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Abstract

Historical evidence suggests that Mafias originally formed to provide enforcement of legitimate property rights when state enforcement was weak. We provide a general equilibrium model of Mafias as enforcement coalitions which protect property from predators. Both the level of predation and the type of enforcement — self-enforcement, specialized competitive enforcement and Mafia enforcement — are endogenous. We identify the conditions under which a coalition emerges and persists and show that Mafias are most likely to be found at intermediate stages of economic development. We also show that Mafias might provide better enforcement to the rich than would a welfare-maximizing state, suggesting a difficulty in the emergence and persistence of state provision of enforcement.

Private enforcement of property rights often arises where state enforcement is weak. Mafias such as the Sicilian Mafia and its progeny in the Sicilian diaspora, the yakuza in Japan and contemporary Russian gangs defend both legal and illegal property from predation. Our reading of history suggests that Mafias are born out of the failure of state enforcement of legal property rights. Yet weak state enforcement of property rights does not always produce Mafias and strong states do not always eliminate Mafias. What factors explain the emergence or disappearance of Mafias? Is state enforcement preferable to private enforcement? For whom?

The main task of this paper is to explore the conditions under which Mafias as coalitions of enforcers form and persist in a formal general equilibrium model in which the volume of predation and of enforcement and its industrial organization are endogenous. We explain two important puzzles about Mafia persistence.

First, why is the Mafia monopoly typically able to defeat defection by its members on the one hand and entry by rivals on the other hand? Second, why does the evolution of strong states face apparent difficulty in displacing Mafias from the enforcement of legal rights?

The view of Mafias as enforcers was proposed by Schelling (1984) and richly elaborated by Gambetta (1994). The available historical evidence suggests that originally Mafias were coalitions of guardians who provided enforcement of legitimate rights. Mafias typically developed after major property rights reforms that were not matched by the establishment of adequate formal enforcement mechanisms. The Sicilian Mafia emerged soon after the abolition of feudalism (1812-1840) when private property was created, land ownership became more diffused and there was no formal authority to protect the newly established rights (Bandiera 2000, Gambetta 1994). Absentee landowners and fragmentation of landholdings brought no fixed settlement on the land, hence the landlords and their rootless tenants were weak relative to the predators who would prey on their farms.[1] Security guards who formerly had been hired by feudal lords to patrol their large estates offered to provide protection to the new landlords. These enforcers became the basis of the Mafia. Enforcement was at first a competitive activity, each Mafia family operated in its own territory with little interaction among each other (see Gambetta 1994). Eventually, coalitions formed. Similarly, the rise of the yakuza in Japan coincided with two major property rights reforms. The first was implemented during the Meji period (1868-1911) when feudalism was abolished and a modern property rights regime was put into place; the second took place during the Allied Occupation after World War II when new rights were established and land was redistributed further. In both cases the reform was not matched by effective formal enforcement bodies. For example, the police were dismantled by the Allied Forces and were thus unable to maintain public order (Milhaput and West, 1999; Hill 2000). The Russian Mafia also emerged when, as a consequence of privatisation and the collapse of the communist regime, private ownership became more widespread, property rights legislation was inadequate and public enforcement highly ineffective (Varese 1994).

Since the enforcement of legal property rights is what legitimizes new born

[1]Tenants would not risk much to defend property not their own. Landlords were usually not present to defend their property.

Mafias, in this paper we abstract from other Mafia enforcement activities. [2][3] In the basic formal environment, local specialized enforcement of property rights against predators (thieves) is provided in a spatial monopolistic competition model. The property to be defended is local (livestock in the Sicilian case, retail goods in the urban shopkeepers case). Some property owners may opt for self defense, others buy specialized enforcement. The Mafia is modelled as a coalition of enforcers which optimize on the size of the membership. Although the coalition could, in principle, dictate the pricing/service policies of its members, in this paper we follow the existing evidence which suggests that Mafia coordination of enforcement is quite limited, resembling the cooperation of neighboring police departments.

Based on this model we explain the market structure of enforcement and describe conditions favorable or unfavorable to the operation of Mafias using a rich harvest of comparative static results. Intuition and casual empiricism suggest that predation and enforcement are countercyclical and will fall with secular growth. However, very poor regions do not usually have Mafias. Consistent with this observation, we show in a simulation of our model that as the (endogenous) number of predators falls from high levels associated with low opportunity cost (low development) to low levels associated with high opportunity

[2]Once their reputation is established, Mafias typically branch into the enforcement of illegal deals within legal markets and into the protection of illegal activities. The existing evidence suggest that, for instance, the Sicilian and American Mafia are actively involved in sustaining cartel arrangements between firms in sectors as diverse as construction, transport and vegetable wholesale (see Gambetta and Reuter 1995). Similar evidence exists for Japan (Woodhall 1996). Finally, Mafias act as governments in the underworld, that is they collect taxes in exchange for governmental services such as dispute settlement, contract rights enforcement but also protection from competitors and from the police (Firestone 1997). Interestingly, there is evidence that gangs operating in low income areas of US cities play a role similar to that of the major organised crime groups. Akerlof and Yellen (1994) report that gangs perform government-like functions both in illegal and legal markets within their territory. Gangs control drug-dealing but they also protect residents from theft and violence by other gangs. That residents often prefer gang services to police services where the police are perceived to be ineffective and/or unfair suggests that, just like Mafias, gangs rise when there is no adequate formal enforcement mechanism. Compared to Mafias, however, gangs have so far failed to form a coalition and they are more akin to monopolistically competitive firms differentiated on the basis of location.

[3]We also ignore in this paper the nonenforcement activities of the individual Mafia members. In reality such legal and illegal activities occur, but with little or no coordination from the center; hence these are not properly Mafia activities in our view. A good analogy of our view of the Mafia is a franchise operation such as McDonald's, which protects its brand and optimizes the number of franchises.

cost (high development), we pass from a stage with no Mafia into a stage with Mafia enforcement and end in a stage with no Mafia again.

Our model gives *economic* reasons why the Mafia is stable.[4] On the one hand, existing members have little incentive to defect given that they are free to optimize on their price/service policies. On the other hand, the Mafia forestalls breakup from competitive entry by maintaining excess capacity in the form of Mafia hangers on.

Mafia persistence in the presence of strong democratic states (for example, Japan) can be explained by political economy in our model. The welfarist state cares about the poor who cannot afford or be afforded enforcement. The poor suffer a negative externality from the predators deflected from protected onto unprotected property. Private enforcers and their rich customers neglect this externality and do better without state enforcement. Counter-intuitively, the Mafia (and *a fortiori* competitive enforcers) may choose also to protect a higher fraction of property than the welfare-maximizing state. In this case, a state which attempts to substitute an optimal policy for private enforcement may fail because all its potential customers, the high value property owners, prefer the Mafia — an example of *cream skimming* in the enforcement of property rights.

Grossman (1995), Polo (1995) and Skaperdas and Syropoulos (1995) share our view of Mafias as governments and analyse issues complementary to those discussed in this paper. Grossman (1995) analyses the interaction between the Mafia and the State when both institutions provide revenue-maximizing property rights enforcement. He show that as long as the State remains viable (i.e. Mafia activity is not too disruptive), the presence of an alternative enforcement agency increases citizens' welfare because it reduces the monopoly power of the State and hence its rent-extraction capability. Polo (1995) analyses the incentive structure and the internal organisation within a single group, e.g. within a single Mafia family and shows how incentive costs determine the optimal group size. Finally Skaperdas and Syropoulos (1995) analyse the origins of Mafia-like groups in the context of a model in which there is no State to enforce property rights and agents must decide how to allocate resources between productive and appropriative activities. Productive activities generate output while appropriative activities only determine its distribution. They argue that agents with a comparative advantage in appropriative activities will rule by coercion. In contrast, we mantain that the main function of Mafias is to sell enforcement *against* predation instead of being primarily engaged in it. Mafias as enforcers are com-

[4]Social norms may help sustain the coalitions too.

monly viewed as extorters — offering protection from the Mafia's own violence. In our model, extortion is at most an enhancement of the Mafia's enforcement business rather than the basis of it (see Section 4).

Our analysis has important policy implications. The popular view suggests that the Mafia has beneficial effects because its monopoly of crime limits a socially undesirable activity. Our view implies that the Mafia has ambiguous effects at best. On the one hand, as it enforces legal activities, it may be beneficial; it may do what the state cannot. On the other hand, as the state grows more capable, the Mafia's potentially excessive enforcement of high value legal property makes its presence undesirable. This paper models the protected activity as a fixed supply of property, so the Mafia affects only the distribution of the property between the owners and the predators. Whether the activity is legal or illegal is immaterial. In a sequel paper we model the Mafia's enforcement of exchange, featuring the expansion of activity under Mafia enforcement. Where the activity is illegal (controlled substances), expansion is undesirable.

Section 1 sets out the basic elements of the model and derives the competitive enforcement equilibrium. Section 2 derives the Mafia equilibrium. Section 3 considers the formation and stability of the Mafia coalition. Section 4 analyzes the Mafia's incentive to engage in extortion. Section 5 contrasts the Mafia equilibrium with a welfare-maximizing state enforcement policy. Section 6 concludes.

1. Competitive enforcement

In any plausible model of predation and property rights enforcement, the interaction of the predators, self-defenders and specialized enforcers is obviously rich with externalities: specialized enforcement deflects predators onto self-defended property, additional specialized enforcers raise the success rate of incumbent enforcers against a given supply of predators, and additional predators raise the success rate of incumbent predators. Thus the key elements making up the structure of self enforcement vs. specialized enforcement must interact in a general equilibrium model.

