2$ where organized criminals, individual criminals and workers all coexist (Fig. 1a), and (ii) $d_1>d_2$ where organized criminals and workers coexist but there are no individual criminals (Fig. 1b). We can now characterize these two occupational choice patterns as follows:

**Proposition 2** (*Occupational Choice*). *Under Assumption1, the households' occupational choice possesses the following properties*:

(i) *Case I*: *If $b^*<\hat{b}$, then households with $d\in[0,d_1)$ choose to commit organized crimes, those with $d\in[d_1,d_2)$ choose to commit individual crimes, and those with $d\in[d_2,1]$ choose to work in the formal labor market.*
(ii) *Case II*: *If $b^*>\hat{b}$, then households with $d\in[0,d_2)$ choose to commit organized crimes and those with $d\in[d_2,1]$ choose to work in the formal labor market.*

*where*

$$\hat{b}\equiv\frac{1}{1-\varphi}\left[\left(1+\frac{1}{a_q}\right)\left(\phi^I w-\frac{\pi z}{\lambda}\right)\frac{\beta^I(r+\lambda+\beta^O e^{*\varphi})}{\beta^O e^{*\varphi}(r+\lambda+\beta^I)}-\frac{\mu(r+\lambda+\beta^O e^{*\varphi})}{a_q\beta^O e^{*\varphi}(r+\lambda+\mu+\alpha)}\left(w-\frac{T}{\lambda}\right)+\frac{P(1+\sigma)z}{\lambda}-\kappa\right]$$

*and*

$$a_q\equiv\frac{q^I}{q^O-q^I}>0.$$

Using (18) and referring to Fig. 1, we can further derive the *fraction* of population of each "occupation" , organized criminals ($O$), individual criminals ($I$) and workers ($W$), as

$$O=\frac{(n/m)R^O}{U+R^I+(n/m)R^O}=d_1,$$
$$I=\frac{R^I}{U+R^I+(n/m)R^O}=d_2-d_1,$$
$$W=\frac{U}{U+R^I+(n/m)R^O}=1-d_2. \tag{19}$$

This completes the determination of the steady-state equilibrium with exogenous victimization (i.e., by regarding $\alpha$, and hence the *level* of each relevant criminal population, as given).

It is important to note that the flow commission bounds correspond directly to the endogenous cutoffs of occupational choice. Specifically, when the flow commission approaches the lower bound ($b^*\to b_1$), $d_1\to 0$ and no household chooses to commit organized crimes. On the contrary, when the flow commission approaches the upper bound ($b^*\to b_2$), $s\to 0$ and no gang leader has the incentive to engage in running a criminal organization.

### 3.2.2. Steady-state matching with exogenous victimization

At this stage we can perform comparative statics with exogenous victimization by characterizing the households' occupational choice. Given the equilibrium commission $b^*$ indicated in Proposition 1 and the soldier's effort $e^*$ reported in (15), we study how the equilibrium proportion of each occupation responds to labor-market conditions, crime deterrence policies and the structure of the criminal organization. Unless referred to otherwise, we focus only on the general case where all three occupations coexist (i.e., Case I).

**Proposition 3** (*Effects of a higher job finding rate*). *Under Assumption1 with exogenous victimization, an increase in the job finding rate encourages a switch from individual criminals to workers without changing the proportion of organized criminals.*

As indicated in Fig. 2a, an improved formal labor market condition raises the worker's net value, thereby inducing marginal individual criminals to switch to the formal sector (the critical point $B$ shifts to $B'$). Because it does not affect the relative payoff between committing an individual crime and committing an organized crime, the population of organized criminals remains unchanged *under a given victimization rate*. Should such an improvement continue, all individual

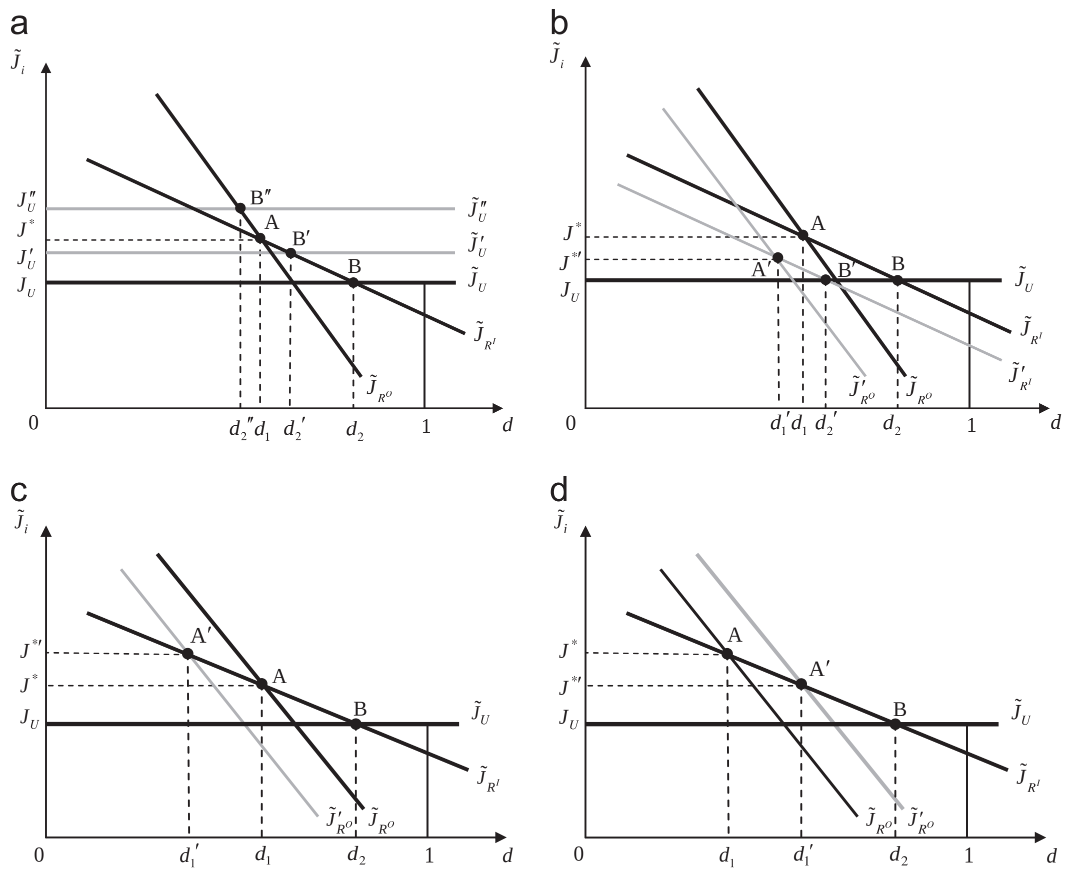



**Fig. 2.** Effects of higher job finding rate $\mu$ (a), tightened crime deterrence $z$ or $\pi$ (b), increasing the gang's monopoly power $\gamma$ (c) and increasing the gang's operating activeness $m$ (d).

criminals will switch to the formal sector and, afterward, some organized criminals will begin to move out to join the labor market (as indicated by the critical point $B''$). An empirically testable implication is that *organized criminal activities are less responsive to formal labor market conditions than individual criminal activities*. For example, such irresponsiveness may explain at least partly why Milhaupt and West (2000) find in Japan that the effects of the unemployment rate and real GDP per capita on the size of gangs (measured by memberships) are statistically insignificant.

**Proposition 4** (*Effects of tightened crime deterrence*). *Under* Assumption1 *with exogenous victimization provided that* $\Delta \equiv (1+a)\lambda w + z$ *is not too large*:

(i) (*effect on workers*) *a tightened crime deterrence policy of either type always induces a switch from criminals to workers*;
(ii) (*effect on organized criminals*) *a tightened crime deterrence policy of either type reduces the proportion of organized criminals*;
(iii) (*effect on individual criminals*)
  a. *when the differential of the disutility cost of committing crimes is sufficiently high* (*resp. low*), *a tightened crime deterrence policy of either types decreases* (*resp. increases*) *the proportion of individual criminals*;
  b. *when the disutility cost differential is moderate, a more severe nonpecuniary punishment lowers the proportion of individual criminals but a higher arrest rate raises it.*

Either crime deterrence policies lower the net values of both types of criminals (so the critical points shift from $A$ and $B$, respectively, to $A'$ and $B'$ in Fig. 2b). It is therefore not surprising that there is an occupational switch from the criminal sector to the formal labor market. Because of a positive interdiction effect ($P > \pi$) and the imposition of a more severe nonpecuniary punishment on organized criminals ($\sigma > 0$), the proportion of organized criminals is unambiguously lower. Concerning the proportion of individual criminals, the net effects of these crime deterrence policies depend crucially on the outflow to the worker pool versus the inflow from the organized criminal pool. Should the disutility cost differential be sufficiently large, the occupational switch from organized to individual criminals is moderate. One may thus expect a net reduction in the proportion of individual criminals in response to a tightened crime deterrence policy.

