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The Logic of Violence in Drug War

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Drug traffickers sometimes share profits peacefully. Other times they fight. We propose a model to investigate this variation, focusing on the role of the state. Seizing illegal goods can paradoxically increase traffickers' profits, and higher profits fuel violence. Killing kingpins makes crime bosses short-sighted, also fueling conflict. Only by targeting the most violent traffickers can the state reduce violence without increasing supply. These results help explain empirical patterns of violence in drug war, which is less studied than are interstate or civil war but often as deadly.

INTRODUCTION

The fundamental puzzle about drug wars is that they are costly but nonetheless recur (cf. Fearon 1995, 379). Sometimes, drug traffickers manage to divide profits peacefully; other times, violence prevails.[1] Why?

Studies of interstate and civil war provide a partial answer (for reviews, see Powell 2002; Ramsay 2017; Walter 2009). Just as states cannot appeal to a supranational government to enforce agreements, traffickers cannot resolve disputes in court. Any agreement to share the market peacefully must therefore be self-enforcing (Fearon 1995; Powell 1993, 2006).

But part of the answer cannot be found in studies of interstate or civil war. Unlike states in the international system, traffickers in illegal markets interact under policy set by a powerful third party: the government.[2] The government decides whether and how aggressively to seize illegal drugs (*interdiction*); this affects traffickers' profits and thus the stakes of the conflict. The government decides whether and how aggressively to jail or kill crime bosses (*beheadings*); this affects traffickers' time horizons and thus their interest in cooperation. And critically, the government can also decide whether to target interdiction and/or beheadings so as to create incentives for violence reduction (Kleiman 2011; Lessing 2018).

We propose a model to investigate how interdiction and beheadings shape cooperation and conflict among traffickers in illegal markets. Traffickers use smuggling routes to move drugs from producers to consumers; the more routes they control, the more drugs they can smuggle and sell. Along the way, they lose a fraction of their goods to government interdiction. In each period, traffickers fight for smuggling routes, and thus profits, which are divided in proportion to traffickers' conflict expenditure.[3] The more conflict expenditure, the more violence.

To understand how interdiction affects violence, we first examine how it affects the stakes of the conflict: traffickers' profits.[4] Previous work has noted that interdiction can reduce the supply of drugs reaching consumer markets, driving up prices; higher prices then boost traffickers' revenues if consumer demand is inelastic (Becker, Murphy, and Grossman 2006). We extend the analysis from *revenues* to *profits*, finding that interdiction can boost traffickers' profits even if demand is slightly elastic. In other words, we find that interdiction raises traffickers' profits under more general conditions than previous work suggests.

When interdiction does boost profits, it also fuels violence among traffickers: in our model, violence rises with the stakes of the conflict. Higher profits tempt traffickers to break low-violence agreements. Traffickers counter this temptation by forging more violent agreements, which deter deviation. This implies a tradeoff: in pursuit of one policy objective (supply reduction), the government sacrifices another (low violence).

Beheadings also hinder cooperation. Because the risk of being incarcerated or killed makes traffickers short-sighted, we model this as a reduction in discount

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[1] Compare, for example, the period of peace under a pact engineered by the Mexican drug trafficker Miguel Ángel Félix Gallardo (Osorno 2009, 239) with the first decade of the Mexican drug war, which was nearly as deadly as the first decade of the war in Iraq.

[2] In interstate or civil war, third parties participate in (e.g.) mediation and peacekeeping (Fey and Ramsay 2010; Kydd 2003) or by directly taking sides (Powell 2017); these roles do not provide a formal analogue for the government's role in illegal markets.

[3] In other words, we characterize the conflict over routes (and profits) as using a repeated contest model. In the Setup section, we discuss how a repeated contest model captures the dynamics of drug-market violence.

[4] In doing so, we endogenize the stakes of the conflict: Bueno de Mesquita (2020) recommends "a political economy approach that takes seriously the two-way relationship between economic and conflict outcomes" (28). See also Powell (2013).

rates—a shortening of "the shadow of the future." Like high profits, impatience undermines low-violence agreements (Axelrod and Hamilton 1981; Bates, Greif, and Singh 2002; Downs, Rocke, and Barsoom 1996; Oye 1985), raising the level of violence in equilibrium.[5]

There is an important exception to the rule that interdiction fuels violence. When cartels are patient enough that they can share the market with no violence at all—that is, when they can use the shadow of the future to support a peaceful equilibrium—interdiction does not necessarily break the peace. While profits affect the level of violence when peace is impossible, peace itself survives some windfalls. This helps explain why peace in illegal markets can coexist with very high profits (e.g., in Colombia in the late 1970s) and (relatedly) why peace can survive swings in interdiction (e.g., in Mexico in the early 2000s). These and similar facts have puzzled researchers, producing skepticism about whether interdiction—or even profits—matter for understanding drug wars.[6]

Finally, we study *conditional repression*: policies in which the government changes interdiction and/or beheadings in response to violence (Kleiman 2011; Lessing 2018). We find that conditional repression can reduce violence among traffickers—but only if the policy is carefully designed. Naively conditional policies, in which the state steps up interdiction and/or beheadings against all cartels whenever violence rises, can paradoxically fuel conflict. Only by targeting the trafficker that deviates from a low-violence agreement can the government be sure to reduce supply of an illegal good and lower violence at the same time.

In addition to the formal war literature cited above, we contribute to a growing body of work on the logic of violence in illegal markets. Lessing (2018) models the effects of conditional repression on cartel–state conflict, finding that conditional repression can lead cartels to eschew fighting the state. Kleiman (2011) argues that "surgical strikes" against the most violent trafficking organization can reduce violence. Relatedly, Snyder and Duran-Martinez (2009) and Durán-Martínez (2018) argue that "state-sponsored protection" can encourage cartels to hide violence. These authors study various forms of conditional repression, but, to the best of our knowledge, previous work does not explicitly examine (as we do) the effects of conditional repression on strategic interaction among traffickers in a dynamic setting. Indeed, Lessing (2018, 73) deems turf war "a worthy and challenging research agenda in its own right."

Our results on interdiction and beheadings also provide theoretical underpinnings for empirical work documenting a relationship between these policies and violence in illegal markets (Calderón et al. 2015; Castillo, Mejía, and Restrepo 2020; Dell 2015; García-Jimeno 2016; Phillips 2015) as well as, more generally, work on violence in illegal markets in Latin America (Angrist and Kugler 2008; Chimeli and Boyd 2010; Dube, Garcia-Ponce, and Thom 2016; Krakowski and Zubiría 2018; Kronick 2020; Mejía and Restrepo 2013; Yashar 2018).

Many forces shaping violence in illegal markets, and indeed many types of violence in illegal markets, lie outside our scope. We focus on violence used for the acquisition of territory in turf war (Lessing 2018, 40), ignoring (to take a few of many examples) violence used for internal discipline, false flag attacks, wars of succession (Reuter 2009), or violent lobbying (Lessing 2015). Rather than comprehensively model all types of violence or all determinants of conflict among traffickers, we seek to illuminate how two key features of prohibition enforcement—interdiction and beheadings—affect traffickers' ability to divide profits peacefully.