Monopolistic competition is the natural competitive market structure to deploy, since the reputation of a local enforcer reaches only over short distances, and his ability to enforce property rights is similarly circumscribed by travel requirements. The equilibrium of a region requires a set of enforcers distributed to cover the relevant territory. If we take Western Sicily as our motivating example, villages are distributed throughout the region and the enforcers locate in the main villages. As more enter, they fill in the smaller villages. We formalize this location story while abstracting from intervillage differences and any irregularities of geography. In a competitive spatial equilibrium the number of enforcers and their locations suffice to drive profits to zero while predators earn equal returns at all locations. Both self-defending farmers and specialized enforcers face a supply of predators whose total numbers are determined in our model by equality of their payoff in predation with their exogenous outside option, the division of predators between protected and unprotected property being determined by equal return to the marginal predator from attacking each type. This structure allows us to model endogneous predator supply simply enough to retain tractability.

1.1. Competitive enforcement Model

Assume that buyers of unit mass are uniformly located on a unit circle and at each location on the circle there is an identical distribution of property ranked from high to low value. The buyers' valuation of property at each location is thus distributed according to $V(\alpha)$, where α is the proportion of buyers on the radial section with valuation greater than or equal to V, and $V_\alpha < 0$.[5] This model of valuation can be rationalized in several other ways, but ours is simple and plausible.

If enforcement is purchased, the buyer's subjective probability of enjoying his property is equal to π'. If he does not buy enforcement his subjective probability of enjoying his property is equal to β'. Normally (and in rational expectations equilibrium), $\beta' < \pi'$. The value of enforcement to the marginal buyer is $(\pi' - \beta')V(\alpha)$. All buyers with valuation greater than or equal to $(\pi' - \beta')V(\alpha)$ will buy enforcement when the enforcer charges a price equal to $(\pi' - \beta')V(\alpha)$. Inframarginal property owners enjoy a surplus.

All property is subject to attack by predators of mass B (for Bandits). The value of each property is private information known only to the property owners but enforcers and predators know the distribution of value. With this spatial structure the enforcers and the predators both choose to locate evenly around the circle. The assignment of buyers to the enforcer is unique when the net value

[5]If the property distribution is uniform, the buyers are distributed on the unit cone with the top of the cone having the highest value property. For other valuation distributions, all horizontal cross sections remain circular with radii which decrease with height, but the cone may be distorted vertically so that the radii need not decrease linearly.

declines with distance from the enforcer, as when there is a collection cost which varies with distance. It is plausible that a tiny collection cost of this type exists and this suffices for a unique assignment without requiring further accounting. Thus B/n of the predators' mass is located in each enforcer's market area and $1/n$ of the property owners' mass is located in each enforcer's market area. The predator knows whether property is protected or not (which gives him some information as to its expected value), but no predator knows the value of the property he attacks. The predators share the common beliefs so those who choose to attack random pieces of unprotected property have a subjective probability of successful stealing equal to $1-\beta'$, and those who choose to attack random pieces of protected property have a subjective probability of stealing equal to $1-\pi'$.

The enforcers of property rights, the property owners and the predators interact on both unprotected and protected property. The property owners who do not buy enforcement interact anonymously in random matches with the mass of predators who attack undefended property. The prey have some exogenous capacity to evade or defend themselves from predators, so that a match need not always result in capture by the predator. The interaction of the prey who do not purchase enforcement and the predators who attack undefended property is modeled with a realized (objective) probability of successful ownership equal to

$$\beta = \frac{1}{1+\theta\frac{B(1-\lambda)/n}{(1-\alpha)/n}} = \frac{1}{1+\theta B\frac{1-\lambda}{1-\alpha}}. \tag{1.1}$$

Here λ is the fraction of predators who choose to prey on protected property. Thus $B(1-\lambda)/n$ is the mass of predators who choose to attack unprotected property on each market segment. Similarly $(1-\alpha)/n$ is the mass of unprotected property owners in each market segment. Then $B\frac{1-\lambda}{1-\alpha}$ is the average intensity of offensive to defensive force on unprotected property[6]. θ is a technological parameter reflecting the relative effectiveness of offensive to defensive force on unprotected property. Equation (1.1) implies that, if θ is equal to 1, and the mass of predators and unprotected property owners is equal, the probability of successful evasion or defense is equal to 1/2. A rise in θ lowers the probability of successful evasion as predators become relatively more effective. Finally, as is plausible, β is increasing in α, decreasing in λ and homogeneous of degree zero in (α, λ). The model of interaction producing β looks like the 'contest

[6] $B(1-\lambda)/(1-\alpha)$ is equal to the match probability for $B(1-\lambda)/(1-\alpha) \leq 1$. In this setup it is reasonable to assume that the match probability is equal to one.

success function' which has been widely used to specify probabilistic results of contests (e.g., Grossman, 1995; Skaperdas and Syropoulos, 1995.) between non-anonymous participants. The anonymous interaction model is distinct because agents are probability takers (there is no coordination of offensive or defensive effort). Note the important negative externality inflicted by those who purchase enforcement on those who do not: $\partial\beta/\partial\alpha < 0$. Intuitively, those who buy enforcement deflect thieves onto those who do not, lowering their probabilty of successful defence.

Now consider the interaction of enforcers and predators on defended property. An enforcement contract is an option purchased by the buyer on the deterrence and recovery services of the enforcer. The realized performance of the enforcer is based on interaction with predators on protected property, resulting in a realized probability of successful defense equal to

$$\pi = \frac{1}{1 + \theta B \frac{\lambda/n}{R}}. \tag{1.2}$$

Here θ is a parameter reflecting the relative effectiveness of offensive technology to the enforcement technology of enforcers, $B\lambda/n$ is the mass of predators who choose to attack protected property, while R represents the enforcement capability of the enforcer to deter attack or to recover the value taken by predators who choose to attack. (Any difference between the technology of self defense and specialized defense is subsumed into R.) The right hand side of π is a contest success function. The interaction of the enforcer and the predators produces a set of contests each with probability π of success for the enforcer and the property owners he protects. (The probabilistic nature of the outcome reflects independent small random shocks to each contest.). The number of protected properties (α) affects the probability of successful defense indirectly through its effect on the number of predators that attack protected property (λ).

In rational expectations equilibrium, the subjective value of β' must be equal to the realized value of β in the interaction of predators and prey and subjective value of π' must be equal to the objective performance of the enforcer π. The property owners are probability takers, as is plausible when they are in large numbers.The anonymous group of predators of size $B\lambda/n$ cannot affect their success rate by their preparations for the contest due to their individual anonymity, so they are probability-takers as well. In contrast, the enforcer is not anonymous because there is only one enforcer on each market segment and the property protected by the enforcer is identified to the predators.[7]

The enforcers maximize profits by selecting the optimal proportion of customers in their area to serve, α. They cannot price discriminate because we assmue they cannot observe the valuations of their customers.[8] The enforcer incurs a cost f of establishing capability R[9]. The enforcer's choice problem is:

$$\max_{\alpha} \frac{\alpha}{n}(\pi' - \beta')V(\alpha) - f. \tag{1.3}$$

Selecting the quantity offered is equivalent to price setting in monopolistic competition and it is more convenient to use the quantity as the instrument. The enforcer has market power through realizing that $V(\alpha)$ is declining in α. We shut down two other channels of market power by assumption. An enforcer with full sophistication replaces $\pi'- \beta'$ with $\left[\frac{1}{1+\theta B\frac{\lambda/n}{R}} - \frac{1}{1+\theta B\frac{1-\lambda}{1-\alpha}}\right]$ in setting up the optimization problem, internalizing both the effect of α on β and the equilibrium reduced form relationship of λ to α as part of the optimization. We assume the enforcer takes the probability β' as exogenous because it reflects the equilibrium interaction of anonymous predators and unprotected property owners across, in principle, the entire unit cylinder. [10] We assume the enforcer plays Nash against

[7]The single enforcer in principle knows he affects his success rate by his capacity R. We simplify by assuming that R is fixed for any individual enforcer, noting that it can be shown that endogenous choice of R turns out to add no new inisght. In contrast, when we consider the Mafia coalition of enforcers, a key element of the problem is that the organization optimally selects the aggregate force level nR with which to oppose the set of predators λB, taking account of its effect on the contest success rate π.

[8]This assumption is an inessential detail — perfect price discrimination allows the enforcer to obtain all the buyers' surplus but the remainder of the model is similar.

[9]The capacity cost plausibly varies with the number of predators the enforcer has to deal with, but we assume the enforcer plays Nash against the predators and thus takes the mass of predators as given. The number of predators the enforcer has to deal with is λ/n, equal to the probability that a protected property will be attacked, $\frac{\lambda/n}{\alpha/n}$times the number of protected properties α/n. We suppress any other effect of the volume of protected property such as collection costs which might rise with the number of customers in specifying the cost of reputation f.

The cost reflects the enforcer's exogenous opportunity cost outside the region (which may be the same as the predators' opportunity cost), but may also include added elements specific to enforcement (the need to establish a reputation requires investment).

[10]In equilibrium of course, as $B(1-\lambda)/n$ predators attack the $(1-\alpha)/n$ unprotected properties on his segment, the interaction on his own market segment is the same as that anywhere else. A sophisticated enforcer might understand the equilibrium and hence be able to optimize the effect of α on β while assuming that all other enforcers would similarly optimize the effect of α on β on their market segments.

the predators, taking the number of predators $\lambda B/n$ as given. Since reputation R is fixed, this means π is exogenous. Our probability-taking enforcer will in Nash equilibrium have his expectations realized, $\pi' = \pi$ and $\beta' = \beta$. Thus the optimal proportion of property owners served, α^*, is determined by:

$$\frac{(\pi - \beta)}{n} \left[V(\alpha^*) + \alpha^* V_\alpha(\alpha^*)\right] = 0, \tag{1.4}$$

With free entry by competitive enforcers, the long run static monopolistically competitive equilibrium implies zero profits, so the number of enforcers n adjusts such that:

$$\frac{\alpha^*}{n} \left[\pi - \beta\right] V(\alpha) - f = 0. \tag{1.5}$$

We assume that f is invariant to n, rationalized by infinitely elastic supply of enforcers from outside the region at a fixed opportunity cost.