As indicated in Proposition 1, under optimal revenue-sharing, the flow commission offered to potential organized criminals is irresponsive to nonpecuniary punishment, but negatively related to the arrest rate. Thus, the occupational switch from organized to individual criminals is more responsive to the arrest policy and the proportion of individual criminals may increase with the intermediate disutility cost differential under which the net effect of nonpecuniary punishment on the proportion of individual criminals is still negative. The possibility of a positive effect on some type of criminals of a tightened crime deterrence policy is new to the existing literature. This possibility is mainly due to the *crime composition effect* resulting from an occupational switch *within* the criminal sector, which is entirely ignored in previous studies.

**Proposition 5** (*Effects of increasing the central gang leader's monopoly power or operating activeness*). *Under Assumption1 with exogenous victimization,*

(i) *an increase in the central gang leader's monopoly power induces a switch from organized criminals to individual criminals, but leaves the proportion of workers unchanged*;
(ii) *a more active operation by the central gang leader induces a switch from individual criminals to organized criminals, while it has no effect on the proportion of workers.*

This proposition suggests that, with exogenous victimization, changes in the structure of the criminal organization only reallocate the population between individual and organized criminal activities, without affecting the total proportion of criminals or the economy-wide crime rate. When the gang leader's internal power is strengthened (a higher $\gamma$ as a result of a lower $\varphi$), the soldiers are offered lower commissions and their net values decrease (see Fig. 2c where the critical point $A$ shifts to $A'$). As a consequence, those with relatively higher disutility costs of committing crimes switch from organized to individual crimes. When the gang leader operates the criminal organization more actively by ordering more subdivisions to plunder goods (a higher $m$), the potential profit is higher and the effective risk is lower due to a positive interdiction effect caused by a reduction in the mass of active soldiers in each subdivision for a given mass of total searching soldiers ($R^O$). As a result, a higher commission is awarded to the soldiers, thereby encouraging more criminals to join the criminal organization.

### 3.2.3. Steady-state matching with endogenous victimization

We next pin down the victimization rate $\alpha^*$ as well as a tuple of population masses $\{N^*, E^*, U^*, \Psi^*, Q^{I*}, R^{I*}, Q^{O*}, R^{O*}\}$, using (1), (7)–(9), and (19). This can be done in two steps. To begin with, we express $(N, E, U, \Psi, Q^I, R^I, Q^O)$ as a function of $(R^O, \alpha)$. We then establish two fundamental relationships to determine $(R^O, \alpha)$ jointly. Consider,

**Assumption 2.** $(m/n)\beta^O e^{\varphi} > \beta^I$.

This assumption implies that the effective robbery rate for an organized criminal ($(m/n)\beta^O e^{\varphi}$) is larger than for an individual criminal ($\beta^I$). This is justified in practice not only because there is the provision of crime-technology information by the criminal organization, but also because soldiers within the criminal organization are complements (with both leading to a higher effective robbery rate).

From Proposition 1, we can see that the soldier's commission $b^*$ and additional effort $e$ (and, accordingly, $d_1$) are both functions of $R^O$ alone, independent of $\alpha$. From (18), we can write: $d_1 = d_1(R^O)$ and $d_2 = d_2(R^O, \alpha)$. Using this property and (5), we can rewrite the first and second expressions of (19) to obtain the two fundamental relationships as follows:

$$\frac{nR^O}{mU(R^O,\alpha)+mR^I(R^O,\alpha)+nR^O} = d_1(R^O),$$
$$\frac{mR^I(R^O,\alpha)}{mU(R^O,\alpha)+mR^I(R^O,\alpha)+nR^O} = d_2(R^O,\alpha)-d_1(R^O). \tag{20}$$

Eq. (20) represents the two occupational choice indifference boundaries in the $(R^O,\alpha)$ space: one between the two criminal activities (denoted by $OC^{IO}$) and the other between individual crimes and formal employment (denoted by $OC^{IW}$). We can show in the Appendix that these two occupational choice indifference boundaries are both upward-sloping in the $(R^O,\alpha)$ space with the $OC^{IO}$ locus being steeper than the $OC^{IW}$ locus (see Fig. 3). To illustrate this intuitively, we focus on the primary effects. In response to an increase in $R^O$, both organized and individual criminals face stiffer competition and hence a lower success rate. To maintain indifference in their occupational choice, it is therefore necessary for the victimization rate to be higher, implying positively sloped relationships. Since the competition facing organized criminals is more direct, one may thus expect the victimization rate to increase more in order to compensate for their losses. As a consequence, the $OC^{IO}$ locus is steeper than the $OC^{IW}$ locus.

Denote $\underline{\alpha}$ as the minimum level of the victimization rate $\alpha$ that ensures a nondegenerate population of criminals and define $I_0 \equiv \lim_{R^O \to 0} d_2(R^O, \underline{\alpha}) - d_1(R^O)$. Consider a sufficient condition,

**Assumption 3.** $I_0 > \mu\underline{\alpha}/((\lambda+\delta+\underline{\alpha})\beta^I + \mu\underline{\alpha})$.

Under Assumptions 1–3 and using Fig. 3, the indifference boundaries $OC^{IO}$ and $OC^{IW}$ determine uniquely $R^{O^*}$ and $\alpha^*$ in a recursive manner. Once $R^{O^*}$ and $\alpha^*$ are solved, the other endogenous variables $(N^*, \Psi^*, E^*, U^*, Q^{I^*}, R^{I^*}, Q^{O^*})$ can also be pinned

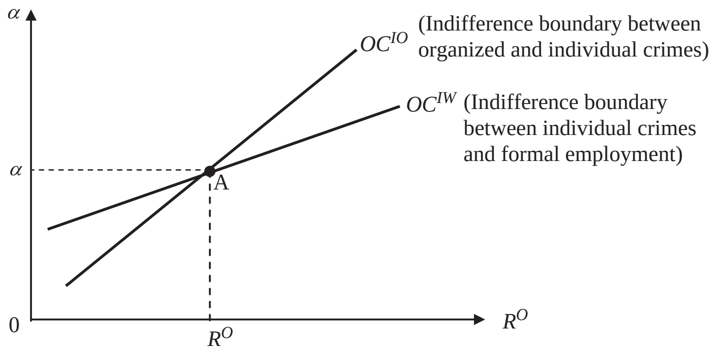



**Fig. 3.** The determination of the mass of active organized criminals and the victimization rate $(R^0, \alpha)$.

down accordingly. We thereby establish the existence of a steady-state equilibrium with exogenous operating activeness. By referring to the Appendix, it is worth noting that the steady-state equilibrium associated with a more actively operated criminal organization (a higher $m$) must feature a larger mass of active soldiers $R^O$.

### 3.3. Central gang leader's decision on the operating activeness

We are now ready to examine how the gang leader optimally determines the extent of operating activeness. The central gang leader chooses $m$ so as to maximize the surplus $s = \Pi_M - \underline{\Pi}$. From the first-order condition associated with a nondegenerate solution $m > 0$ (see the Appendix), we can see that, by increasing the number of active subdivisions, the gang leader may raise the revenues as long as his gains from more active operations exceed his payments to soldiers, even though the gang leader must face a higher organizational cost. Obviously, the optimal number of active subdivisions is determined by comparing the former marginal benefit with the latter marginal cost.

We will restrict our attention to the case with a nondegenerate solution (i.e., by ruling out the case of $\partial s / \partial m < 0$). However, we will allow for the case with no hidden subdivision in the criminal organization (i.e., with $m = n$, which holds under $\partial s / \partial m > 0$). In the case with an interior solution (i.e., $0 < m < n$), we must also check the second-order condition (i.e., $\partial^2 s / \partial m^2 < 0$) to ensure the maximum. Apparently, with endogenous victimization and the gang's operating activeness, it becomes very difficult (if not impossible) to establish the aforementioned conditions or to analytically characterize the steady-state equilibrium. Thus, we will examine these conditions and perform the comparative-static exercises numerically to which we now turn.

## 4. Numerical analysis

In this section, we will provide a numerical characterization of the steady-state equilibrium based on reasonable parametrization of the model economy delineated in Sections 2 and 3 above. In the absence of empirical observations of some key individual and organized criminal activities, we cannot fully calibrate the model to fit the underlying economy. Instead, as shown in the Appendix, we appropriately parametrize the model as best as we can to generate realistic model predictions. The benchmark parameter values are summarized below.