SETUP: GUNS, BUTTER, COCAINE, AND ANARCHY

We model drug cartels as profit-maximizing firms engaged in two types of activities: *productive* activities, in which they buy drugs from producers and then move those drugs to consumer markets, evading government enforcers along the way, and *military* activities, in which they fight other cartels for the routes used to transport drugs.[7,8]

Proofs of all lemmas and propositions appear in Appendix A.

Buying, Shipping, and Selling Illegal Goods

Cartels' productive activities can be described in one sentence: Cartel $i \in I$ buys a quantity x_i of illicit drugs in producer markets at a price p_p, transports those drugs through R_i, routes it controls, and sells them in consumer markets at a price p_c.

We assume that a fixed number n of cartels participates in drug trafficking. The principal cost of this assumption is that it precludes analyzing how government policy affects cartel consolidation and/or fragmentation, which are perpetual features of illegal markets (e.g., Durán-Martínez 2018). For example, we do not study the conditions under which arresting crime bosses would split a cartel into smaller factions (Phillips 2015, 326), nor do we study the conditions under which higher profits could draw new cartels into the market.

[5] In some models of interstate war, long time horizons *frustrate* cooperation because the victor locks in her gains: she wins the prize for all future periods (e.g., Powell 1993). We assume instead that a trafficker who deviates from a collusive, low-violence agreement for one period is then punished in subsequent periods. As we discuss below, this is a more natural assumption in our setting.

[6] For example, Durán-Martínez (2018) concludes that "economic explanations … are limited in explaining why violence can be associated with both high and low market prices and with both shortages and ample supplies of drugs" (8).

[7] We follow the literature in modeling traffickers as profit-maximizing firms (Burrus 1999; Baccara and Bar-Isaac 2008; Poret 2003; Poret and Téjédo 2006).

[8] While in principle our model applies to any illegal goods market, for concreteness we frame the discussion in terms of the international cocaine market. We use the term *cartel* because early Colombian traffickers described themselves as *carteles* and the term thereafter became widely used and anglicized; it is conventional and less cumbersome than "drug-trafficking organizations."

If beheadings and/or interdiction were to change the number of cartels, these policies would also affect violence in ways we do not consider. In Appendix A.10, however, we do discuss comparative statics on the number of cartels n.[9] Endogenizing n would enrich the model but add considerable complexity.

The government seizes a fraction of all drug shipments; the size of the fraction depends on government expenditures on interdiction, which we denote e. By *interdiction*, we mean any operation targeting drug shipments: seizing drugs in transit, patrolling routes, or attacking drug boats or airplanes. *Interdiction* excludes capturing or killing cartel leaders (*beheadings*), which we model as a separate policy.

The amount that the cartel sells in consumer markets (q_i) increases with the amount it purchases (x_i) and the routes it controls (R_i) and decreases with the government's interdiction expenditures (e): $q_i = q(x_i, R_i, e)$. Interdiction shrinks the fraction of drugs that reaches consumer markets, thereby reducing the marginal productivity of both drug purchases (x_i) and routes (R_i). There are decreasing marginal returns both to drug purchases (x_i) and to control of routes (R_i). We state and prove additional properties of the production function q in Appendix A.1.

We make the simplifying assumption that all cartels are equally efficient, so that the function $q(x_i, R_i, e)$ holds for every cartel. Introducing asymmetry would make for an interesting extension.[10]

In our baseline analysis, we also assume that the production function $q(x_i, R_i, e)$ has constant returns to scale in routes (R_i) and quantity purchased (x_i). This does *not* imply constant returns to scale in all cartel operations. We do not assume constant returns to conflict investment, nor do we preclude the possibility that there are, for example, fixed costs such as hiring bodyguards or, say, inefficiencies in running a large organization. Rather, constant returns to scale in routes (R_i) and drugs purchased (x_i) amounts to assuming that drug smuggling is additive across routes.[11] This would be violated if, for example, controlling a large swath of territory made it more difficult for the government to monitor certain routes—in which case doubling routes (R_i) might allow the cartel to more than double drugs sold.

Introducing complementarities across routes would make for an interesting, but complex, extension to the model. Therefore, we focus on production with constant returns to scale, but we provide intuition throughout for how our results would change if we relaxed this assumption.

Each cartel controls a small share of the total market, so it has no market power and takes both upstream and downstream prices as fixed.[12] But all traffickers together account for an important share of the total drug trade, so the total quantity of drugs supplied—that is, $Q = \sum_{i \in I} q_i$—affects prices. We denote the elasticity of demand for drugs in the consumer market ϵ_c.[13]

We assume that drug cartels cannot collude to reduce quantity. For one thing, monitoring compliance would be exceptionally difficult. Cartels' sales are less visible to rivals even than quantity or price choices of legal firms, which are themselves difficult to observe. For another, we are not aware of any examples of this type of collusion in the qualitative literature on illegal markets (Kenney 2007, 234–5).

Fighting for Trafficking Routes

In order to move drugs from producers to consumers, traffickers need to control smuggling routes. We model the conflict over smuggling routes as a repeated contest: in each period, routes are redivided in proportion to each cartel's investment (g_i) in firearms, salaries of gunmen, and related costs. This conflict expenditure (g_i) automatically generates violence according to a function $v(g_1, \ldots, g_n)$ that (a) increases in the expenditure of every cartel and (b) is zero when all cartels have zero conflict expenditure. Because conflict expenditure is symmetric in equilibrium, we use *conflict expenditure* and *violence* interchangeably.

There is a continuum of drug-trafficking routes normalized to one: $\sum_{i \in I} R_i = 1$.[14] Each cartel's share of routes is determined by a contest success function $R(g_i, G_{-i})$ that depends both on own conflict expenditure and on the total amount $G_{-i} = \sum_{j \neq i} g_j$ spent by all other cartels:

$$R(g_i, G_{-i}) = \frac{g_i}{g_i + G_{-i}}. \quad (1)$$

This function implies diminishing marginal returns to own conflict expenditure: as cartel i increases conflict expenditure, g_i, its share of routes increases, but more slowly as g_i grows. This assumption is common in the

[9] We omit these comparative statics from the main text because they generally require more modeling assumptions than our main results do.

[10] Considering asymmetry is nontrivial because it complicates equilibrium selection in the dynamic setting. With symmetry, we simply focus on the symmetric equilibrium with the lowest violence. Under asymmetry, there would be no obvious equilibrium selection criterion, and the comparative statics would vary across equilibria.

[11] To be precise, constant returns to scale requires both additivity across routes *and* a functional form assumption. But, as we show in Appendix F, only the additivity assumption is necessary for the primary results in our paper. We maintain the functional form assumption in the main text not because it is required, but because relaxing it would necessitate more complex notation throughout.

[12] For the case of cocaine trade through Mexico, for instance, a rough estimate of the Herfindahl–Hirschman Index gives 0.15, suggesting that this is a reasonable assumption (Castillo, Mejía, and Restrepo 2020).

[13] We assume that prices in the producer market, p_p, are fixed, which corresponds to an elasticity $\epsilon_p = \infty$. This simplifies the analysis without sacrificing any important insights. In Appendix D, we relax this assumption, allowing $\epsilon_p \in (0, \infty)$, and the main results hold.