Now consider the allocation of predators, λ, and the number of total predators, B. The proportion of predators who attack protected property is determined by the equality of expected return in attacks on the two types of property. Thus

$$[1 - \beta] \underset{x \geq \alpha^*}{E} [V(x)] = [1 - \pi] \underset{x < \alpha^*}{E} [V(x)], \tag{1.6}$$

where the left hand side of the equation is the return from attacking unprotected (low value) property and the term on the right is the expected return from attacking protected (high value) property, and $E[.]$ is the expectation operator. We abstract from punishment of predators who are caught preying on protected property without loss of generality.[11] It is convenient for subsequent purposes to have compact notation for the average high and low value properties:

$$\begin{aligned} V^H &\equiv \underset{x < \alpha^*}{E} [V(x)] \\ V^L &\equiv \underset{x \geq \alpha^*}{E} [V(x)]. \end{aligned}$$

Finally, the mass of predators B includes all agents whose alternative option is worse than the expected payoff from predation. Normalizing the maximum potential number of predators to one and assuming that alternative options are uniformly distributed on $[0, w]$ we have:

[11] With a sufficiently harsh punishment, no predators will ever attack protected property. For less harsh punishments, the effect of the size of punishment is simply to raise the equilibrium π and lower the equilibrium β without changing any qualitative properties of the system.

$$B = \frac{(1-\beta)\, V^L}{w} \tag{1.7}$$

The full equilibrium of the system is reached when the predators allocation condition (1.6), the predators' entry condition (1.7), the enforcer's choice of customers (1.4) and the free entry condition (1.5) are all satisfied with the anticipated probabilities being equal to the values implied by the contest success functions (1.2) and (1.1). This 6 equation system determines $(B, \lambda, \alpha, \pi, \beta, n)$.

1.2. Existence and Uniqueness of Equilibrium

We are mainly interested in interior equilibrium. If it exists, we are interested in sufficient conditions to guarantee that it is unique. It is possible that no interior solution exists, and either $\alpha^* = 0$ (no enforcement is offered) or $\alpha^* = 1$ (all property is protected). The no enforcement case is more likely as fixed costs are high relative to willingness to pay while the full enforcement case arises when the elasticity of demand remains sufficiently far above one throughout the range of α.[12]

In the Appendix we prove:

Proposition 1. *For $V(0)/f$ sufficiently large and $V(1)/f$ sufficiently small, and $w < \frac{\theta V^L}{(1-\alpha^*)}$; specialized enforcement is offered to a unique fraction of property.*

When $w \geq \frac{\theta V^L}{(1-\alpha^*)}$, the solution is ($B^* = n^* = 0$, $\pi^* = \beta^* = 1$), which implies that there will be no predators and no demand for enforcement.[13] When $V(0)/f$ is too small, no specialized enforcer can break even. When $V(0)/f$ is too large, all property is protected. The objective probability β is undefined

[12] We avoid complex questions of the origin of reputation in a dynamic setting by assuming expenditure of f creates a capabilty R which results in anticipated reputation for effectiveness modelled as above. Reputational models generally have multiple Nash equilibria. A zero enforcement equilibrium obtains if enforcers have no reputation, buyers expect their services to have no value, hence they never buy protection and the enforcers never have the opportunity to demonstrate their ability and thus create a reputation. Symmetrically there is always a zero predation equilibrium: if predators expect to always fail, they never attack and hence never discover that they could be successful. History such as that of 19th century Sicily tells us that initial conditions matter in creating reputation.

[13] The condition is evaluated at α^*, because if any protection were to be offered it would protect that fraction of property.

since $\alpha = \lambda = 1$. The equilibrium depends entirely on expectations of self-defense success β'. [14]

1.3. Comparative Statics

The model of private enforcement equilibrium has interesting comparative statics, summarised in Table 1. Besides the parameters presented above, we allow for a multiplicative shift v in the property value function.

TABLE 1

	$d\beta$	$d\pi$	dB	dn
dw	+	+	-	-
$d\theta$	-	-	+	+
dR	+	+	-	-
df	-	-	+	?
dv	-	-	+	+

If alternative opportunities worsen (w falls), if predators become more effective (θ increases) or if property value increases (v increases) there will be more predators (B increases) but also more enforcers (n increases) in equilibrium. Intuitively, since there are more predators both protected and unprotected property is less safe (both π and β fall), yet β has to fall more than π in order to keep the allocation constraint (1.6) satisfied. It follows that, given α^*, the price of enforcement is higher, which makes more enforcers enter the market.

If enforcers become more effective (i.e. R increases), there will be fewer predators but also fewer enforcers in equilibrium. Intuitively when enforcers are more effective protected property is safer. To satisfy the allocation constraint also unprotected property must become safer otherwise we end up in the corner solution where predators attack only unprotected property. Given that β increases more than π, the price of enforcement is lower and this drives enforcers out of the market.

[14] There are two cases: if property owners and predators are pessimistic about the effectivness of their self-defense and $\beta' < \frac{Rw-\theta f}{Rw}$ there is an interior solution with $\pi = \frac{Rw\beta'}{Rw-\theta f}, B = \frac{(Rw\left(1-\beta'\right)-\theta f)V(1)}{Rw-\theta f}, n = \frac{\beta'\theta V(1)}{Rw-\theta f}$. This solution exists as long as $Rw - \theta f > 0$. Alternatively, if property owners and predators are optimistic about self-defense ($\beta' > \frac{Rw-\theta f}{Rw}$), the equilibrium is at $\pi = 1, B = 0, n = V\left(1\right)\frac{1-\beta'}{f}$

Finally if the fixed cost of enforcement increases there will be more predators in equilibrium, property (both protected and unprotected) will be less safe and the effect on the number of enforcers is ambiguous. Intuitively we expect n to fall as f increases. When this happens, though, both π and β fall. As explained above, β has to fall more than π in order to keep the allocation constraint satisfied. It follows that, given α^*, the price of enforcement is higher, which has a countervailing effect on the number of enforcers in equilibrium.

The equilibrium solution is homogeneous of degree zero in v, w, f, respectively property valuation and the outside options of predators and enforcers. We regard economic development as a rise in w relative to v or f, as reflecting real income increases of a non-property owning class. For simplicity we define stage of development as simply the change in w.

2. The Mafia Coalition

The Mafia regime of enforcement provision is characterized by a coalition of the enforcers. For simplicity we think the coalition as yielding a monopoly of enforcers in the region. Once organized, we analyze how the monopoly deters entry by competitors and optimizes profits over the number of incumbent enforcers. In the Sicilian case, Mafia families within each province formed a coalition in the late 50s. The function of the coalition was to settle disputes within and between families, to chose family heads whenever a power vacuum occurred and, most importantly, to regulate mergers, divisions and allocation of territory.

The Mafia limits its numbers to achieve positive profits. The Mafia head in principle could dictate the pricing/service policies of its members, but we regard this as an unrealistically centralized model of the organization. Detailed price directives will provide more profits but also offer opportunities to cheat. A loose coalition which only controls entry is compatible with the observed structure and persistence of the Mafia and consistent with the available evidence on the actual coalitions.

Formally, the Mafia head optimizes joint profits (equal to individual profits of the members) over n. We take total profit to be the relevant objective function because, as explained below, in the formation of the coalition, some of the original number of enforcers must be retired and compensated with a share of the profits.[15] The Mafia may be able to freely optimize n, or it may face the need

[15]Later on in its history, the Mafia organization hires extra enforcers at competitive wages as

to increase n sufficiently to prevent entry by ensuring that potential entrants cannot cover their costs. We consider both cases, taking the unconstrained case here and examining the constrained case in Section 3. In selecting the optimal n, the Mafia head understands that the share of protected property α^* will be set so as to achieve (1.4).

Considering the selection of optimal n as part of the profit maximization problem we have:

$$\max_n \alpha^* \left(\frac{1}{1+\theta \frac{B\lambda}{nR}} - \frac{1}{1+\theta \frac{B(1-\lambda)}{1-\alpha^*}} \right) V^* - fn.$$

The optimal selection of n is assumed to take λ as given; the monopolist plays Nash with respect to the number of predators. The first order condition for n is:

$$\alpha^* V^* \pi(1-\pi)\frac{1}{n} - f = 0. \tag{2.1}$$

The first order condition is necessary and sufficient for an optimum since the objective function is concave in n.

The equilibrium system for determining all endogenous variables with a Mafia enforcement organization is formed by replacing the zero profit condition of monopolistic competition with the first order condition in n. The system reduces to

$$\begin{aligned}
\pi &= \frac{1}{1+\theta B \frac{\lambda/n}{R}} \\
\beta &= \frac{1}{1+\theta B \frac{1-\lambda}{1-\alpha}} \\
[1-\beta]\, V^L &= [1-\pi]\, V^H \\
n &= \frac{\alpha^* V^* \pi(1-\pi)}{f} \\
B &= \frac{(1-\beta)\, V^L}{w}
\end{aligned}$$

Proposition 2. *For $V(0)/f$ sufficiently large and $V(1)/f$ sufficiently small, and $w < \frac{\theta V^L}{(1-\alpha^*)}$, a unique interior monopoly solution exists. Proof: see the Appendix.*

distinguished from its members who have shares in total profits.

As is intuitive, monopoly restricts the level of enforcement. Formally:

Proposition 3. *The optimal n chosen by the coalition, n^m , is lower than the one that would result under monopolistic competition.*
Proof: To compare the equilibria we solve the sub-system which constrains both forms of organization for given n :

$$\begin{aligned} \pi^* &= \frac{1}{1+\theta B \frac{\lambda/n}{R}} \\ \beta^* &= \frac{1}{1+\theta B \frac{1-\lambda}{1-\alpha}} \\ [1-\beta] V^L &= [1-\pi] V^H \\ B &= \frac{(1-\beta) V^L}{w}. \end{aligned}$$

This yields $\pi^*(n), \beta^*(n), \lambda^*(n), B^*(n)$. The Appendix shows that profits are monotonically decreasing in n. This implies that the equilibrium number of enforcers must be smaller under the Mafia than under monopolistic competition, QED.