Benchmark parameter values

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| $q^I$ | 0.9 | $w$ | 8 | $c$ | 1.2 | $\beta^I$ | 0.2972 | $\mu$ | 0.824 | $z$ | 0.126 |
| $q^O$ | 1.2 | $a$ | 0.45 | $F_0$ | 0.00033 | $\beta^O$ | 0.6935 | $\eta$ | 0.824 | $\nu$ | 350 |
| $r$ | 0.14 | $\xi$ | 2/3 | $F_1$ | 0.00007 | $\lambda$ | 0.01 | $\pi$ | 0.1 | $\sigma$ | 1 |
| $\delta$ | 0.1386 | $\varphi$ | 0.5 | $\varsigma$ | 5 | $\kappa$ | 6.1229 | $A$ | 7.0163 | | |

The numerical exercises not only help qualify those ambiguous comparative-static outcomes, but also serve to quantify the endogenous responses to parameter shifts as well as to provide a more concrete evaluation of the effectiveness of crime deterrence policies.

### 4.1. Quantitative comparative-static results

Under the selected and computed parameters based on the benchmark model, Assumptions 1–3 are all met. We can now examine how the steady-state equilibrium with endogenous victimization responds to labor-market conditions, crime deterrence policies and the central gang leader's monopoly power. We focus on the responses of (i) the employment rate $(E/\overline{N})$ and the worker's victimization rate $(\alpha)$, (ii) the central gang leader's surplus $(s)$, the organized criminal's commission $(b^*)$, the probability of dismantling a subdivision of the criminal organization $(P)$, and the extent of operating activeness $(m)$, and (iii) the overall crime rate ($(\overline{N}-N)/\overline{N}$), the composition of crimes measured by the ratio of organized to individual criminals ($\Psi/(1-\Psi)$), the masses of criminals ($R^O$, $Q^O$, $R^I$, and $Q^I$), and the fractions of occupations ($O, I$, and $W$). The results are reported in Table 1.

**Result 1** (*Effects of a higher job finding rate*). An increase in the job finding rate raises the employment rate and the fraction of workers, but reduces the victimization rate, the fractions of individual and organized criminals, and the masses of individual and organized criminals in both states. While the overall crime rate is lowered, the ratio of organized to individual criminals is raised. Moreover, the central gang leader's surplus and the probability of dismantling a subdivision decrease, whereas the organized criminal's commission rises.

Intuitively, an improved labor market condition as a result of a higher job finding rate ($\mu$) encourages households to stay in the labor market ($W$ increases), thereby reducing an individual's incentives to commit crimes of either type ($I$ and $O$ both decrease). Thus, the employment rate increases and the populations of individual and organized criminals in both the acquisition and consumption states decrease, leading to a lower overall crime rate. With a thicker labor market, each worker's victimization rate is also reduced. As a result of a lower mass of organized criminals in the acquisition state ($R^O$), the probability of dismantling a subdivision is also lower. This provides a buffer for organized criminals to escape from law enforcement, thereby causing the composition of crime to change from individual to organized criminal activities (i.e., $\Psi/(1-\Psi)$ increases). The reduction in the effective arrest rate facing organized criminals increases the soldier's effort and the flow commission. However, due to a reduction in the mass of organized criminals in the acquisition state, the gang leader's surplus is lower.

**Result 2** (*Effects of tightened crime deterrence*). A tightened crime deterrence policy of either types increases the employment rate and the fraction of workers, but decreases the victimization rate, the fraction of organized criminals, the mass of organized criminals, the overall crime rate, t*he ratio of organized to individual criminals and* the gang leader's surplus. While a higher arrest rate raises the probability of dismantling a subdivision and reduces the commission to soldiers, a higher nonpecuniary punishment leads to the opposite outcome. Moreover, the effects of a higher nonpecuniary punishment are to decrease the fraction and the mass of individual criminals, whereas the impacts of a higher arrest rate are generally ambiguous.

While it is not surprising that a tightened crime deterrence policy of either types ($\pi$ or $z$) suppresses overall criminal activities and encourages labor market activities, the underlying channels of these two policies are different. In response to tightened nonpecuniary punishment, the risk-sharing effect leads to a reduction in the probability of dismantling a subdivision ($P$) because fewer searching soldiers in an active subdivision lowers its exposure for being detected. In addition to this negative risk-sharing effect, however, a tightened arrest rate also generates a positive direct effect on the dismantling probability. Our numerical results suggest that the direct effect dominates the risk-sharing effect and hence the dismantling probability responds positively to the arrest rate. Thus, the equilibrium commission is lower in response to a higher arrest rate but higher in response to tightened nonpecuniary punishment. Regardless of the different responses of the dismantling probability and equilibrium commission, the reduction in the mass of organized criminals in the acquisition state causes the gang leader's surplus to fall.[18]

As shown in Proposition 4, a tightened crime deterrence policy of either types generates a direct effect that discourages both individual and organized crimes. However, because of a positive interdiction effect ($P > \pi$) and the imposition of a more severe nonpecuniary punishment on organized criminals ($\sigma > 0$), there is a crime composition effect as a result of an occupational switch from organized to individual criminals, thus leading to a lower ratio of organized to individual criminals. Since a more severe nonpecuniary punishment raises the soldier's commission but a higher arrest rate lowers it, it is expected that *the crime composition effect is stronger in response to the arrest policy*. Our numerical results indicate that when the level of the arrest rate is sufficiently low, this crime composition effect may outweigh the direct deterrence effect, causing the fraction and the mass of individual criminals to rise. This nonmonotone response to the arrest policy illustrates the potential importance of the crime composition effect for evaluating the crime deterrence policy.

**Remarks.** Two important policy implications concerning the effectiveness of crime deterrence can now be drawn:

(i) In the presence of the risk-sharing effect stated above, the central gang leader's endogenous response can diminish the effectiveness of crime deterrence policies. Yet, due to the positive direct effect of the arrest rate on the dismantling probability, *the arrest rate policy is more effective than the nonpecuniary punishment policy in reducing the overall crime rate*. As shown in Fig. 4, the marginal effect of $z$ is much less than that of $\pi$: a 1% increase in $z$ lowers the overall crime rate by about 0.26%, whereas a 1% increase in $\pi$ reduces the overall crime rate by about 0.57%. As for the composition of crimes, the nonpecuniary punishment policy is also not as effective as the arrest rate policy in discouraging the more

[18] When the arrest rate rises to $\pi = 0.128$, the probability of dismantling a subdivision becomes too high and the central gang leader's surplus falls to zero.

**Table 1**
Quantitative comparative statics with respect to the job finding rate $\mu$, the central gang's monopoly power $\gamma$, the arrest rate $\pi$ and nonpecuniary punishment $z$.