[14] As Appendix F clarifies, this normalization allows the relative size of each route to be proportional to its potential profitability.

literature (Fearon 2018; Skaperdas 1996). Moreover, it is well-motivated: the marginal return to the first firearm should be greater than the marginal return to the thousandth. A second feature of this contest success function is homogeneity of degree zero: if all cartels increase conflict expenditure proportionally, route shares stay the same. Throughout, we highlight how departures from this contest success function affect our results.

Three features of drug wars motivate our use of a repeated contest model. First, cartel turf boundaries change frequently—much more frequently than do international borders. Therefore, it would be inappropriate, in our view, to model turf war as, for example, a costly lottery in which the victor locks in her gains for all future periods (e.g., Fearon 2018; Powell 1993, 2006). Indeed, Powell (1993) notes that the notion of a permanent victor is unrealistic even in the context of interstate war (121); in our context, it would be yet more unrealistic. Our model allows turf boundaries to be redrawn in each period.

Second, conflict among cartels often involves intermediate outcomes: multiple cartels share the contested territory rather than one cartel winning it all. Our model naturally accommodates these divisions.

Third, our repeated contest model assumes that purchasing arms mechanically entails using them. This is better suited to our setting than the assumption that purchasing and using arms constitute separate decisions (e.g., Fearon 2018; Jackson and Morelli 2009; Powell 1993). For one thing, cartels' arms purchases are less visible (to competitors) than states' military expenditures; it is thus harder to make a case for arms as deterrence. For another, the notion of *continuous* variation in violence—that is, that competing traffickers could engage in low- or medium-intensity skirmishes, not just all-or-nothing war—constitutes a reasonable description of cartel relations (but might be hard to justify among states).[15]

This choice also evades the problem posed by Jackson and Morelli (2009), who show that arms levels high enough to deter war are not stable: "given that war is costly, if one of the countries deviates and slightly lowers its arms level, then the countries will still not go to war and the deviating country will save some resources" (282). In other words, temporary spending cuts save money without drawing attack, meaning that there is no pure-strategy peaceful equilibrium.[16] Fearon (2018) provides one solution to this problem, arguing that arms may provide leverage in bargaining over international issues. In our setting, the problem does not arise: when purchasing arms mechanically entails using them, any cut in conflict expenditure immediately reduces that cartel's share of routes.

[15] Fearon (2018) describes variation in arms levels as a continuous measure of "the costs of anarchy" in the international system. Here, similarly, variation in violence provides a continuous measure of the costs of anarchy in an illegal market.

[16] If states arm simultaneously, as traffickers do in our model.

Profit

Since cartel i sells a quantity q_i of drugs in the consumer market at a price p_c, it ultimately obtains profit given by

$$\pi_i = p_c q(x_i, R(g_i, G_{-i}), e) - g_i - p_p x_i \tag{2}$$

While cartels make two decisions—the quantity of drugs to buy (x_i) and how much to invest in conflict, (g_i), only conflict expenditure (g_i) affects strategic interaction among cartels. Since cartels are price takers, the quantity of drugs sold by cartel i does not affect its rivals.[17]

THE EFFECT OF INTERDICTION ON PROFIT

Understanding the effect of interdiction on intercartel violence requires first understanding the effect of interdiction on cartels' *productive* profit: the difference between total drug revenue and the total cost of purchasing drugs from producers, or $\pi^A = p_c Q - p_p X$, where $Q = \sum_i q_i$ is aggregate supply to consumers and $X = \sum_i x_i$ is the total quantity that cartels purchase from producers. (As opposed to *net profit*, $\pi^A - \sum_i g_i$, which also takes into account conflict expenditure).

One straightforward result of the setup presented thus far is that aggregate supply Q and aggregate drug purchases X—and thus productive profit π^A—are independent of the distribution of routes across cartels (Appendix A.3). This is a consequence of assuming symmetry and constant returns to scale in route ownership (R_i) and drug purchases (x_i), and it simplifies our baseline analysis. However, throughout the paper we discuss how relaxing constant returns to scale affects our key comparative statics. Moreover, under conditional repression, it is no longer the case that aggregate supply and aggregate drug purchases are independent of the distribution of routes across cartels; we discuss the complication below.

To anticipate why the quantity π^A is so critical, note that we can rewrite each cartel's profit (π_i) as a function of aggregate productive profit (π^A):

Lemma 1. *Cartel i's profit can be restated as*

$$\pi_i = \pi^A R(g_i, G_{-i}) - g_i, \tag{3}$$

which emphasizes that cartels' conflict expenditure (g_i) allows them to control a share of routes $R(g_i, G_{-i})$, thereby obtaining that same share of the aggregate productive profit (π^A).

Interdiction reduces the supply of drugs reaching consumers, which raises prices. In Appendix A.5, we show formally why interdiction reduces supply. Empirically, while there is substantial skepticism about whether interdiction can permanently reduce the supply of illegal drugs, there are also many examples of

[17] If cartels had some market power, interaction through drug quantities would become relevant. Bueno de Mesquita (2020) studies interaction through prices.

stepped-up interdiction causing jumps in the price of heroin (Reuter 1985, 8), cocaine (Caulkins and Reuter 2010, 247), and alcohol during Prohibition (Miron and Zwiebel 1991). Supply reduction immediately implies how interdiction affects aggregate *revenue* from drug sales. If consumer demand for drugs is price inelastic (that is, if $\epsilon_c > -1$), interdiction increases revenue; if consumer demand for drugs is price elastic ($\epsilon_c < -1$), interdiction decreases revenue.

But aggregate *revenue* is not the quantity that matters for understanding violence among traffickers. Aggregate revenue may constitute a good measure of the harm caused *to consumers* by illegal drugs, which is why Becker, Murphy, and Grossman (2006) focus on the -1 threshold in their analysis.[18] We instead seek to understand the effect of interdiction expenditure e on aggregate productive profit (π^A). The derivative $\partial\pi^A/\partial e$ allows us to solve for a price-elasticity threshold $\hat{\epsilon}_c$ above which interdiction increases aggregate productive profit (π^A):

$$\hat{\epsilon}_c = -1 - \frac{\left(\frac{\partial q}{\partial X}\right)^2}{\frac{\partial q}{\partial e}\frac{\partial^2 q}{\partial X^2}}\left(\frac{\partial \log q}{\partial e} - \frac{\partial \log \frac{\partial q}{\partial X}}{\partial e}\right). \tag{4}$$

Proposition 1: (a) *If* $\epsilon_c < \hat{\epsilon}_c$*, then* $\frac{\partial \pi^A}{\partial e} < 0$*: If demand is sufficiently elastic, interdiction reduces aggregate productive profit.*

(b) *If* $\epsilon_c > \hat{\epsilon}_c$*, then* $\frac{\partial \pi^A}{\partial e} > 0$*: If demand is sufficiently inelastic, interdiction increases aggregate productive profit.*

The threshold in Equation 4 is -1 plus a correction, because interdiction affects cartels' *costs* in addition to revenues. There are two opposing forces. On one hand, interdiction drives up prices, in response to which cartels buy more drugs, increasing costs $p_p X$. On the other hand, interdiction lowers the marginal productivity of drugs, leading cartels to buy fewer drugs—thereby decreasing costs $p_p X$. The relative size of these two effects determines the sign of the correction to the -1 threshold.[19]

Which effect dominates depends, in turn, on the functional form of $q(x, R, e)$, the function mapping drug purchases, routes, and interdiction to drugs sold in the consumer market. One straightforward property q must satisfy is that it should never exceed x: a cartel cannot sell more drugs than it buys. Though this assumption alone does not pin down the sign of the correction, in Appendix C we show that the correction is negative for a wide variety of functional forms that satisfy it.