Security of property suffers from the organization of the coalition as follows. All else equal, if the enforcers form a coalition property will be less secure ; the price of enforcement will be higher; there will be more predators; and the share of predators that choose to attack protected property will be higher.[16]

These results (profits to the Mafia coexisting with more predators and a lower share of unprotected property) all resemble the popular intuition that the Mafia acts as an extorter rather than an enforcer. Despite its clean hands, the Mafia looks guilty. Section 4 shows that starting from this nonextortionate equilibrium, the Mafia does always have an incentive to increase its profits by extortion, paying predators to prey on unprotected property.

The comparative statics of the model are similar to the those reported in section 1.3 above.[17] The profits of the coalition are equal to:

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[16]That is, $\frac{\partial \pi^*(n)}{\partial n} > 0$, $\frac{\partial \beta^*(n)}{\partial n} > 0$, $\frac{\partial(\pi^*(n)-\beta^*(n))}{\partial n} < 0$, $\frac{\partial B^*(n)}{\partial n} < 0$, $\frac{\partial \lambda^*(n)}{\partial n} > 0$. Offsetting this disadvantage of monopoly, if uncoordinated enforcers have higher costs of obtaining a reputation R, the Mafia equilibrium can be more secure than the competitive equilibirum.

[17] The comparative statics on the number of enforcers are slightly more complex. If $V^H > 2V^L$ (i.e. the V function is steep) n moves in the opposite direction of π thus all the comparative statics are like those in Table 1. On the other hand if $V^H < 2V^L$ and π is very small, there might be a region in which n moves in the same direction as π so that results are reversed. Note that $V^H > 2V^L$ guarantees positive profits.

$$P^* = V^* \alpha^* (1 - \beta^*) \left(\frac{\left(V^H - V^L\right)^2 - \beta^* \left(V^L\right)^2}{\left(V^H\right)^2} \right)$$

which is decreasing in β^*. It follows that profits are higher when the market for enforcement is tighter, either because of high demand (high θ, low w) or because of low supply (high f, low R). It is also interesting to note that profits per member $\left(\frac{P^*}{n^*} = \left(\frac{f\left(V^H - V^L\right)V^H}{(V^H - V^L + \beta^* V^L)V^L} \right) - f \right)$ are decreasing in w and R and increasing in θ. These comparative statics provide a channel through which development can shift the organization of enforcement. We discuss these forces after incorporating the cost of organizing the coalition, as a richer story then emerges.

3. Coalition Formation and Stability

Coalitions frequently form peacably, and we focus on these.[18] To form a coalition the enforcers must sustain some coordination cost, which is increasing in n. A necessary condition for a mutually agreed coalition is that everybody, i.e. including those that either exit the market or become employees of other enforcers, is better off. The necessary condition for coalition formation is that the total coalition profits ("potential" benefit) exceed the coordination cost *evaluated at the number of enforcers under competitive equilibrium.* A similar rationale applies to the coalition in its maturity. As we show below, the Mafia forestalls breakup from competitive entry by maintaining a fringe of hangers-on at some wage. This constitutes an excess capacity (up to the competitive level of enforcement) which deters entry, as we show below. That powerful Sicilian families let smaller families operate in their territory under their direct supervision (Gambetta 1994) supports our assumption about the structure of the co-ordination cost.

Formalizing this story and assuming that the coordination cost is linear in the number of original members, the monopolistic competition solution n^c , the net profits from forming the coalition are $\Phi(X) = P^*(X) - cn^c$, where P^* is the optimized profit of the coalition, c is the per capita cost of coordination and

[18]Conflict can of course result in coalitions which destroy opposing rivals. This may be associated with errors or asymmetries in a rational maximizing environment.

$X = R, w, \theta$. The coalition can form only if $\Phi > 0$. This necessary condition is also sufficient with rational enforcers provided the coordination cost reflects all costs.

Key insight into when coalitions form is gained from the comparative statics of coalition net profits. The comparative statics are not a trivial extension of previous results because X affects P^* and n^c in a similar way. For instance, a fall in w increases coalition profits while at the same time it increases the number of enforcers and hence the coordination costs. Further restrictions produce sharp results.

Lemma 1. *If $V(\alpha)$ is linear then profits are increasing in w when w is small and decreasing when w is large.*
Proof: see the Appendix.

The Lemma implies that *Mafias are likely to emerge at intermediate stages of development.* If w were very high there would be no bandits and no scope for enforcement (since there is no interior solution when w is high). If w were very low there would be many bandits and many enforcers in monopolistic competition. The latter would make the transition to the coalition structure difficult because of coordination costs. Figure 1 in the Appendix simulates our model.[19] Similarly, if R is high at the start there will be only a few enforcers in monopolistic competition, which implies that they can coordinate and move to a coalition very easily (see Figure 2 in the Appendix). Interestingly, this is consistent with the fact that the founders of most Mafias were people with an existing reputation for strength/brutality like the Sicilian feudal guards and the Japanese samurai. It is also consistent with the fact that Mafias emerged only in some of the cases in which the rule of law was missing. We could argue that in the other cases, private enforcers did exist when the state was weak but didn't manage to collude and thus survive the conditions that determined their rise in the first place. While the Proposition and its implication are based on restrictive assumptions, the implications appear to be robust.

3.1. Why the Coalition Is Stable

Coalitions in general are difficult to enforce in the absence of legal mechanisms to restrain opportunistic behavior. The incentives to defect rise with the profits

[19] For the simulation we assume that $f = \frac{\alpha V}{15}$; $R = 2$ (when fixed); $w = \frac{1}{32}$ (=1/4 expected value of unprotected property, when fixed) and $f/d = 1$

of the coalition. The success of Mafia coalitions thus presents something of a puzzle: stable, long- lived and profitable coalitions persist despite a complete absence of legal enforceability.

Members' incentive to defect and outside enforcers' incentive to enter the market crucially depend on the comparison between the enforcement technology of the Mafia and that of individual enforcers. The organization plausibly has a better technology, reflected in a smaller expenditure f for given reputation R than do independent enforcers. This is so for two reasons. First, reputation requires investment by the enforcer to acquire and maintain. An individual enforcer acting alone has limited ability to impress the surrounding population with his efficiency and brutality whereas coalition members can benefit from other members' reputation and are thus able to achieve a given level of reputation at lower cost than it would take to acquire it on their own. Second, the organization can share information and apprehension of the predators who attempt to run away into other 'jurisdictions', much as local law enforcement agencies cooperate in legal enforcement activity. This increases the capability of the individual enforcers.

Note that, since the coalition does not dictate the price/service policies of its members, the latter cannot cheat in the "classical" sense. Competitive entry is therefore the main threat to the coalition's survival. The power of the Mafia to maintain its coalition against competitive outsiders depends on the excess capacity it has retired in order to form in the first place. Let f^e be the fixed cost entrants have to pay to acquire reputation R. Define gross revenues $G(n) = [\pi - \beta] V(\alpha)$; $G_n < 0$,as shown in the Appendix. Profits for the coalition are equal to $G(n^m) - fn^m - cn^c > 0$.

Proposition 4. *For $f^e \geq f + cn^c/n^m$, the coalition is stable. For $f < f^e < f + cn^c/n^m$, the coalition is knife-edge stable.*
Proof:
1. if the fixed cost of entrants is high enough, $f^e > \frac{1}{n^m} G(n^m)$, then no one will find it profitable to enter.
2. If $f^e > f$ but still not too high $\left(f + c\frac{n^c}{n^m} < f^e < \frac{1}{n^m} G(n^m)\right)$ somebody will enter but there will not be enough pressure to make the coalition split (i.e. coalition profits are still positive, despite entry). The coalition's best response in this case is to increase n^m and drive the entrants out of the market. Indeed, following entry, the coalition's profits would be: $\frac{n^m}{n^m+n^e} G(n^m + n^e) - fn^m - cn^c = (f^e - f) n^m - cn^c$. Whereas if the coalition increases its membership up to $(n^m + n^e)$ its profits would be $G(n^m + n^e) - f(n^m + n^e) - cn^c =$

$(f^e - f)(n^m + n^e) - cn^c$, which is larger than $(f^e - f)\, n^m - cn^c$. It is then credible for the coalition to say that in case of entry it will raise n_m slightly above $(n_m + n_e)$, generating negative profits for the entrants.
3. If $f < f^e < f + cn^c/n^m$, then there will be no successful *attacks. If entrants face the same fixed cost f as the Mafia, they will enter until $\frac{n^e}{n^m+n^e} G(n^m + n^e) - fn^e = 0$, which implies that $n^e = n^c - n^m$. If n^e new enforcers enter the market the coalition profits will equal: $\frac{n^m}{n^m+n^e} G(n^m + n^e) - cn^c = -cn^c < 0$. Clearly, this cannot be an equilibrium and the coalition will break down. Now there are too many enforcers in the market, all making negative profits so that some enforcers must exit. It is reasonable to think that the new entrants will be pushed out for they are less well known as enforcers. In this case the coalition is knife-edge stable, i.e. there is an equilibrium in which the coaltion makes positive profits and is never attacked, QED.*

The stability result should be qualified on two lines. On the one hand, note that in the knife edge case, an asymmetry which favors entrants will tip the balance to successful entry. Moreover, case 2 must be qualified when the fixed cost advantage of the Mafia is offset by a coordination cost $C(n^m)$ which is plausibly increasing and strictly convex in the number of Mafia members n^m. Previously we have set $C' = f$ and $C'' = 0$. Obviously, as C'' is large, the Mafia finds it costly to drive n^m large enough to displace all competitive firms, so the equilibrium includes a competitive fringe. On the other hand, the comparative statics of the Mafia coalition show that as the Mafia's experience and reputation grows (R rises), then the optimal n^m falls. This lowers the coordination cost and makes the Mafia still more impervious to outside competition. This is an important aspect of the apparent stability of Mafias over time.