| $\mu$ | $Q^I$ | $R^I$ | $Q^O$ | $R^O+R^H$ | $\Psi/(1-\Psi)$ | $W$ | $I$ | $O$ | $\alpha$ | $E/\bar{N}$ | $(\bar{N}-N)/\bar{N}$ | $b^*$ | $e^*$ | $P$ | $s$ | $m$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.4 | 250.3 | 125.1 | 120.7 | 34.75 | .4140 | .4690 | .3754 | .1554 | .2283 | .2414 | .5309 | 12.0642 | .9851 | .1672 | 83.19 | 15 |
| 0.45 | 217.1 | 108.5 | 120.2 | 34.57 | .4753 | .5195 | .3256 | .1547 | .1633 | .3068 | .4804 | 12.0869 | .9870 | .1665 | 81.98 | 15 |
| 0.5 | 191.3 | 95.67 | 119.7 | 34.39 | .5369 | .5588 | .2870 | .1541 | .1285 | .3595 | .4411 | 12.1091 | .9888 | .1657 | 80.80 | 15 |
| 0.55 | 170.4 | 85.21 | 119.2 | 34.22 | .6002 | .5908 | .2556 | .1534 | .1066 | .4035 | .4091 | 12.1309 | .9906 | .1649 | 79.63 | 15 |
| 0.6 | 153.0 | 76.50 | 118.7 | 34.06 | .6658 | .6176 | .2295 | .1528 | .0915 | .4411 | .3823 | 12.1524 | .9923 | .1642 | 78.48 | 15 |
| 0.65 | 138.1 | 69.08 | 118.2 | 33.89 | .7342 | .6405 | .2072 | .1521 | .0804 | .4736 | .3594 | 12.1737 | .9941 | .1635 | 77.33 | 15 |
| 0.7 | 125.3 | 62.68 | 117.8 | 33.73 | .8057 | .6603 | .1880 | .1515 | .0719 | .5021 | .3396 | 12.1946 | .9958 | .1628 | 76.20 | 15 |
| 0.75 | 114.2 | 57.10 | 117.3 | 33.56 | .8808 | .6777 | .1713 | .1509 | .0652 | .5273 | .3222 | 12.2154 | .9975 | .1620 | 75.07 | 15 |
| **0.824** | **100.0** | **50.00** | **116.6** | **33.33** | **1.000** | **.7000** | **.1500** | **.1500** | **.0574** | **.5600** | **.3000** | **12.2459** | **1.000** | **.1610** | **73.41** | **15** |
| 0.85 | 95.65 | 47.82 | 116.4 | 33.25 | 1.043 | .7068 | .1434 | .1496 | .0552 | .5700 | .2931 | 12.2563 | 1.000 | .1606 | 72.84 | 15 |
| 0.9 | 87.84 | 43.92 | 115.9 | 33.09 | 1.131 | .7191 | .1317 | .1490 | .0514 | .5883 | .2808 | 12.2764 | 1.002 | .1600 | 71.74 | 15 |
| $\gamma$ | $Q^I$ | $R^I$ | $Q^O$ | $R^O+R^H$ | $\Psi/(1-\Psi)$ | $W$ | $I$ | $O$ | $\alpha$ | $E/\bar{N}$ | $(\bar{N}-N)/\bar{N}$ | $b^*$ | $e^*$ | $P$ | $s$ | $m$ |
| 0.4 | 49.08 | 24.54 | 296.1 | 60.85 | 4.848 | .5693 | .0736 | .3569 | .1193 | .4297 | .4306 | 17.6724 | 1.731 | .2742 | 357.4 | 16 |
| 0.42 | 60.25 | 30.12 | 246.5 | 54.55 | 3.331 | .6085 | .0903 | .3011 | .0972 | .4687 | .3914 | 16.4002 | 1.553 | .2498 | 294.0 | 16 |
| 0.44 | 70.99 | 35.49 | 205.1 | 48.68 | 2.383 | .6396 | .1064 | .2538 | .0820 | .4998 | .3603 | 15.2295 | 1.392 | .2262 | 233.9 | 16 |
| 0.46 | 81.22 | 40.61 | 170.4 | 43.19 | 1.753 | .6645 | .1218 | .2136 | .0712 | .5246 | .3354 | 14.1519 | 1.248 | .2035 | 177.1 | 15 |
| 0.47 | 86.13 | 43.06 | 155.2 | 40.60 | 1.515 | .6749 | .1291 | .1958 | .0670 | .5350 | .3250 | 13.6457 | 1.181 | .1925 | 149.9 | 15 |
| 0.48 | 90.89 | 45.44 | 141.2 | 38.09 | 1.315 | .6843 | .1363 | .1793 | .0633 | .5443 | .3156 | 13.1598 | 1.117 | .1818 | 123.6 | 15 |
| 0.49 | 95.51 | 47.75 | 128.4 | 35.67 | 1.145 | .6926 | .1432 | .1641 | .0602 | .5526 | .3073 | 12.6935 | 1.057 | .1713 | 98.13 | 15 |
| **0.5** | **100.0** | **50.00** | **116.6** | **33.33** | **1.000** | **.7000** | **.1500** | **.1500** | **.0574** | **.5600** | **.3000** | **12.2459** | **1.000** | **.1610** | **73.41** | **15** |
| 0.51 | 104.3 | 52.17 | 105.8 | 31.07 | .8747 | .7065 | .1565 | .1369 | .0551 | .5665 | .2934 | 11.8161 | .9456 | .1510 | 49.45 | 14 |
| 0.52 | 108.5 | 54.27 | 95.85 | 28.90 | .7661 | .7124 | .1628 | .1247 | .0530 | .5723 | .2875 | 11.4033 | .8939 | .1412 | 26.23 | 14 |
| 0.53 | 112.6 | 56.31 | 86.65 | 26.79 | .6715 | .7176 | .1689 | .1134 | .0512 | .5775 | .2823 | 11.0069 | .8448 | .1316 | 3.732 | 14 |
| $\pi$ | $Q^I$ | $R^I$ | $Q^O$ | $R^O+R^H$ | $\Psi/(1-\Psi)$ | $W$ | $I$ | $O$ | $\alpha$ | $E/\bar{N}$ | $(\bar{N}-N)/\bar{N}$ | $b^*$ | $e^*$ | $P$ | $s$ | $m$ |
| 0.05 | 103.9 | 51.99 | 201.4 | 55.71 | 1.648 | .5867 | .1559 | .2572 | .1007 | .4505 | .4132 | 13.0737 | 1.067 | .1331 | 373.4 | 19 |
| 0.06 | 107.4 | 53.70 | 174.4 | 48.61 | 1.384 | .6157 | .1611 | .2231 | .0875 | .4786 | .3842 | 12.8788 | 1.051 | .1396 | 277.5 | 17 |
| 0.07 | 107.8 | 53.90 | 154.4 | 43.33 | 1.223 | .6404 | .1617 | .1978 | .0775 | .5026 | .3595 | 12.7042 | 1.037 | .1454 | 206.7 | 17 |
| 0.08 | 106.3 | 53.15 | 139.0 | 39.24 | 1.117 | .6622 | .1594 | .1782 | .0696 | .5236 | .3377 | 12.5429 | 1.024 | .1509 | 152.1 | 16 |
| 0.085 | 105.0 | 52.53 | 132.5 | 37.53 | 1.079 | .6723 | .1575 | .1700 | .0661 | .5333 | .3276 | 12.466 | 1.017 | .1535 | 129.2 | 15 |
| 0.09 | 103.5 | 51.78 | 126.7 | 35.98 | 1.047 | .6819 | .1553 | .1626 | .0630 | .5426 | .3180 | 12.391 | 1.011 | .1560 | 108.7 | 15 |
| 0.095 | 101.8 | 50.93 | 121.4 | 34.59 | 1.021 | .6911 | .1528 | .1560 | .0601 | .5514 | .3088 | 12.3177 | 1.005 | .1585 | 90.24 | 15 |
| **0.1** | **100.0** | **50.00** | **116.6** | **33.33** | **1.000** | **.7000** | **.1500** | **.1500** | **.0574** | **.5600** | **.3000** | **12.2459** | **1.000** | **.1610** | **73.41** | **15** |
| 0.105 | 97.99 | 48.99 | 112.3 | 32.18 | .9829 | .7085 | .1469 | .1444 | .0550 | .5681 | .2914 | 12.1753 | .9942 | .1634 | 58.06 | 14 |
| 0.11 | 95.87 | 47.93 | 108.3 | 31.12 | .9695 | .7167 | .1438 | .1394 | .0526 | .5761 | .2832 | 12.1058 | .9885 | .1658 | 43.99 | 14 |
| 0.115 | 93.66 | 46.83 | 104.6 | 30.15 | .9594 | .7247 | .1404 | .1347 | .0504 | .5837 | .2752 | 12.0373 | .9829 | .1682 | 31.05 | 14 |
| 0.125 | 89.01 | 44.50 | 98.09 | 28.42 | .9475 | .7399 | .1335 | .1265 | .0464 | .5983 | .2600 | 11.9027 | .9719 | .1728 | 8.021 | 13 |
| $z$ | $Q^I$ | $R^I$ | $Q^O$ | $R^O+R^H$ | $\Psi/(1-\Psi)$ | $W$ | $I$ | $O$ | $\alpha$ | $E/\bar{N}$ | $(\bar{N}-N)/\bar{N}$ | $b^*$ | $e^*$ | $P$ | $s$ | $m$ |
| 0.07 | 105.8 | 52.92 | 137.5 | 40.88 | 1.123 | .6628 | .1587 | .1783 | .0689 | .5244 | .3371 | 11.3097 | .9235 | .1937 | 120.7 | 15 |
| 0.08 | 105.3 | 52.65 | 133.0 | 39.22 | 1.090 | .6697 | .1579 | .1722 | .0667 | .5310 | .3302 | 11.5094 | .9398 | .1866 | 111.3 | 15 |
| 0.09 | 104.5 | 52.25 | 129.0 | 37.72 | 1.063 | .6765 | .1567 | .1667 | .0645 | .5375 | .3234 | 11.6927 | .9548 | .1802 | 102.3 | 15 |
| 0.1 | 103.4 | 51.74 | 125.2 | 36.36 | 1.041 | .6831 | .1552 | .1616 | .0624 | .5438 | .3168 | 11.8613 | .9686 | .1743 | 93.78 | 15 |
| 0.11 | 102.2 | 51.13 | 121.7 | 35.12 | 1.022 | .6896 | .1534 | .1568 | .0605 | .5501 | .3103 | 12.0172 | .9813 | .1689 | 85.68 | 15 |
| **0.126** | **100.0** | **50.00** | **116.6** | **33.33** | **1.000** | **.7000** | **.1500** | **.1500** | **.0574** | **.5600** | **.3000** | **12.2459** | **1.000** | **.1610** | **73.41** | **15** |
| 0.13 | 99.41 | 49.70 | 115.5 | 32.94 | .9957 | .7023 | .1491 | .1484 | .0568 | .5622 | .2976 | 12.2959 | 1.004 | .1593 | 70.67 | 14 |
| 0.14 | 97.81 | 48.90 | 112.7 | 31.98 | .9864 | .7085 | .1467 | .1447 | .0550 | .5681 | .2914 | 12.4211 | 1.014 | .1550 | 63.71 | 14 |
| 0.15 | 96.11 | 48.05 | 110.1 | 31.09 | .9794 | .7146 | .1441 | .1412 | .0533 | .5739 | .2853 | 12.5381 | 1.023 | .1510 | 57.10 | 14 |
| 0.16 | 94.34 | 47.17 | 107.6 | 30.26 | .9746 | .7205 | .1415 | .1379 | .0517 | .5796 | .2794 | 12.6477 | 1.032 | .1473 | 50.80 | 14 |
| 0.17 | 92.50 | 46.25 | 105.3 | 29.49 | .9718 | .7263 | .1387 | .1348 | .0502 | .5852 | .2736 | 12.7506 | 1.041 | .1439 | 44.81 | 14 |

serious type of crimes (i.e., organized crimes). Indeed, the relative difference in the two marginal effects on the composition of crimes is even more substantive than that in relation to the overall crime. It should be noted that while this result at its face value is similar to the prediction by Becker (1968) and Ehrlich (1973), the underlying channels via the composition and risk-sharing effects in our model are entirely different from what is found in their studies.