In other words, the threshold $\hat{\epsilon}_c$ is generally < -1: interdiction boosts profits even if demand is slightly elastic.[20] Given empirical uncertainty over the price elasticity of demand for cocaine (Gallet 2014), this correction is important.[21] Without it, we might conclude that enforcement has only negligible effects on the stakes of the conflict; with it, we understand why interdiction can raise the stakes.

THE CONFLICT OVER SMUGGLING ROUTES: SETUP

Why Does Violence Increase with the Stakes?

For reasons described above, we characterize conflict among traffickers using a contest model—that is, a model in which profits are divided in proportion to cartels' conflict expenditure. In a single-shot game, it is a well-known property of contest models that conflict increases with the stakes (Garfinkel and Skaperdas 2007, 661). In a repeated contest model, conflict also increases with the stakes, for reasons we discuss below, but this result is less well-known (though see Fearon 2018, 532).

Other models of conflict produce the reverse outcome: that conflict abates as the pie grows, or equivalently, that hard times drive conflict. This can arise from lack of information. When firms collude on prices, for example, unobserved negative demand shocks can trigger price wars because firms wrongly suspect their coconspirators of undercutting a deal (Green and Porter 1984). In politics, similarly, asymmetrically observed economic shocks require a less-informed opposition to discipline a more-informed government by fighting whenever the government makes a low offer, which occurs when times are bad (Dal Bó and Powell 2009). Neither of these mechanisms strikes us as especially relevant to conflict among traffickers, who neither collude on price nor bargain over profits. Moreover, the information problems in these models arise from short-term shocks, whereas we analyze long-term shifts that stem from policy changes.

In another set of models, positive shocks to certain economic sectors increase wages, raising the opportunity cost of fighting and thereby decreasing conflict (Dal Bó and Dal Bó 2011). But the core logic actually works in the same direction as in our model: in Dal Bó and Dal Bó (2011), conflict declines as the economy grows

[18] Becker, Murphy, and Grossman (2006) do not formally consider violence. Subsequent studies have taken the -1 threshold out of context, concluding that it also determines how cartel *profits*—and thus conflict—change with interdiction.

[19] This can be seen in Equation 4: the sign of the correction to the -1 threshold is determined by $\frac{\partial \log q}{\partial e} - \frac{\partial \log \frac{\partial q}{\partial X}}{\partial e}$, which is the difference of the two opposing effects.

[20] To provide a sense of the magnitude of the correction, we choose a functional form form for q and calculate $\hat{\epsilon}_c$ using data from Reuter (2004, 130) in Appendix C. This yields $\hat{\epsilon}_c = -1.1$. Many empirical estimates of the price elasticity of cocaine fall between -0.9 and -1 (Gallet 2014), and some lie between -1 and -1.1: below -1, but above our threshold. This underscores the empirical significance of the correction.

[21] The relevant quantity in our setting is the wholesale price elasticity, not the retail price elasticity. However, there are few empirical estimates of wholesale price elasticities, in part because wholesale prices are even more difficult to observe than retail prices. But a standard theoretical result is that wholesale elasticities are driven to a large extent by retail elasticities, which suggests that if the retail price elasticity lies above the threshold we derive, the wholesale price elasticity likely does, too.

only because the size of the *appropriable* pie shrinks, in relative terms (relative to wages). Similarly, in Fearon (2008), conflict abates as the economy grows because development reduces the *fraction* of resources that are appropriable.[22] Thus, in these models, a growing pie reduces violence only by *lowering* the stakes of conflict relative to the stakes of other activities. Similarly, in our model, shrinking profits reduce violence by lowering the stakes of conflict.

Stage Game

Recall from Lemma 1 that cartel i's one-period problem can be written as follows:

$$\max_{g_i} \pi_i = \pi^A \mathrm{R}(g_i, G_{-i}) - g_i \tag{5}$$

This resembles a problem faced by actors in other one-period models in which a prize is divided according to a contest success function (like R), and the results are analogous: cartels' investments g_i in the conflict rise with the stakes π^A (Garfinkel and Skaperdas 2007, 661).[23]

This, in turn, tells us how violence in the unique symmetric stage-game Nash equilibrium changes with interdiction. When demand is sufficiently inelastic (that is, when $\epsilon_c > \hat{\epsilon}_c$), violence increases with interdiction; otherwise, violence declines with interdiction (Appendix A.6).[24]

The level of violence in the stage-game equilibrium, which we denote g^N, is the level of violence we would expect in the repeated game in the absence of cooperation. It is thus the upper bound of the set of levels of violence that can be sustained in a repeated game.

Setup of the Repeated Game

Of course, cartels do not interact in a one-period setting. They interact repeatedly, which enables less violent solutions to the conflict over routes—just as repeated interaction enables cooperation among states (e.g., Fearon 1995, 2018; Powell 1993, 2006). A key difference between our model and previous literature lies in the role of the third party. Rather than serve as mediator or peacekeeper (Fey and Ramsay 2010; Kydd 2003; Walter 2002), the state shapes strategic interaction among traffickers by changing the size of the pie (profits), by changing traffickers' time horizons, and, in some cases, by explicitly creating incentives for violence reduction.

Cartel i's total profits are the discounted sum of the profits obtained in each period:

$$\Pi_i = \sum_{t=0}^{\infty} \beta^t \pi_{i,t} \tag{6}$$

where $\pi_{i,t}$ is the profit obtained by cartel i in period t and $\beta \in (0,1)$ is the discount factor. This discount factor depends both on a monetary discount (related to the interest rate), which we call δ, and the probability p that the cartel leader will still be in charge in the next period, such that $\beta = \delta p$.

The probability p of a cartel leader staying in power depends on the government: we assume that policies that are directed at capturing or killing capos decrease p, thereby decreasing the value of the future for current bosses (i.e., making leaders more impatient). In other words, we assume that when a government begins aggressively targeting kingpins, remaining cartel leaders become more pessimistic about their own survival.

Punishment Strategies

The baseline equilibrium repeats the stage-game Nash equilibrium perpetually, with profit $\Pi^N = \pi^N/(1-\beta)$ and conflict expenditure g^N for each cartel; this is the equilibrium that arises in the absence of cooperation. The comparative statics are exactly as in the stage-game Nash equilibrium: interdiction increases violence if demand is sufficiently inelastic and decreases it otherwise.