4. The Mafia as Predator

Our treatment of the Mafia stresses its socially productive role as a provider of enforcement services. The Mafia is often alternatively portrayed as an extorter, offering 'enforcement' from harm it will inflict unless payment is made. A simple extension of our model formalizes a synthesis of the two views. The Mafia coalition of the preceding sections can increase its profits by engaging in some predation on unprotected property, thereby raising demand for its enforcement. The predators under Mafia license must be paid their opportunity cost, equal to the expected gain from predation on unprotected property plus an extra payment from the Mafia. We assume the Mafia optimally selects the amount of extra predation.

Predators allocate themselves between protected and unprotected property to equalize the return, which is equal to the opportunity cost of the marginal predator. The opportunity costs x are assumed to be uniformly distributed on the interval $[0, w]$. This leads to the expression for independent predators supply:

$$B = \Pr[x \leq (1-\beta)\overline{V}^L] = \frac{(1-\beta)\overline{V}^L}{w}$$

Now assume that the Mafia wishes to raise the level of predation above that level. It can hire predators and assure them a payment equal to their opportunity cost. This leads to a supply of Mafia licensed predators equal to:

$$B^m = \Pr[(1-\beta)\overline{V}^L \leq x \leq (1-\beta)\overline{V}^L + m] = \frac{m}{w}$$

The total supply of predators is equal to $B + B^m$. By controlling its payment m, the Mafia controls the supply of predators at the margin. The licensed predators will prey only on unprotected property, but the equilibrium allocation condition of unlicensed predators continues to determine the fraction of all predators who attack protected property by equality of returns between attacks on protected and unprotected property.

The Mafia coalition controls the number of enforcers n and the payment to licensed predators m. We assume away potential entry for simplicity. The efficient Mafia solves:

$$\max_{n,m} V^*\alpha^* \left[\frac{1}{1+\theta(B+m/w)\frac{\lambda}{nR}} - \frac{1}{1+\theta(B+m/w)\frac{1-\lambda}{1-\alpha^*}} \right] - fn - m^2/w.$$

The first order condition with respect to m is

$$V^*\alpha^* \frac{\theta}{w} \left[-\pi\frac{\lambda}{nR} + \beta\frac{1-\lambda}{1-\alpha^*} \right] - 2\frac{m}{w} = 0. \tag{4.1}$$

It can be shown that the square bracket term is always positive when $\pi > \beta$, as required for equilibrium. This implies that it always pays for the Mafia to enlist at least some licensed predators to raise demand for its services. The optimal interior values of m and n are implied by the first order conditions, provided the second order conditions are met. The objective function is not necessarily concave in m, especially for arbitrary values of λ. Therefore it is possible that the best solution for the Mafia is to enlist all available predators. We ignore this possibility in our discussion. The main point is that the Mafia will always have an incentive to prey on the unprotected, 'subsidizing' attacks on unprotected property.

How important is the Mafia's incentive to prey on the unprotected? If small,we may expect that cultural norms prevent the Mafia from predatory behavior. (Formally, we can allow for paying m to raise f, thus reducing the profitability of preying on the unprotected.) If the incentives are large, we may expect that norms fail and avarice prevails.

5. Optimal vs. Private enforcement

States which provide a reasonable level of service to their citizens are often represented as maximizing a social welfare function with their policies, justified by thinking of redistributive policies being carried on behind the scenes. Welfare maximizing policy on *legal* property rights enforcement is thus interesting to compare with private Mafia or competitive enforcement whether or not we believe any states closely approach this behavior. Intuitively we expect that welfare-maximizing state policy will protect more property with a greater intensity of force when all else is equal. In contrast our model implies that (1) the welfare-maximizing state will always defend any given proportion of property less intensively than would the Mafia or competitive enforcement and (2) the state could choose to defend a lower proportion of property. These at first puzzling results arise because of the negative externality which enforcement inflicts on the undefended property — the welfarist state cares about the deflection of predation onto low value property whereas the private enforcers do not. We give an example of optimal underenforcement by the state below.

In circumstances where the welfare-maximizing state defends a lower proportion of property less intensively, *even a strong state may not be able to maintain its policy against private enforcement.* All its potential customers for enforcement would prefer the private organization of enforcement. Private enforcement in either its competitive or Mafia version may then come along and *cream skim* the most valuable property. As an example of this phenomenon, think of the growth of gated communities containing people who shelter their incomes in offshore tax havens. The deflected predators batten onto the low value state protected or unprotected property with greater intensity, increasing the incentive to defect from state enforcement. The cream skimming problem in enforcement is far more general than our setup might indicate. For example, the 'political support function' approach models the state as maximizing a combination of contributions from its supporters (in our model, the rich) and the general welfare (reflecting the interests of the poor voters). The political support function can be derived as a reduced form of the Bernheim and Whinston menu auction model. Compared to the welfarist state, the political support maximizing state cares less about the poor, but compared to the Mafia it cares more.

Faced with a cream skimming situation, the welfarist state has several options. At one extreme, when it is weak, it can forestall the privatization of enforcement by abandoning its welfare-maximizing policy and imitating the Mafia. This solution resembles state enforcement policy being "captured" by the rich. Even imitating the Mafia may not suffice to preserve state enforcement. Private enforcement potentially has advantages over a state which ignores the negative externality inflicted on the poor by enforcement of the rich. Mafias or other private enforcers may be able to ignore civil rights and other restrictions on legal enforcement processes. As Grossman (1995) points out, a coexistence in Nash equilibrium will provide more enforcement than the state would choose if it were a monopoly which maximized rents. At the other extreme, a sufficiently strong state can regulate or eliminate private enforcement to enact its own welfare-maximizing policy. There are likely to be economies of scale in enforcement provision which enhance the power of the state. More democratic states are more likely to place weight on the welfare of the owners of lower value property. These considerations suggest that a strong democratic state may drive out private enforcement. It is premature to build a model of state rivalry with the Mafia, but the considerations we present will be part of such a full political economy model.

To formalize the comparison of optimal vs. private enforcement, suppose that the state can collect lump sum taxes to pay for the cost of enforcement. The state and the private sector have the same enforcement technology. The welfare function of the state is the expected value of property less the cost of defense: $W(n, \alpha; B, \lambda) \equiv \pi(n, B, \lambda)S(\alpha) + \beta(\alpha, B, \lambda)D(\alpha) - fn$ where $S(\alpha) \equiv \int_0^\alpha V(x)dx - \alpha V(\alpha)$, $D(\alpha) \equiv \int_0^1 V(x)dx - V(1) - S(\alpha)$. $S(\alpha)$ and $D(\alpha)$ are the surpluses associated with protected and unprotected property respectively. The objective probability functions $\pi(\cdot)$ and $\beta(\cdot)$ are the same as in our earlier analysis. We assume that the state plays Nash against the predators so λ and B are taken as given. Welfare changes with α and n according to:

$$\begin{aligned} W_\alpha &= (\pi-\beta)(-\alpha V_\alpha) + D\beta_\alpha \\ W_n &= \pi_n S - f. \end{aligned} \tag{5.1}$$

These should be compared to the first order conditions for the Mafia:

$$\begin{aligned} (\pi-\beta)(V+\alpha V_\alpha) &= 0 \\ \pi_n \alpha V(\alpha) - f &= 0. \end{aligned} \tag{5.2}$$

To compare the Mafia and optimal solutions, we consider evaluation of the welfare derivatives (5.1) at the Mafia solution values and see in which direction α and n must move to approach the social welfare maximizing values. $W_n(n^m, \alpha^m) < 0$ whenever $S(\alpha^m) < \alpha^m V(\alpha^m)$, which holds in a wide class of cases. (For example, with linear demand for the valuation of property, we can show that W_n is negative.[20]) Then the state employs fewer enforcers, since $\pi_{nn} < 0$ at the Mafia solution (by the Mafia's second order condition). The intuition is that the rich who buy enforcement overvalue it from a social point of view at the margin: $\pi_n S < \pi_n \alpha V$. Nevertheless, the rich who obtain enforcement prefer the Mafia because a typical rich individual i with valuation $V(\alpha^i)$ earns a surplus from dealing with the Mafia equal to $(\pi-\beta)[V(\alpha^i) - V(\alpha^m)]$, a surplus which *is* locally increasing in n. A rise in n also indirectly benefits the poor, since in general equilibrium a sufficient number of predators are driven out so that β also rises. We assume the state plays Nash against the predators so the state does not internalize this externality. In contrast to the clear results for n, $W_\alpha(n^m, \alpha^m) \gtreqless 0$. This arises because of the tradeoff of two forces, the monopoly power of the Mafia (which limits sales) vs. the negative externality enforcement inflicts on unprotected property (which limits state enforcement). With no externality, $\beta_\alpha = 0$ and the state would protect all property, from (5.1), whereas the monopoly power of the Mafia limits sales, from (5.2). Thus the fraction of property the state chooses to protect might be higher or lower than that

[20]For the linear V case, $S = -\alpha^2 V_\alpha/2$. At the profit maximizing value of α^m, $S = \alpha V/2$. Then

$$\begin{aligned} W_n(n^m, \alpha^m) &= \pi_n(n^m, \alpha^m)\alpha^m V(\alpha^m)/2 - f \\ &= -\pi_n \alpha V/2 < 0, \end{aligned}$$

where the second equation follows from using the Mafia's first order condition.

protected by the Mafia, depending on the value of the exogenous parameters. [21]

The Appendix shows that for linear V, the state protects less property than the Mafia whenever the equilibrium β^m is sufficiently large. Exact expressions for the critical value are derived. It is interesting to note that the state will locally protect less properties when the outside opportunity cost of predation (w) is high.[22] Associating w with economic development, we infer that cream skimming is more likely for more developed economies.[23]

6. Conclusion

We have built a formal general equilibrium model of the Mafia as a coalition of enforcers of property rights. We explain how the Mafia coalition can be stable despite the presence of potential entrants. Compared to competitive enforcement, the Mafia offers too little enforcement at too high a price. Compared to socially optimal enforcement however, the Mafia offers too much enforcement because private enforcement ignores the effect of increased predation on the unprotected property.