(ii) By a quantitative experiment, Engelhardt et al. (2008) find that while crime deterrence policies have strong effects on criminal activities, they have virtually no effect on the labor-market outcomes. By contrast, our numerical exercises indicate that there exists a *nonnegligible effect* of either policies on the employment rate in the formal labor market: a 5% increase in the arrest rate raises the employment rate by about 1.46%, whereas a 5% increase in the nonpecuniary punishment increases the employment rate by about 0.67%.

It is evident from Results 1 and 2 that, in response to any labor-market and crime policy, the unemployment and the overall crime rates always change in the same direction. This positive relationship between the unemployment and the crime rates corroborates the empirical findings in Gould et al. (2002), as well as the theoretical results in Burdett et al. (2003) and Huang et al. (2004).

More importantly, Results 1 and 2 also provide empirically testable implications for the equilibrium relationship between the overall rate and the composition of crimes, highlighted as follows:

**Result 3** (*Overall crime rate versus the composition of crimes*). The relationship between the overall crime rate and the ratio of organized to individual criminals is negative in response to changes in labor-market conditions, but positive in response to changes in crime deterrence policies.

In particular, in response to changes in labor-market conditions, the overall crime rate and the ratio of organized to individual criminals exhibit a negative relationship. That is, while the economy-wide criminal activity declines, the proportion of more severe (organized) crimes rises due to the presence of a risk-sharing effect on organized crimes. This result implies that those labor-market policies aimed at improving labor-market opportunities (such as those discussed in Engelhardt et al., 2008) may reduce the overall crime rate, but need not benefit the society if the detrimental effect from rising organized crime is sufficiently large. On the contrary, in response to changes in crime deterrence policies and the structure of the criminal organization, the overall crime rate and the ratio of organized to individual criminals exhibit a positive relationship. That is, when the economy-wide criminal activity is lower, the proportion of more severe crimes falls more than proportionately. This provides a rationale for a stronger crime-reduction effect of punishments due to changes in the composition of crimes.

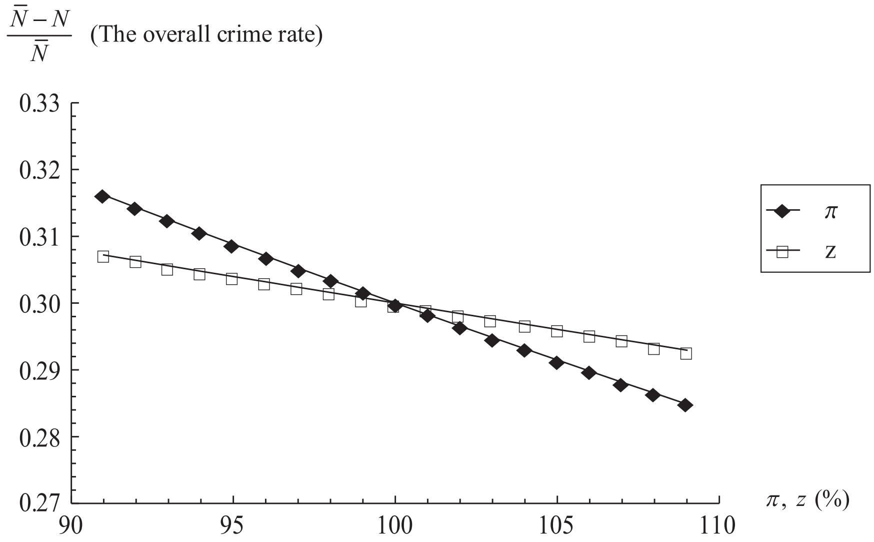
**Result 4** (*Responses to an increase in the central gang leader's monopoly power*). An increase in the gang leader's monopoly power increases the employment rate, the fraction of workers and individual criminals, and the masses of individual criminals in both states, while reducing the victimization rate, the fraction of organized criminals, the masses of organized criminals in both states, the overall crime rate, and the ratio of organized to individual criminals. Moreover, it decreases the probability of dismantling a subdivision, the equilibrium commission to soldiers, as well as the gang leader's surplus.

Proposition 1 indicates that, for a given victimization rate, the direct effect of the rising monopoly power of the gang leader (a higher $\gamma^*$ as a result of a lower $\varphi$) results in a lower commission to soldiers. This negative commission effect induces an occupational switch from organized to individual crimes without affecting either the total proportion of criminals or the mass of workers, as shown in Proposition 5. However, in general equilibrium, such an occupational switch leads to tougher competition in the individual crime market, thereby causing some with relatively higher disutility costs of committing crimes to switch to the formal labor market. Thus, the overall crime rate is lower, the employment rate is higher, and the thickened labor market causes the victimization rate facing each worker to fall. As a result of a lower mass of organized criminals in the acquisition state, the gang leader's surplus decreases.

In the conventional literature, a criminal organization is often thought of as a monopolistic firm, and the theory of monopoly is predominantly used to analyze organized crimes. Because criminal activities are seen as “social bads” and because a monopolistic market structure is associated with a smaller “output of crime” than a perfectly competitive one, organized crimes are viewed as socially more preferred. Although our numerical results suggest that a higher monopoly power of the central gang leader lowers the overall crime rate, the equilibrium level of individual criminal activities increases.

**Result 5** (*Responses of the central gang leader's operating activeness*). The number of active subdivisions in the criminal organization declines when the job finding rate is higher, the central gang leader's monopoly power increases, or the crime deterrence policy is tightened.

In response to a higher job finding rate, a higher gang leader's monopoly power, or tightened crime deterrence, households are discouraged from joining the criminal organization, thereby resulting in a lower fraction and hence a smaller mass of organized criminals. As a consequence, the gang leader becomes less active in his operation. As shown in Proposition 3, individual crimes can be viewed as a buffer to changes in the formal labor-market conditions; thus, organized criminal activities are less responsive to the job finding rate, as is the gang's operating activeness. From our numerical results, it can be seen that as the gang leader's monopoly power measured by $\gamma^* = 1-\varphi$ rises from 0.4 to 0.53 (benchmark $\gamma^* = 0.5$), the gang's surplus-maximizing number of active subdivisions declines from 16 (out of 20) to 14. When the arrest rate increases from 5% to 12.5% (benchmark $\pi = 10\%$) or when the nonpecuniary punishment increases from 0.07 to 0.17 (i.e., about 50% below and above its benchmark value of 0.126), the gang's surplus-maximizing number of active subdivisions decreases from 16 to 14. When the two crime deterrence policies are allowed to change jointly, Chart 1 shows that the gang's surplus-maximizing number of active subdivisions is lower when both deterrence policies are tightened and higher when both policies are loosened, ranging from 11 (i.e., 55% of subdivisions are active) to 17 (i.e., 85% of subdivisions are active).