But cartels can do better through cooperation. Repeated interaction allows cartels to sustain low-violence pacts by threatening to punish any cartel that deviates. Punishment yields profits π^p for all subsequent periods.[25]

We consider two punishment strategies. With *Nash reversion*, cartels punish by moving to the stage-game Nash equilibrium, with $\pi^p = \pi^N$ in every subsequent period. With *maximal constant punishment*, cartels punish by moving to an even more violent equilibrium with even lower profits, $\pi^p = \pi^m < \pi^N$. We define maximal constant punishment (or just maximal punishment, for short) as the harshest punishment possible within the set of subgame-perfect strategies in which nondeviating cartels punish the deviator by spending a constant conflict expenditure $\tilde{g}$ for all subsequent periods; during the punishment phase, the deviator can choose its conflict expenditure freely. Our results also hold if punishment lasts only for T periods, after which cartels return to the low-violence agreement (Appendix A.11).[26]

[22] An analogous mechanism drives a second logic of conflict in Dal Bó and Powell (2009): conflict wanes as the economy grows because the government can only lowball the opposition up to the value of the asymmetrically observed economic shock, which is large relative to a small economy but negligible relative to a large economy.

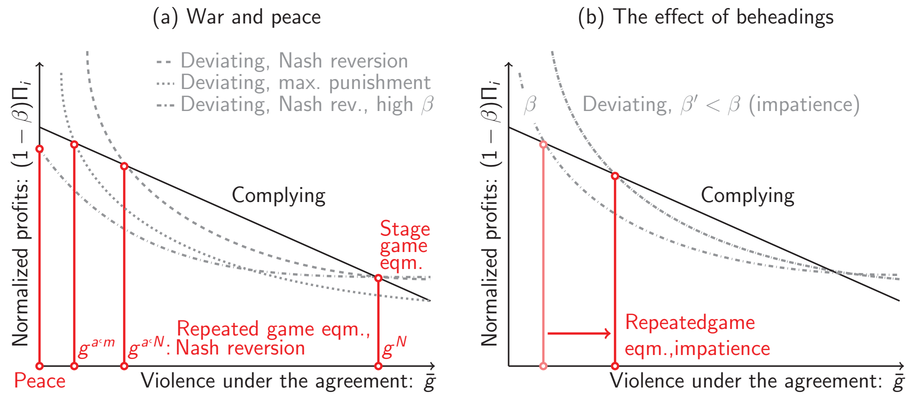
[23] This can be seen immediately from the first-order condition: $\pi^A(\partial \mathrm{R}/\partial g_i) = 1$. If π^A increases, $\partial \mathrm{R}/\partial g_i$ would need to decline in order to preserve the equality. Because R has diminishing marginal returns to g_i, this implies higher levels of conflict expenditure g_i.

[24] If we relax the assumption of constant returns to scale, these results hold, but for a *different* elasticity threshold, $\hat{\epsilon}'_c$ (see Appendix C.2).

[25] Our results also hold if punishment is limited to T periods; see Appendix A.11.

[26] Our results also hold for even more general equilibrium strategies, which we state in Appendix A.10, but these general statements require assumptions on the way punishment strategies evolve as model parameters change due to the multiplicity of equilibria. We prefer to avoid those complications in the main text.

FIGURE 1. The Shadow of the Future and Violence in Illegal Markets



Note: Panel (a) illustrates how cartels can use the shadow of the future to construct self-enforcing agreements with less violence than in the stage-game equilibrium (Proposition 3) or even with no violence at all (Proposition 2). Figure (b) illustrates how the equilibrium level of violence (under an intercartel agreement) changes when the government steps up arrests or killings of cartel leaders, which (we argue) shortens their time horizons (Proposition 4).

Let $\bar{g}$ be the level of conflict expenditure under the low-violence agreement; in a slight abuse of notation, $\bar{g}$ also denotes the one-period strategy profile in which every cartel spends $\bar{g}$. The agreement can be sustained if cartels prefer to honor the agreement instead of deviating for one period and then incurring punishment thereafter.

This implies one of two *incentive constraint*s (IC1): $\frac{1}{1-\beta}\pi_i(\bar{g}) \geq \max_{g_i} \pi_i(g_i, \bar{g}_{-i}) + \frac{\beta}{1-\beta}\pi^p$, which simplifies to

$$\pi_i(\bar{g}) \geq (1-\beta)\max_{g_i} \pi_i(g_i, \bar{g}_{-i}) + \beta\pi^p. \tag{7}$$

For maximal punishment, a second incentive constraint must be satisfied: it must be advantageous for cartels to actually punish the deviator. This requires that they, in turn, be punished if they renege on the punishment strategy.

Let $\tilde{g}^i$ refer to a one-period strategy profile to punish cartel i. All cartels except for i spend some quantity $\tilde{g}^i_{-i} = \tilde{g}$, while i spends the quantity that maximizes its profits, $\tilde{g}^i_i = \text{argmax}_{g_i} \pi_i\left(g_i, \tilde{g}^i_{-i}\right)$. A punishing cartel $j \neq i$ thus sticks to the punishment strategy if the following incentive constraint (IC2) holds:

$$\pi_j\left(\tilde{g}^i\right) \geq (1-\beta)\max_{g_j} \pi_j\left(g_j, \tilde{g}^i_{-j}\right) + \beta\pi_j\left(\tilde{g}^j\right). \tag{8}$$

For cartel $j \neq i$, punishing the deviator and obtaining profits $\pi_j\left(\tilde{g}^i\right)$ must be preferable to deviating and getting profits $\max_{g_j} \pi_j\left(g_j, \tilde{g}^i_{-j}\right)$ for one period, after which j is punished by all other cartels—including the original deviator i—obtaining profits $\pi_j\left(\tilde{g}^j\right)$ thereafter.

Maximal punishment is the maximum expenditure $\tilde{g}$ such that IC2 holds, leading to punishment profits $\pi^p = \pi_i\left(\tilde{g}^i\right)$ in the first incentive constraint.

RESULTS: THE EFFECT OF INTERDICTION AND BEHEADINGS ON VIOLENCE

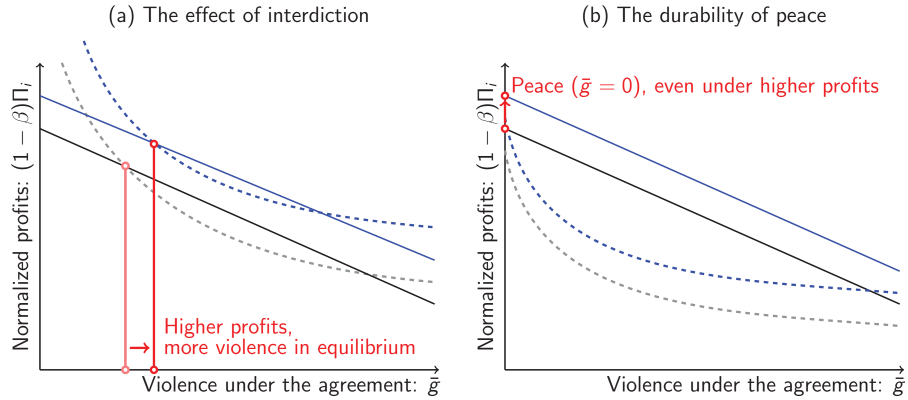
To understand how interdiction and beheadings affect violence among traffickers, we first describe how the shadow of the future allows cartels to cooperate. Rather than devote g^N to conflict expenditure as in the stage-game Nash equilibrium, cartels agree to share the market with some lower conflict expenditure $\bar{g} < g^N$—and thus lower violence. More conflict expenditure $\bar{g}$ under the agreement reduces the benefits of defecting relative to the benefits of sticking to the deal. Just as arms levels can deter war between states (e.g., Fearon 2018; Powell 1993), conflict expenditure and the threat of future punishment can deter cartels from breaking an agreement.