The elements of this paper provide a framework for future work. First, they indicate the payoff to a study of the industrial organization of the Mafia. Why does it refrain from monopolising the production of illegal goods? What legal enforcement does it concede to the state and under what circumstances? We hope to explore these themes in future research.

A key simplification of this paper is that the amount of property to be protected or predated is constant. Most forms of enforcement are likely to increase the volume of the protected activity. This can be desirable if the activitiy is

[21] Moreover, the local concavity of W in α cannot be inferred from the local concavity of the Mafia′s profit function at n^m, α^m, .which means we cannot infer the welfare improving direction of change in α from the first derivative only.

[22] Whether the state protects less properties than the Mafia depends on the equilibrium value of β (the probability of successful self-defence) being sufficiently high and β is increasing in w as shown above.

[23] What about competitive private enforcement compared to the social optimum? The Mafia and competive enforcers both protect the same proportion of property, while competitive enforcement offers more enforcers than does the Mafia coalition, which in turn offers more than the optimal amount. Thus competition does worse than the Mafia in n while offering the same value of α.

good but undesirable if the activity is bad. In a sequel paper we analyze the enforcement of exchange.

7. Appendix

7.1. Solution and Comparative Statics- Monopolistic Competition

7.1.1. Solution

The system is:

$$\begin{aligned}
\pi^* &= \frac{1}{1+\theta B \frac{\lambda/n}{R}} \\
\beta^* &= \frac{1}{1+\theta B \frac{1-\lambda}{1-\alpha}} \\
[1-\beta]\, V^L &= [1-\pi]\, V^H \\
\pi - \beta &= \frac{nf}{V^* \alpha^*} \\
B &= \frac{(1-\beta)\, V^L}{w}
\end{aligned}$$

The solution:

$$\begin{aligned}
\pi^* &= \frac{V^L}{V^H}\beta^* + \frac{V^H - V^L}{V^H} \\
\lambda^* &= 1 - \frac{w\,(1-\alpha^*)}{\theta V^L \beta^*}. \\
B^* &= (1-\beta^*)\,\frac{V^L}{w} \qquad (7.1) \\
n^* &= V^* \alpha^* \frac{\left(V^H - V^L\right)(1-\beta^*)}{f V^H} \qquad (7.2)
\end{aligned}$$

Where β^* is a root of

$\left(fV^H\left(V^L\right)^2\theta + RV^*\alpha^* wV^L\left(V^H - V^L\right)\right)\beta^2 +$
$\left(+fV^HV^L\theta\left(V^H - V^L\right) - fV^HV^Lw\left(1-\alpha\right) - RV^*\alpha^* wV^L\left(V^H - V^L\right)\right)\beta +$
$-fV^Hw\left(1-\alpha\right)\left(V^H - V^L\right) = 0$

Define $a = \left(fV^H\left(V^L\right)^2\theta + RV^*\alpha^* wV^L\left(V^H - V^L\right)\right)$
$b = \left(+fV^HV^L\theta\left(V^H - V^L\right) - fV^HV^Lw\left(1-\alpha\right) - RV^*\alpha^* wV^L\left(V^H - V^L\right)\right)$
$c = -fV^Hw\left(1-\alpha\right)\left(V^H - V^L\right)$

The polinomial has two roots: $\rho_1 = \frac{-b-\sqrt[2]{b^2-4ac}}{2a}$ and $\rho_2 = \frac{-b+\sqrt[2]{b^2-4ac}}{2a}$

7.1.2. Existence and Uniqueness

An interior solution exist if $\rho_{1,}\rho_2$ are real and if at least one of them is between 0 and 1.

1. $\left(V^H - V^L\right) > 0 \Rightarrow c < 0 \Rightarrow b^2 - 4ac > 0 \rightarrow \rho_{1,}\rho_2$ are real

2. We show that the smallest root of the quadratic expression above is always negative, thus if a solution exists it is unique:
$\frac{-b-\sqrt[2]{b^2-4ac}}{2a} < 0$ if $-b < \sqrt[2]{b^2-4ac}$
If $b > 0$ this is always true.
If $b < 0 : 4ac < 0 \Rightarrow b^2 < b^2 - 4ac$ always.

3. An interior solution exists if the largest root lies between 0 and 1 :
$\frac{-b+\sqrt[2]{b^2-4ac}}{2a} > 0$ if $\sqrt[2]{b^2-4ac} > b$
If $b < 0$ it is always true
If $b > 0$ then $4ac < 0 \rightarrow \ b^2 - 4ac > b^2$ always.

$\frac{-b+\sqrt[2]{b^2-4ac}}{2a} < 1$ if $\sqrt[2]{b^2-4ac} < b + 2a$
Taking squares and rearranging we get: $a + b + c > 0$,which is satisfied iff $w < \frac{\theta V^L}{(1-\alpha^*)}$[24]

Thus $\beta^* = \frac{-b+\sqrt[2]{b^2-4ac}}{2a}$

[24] $w < \frac{\theta \bar{V}^L}{(1-\alpha^*)}$ is also sufficient to guarantee that $b + 2a > 0$

7.1.3. Comparative Statics

Note that:
$\frac{\partial\beta}{\partial X} = \frac{-\left(\frac{\partial a}{\partial X}\beta^2+\frac{\partial b}{\partial X}\beta+\frac{\partial c}{\partial X}\right)}{2a\beta+b}$ where $X = R, w, \theta, f$

Note also that $2a\beta + b = \sqrt[2]{b^2 - 4ac} > 0$
By straightforward (and tedious) computation we can show that:

$\frac{\partial\beta}{\partial R} = \frac{\beta(1-\beta)V^*\alpha^* wV^L\left(V^H-V^L\right)}{2a\beta+b} > 0;$
$\frac{\partial\beta}{\partial w} = \frac{\beta(1-\beta)V^*\alpha^* RV^L\left(V^H-V^L\right)+\beta fV^H V^L(1-\alpha)+fV^H(1-\alpha)\left(V^H-V^L\right)}{2a\beta+b} > 0$
$\frac{\partial\beta}{\partial\theta} = \frac{-\left(\beta^2 fV^H\left(V^L\right)^2+\beta fV^H V^L\left(V^H-V^L\right)\right)}{2a\beta+b} < 0$
$\frac{\partial\beta}{\partial f} = -\frac{1}{f}\frac{\beta(1-\beta)V^*\alpha^* RV^L\left(V^H-V^L\right)}{2a\beta+b} < 0$

which implies that:
$\frac{\partial\pi}{\partial R} = \frac{V^L}{V^H}\frac{\partial\beta}{\partial R} > 0; \frac{\partial\pi}{\partial w} = \frac{V^L}{V^H}\frac{\partial\beta}{\partial w} > 0; \frac{\partial\pi}{\partial\theta} = \frac{V^L}{V^H}\frac{\partial\beta}{\partial\theta} < 0; \frac{\partial\pi}{\partial f} = \frac{V^L}{V^H}\frac{\partial\beta}{\partial f} < 0;$

and:
$\frac{\partial B}{\partial R} = -\frac{V^L}{w}\frac{\partial\beta}{\partial R} < 0; \frac{\partial B}{\partial\theta} = -\frac{V^L}{w}\frac{\partial\beta}{\partial\theta} > 0; \frac{\partial B}{\partial f} = -\frac{V^L}{w}\frac{\partial\beta}{\partial f} > 0; \frac{\partial B}{\partial w} = -\frac{V^L}{w}\frac{\partial\beta}{\partial w} - \left(1-\beta^*\right)\frac{V^L}{w^2} < 0;$
and:
$\frac{\partial\lambda}{\partial R} = \frac{w(1-\alpha^*)}{\theta V^L\beta^2}\frac{\partial\beta}{\partial R} > 0; \frac{\partial\lambda}{\partial f} = \frac{w(1-\alpha^*)}{\theta V^L\beta^2}\frac{\partial\beta}{\partial f} < 0$

and finally that:
$\frac{\partial n}{\partial R} = -\frac{V^*\alpha^*\left(V^H-V^L\right)}{fV^H}\frac{\partial\beta}{\partial R} < 0; \frac{\partial n}{\partial\theta} = -\frac{V^*\alpha^*\left(V^H-V^L\right)}{fV^H}\frac{\partial\beta}{\partial\theta} > 0;$
$\frac{\partial n}{\partial w} = -\frac{V^*\alpha^*\left(V^H-V^L\right)}{fV^H}\frac{\partial\beta}{\partial w} > 0.$

7.2. Solution and Comparative Statics- Coalition Case.

The system is:

$$\pi^* = \frac{1}{1+\theta B\frac{\lambda/n}{R}}$$
$$\beta^* = \frac{1}{1+\theta B\frac{1-\lambda}{1-\alpha}}$$

$$
\begin{aligned}
[1-\beta] V^L &= [1-\pi] V^H \\
n &= \frac{\alpha^* V^* \pi(1-\pi)}{f} \\
B &= \frac{(1-\beta) V^L}{w}
\end{aligned}
$$

The solution is:

$$
\begin{aligned}
\pi^* &= \frac{V^L}{V^H}\beta^* + \frac{V^H - V^L}{V^H} \\
\lambda^* &= RV^*\alpha^* w V^L \frac{(1-\beta^*)}{\theta f \left(V^H\right)^2} \\
B^* &= \frac{(1-\beta^*)V^L}{w} \qquad (7.3) \\
n^* &= \frac{V^*\alpha^*}{f}\pi^* \left(1-\pi^*\right) \qquad (7.4)
\end{aligned}
$$

Where β^* is a root of $\left(RV^*\alpha^* w(V^L)^2\right)\beta^2 + \left(f\theta V^L \left(V^H\right)^2 - RV^*\alpha^* w(V^L)^2\right)\beta - f\left(V^H\right)^2 w\left(1-\alpha\right) = 0$

Define

$A = \left(RV^*\alpha^* w(V^L)^2\right)$

$B = \left(f\theta V^L \left(V^H\right)^2 - RV^*\alpha^* w(V^L)^2\right)$

$C = -f\left(V^H\right)^2 w\left(1-\alpha\right)$

7.2.1. Existence and Uniqueness

An interior solution exist if q_1,q_2 are real and if at least one of them is between 0 and 1.