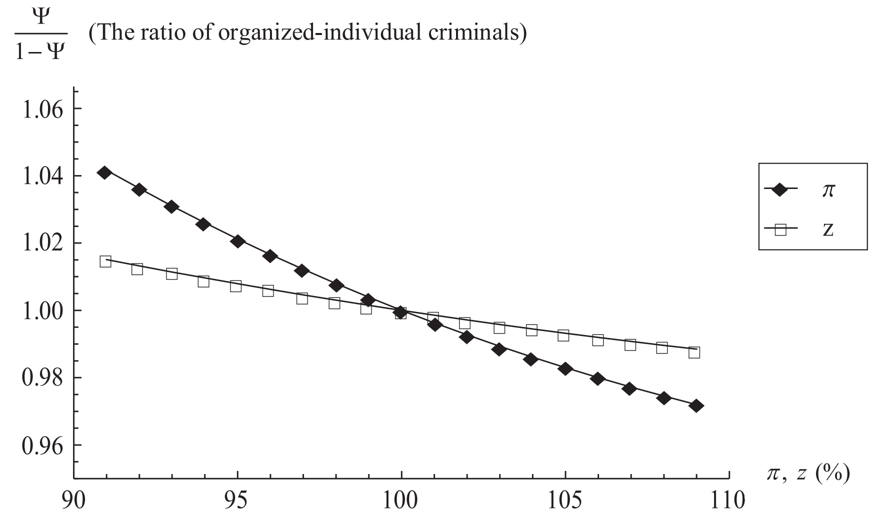




**Fig. 4.** The marginal effects of the arrest rate $\pi$ and nonpecuniary punishment $z$.

### 4.2. On the size of the criminal organization

In this subsection, we will address two separate issues concerning the size of the criminal organization measured by $n$. On the one hand, we will examine the effect of an exogenous increase in the size of the criminal organization on criminal activities. On the other, we will also determine the surplus-maximizing size of the criminal organization.

It should be noted that there are two indicators that may capture the monopoly power of the gang leader in our model: one is the central gang leader's power $\gamma^*$ (pinned down by $1-\varphi$, as used in the previous section) and another is the scale of the criminal organization, namely, the total number of subdivisions $n$. Result 4 points out a common notion in the literature whereby a higher monopoly power is associated with a lower crime rate. To have a more complete picture, we now turn to investigating the relationship between the size of the criminal organization, the overall crime rate measured by $(\overline{N}-N)/\overline{N}$, the employment rate, and type-specific criminal activities (as reported in Table 2). We further determine the surplus-maximizing size of the criminal organization, depending on the underlying primitives.

**Result 6** (*Effects of an expansion in the size of the criminal organization*). When the size of the criminal organization is relatively small (large), an exogenous increase in such size reduces (raises) the employment rate, but increases (decreases) the fraction and the mass of organized criminals, the victimization rate, the central gang leader's surplus, the overall crime rate and the ratio of organized to individual criminals. Moreover, the fraction of active subdivisions is weakly decreasing in the size of the criminal organization.

| $\pi$ \ $m$ | **0.025** | **0.126** | **0.225** | **0.325** |
|---|---|---|---|---|
| **0.07** | 17 | 17 | 16 | 15 |
| **0.10** | 15 | 15 | 14 | 13 |
| **0.13** | 14 | 13 | 12 | 12 |
| **0.16** | 13 | 12 | 12 | 11 |
| **0.19** | 12 | 12 | 11 | 11 |

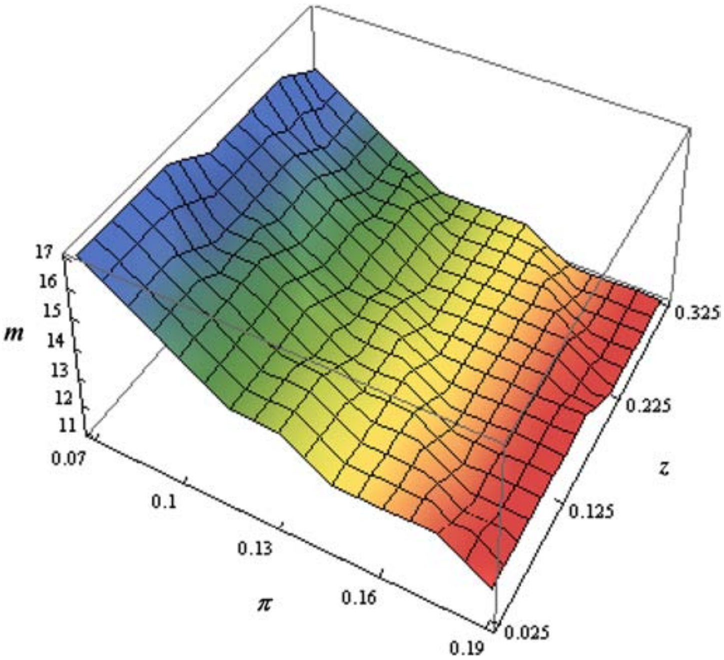



**Chart 1.** The gang's surplus-maximizing operating activeness $z$.

**Table 2**
The effects of an expansion in the size of the criminal organization $n$.

| $n$ | $R^I$ | $R^O+R^H$ | $\Psi/(1-\Psi)$ | $W$ | $I$ | $O$ | $\alpha$ | $E/\overline{N}$ | $(\overline{N}-N)/\overline{N}$ | $b^*$ | $F$ | $P$ | $s$ | $m$ | $m/n$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 10 | 52.67 | 31.45 | 1.259 | .6430 | .1580 | .1989 | .0805 | .5031 | .3569 | 15.94 | 40.00 | .2821 | 423.7 | 10 | 1.000 |
| 11 | 49.84 | 34.44 | 1.458 | .6323 | .1495 | .2181 | .0855 | .4924 | .3676 | 15.98 | 64.42 | .2810 | 445.0 | 11 | 1.000 |
| **12** | **47.05** | **37.41** | **1.680** | **.6216** | **.1411** | **.2371** | **.0906** | **.4818** | **.3783** | **16.03** | **99.53** | **.2799** | **455.4** | **12** | **1.000** |
| 13 | 44.29 | 40.35 | 1.927 | .6109 | .1328 | .2561 | .0959 | .4711 | .3890 | 16.08 | 148.5 | .2789 | 451.9 | 13 | 1.000 |
| 14 | 41.56 | 43.26 | 2.205 | .6003 | .1246 | .2749 | .1015 | .4605 | .3996 | 16.12 | 215.1 | .2779 | 430.7 | 14 | 1.000 |
| 15 | 38.86 | 46.15 | 2.518 | .5897 | .1165 | .2936 | .1074 | .4499 | .4102 | 16.17 | 303.7 | .2768 | 387.3 | 15 | 1.000 |
| **16** | **36.19** | **49.01** | **2.875** | **.5791** | **.1085** | **.3122** | **.1135** | **.4394** | **.4208** | **16.21** | **419.4** | **.2758** | **316.7** | **16** | **1.000** |
| 17 | 42.90 | 41.18 | 1.751 | .6458 | .1287 | .2254 | .0793 | .5059 | .3541 | 14.45 | 303.7 | .2252 | 247.8 | 15 | .8820 |
| 18 | 45.17 | 38.59 | 1.454 | .6672 | .1355 | .1971 | .0701 | .5273 | .3327 | 13.67 | 303.8 | .2022 | 185.2 | 15 | .8330 |
| 19 | 47.55 | 35.97 | 1.207 | .6851 | .1426 | .1721 | .0630 | .5451 | .3148 | 12.93 | 304.0 | .1808 | 127.1 | 15 | .7890 |
| 20 | 50.00 | 33.33 | 1.000 | .7000 | .1500 | .1500 | .0574 | .5600 | .3000 | 12.24 | 304.7 | .1610 | 73.41 | 15 | .7500 |
| 21 | 57.84 | 25.14 | .5658 | .7282 | .1735 | .0981 | .0476 | .5882 | .2717 | 10.68 | 220.6 | .1185 | 27.76 | 14 | .6670 |

**Result 7** (*Surplus-Maximizing Size of the Criminal Organization*). When the household's opportunity cost of committing crimes and the gang's organizational cost are low (high), the surplus-maximizing size of the criminal organization is associated with fully (partially) active subdivisions.

Intuitively, regardless of the *initial* size, a larger size always raises the organizational cost. In the case with a smaller initial size of the criminal organization, the scarcity of soldiers leads the gang to a full operation of all subdivisions (i.e., $m/n=1$). An exogenous expansion of the gang's size induces an occupational switch toward organized crimes and lowers the employment rate. The latter effect causes each worker to face a higher victimization rate. As the mass of active soldiers increases, the gang leader's potential profits also rise. Diagrammatically, we can illustrate these effects using Fig. 3: in response to an expansion in the gang's size, the $OC^{IO}$ locus shifts rightward ($R^O$ rises for a given $\alpha$) whereas the $OC^{IW}$ locus shifts upward ($\alpha$ rises for a given $R^O$), leading to higher values of $R^O$ and $\alpha$ under normality and regularity conditions. As a result, not only the overall crime, but also the ratio of organized to individual crimes, increases. However, in the case with a larger initial size of the criminal organization, it is not necessary for the gang to fully operate all subdivisions (under the benchmark parametrization, for example, hidden subdivisions arise when $n>16$). It is interesting to note that, due to the conflicting effects, the net effect of the size of the criminal organization on the overall crime rate is nonmonotone. That is, when the central gang leader's monopoly power is measured by the size of the criminal organization (rather than by its internal power), an increase in the monopoly power can be associated with a *larger* output of crimes, in contrast to the conventional literature.