To see this, consider Figure 1a. Conflict expenditure under an intercartel agreement, $\bar{g}$, increases along the x-axis; the y-axis plots normalized total profits. (The normalization ensures that profits under *complying* with the agreement don't shift graphically as we vary the discount rate.) Profits under deviation are convex because of diminishing returns to conflict expenditure; profits under complying, in contrast, decline linearly: as violence under the agreement grows, cartels obtain the same productive profit but spend more on the conflict.

The point labeled *Peace* illustrates how cartels can agree to share the market with no violence at all. When the shadow of the future is long enough, the threat of punishment is sufficient to deter cartels from breaking a peaceful agreement—that is, an agreement to share the market with zero conflict expenditure and zero violence.[27] The incentive constraint that must hold for peace to be

[27] As noted above, Fearon (2018) uses a repeated contest model to characterize bargaining over an international issue, just as we use a repeated contest model to characterize cartels' conflict over routes. But because Fearon (2018) layers bargaining over an international issue on top of another conflict—a territorial conflict, resolved by a costly lottery—his model (unlike ours) precludes the first-best outcome of zero costly armament.

FIGURE 2. The Effect of Interdiction on Violence



Note: Panel (a) illustrates an unintended consequence of interdiction (or, more generally, a consequence of an increase in profits): higher productive profits raise the benefits of breaking an agreement more than the benefits of sticking to it, which increases the level of violence required for an agreement to hold. Panel (b) illustrates why an increase in profits does not necessarily break a peaceful agreement, when cartels are patient enough to share the market with no violence at all.

sustained is $\pi_i(\bar{g}=0) \geq (1-\beta)\max_{g_i}\pi_i(g_i,\bar{g}_{-i}=0)+\beta\pi^p$, where $\pi_i(\bar{g}=0)$ are profits under complying with the agreement, $\max_{g_i}\pi_i(g_i,\bar{g}_{-i}=0)$ are profits from breaking the agreement (which the deviator enjoys for one period), and π^p are profits under the subsequent punishment. Isolating β yields[28]

$$\beta \geq \frac{n-1}{n\left(1-\frac{\pi^p}{\pi^A}\right)}, \tag{9}$$

which leads to the following proposition:

Proposition 2. *For punishment strategy $p \in \{N,m\}$, a peaceful equilibrium can be sustained if $\beta \geq \bar{\beta}^p$, where $\bar{\beta}^N > \bar{\beta}^m$.*

Proposition 2 reveals that cartels can indeed coexist without any violence if cartel leaders are sufficiently patient.[29] Below, we discuss how government policy changes the threshold $\bar{\beta}^p$.[30]

Even if peace cannot be sustained ($\beta < \bar{\beta}^p$), we would expect cartels to coexist with less violence than in the one-shot game (that is, less violence than g^N). In particular, we would expect them to arrive at an intermediate outcome in which they agree to spend $\bar{g} < g^N$ on the conflict, after which each cartel ends up controlling the same share of routes as in the stage-game equilibrium ($R^a = 1/n$), but with higher profit.

In Figure 2a, the points labeled $g^{a,m}$ and $g^{a,N}$ mark opportunities for sharing the market with less violence than in the stage-game equilibrium. Specifically, $g^{a,m}$ and $g^{a,N}$ mark the lowest levels of violence that cartels can sustain under maximal punishment and Nash reversion, respectively, for an arbitrary discount rate β. In other words, these are two of the low-violence pacts that will hold against the temptation of breaking out, ramping up conflict expenditure for one period, and then incurring punishment thereafter. In Appendix A, we demonstrate the following:

Proposition 3. *There exist nonnegative $g^{a,m}$ and $g^{a,N}$ (with $g^{a,m} \leq g^{a,N}$) such that with punishment strategy p all levels of expenditure in $[g^{a,p}, g^N]$ can be sustained and no level of expenditure below $g^{a,p}$ can be sustained. Lower bounds $g^{a,m}$ and $g^{a,N}$ are only equal when they are both zero (i.e., a peaceful equilibrium), under the conditions in Proposition 2.*

Having established the possibility both of peace (Proposition 2) and of low-violence agreements (Proposition 3), we turn to three comparative statics.[31]

[28] To see this, note that under a peaceful agreement each cartel obtains $1/n$ routes, and from Lemma 1, each cartel obtains profits $\pi_i(\bar{g}=0)=(1/n)\pi^A$. For a single period, the deviator would take all the aggregate productive profit with a tiny conflict investment η, gaining $\max_{g_i}\pi_i(g_i,\bar{g}_{-i}=0)=\pi^A-\eta \approx n\,\pi_i(\bar{g}=0)$, thus increasing its profit by a factor of n. From the next period on, the deviator would receive profits π^p under the punishment strategy.

[29] The existence of a peaceful equilibrium is not a consequence of the fact that the contest success function (Equation 1) has a discontinuity at the origin, which allows a cartel to win all routes with infinitesimal expenditure. Actually, this discontinuity makes it more profitable to deviate, making it *harder* for cartels to sustain a peaceful equilibrium. Similar functional forms with no discontinuity at the origin are more likely to result in peaceful equilibria. For example, $R(g_i, G_{-i}) = \frac{a+g}{na+g_i+G_{-i}}$, where a is some constant.

[30] In Appendix A.8, we also show that the threshold decreases with the number of cartels (i.e., peace is harder to sustain with more cartels), though these results are more sensitive to modeling assumptions.

[31] We take comparative statics focusing on the equilibria with the lowest level of expenditure, $g^{a,p}$, since these lower bounds characterize the set of sustainable equilibria. These are the equilibria that satisfy the incentive-compatibility constraints with equality, such that $\pi_i(\bar{g})=(1-\beta)\max_{g_i}\pi_i(g_i,\bar{g}_{-i})+\beta\pi^p$. We define $v^{a,p}$ as the level of violence that obtains when all cartels spend $g^{a,p}$ in the conflict.