$\alpha < 1 \rightarrow C < 0 \Rightarrow B^2 - 4AC > 0 \rightarrow q_1$,$q_2$ real

2. We show that the largest root of the quadratic expression above is never larger than 0, thus if a solution exists it is unique:

$\frac{-B-\sqrt[2]{B^2-4AC}}{2A} > 0$ if $\sqrt[2]{B^2-4AC} < -B$.

If $B > 0$ then $-B < 0 \rightarrow \sqrt[2]{B^2-4AC} > -B$ always.

If $B < 0$ then $4AC < 0 \rightarrow \sqrt[2]{B^2-4AC} > -B$ always.

3. An interior solution exists if the largest root lies between 0 and 1 :
$\frac{-B+\sqrt[2]{B^2-4ac}}{2a}>0$ if $\sqrt[2]{B^2-4AC}>B$
If $B<0$ it is always true
If $B>0$ then $4AC<0 \rightarrow \sqrt[2]{B^2-4AC}>B$ always.
$\frac{-B+\sqrt[2]{B^2-4AC}}{2A}<1$ if $\sqrt[2]{B^2-4AC}<B+2A$

It is immediate to show that $2A+B>0$.Taking squares and rearranging the above condition can be written as $A+B+C>0$,which is satisfied iff $w<\frac{\theta V^L}{(1-\alpha^*)}$

Thus $\beta^*=\frac{-B+\sqrt[2]{B^2-4AC}}{2A}$

7.2.2. Comparative Statics.

Note that:
$\frac{\partial q}{\partial X}=\frac{-\left(\frac{\partial A}{\partial X}\beta^2+\frac{\partial B}{\partial X}\beta+\frac{\partial C}{\partial X}\right)}{2A\beta+B}$ where $X=R,w,\theta,f$

Note also that $2A\beta+B=\sqrt[2]{B^2-4AC}>0$
By straightworfard (and tedious) computation we can show that:
$\frac{\partial\beta}{\partial R}=\frac{\beta(1-\beta)V^*\alpha^*w(V^L)^2}{2A\beta+B}>0;$
$\frac{\partial\beta}{\partial w}=\frac{\beta(1-\beta)V^*\alpha^*R(V^L)^2+f\left(V^H\right)^2(1-\alpha)}{2A\beta+B}>0;$
$\frac{\partial\beta}{\partial\theta}=\frac{fvV^L\left(V^H\right)^2}{2A\beta+B}>0;$
$\frac{\partial\beta}{\partial f}=\frac{-\left(V^H\right)^2\left(\beta\theta V^L-w(1-\alpha)\right)}{2A\beta+B}<0$ since $\left(\beta\theta V^L-w\left(1-\alpha\right)\right)>0$[25]

and:
$\frac{\partial\pi}{\partial R}=\frac{V^L}{V^H}\frac{\partial\beta}{\partial R}>0;\ \frac{\partial\pi}{\partial w}=\frac{V^L}{V^H}\frac{\partial\beta}{\partial w}>0;\ \frac{\partial\pi}{\partial\theta}=\frac{V^L}{V^H}\frac{\partial\beta}{\partial\theta}<0;\ \frac{\partial\pi}{\partial f}=\frac{V^L}{V^H}\frac{\partial\beta}{\partial f}<0$

and:
$\frac{\partial B}{\partial R}=-\frac{V^L}{w}\frac{\partial\beta}{\partial R}<0;\ \frac{\partial B}{\partial\theta}=-\frac{V^L}{w}\frac{\partial\beta}{\partial\theta}>0;\ \frac{\partial B}{\partial f}=-\frac{V^L}{w}\frac{\partial\beta}{\partial f}>0;\ \frac{\partial B}{\partial w}=-\frac{V^L}{w}\frac{\partial\beta}{\partial w}-\left(1-\beta^*\right)\frac{V^L}{w^2}<0;$

finally:
$\frac{\partial n}{\partial X}=\frac{V^*\alpha^*}{f}\left(1-2\pi\right)\frac{\partial\pi}{\partial X}$ for $X=R,w,\theta.$
If $\pi>\frac{1}{2}$[26] we have:
$\frac{\partial n}{\partial R}<0;\ \frac{\partial n}{\partial w}<0;\ \frac{\partial n}{\partial\theta}>0.$

[25] $\left(\beta\theta vV^L-w\left(1-\alpha\right)\right)>0$ if $\beta>\frac{w(1-\alpha)}{\theta vV^L}=\frac{-C}{A+B}$ which is verified.
[26] A sufficient condition is $V^H>2V^L$, which also guarantees that profits are positive.

7.3. Coalition vs Monopolistic Competition: a Comparison

This section compares the outcomes in the cases of monopolistic competition and coalition. Since the two cases differ only for the equation that determines n, instead of comparing parameter values directly we solve the system as a function of n and analyse how parameters change with n.

$$\pi = \frac{1}{1+\theta B\frac{\lambda/n}{R}}$$
$$\beta = \frac{1}{1+\theta B\frac{1-\lambda}{1-\alpha}}$$
$$[1-\beta]\,V^L = [1-\pi]\,V^H$$
$$B = \frac{(1-\beta)\,V^L}{w}$$

the interior solution is:

$\beta^* = \frac{w(1-\alpha)}{\theta V^L(1-\lambda^*)}; \pi^* = \frac{V^L}{V^H}\beta^* + \frac{V^H-V^L}{V^H}; B = \frac{V^L}{w} - \frac{(1-\alpha)}{\theta(1-\lambda^*)}$ and $\lambda^* = \frac{-b-\sqrt[2]{b^2-4ac}}{2a}$
where[27]:
$a = \theta\left(V^H - V^L\right)$
$b = -\left(\theta\left(V^H - V^L\right) + w\,(1-\alpha) + Rnw\right)$
$c = Rnw$

Profits are equal to: $P(n) = \frac{V^H-V^L}{V^H}\,(1-\beta^*(n))\,V^*\alpha^* - fn.$

We can show that:
1. If a coalition is formed there will be fewer enforcers.

Note that $\frac{\partial\beta^*}{\partial\lambda^*} > 0$ and that $\frac{\partial\lambda^*}{\partial n} = \frac{Rw(1-\lambda^*)}{\sqrt[2]{b^2-4ac}} > 0$, from which it follows that $\frac{\partial P}{\partial n} < 0$.
Since profits are positive if there is a coalition and zero under monopolistic competition it follows that, given $\frac{\partial P}{\partial n} < 0$, there must be more enforcers in the monopolistically competitive case.

[27] It is easy to show that the other solution is always larger than 1.

2. If a coalition is formed every property will be less secure, there will be more bandits and the share of bandits attacking protected property will be higher.

Note that $\frac{\partial \beta^*}{\partial \lambda^*} > 0$, $\frac{\partial \pi^*}{\partial \lambda^*} > 0$, $\frac{\partial B^*}{\partial \lambda^*} < 0$. The result follows from $\frac{\partial \lambda^*}{\partial n} > 0$ and the fact that n is smaller when a coalition is formed.

7.4. Additional Results when V is linear.

For the linear V case we can obtain the welfare derivative with respect to α of Section 5 as

$$\begin{aligned} W_\alpha &= \frac{-V_a}{2}\left[2\alpha^m(\pi^m - \beta^m) - (1+\alpha^m)\beta^m(1-\beta^m)\right] \text{ where we use} \\ \beta_\alpha &= -\beta(1-\beta)/(1-\alpha). \end{aligned}$$

For $V(1) = 0$, $\alpha^m = 1/2$. Moreover, evaluating (1.6) for the linear case we obtain

$$\begin{aligned} (1-\pi)\left[1+\widehat{V}\right] &= (1-\beta)/2 \\ &\Longrightarrow \pi - \beta = (1-\beta)\frac{1+\widehat{V}}{2+\widehat{V}} \textit{ where} \\ \widehat{V} &\equiv \frac{V(0) - V(1/2)}{2V(1/2)} > 0. \end{aligned}$$

Substituting into W_α we obtain:

$$W_\alpha = \frac{-V_a}{2}(1-\beta^m)\left[\frac{1+\widehat{V}}{2+\widehat{V}} - \frac{3}{2}\beta^m\right] < 0 \textit{ for } \beta^m \geq 1/2.$$

Evaluating the second derivative we obtain:

$$\begin{aligned} W_{\alpha\alpha} &= \frac{-V_\alpha}{2}(1-\beta^m)\left\{\frac{1+\widehat{V}}{1+\widehat{V}/2} + \frac{\beta^m}{1-\alpha^m}\left[-1+3\alpha^m + (1+\alpha^m)(1-2\beta^m)\right]\right\} \\ &= \frac{-V_\alpha}{2}(1-\beta^m)\left\{\frac{1+\widehat{V}}{1+\widehat{V}/2} + 2\beta^m(2-3\beta^m)\right\} \textit{ with } \alpha^m = 1/2. \end{aligned}$$

For β^m sufficiently large, W is decreasing in α and locally concave in α at α^m. Since $W_{\alpha n} = 0$, for β^m sufficiently large, W is locally concave in α, n. This suggests that the optimal values of α and n are smaller than for the Mafia when β^m is sufficiently large. Of course, since endogenous variables such as λ will change with α and n, W need not be a concave function of α and n. Thus it is difficult to compare the optimal values of α and n defined by $W_a = 0 = W_n$ with the Mafia solution α^m, n^m in general. We derive exact solutions for the critical value of β^m for which the state protects less propertythe case where: $V = b - \frac{\alpha}{2}$ and $b = 0.5 \Rightarrow V^H = 3/8; V^L = 1/8$.