By balancing the rising organizational cost with the rising potential profit, one can endogenously pin down the surplus-maximizing gang's size. Under the benchmark parametrization, this surplus-maximizing gang's size turns out to be 12. In this case, all subdivisions are active. It is interesting to note that the surplus-maximizing gang's size need not lead to the largest organization in gang memberships. Under the benchmark parametrization, gang memberships (measured by $R^O+R^H$ or $O$) reach the maximum when the number of subdivisions is 16. In this case, gang memberships turn out to be 31% larger than under the surplus-maximizing gang's size (12) whereas the employment rate reaches the trough and the overall crime rate and the ratio of organized to individual criminals are both peaked. However, the surplus accruing to the gang leader is only about 70% of its maximized level because the incremental potential profit cannot cover the incremental organizational cost. This rapidly increasing organizational cost discourages the formation of large-size criminal organizations.[19] As discussed in Reuter (1983), the high risks and costs associated with criminal organizations limit their size. This is empirically verified by Reuter and Haaga (1989) concerning the observations of small-size drug trafficking organizations. Since our model provides detailed economic channels underlying the determination of the size and memberships of gangs, it may be used to guide empirical analysis toward understanding the size variation of gangs.

While in the benchmark the surplus-maximizing gang size implies a full operating activeness ($m/n=1$), it is easy to produce a case with partial operating activeness by selecting different parameter values. Consider an alternative economy with higher organizational efficiency of the gang ($A=10$) and higher returns to scale to the soldier's effort ($\varphi=0.6$). These are accompanied by a larger variable operating cost ($c=12$) and a greater curvature of the organizational cost in the expansion of gang size ($\varsigma=6.15$). Under this parametrization, the surplus-maximizing gang size falls to 8 whereas the number of active subdivisions becomes 7 (so $m/n=0.875$ and not all subdivisions are active).

Finally, one may inquire as to what happens with multiple gangs being involved in organized crimes. There are two direct effects: while competition naturally decreases each gang's size, the internal power of each gang leader must also be reduced. If the gang monopolist is originally not over-sized, Result 6 implies that a reduction in the gang's size through competition can lower the mass and the fraction of organized crimes and the overall crime rate. Yet, from Result 4, a reduction in the gang leader's internal power tends to raise the soldiers' commissions and increase organized criminal activities as well as the overall crime rate. In addition to these opposing direct effects, there is a negative interdiction effect that makes the arrest policy less effective, causing organized criminal activities and the overall crime rate to rise. On balance, the net effects of gang competition on the composition and the overall rate of crimes are generally ambiguous.

## 5. Concluding remarks

We have developed a general-equilibrium search-theoretic framework to examine the interactions between the formal labor market and the individual as well as the organized criminal activities. We have shown that changes in labor market conditions, crime deterrence policies and the monopoly power of the criminal organization may lead to very different occupational choice outcomes. These outcomes together with the endogenous determination of workers' victimization rates, criminals' arrest rates, the soldiers' flow commission, and the gang's operating activeness have led to very rich comparative-static results. We would like to highlight some interesting model predictions that help address the following questions regarding empirically testable hypotheses or policy implications.

- Is the relationship between the overall crime rate and the ratio of organized to individual criminals always positive? We have shown that while such a relationship is positive in response to changes in crime deterrence policies and the structure of the criminal organization, it is negative in response to changes in labor-market conditions.
- Is the level of crimes lower under a monopolized criminal organization? We have shown that the opposite applies when the gang leader's monopoly power is measured by the scale of the criminal organization in which an increase in the monopoly power is associated with a larger output of crime.
- Can labor-market improvement programs serve as anti-crime policies to benefit the society? We have shown the possibility of a detrimental effect from rising organized crimes: while the economy-wide criminal activity falls, the proportion of more severe organized crimes rises due to the risk-sharing effects associated with organized crimes.
- Would conventional crime deterrence policies be effective when the composition of crimes responds endogenously? We have shown that due to this crime composition effect, the population of a particular type of criminal (in particular, individual crimes) may rise in response to a tightened crime deterrence policy (in particular, an arrest policy). Moreover, due to its direct influence on the dismantling rate of the active subdivisions of the organized organization, an arrest policy is generally more effective than a nonpecuniary punishment policy in terms of reducing the overall crime rate or discouraging the more severe organized crimes.

[19] When $n$ rises to 22, the central gang leader's surplus turns out to be negative.

In particular, our theoretical findings concerning the first three aforementioned issues can be tested empirically with existing data based on reports of law enforcement agencies as well as surveys from field investigations and interviews with arrestees and law enforcers, where we can collect data on theft/burglary/robbery and drug trafficking crimes committed by individuals and gangs. Regarding the non-monotonic relationship between the overall crime rate and the ratio of organized to individual criminals, one may compute the overall crime rates for states from the FBI's Uniform Crime Reporting data and the ratios of gang and nongang-related crimes from the National Gang Intelligence Center (National Gang Threat Survey) as well as state governments' statistics concerning Gang Threat Assessments. With respect to the size variation of gangs, one may investigate whether the number of gang sets and the overall crime rate are positively correlated across space and why the size of gangs is small. The measures of gang sets and gang memberships can be found in the National Gang Threat Survey (state variation) and in, for example, the New Jersey State Policy Gang Survey (county variation). With the data delineated above, one can then examine the responsiveness of organized criminal activities (measured by gang memberships, gang-related crime incidents and the ratios of gang and nongang-related crimes) to formal labor market conditions.

A natural extension to our occupational choice framework is to allow some criminals to participate in the formal labor market on a part-time basis. It is expected that the criminals' participation in the formal sector may dampen the effects of labor market conditions and crime deterrence policies. The second extension is to consider a “peer learning effect” in that the flow rate at which an organized criminal encounters a victim is positively related to the total mass of organized criminals in the acquisition state. This may yield strategic complementarity between the individual agent's occupational choice decisions, possibly resulting in the coexistence of high organized crime and low organized crime equilibria. Finally, our framework can be used to perform a normative analysis of the optimal law enforcement. In particular, how to design a deterrence policy against organized crimes may be very different from a more conventional policy against individual crimes. Of course, to successfully perform any of these extensions, it is necessary to further simplify the benchmark model.

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## Appendix A

For detailed mathematical derivations and proofs and numerical parametrization, the reader is referred to our working paper at http://pingwang.wustl.edu/.

*Existence of a steady-state equilibrium with exogenous operating activeness*: From (1), (7)–(9), and (19) we can express the steady-state equilibrium values $(N, E, U, \Psi, Q^I, R^I, Q^O)$ as a function of $(R^O, \alpha)$. By defining $\Omega^1 \equiv nR^O/(mU+mR^I+nR^O) - d_1(R^O)$ and $\Omega^2 \equiv nR^I/(mU+mR^I+nR^O) - [d_2(R^O,\alpha) - d_1(R^O)]$, the slopes of the $OC^{IO}$ and the $OC^{IW}$ loci are given by $d\alpha/dR^O|_{OC^{IO}} = -\Omega^1_{R^O}/\Omega^1_\alpha$ and $d\alpha/dR^O|_{OC^{IW}} = -\Omega^2_{R^O}/\Omega^2_\alpha$. From (20), we obtain

$$\Omega^1_{R^O} \equiv \frac{mn\left[U+R^I - R^O \dfrac{\partial(U+R^I)}{\partial R^O}\right]}{(mU+mR^I+nR^O)^2} - \frac{\partial d_1}{\partial R^O} > 0,$$

$$\Omega^1_\alpha \equiv \frac{-mnR^O}{(mU+mR^I+nR^O)^2}\frac{\partial(U+R^I)}{\partial\alpha} - \frac{\partial d_1}{\partial\alpha} < 0,$$

$$\Omega^2_{R^O} \equiv \frac{m\left[(mU^*+nR^O)\dfrac{\partial R^I}{\partial R^O} - mR^I\cdot\dfrac{\partial U}{\partial R^O} - nR^I\right]}{(mU+mR^I+nR^O)^2} - \frac{\partial(d_2-d_1)}{\partial R^O} < 0,$$

$$\Omega^2_\alpha \equiv \frac{m\left[(mU+nR^O)\dfrac{\partial R^I}{\partial\alpha} - mR^I\cdot\dfrac{\partial U}{\partial\alpha}\right]}{(mU+mR^I+nR^O)^2} - \frac{\partial(d_2-d_1)}{\partial\alpha} \gtrless 0,$$

where $\partial d_1/\partial\alpha = 0$, $\partial d_1/\partial R^O < 0$, $\partial(d_2-d_1)/\partial\alpha > 0$, and $\partial(d_2-d_1)/\partial R^O > 0$ if the indirect tax revenue effect is not too strong. Under the normality condition that better labor market conditions reduce criminal activities, $\Omega^2_\alpha > 0$ (which implies $d\alpha/dR^O|_{OC^{IW}} > 0$) and $d\alpha/dR^O|_{OC^{IW}} < d\alpha/dR^O|_{OC^{IO}}$.