Beheadings, Impatience, and Intercartel Violence

Figure 1b illustrates what happens when the shadow of the future shortens.[32] The (normalized) profits under complying with the agreement don't change, but the normalized profits under deviating from the agreement increase, as cartels put more weight on the one-period spree in which they enjoy an outsized share of profits. In other words, more forward-looking cartels are more easily deterred by the threat of future punishment, which facilitates low-violence pacts:

Proposition 4. *Under punishment strategy $p \in \{N, m\}$, if the discount factor is such that peace cannot be sustained* (i.e., $\beta < \bar{\beta}^p(n)$), *then* $\frac{\partial v^{a,p}}{\partial \beta} < 0$. *More forward-looking cartels decreases the level of violence.*

Formally, this is a straightforward result, but it has an important substantive interpretation. If jailing or killing cartel leaders shortens other capos' time horizons, this policy—while perhaps politically popular—exacerbates intercartel violence. This suggests a possible mechanism driving empirical findings like those of Calderón et al. (2015), who find that the Mexican government's aggressive campaign to arrest and execute cartel leaders increased the homicide rate. If this "kingpin strategy" made cartel leaders more short-sighted, it also would have strengthened their temptation to break low-violence pacts.

Of course, targeting kingpins could drive violence through mechanisms other than shortening the shadow of the future. Calderón et al. (2015) mention four possible mechanisms: that removing kingpins could trigger wars of succession, that it could shift the offense-defense balance in favor of offense, that it could spur internal disciplinary violence, and that it could prompt cartels to attack the state. While there are perhaps too few cases to rigorously distinguish among these mechanisms (nor are they mutually exclusive), our story does entail different empirical implications. While wars of succession or internal disciplinary violence would likely generate conflict within the targeted cartel's territory, our proposed mechanism would generate violence elsewhere as well. Similarly, while the other proposed mechanisms would explain intracartel violence, cartel–state violence, or violence against the beheaded cartel, our mechanism predicts intercartel violence more broadly. Moreover, our model suggests that the mere publication of the Mexican government's list of most-wanted kingpins could work against intercartel pacts by affecting all cartel leaders' expectations, while other possible mechanisms rely on the actual arrest or execution of cartel leaders.

Overall, our result on beheadings, impatience, and violence underscores the danger of kingpin strategies. Our model implies that this policy can spark violence not only locally (near the targeted cartel's territory) but also globally—and not only in the wake of arrests or killings, but also in anticipation of them.

[32] We draw the figure assuming Nash reversion as a punishment strategy, but the logic would look very similar under maximal punishment.

The Unintended Consequence of Interdiction

We now turn to the relationship between interdiction and violence. Under what conditions does interdiction intensify violent conflict among cartels? Under what conditions does interdiction mitigate violence? Under what conditions does it not matter one way or the other?

To answer these questions, note first that aggregate *productive* behavior (that is, cartels' purchase and sale of drugs) in the repeated game is identical to that in the stage game. This means that, under an agreement with less violence than in the stage-game Nash equilibrium, interdiction still reduces supply—and the discount factor does not affect it (Appendix A.3).

Proposition 1 established that when demand is sufficiently inelastic, interdiction boosts traffickers' productive profit. Figure 2a depicts how this increase in profits affects intercartel agreements: total profits under the agreement and total profits under deviation both increase, but profits under deviation increase *more.* The logic is straightforward. Under a low-violence agreement with conflict expenditure $g^{a,p}$, complying and deviating entail equal profits but from different sources. Complying cartels control a small number of routes but also have low conflict expenditure; a deviating cartel controls more routes but has higher conflict expenditure. Therefore, interdiction that raises productive profit will confer larger benefits on the deviating cartel than the complying cartel because the deviating cartel controls more routes and thus a larger share of productive profits (see Appendix A.10 for additional discussion).

Because interdiction raises the benefits of deviating more than the benefits of sticking to the agreement, the original level of conflict expenditure $\bar{g}$ will be insufficient to deter deviators. As a consequence, conflict expenditure—and thereby violence—must increase (The effect is reversed if demand is sufficiently elastic). We find the following:

Proposition 5. *Under punishment strategy $p \in \{N, m\}$, if the discount factor is such that peace cannot be sustained (i.e., $\beta < \bar{\beta}^p$), the comparative statics on the level of violence under maximal punishment are as follows:*

(a) *If $\epsilon_c < \hat{\epsilon}_c$, then $\frac{\partial v^{a,p}}{\partial e} < 0$: If demand is sufficiently elastic, interdiction reduces violence.*
(b) *If $\epsilon_c > \hat{\epsilon}_c$, then $\frac{\partial v^{a,p}}{\partial e} > 0$: If demand is sufficiently inelastic, interdiction increases violence.*

Proposition 5 says that violence follows productive profit. When demand is sufficiently inelastic, interdiction raises the stakes of the conflict (productive profit) and fuels violence.[33,34]

[33] In Appendix A.10, we also analyze how violence changes with the number of cartels n, though these results are more sensitive to modeling assumptions.

[34] If we relax the assumption of constant returns to scale in drug purchases x_i and routes R_i, then we can establish results analogous to those of 5(a) and 5(b), but for a *different* elasticity threshold $\hat{\epsilon}'_c$ (Appendix C.2).

This result helps explain empirical patterns of violence in illegal markets. That alcohol prohibition in the United States fueled violence is firmly established both in the academic literature and in Hollywood films (e.g., Miron 1999; Owens 2011, 2014). We also know that the violence stemmed largely from conflict over the illegal alcohol market (e.g., Miron 1999; Owens 2011, 2014). Equally apparent is that gangs sometimes divided the alcohol business peacefully. Okrent (2010) provides numerous examples both of gang treaties ("you take the north side, I'll take the south") and also of "escalating arms races" among competing criminal organizations (275).

What accounts for this variation? García-Jimeno (2016) collected data on the intensity of the enforcement of Prohibition, which varied both across cities and over time. In Okrent's (2010) simplification, local enforcement "took on one of two humors—either a vigor that outshone federal efforts or something close to torpor" (255). García-Jimeno (2016) estimates the elasticity of crime to prohibition enforcement, finding "that the Prohibition-related homicide rate was increasing with the level of law enforcement" (513).

Our model illuminates a possible mechanism: that enforcement reduced the supply of alcohol, driving prices up and increasing gangs' incentives to fight rather than abide by treaties. As Okrent (2010, 274) observed, "To secure a cash flow like [3.6 billion untaxed dollars], murder could seem like bookkeeping."

Of course, there are other mechanisms through which interdiction could drive intertrafficker violence. For one thing, an intense interdiction campaign in one location could displace cartels, which could generate conflict (Dell 2015). For another, a cartel might commit to deliver a certain quantity of drugs to consumer markets; if the government then seized part of that shipment, the cartel might attack a rival in desperation. But these alternative mechanisms entail empirical implications different from those implied by our model. Conflict arising from displacement or desperation would spark local and short-run violence in the wake of specific seizures, whereas our model implies a global increase in violence—cartels everywhere know that the new equilibrium means higher profits, which fuels conflict.

Castillo, Mejía, and Restrepo (2020) observe this outcome in Mexico. Around 2008, the US and Colombian governments moved from an ineffective strategy of coca crop eradication—which one writer compared to "trying to drive up the price of fine art by raising the cost of paint" (Wainwright 2016)—to the more effective approach of drug interdiction (Mejía and Restrepo 2016). This policy change had an unintended consequence: higher prices and higher profits for the Mexican drug cartels that bring Colombian cocaine to consumers. Simultaneously, violence in Mexico doubled. Castillo, Mejía, and Restrepo (2020) estimate that a 1% decrease in the supply of cocaine (because of interdiction) drove a 0.12% to 0.16% increase in homicide rates in the Mexican municipalities most exposed to drug trafficking. Our model provides a possible explanation for this result: negative supply shocks increased the stakes of conflict and thus violence among cartels.