7.4.1. Welfare Maximising State vs. the Mafia (ref. section 5)

Note that $V(1) = 0 \implies V_\alpha = -V(0) = -V^0$. For linearity we can show that $D > \alpha V > S$ for $\alpha < 1$. The profit maximizing Mafia solution for α is 1/2 in the linear case. Then $D = 3S$, $\alpha V = 2S, S = -V_\alpha/8 = V(0)/8$. Since $\pi_n = \pi(1-\pi)/n$, comparing the optimal and Mafia derivatives with respect to n at the profit maximizing $\alpha = 1/2$, we see that since $\alpha V > S$, the state must have too small a value of π_n for its first order condition to hold when evaluating at the Mafia solution. By $\pi_{nn} < 0$ the state must reduce n to move toward its optimum. Now evaluate the derivative of welfare with respect to α at the Mafia value of $\alpha = 1/2, n = n_m$. Using the formula for β, we have $\beta_\alpha = -\beta(1-\beta)/(1-\alpha)$. We know $D = (-V_\alpha/2)(1-\alpha^2)$ using linearity. The social welfare derivative with respect to α can now be written as

$$(\pi - \beta)(-\alpha V_\alpha) + D(\alpha)\beta_\alpha = (-V_\alpha)[(\pi - \beta)\alpha - \beta(1-\beta)(1+\alpha)/2].$$

Evaluating the square bracket expression at $\alpha = 1/2$ and factoring out 1/2 the welfare derivative is signed by:

$$\pi - \beta - \beta(1-\beta)3/2.$$

Now we solve for a quasi-reduced form in π as a function of β. We know that the predator allocation condition implies $(1-\pi)V^H = (1-\beta)V^L$. Linearity of demand and $\alpha = 1/2$ implies $V^H/V^L = 3$. The predator allocation condition then implies that $\pi = 2/3 + \beta/3$.and $\pi - \beta = (1-\beta)2/3$. Substituting into square bracket expression we obtain:

$$(2/3)(1 - \beta) - \beta(1-\beta)3/2.$$

As plotted below, this expression can have either sign, depending on the free parameters which determine equilibrium β.

The critical interior value of β for which the derivative of welfare with respect to α is equal to zero is solved from
$(2/3)(1-\beta)-\beta(1-\beta)3/2=0.$, The solution is : $\{\beta = .44444\}, \{\beta = 1.0\}$. The diagram shows that cream skimming is the solution when theMafia equilbrium value of β exceeds .44. For this range, social welfare is decreasing in α when evaluated at the Mafia solution. Social welfare is always decreasing in n at the Mafia solution.

We must check that positive profits are earned by the Mafia in this range. Mafia profits are given by $(\pi - \beta)\alpha V > fn = \pi(1-\pi)\alpha V$ where the latter equality follows from the optimal selection of n by the Mafia. The two conditions imply that positive profits require $\pi > \beta^{1/2}$. Combined with the predator allocation condition in the linear case, this means -$3\beta^{1/2} + \beta + 2 > 0$. Plotting the left hand side as a function of β we have

This shows that for any value of β which emerges as an equilibrium value, Mafia profits are positive.

Figure 1. Net coalition pro…t as a function of w--Parameters values: f=aV/15; R=2, f/d=1

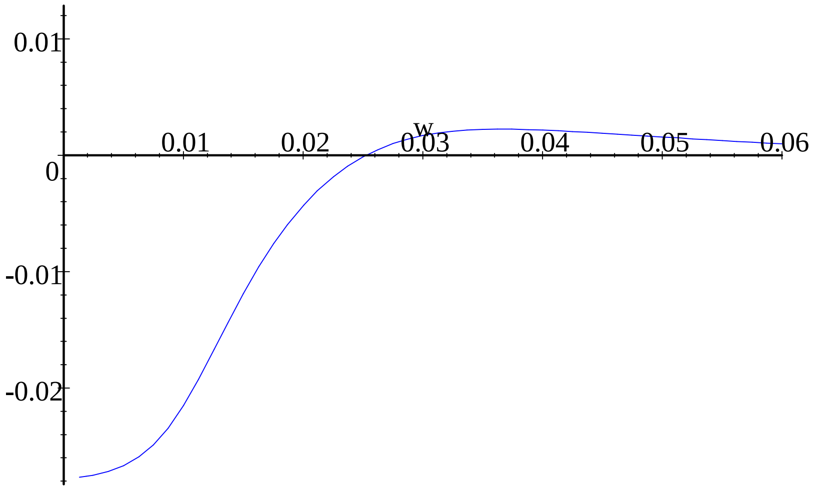


Figure 2. Net coalition pro…t as a fct of R-- Parameters values: f=aV/15;w=1/32, f/d=1

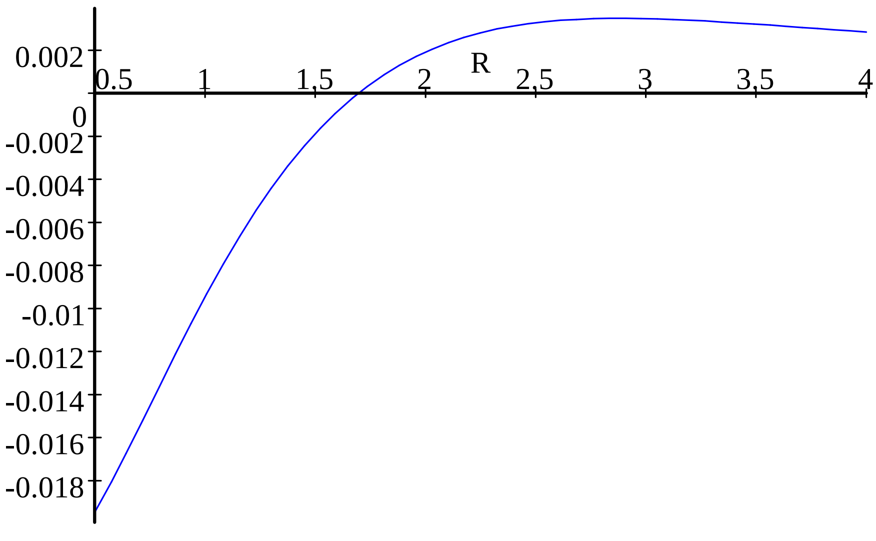


Figure 3: State Protetion vs. Mafia Protection

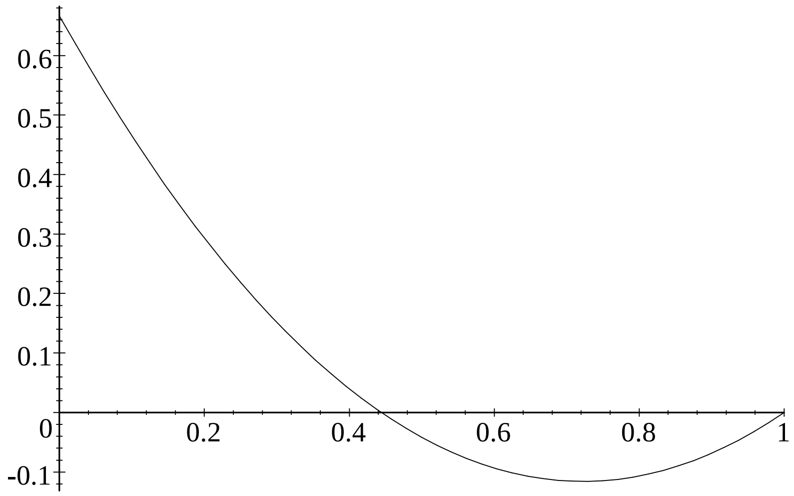
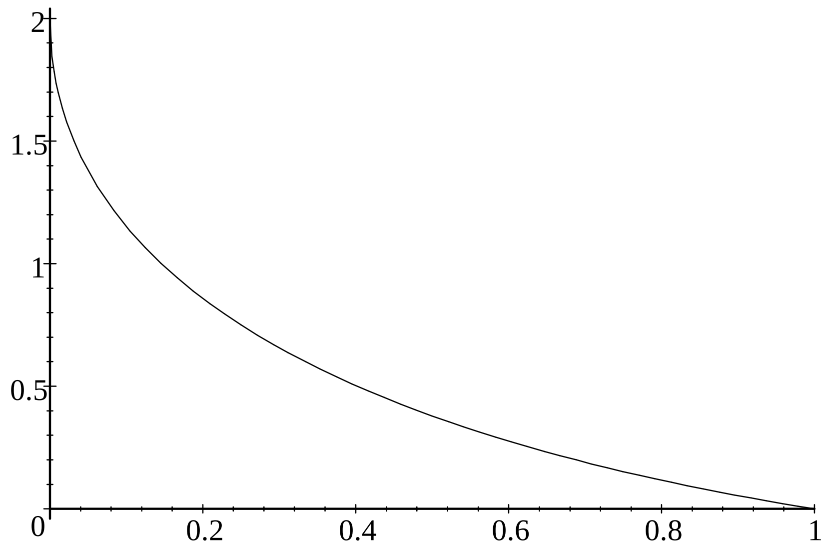


Figure 4: Profits as a function of β



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