We now use (20) to solve the steady-state equilibrium with exogenous operating activeness. We use the first expression of (20) and apply the implicit function theorem to obtain: $\alpha = f(R^O, m)$. We then substitute the above relationship into the second expression of (20) to yield the fixed point mapping

$$R^O = \Phi(R^O, m) \equiv \frac{m}{n}\left[\left(\frac{1}{d_2(R^O, f(R^O, m)) - d_1(R^O)} - 1\right) R^I(R^O, f(R^O, m)) - U(R^O, f(R^O, m))\right],$$

where we can show that $\Phi(R^O, m)$ is increasing in $R^O$ and is steeper than the 45° line, provided that $m > 1$. We can also show that $\Phi(0, m) < 0$ and $\partial\Phi(R^O, m)/\partial R^O > 1$, which imply the existence of a unique fixed point $R^O > 0$. Moreover, we can further show that $\Phi(0, m)$ is decreasing in $m$, implying that the steady-state equilibrium associated with a more actively operated criminal organization (a higher $m$) must feature a larger mass of active soldiers $R^O$. □

*Endogenous determination of operating activeness*: Given $R^O = R^O(m)$, the first-order condition is

$$\left[-A\beta^O w\left(\frac{\partial e^{*\varphi}}{\partial m} - \frac{\partial (Pe^{*\varphi})}{\partial m}\right) - \frac{n}{m}\frac{\partial b^*}{\partial m} + \frac{nb^*}{m^2}\right] R^O + \left[A(1-P)\beta^O e^{*\varphi} w - c - \frac{nb^*}{m}\right]\frac{\partial R^O}{\partial m} - \frac{\partial F}{\partial m} = 0. \quad \square$$

## Appendix B. Supplementary data

Supplementary data associated with this article can be found in the online version at http://dx.doi.org/10.1016/j.euroecorev.2013.05.004.

## References


Becker, G.S., 1968. Crime and punishment: an economic approach. Journal of Political Economy 76, 169–217.
Bouchard, M., Spindler, A., 2010. Groups, gangs, and delinquency: does organization matter?. Journal of Criminal Justice 38, 921–933.
Buchanan, J.M., 1973. A defense of organized crime?. In: Rottenberg, S. (Ed.), The Economics of Crime and Punishment, American Enterprise Institute, Washington, DC, pp. 119–132.
Burdett, K., Lagos, R., Wright, R., 2003. Crime, inequality, and unemployment. American Economic Review 93, 1764–1777.
Chang, J.J., Lu, H.C., Chen, M., 2005. Organized crime or individual crime? endogenous size of a criminal organization and the optimal law enforcement. Economic Inquiry 43, 661–675.
Conley, J., Wang, P., 2006. Crime and ethics. Journal of Urban Economics 60, 107–123.
Diamond, P., 1984. Money in search equilibrium. Econometrica 52, 1–20.
Ehrlich, I., 1973. Participation in illegitimate activities: a theoretical and empirical investigation. Journal of Political Economy 83, 521–565.
Engelhardt, B., Rocheteau, G., Rupert, P., 2008. Crime and the labor market: a search model with optimal contracts. Journal of Public Economics 92, 1876–1891.
Esbensen, F., Huizinga, D., 1993. Gangs, drugs, and delinquency in a survey of urban youth. Criminology 31, 565–589.
Garoupa, N., 2000. The economics of organized crime and optimal law enforcement. Economic Inquiry 38, 278–288.
Garoupa, N., 2007. Optimal law enforcement and criminal organization. Journal of Economic Behavior & Organization 63, 461–474.
Gould, E., Mustard, D., Weinberg, B., 2002. Crime rates and local labor market opportunities in the united states, 1979–97. Review of Economics and Statistics 84, 45–61.
Gottschalk, P., 2008. How criminal organizations work: some theoretical perspectives. Police Journal 81, 46–61.
Grossman, H.I., 1995. Rival kleptocrates: the mafia versus the state. In: Fiorentini, G., Peltzman, S. (Eds.), The Economics of Organized Crime, Cambridge University Press and CEPR, Cambridge, pp. 143–156.
Hagedorn, J.M., 1994. Neighborhoods, markets, and gang drug organization. Journal of Research in Crime and Delinquency 31, 264–294.
Huang, C.C., Laing, D., Wang, P., 2004. Crime and poverty: a search-theoretic approach. International Economic Review 45, 909–938.
Howell, J.C., Egley Jr., A., George, E.T., Griffiths, E., 2011. U.S. Gang Problem Trends and Seriousness, 1996–2009. National Gang Center Bulletin, No. 6. Office of Juvenile Justice and Delinquency Prevention.
İmrohoroğlu, A., Merlo, A., Rupert, P., 2004. What accounts for the decline in crime? International Economic Review 45, 707–729.
Kaplan, D., Dubro, A., 2003. Yakuza: Japan's Criminal Underworld. University of California Press, Berkeley, CA.
Kinnes, I., 2000. From Urban Street Gangs to Criminal Empires: The Changing Face of Gangs in the Western Cape, ISS Monograph 28, Institute of Security Studies, Halfway House.
Klein, M.W., 1968. From Association to Guilt: The Group Guidance Project in Juvenile Gang Intervention. University of Southern California Press, Los Angeles.
Klein, M.W., 1998. Street gangs. In: Tonry, M. (Ed.), The Handbook of Crime and Punishment, Oxford University Press, Oxford, pp. 111–132.
Kühne, H.H., 1994. Comparisons in good and bad: criminality in Japan and Germany. Forensic Science International 69, 187–193.
Levitt, S., Venkatesh, S., 2000. An economic analysis of a drug-selling gang's finances. Quarterly Journal of Economics 115, 755–789.
Liddick, D., 1999. The enterprise "model" of organized crime: assessing theoretical propositions. Justice Quarterly 16, 403–430.
Lochner, L., 2004. Education, work and crime: a human capital approach. International Economic Review 45, 811–843.
Mallory, S.L., 2007. Understanding Organized Crime. Jones and Bartlett Publishers, Sudbury, MA.
Mansour, A., Marceau, N., Mongrain, S., 2006. Gangs and crime deterrence. Journal of Law, Economics, and Organization 22, 315–339.
Merlo, A., 2001. The Research Agenda: Dynamic Models of Crime and Punishment, Economic Dynamics Newsletter 2 (2) (supplement to the Review of Economic Dynamics 2.2).
Mieczkowski, T., 1986. Geeking up and throwing down: heroin street life in detroit. Criminology 24, 645–666.
Milhaupt, C.J., West, M.D., 2000. The dark side of private ordering: an institutional and empirical analysis of organized crime. The University of Chicago Law Review 67, 41–98.
Paoli, L., 2007. Mafia and organised crime in italy: the unacknowledged successes of law enforcement. West European Politics 30, 854–880.
Reuter, P., 1983. Disorganized Crime: The Economics of the Visible Hand. MIT Press, Cambridge, MA.
Reuter, P., 1985. The Organization of Illegal Markets: An Economic Analysis. National Institute of Justice, Washington, DC.
Reuter, P., Haaga, J., 1989. The Organization of High-Level Drug Markets: An Exploratory Study. Rand, Santa Monica, CA.
Sah, R.K., 1991. Social osmosis and patterns of crime. Journal of Political Economy 94, 1272–1295.
Salagaev, A., Shashkin, A., Sherbakova, I., Touriyanskiy, E., 2005. Contemporary Russian gangs: history, membership, and crime involvement. In: Decker, S. H., Weerman, F.M. (Eds.), European Street Gangs and Troublesome Youth Groups, AltaMira Press, Walnut Creek, CA, pp. 169–191.

Schelling, T.C., 1967. Economic analysis of organized crime. In: President's Commission on Law Enforcement and Administration of Justice, Organized Crime, Washington, DC.
Schneider, J.L., 2001. Niche crime: the Columbus gangs study. American Journal of Criminal Justice 26, 94–103.
Siegel, L.J., 2012. Criminology: The Core. Cengage Learning, Wadsworth, CA.
Spergel, I.A., 1990. Youth gangs: continuity and change. In: Tonry, M., Morris, N. (Eds.), Crime and Justice: A Review of Research, The University of Chicago Press, Chicago, pp. 171–275.
Taylor, C., 1990. Dangerous Society. Michigan State University, East Lansing, MI.
Thornberry, T.P., Krohn, M.D., Lizotte, A.J., Chard-Wierschme, D., 1993. The role of juvenile gangs in facilitating delinquent behavior. Journal of Research in Crime and Delinquency 30, 55–87.
Venkatesh, S., Levitt, S., 2000. Are we a family or a business? history and disjuncture in the urban American street gang. Theory and Society 29, 427–462.