Government efforts to reduce supply through interdiction have often been criticized for being ineffective. Our model provides another cause for concern: if they *are* effective, they may spur violence in illegal markets.

The Durability of the First-best Outcome

Proposition 5 raises an empirical question: If interdiction (or more generally, profits) fuel intercartel violence, why do we observe periods of high profits and yet minimal violence in illegal markets? And why does this peace sometimes appear immune to changes in interdiction?

This section provides an answer. When cartels are patient enough that they can share the market with no violence at all, interdiction does not necessarily break the peace. Figure 2b visualizes the logic. Even if interdiction boosts total profits, shifting both curves outward from the origin, patient-enough cartels can still share the market peacefully. In other words, interdiction can narrow the gap between the profits from deviating and the profits from complying, without entirely closing that gap.[35] As long as the discount factor remains above the threshold in Equation 9, changes in interdiction will not break intercartel peace.[36]

This may explain how a peaceful agreement among Colombian cartels survived a surge in profits in the late 1970s and early 1980s (Lessing 2018, 129). It may also explain how, for many years, Mexican cartels ran a massive cocaine trafficking operation with few turf-war homicides.[37] In Appendix E, using the same research design as Castillo, Mejía, and Restrepo (2020), we show that interdiction did *not* drive violence among Mexican cartels in the pre-2006 period. Why did interdiction generate violence in Mexico after 2006 but not before? Our model suggests an explanation. Prior to the Mexican government's "decapitation strategy," cartel leaders were patient enough to abide by a peaceful agreement. The peaceful agreement could survive fluctuations in profit, but targeting kingpins shortened capos' time horizons. The peaceful equilibrium broke down, and in the absence of peace, the logic of our model prevailed. Profits, and thus violence, rose with interdiction.

[35] As Figure 2b makes clear, this is a result of the fact that violence is bounded below at zero. This is true both in our model and in reality; this corner solution therefore has a real-world analogue: cartels do sometimes share the market without any turf war.

[36] Moreover, if the contest success function is homogenous, the β threshold required for peace does not depend on interdiction at all.

[37] Trejo and Ley (2018) study intercartel turf conflict in the 1990s and early 2000s; they collect data showing that intercartel conflict produced 150–275 deaths per year between 1996 and 2003. This is (at least) an order of magnitude lower than the death toll in the intercartel turf war beginning in 2007.

The fact that profits only affect violence when traffickers cannot sustain peace underpins the danger of jailing or killing high-profile traffickers. The risk of being captured or killed makes capos shortsighted, which makes peace harder to sustain. But once a peaceful equilibrium is infeasible, the level of violence begins to respond to profits. Therefore, targeting kingpins and ramping up interdiction—which often go hand-in-hand as part of a crackdown—constitute a fatal combination: taking out capos breaks a peaceful equilibrium, and then rising profits fuel violence.

PEACEFUL PROHIBITION?

In the policies analyzed thus far, the government simply seeks to reduce the quantity of drugs reaching consumers. In principle, of course, the government could also attempt to design policy so as to reduce violence (Kleiman 2011; Lessing 2018). Indeed, qualitative work has long documented evidence that governments do this. Snyder and Duran-Martinez (2009), for example, argue that governments sometimes provide "state-sponsored protection" (that is, leniency) to certain cartels in exchange for (among other things) low violence (or in exchange for hiding violence, Duran-Martinez 2015). Cruz and Duran-Martinez (2016) describe governments effectively helping enforce gang truces. This section analyzes these policies formally. We first describe how two policies that might appear to reduce violence could in fact exacerbate it. We then turn to policies that, we find, can reduce supply and facilitate cooperation at the same time.

Indiscriminate Conditionality

Consider first a policy in which the state sets the overall level of interdiction in response to cartels' behavior. In an attempt to keep violence below some level $\bar{v}$, the state increases interdiction from e to $\tilde{e}$ whenever total violence rises above $\bar{v}$. We call this *indiscriminate conditional interdiction* because the policy conditions interdiction on overall violence, but it does not discriminate among cartels: as in the baseline model, the policy treats all cartels equally.

This policy might appear to encourage cartels to abide by low-violence agreements. If breaking the agreement would provoke the government to step up interdiction, cartels might be more likely to stick with the deal. We show in Appendix A.12 that this logic is incorrect. When demand is sufficiently inelastic, more interdiction actually boosts cartel profits.[38] Paradoxically, then, indiscriminate conditionality makes deviation *more* attractive: for a cartel considering breaking out of a low-violence pact, the government choosing $\tilde{e} > e$ looks like a reward—not a punishment.

Of course, this implies that the government could reduce violence by *decreasing* interdiction in response to conflict: that is, by setting $\tilde{e} < e$ whenever violence rises above $\bar{v}$. Such a policy strikes us as implausible. First, the government would have to intentionally and explicitly abandon the goal of supply reduction. Second, a promise to ease up on interdiction whenever cartels start fighting would be a tough sell to the public.

One might think that more arrests or killings of cartel leaders in response to violence—conditional beheading—would unambiguously facilitate low-violence pacts. Under *indiscriminate conditional beheading*, the government would more aggressively target kingpins whenever a low-violence agreement broke down, thus reducing cartels' discount factor β in the (off-path) post-deviation period. Unlike conditional interdiction, which could potentially fuel violence through boosting profits, conditional beheading does not affect aggregate supply one way or the other.

We nevertheless find that indiscriminate conditional beheading can entail its own competing forces. While indiscriminate conditional beheading indeed reduces violence in equilibrium when cartels use Nash reversion as a punishment strategy, the consequences are ambiguous under maximal punishment (Appendix A.12). On one hand, the returns to deviating decline because deviation induces more arrests and killings; this facilitates pacts (just as under Nash reversion). On the other hand, additional beheadings in the (off-equilibrium path) postdeviation setting make cartels more impatient, hampering their ability to enforce harsh punishments. This works against low-violence agreements.

Targeted Conditionality

Indiscriminate conditionality is a blunt tool. What if the state instead targeted the cartel that deviates from a low-violence pact?

Consider a policy in which the state sets interdiction at the default level e if all cartels abide by the low-violence agreement. Whenever some cartel deviates from the agreement, the state sets a higher level of interdiction $\bar{e}$ for that cartel while keeping the default level e for every other cartel. We call this *targeted conditional interdiction.*

Unlike indiscriminate conditional interdiction, targeted conditional interdiction exerts opposing forces on low-violence pacts. On one hand, raising $\bar{e}$ (interdiction against the punished cartel) can reduce overall supply, raising profits (if demand is sufficiently elastic) and making deviation more tempting. On the other hand, raising $\bar{e}$ reduces the punished cartel's "productivity." A smaller fraction of the punished cartel's drug purchases makes it to consumers. Under targeted conditionality, the punished cartel's routes lose value. This discourages deviation.

Under what conditions will the latter force dominate? In other words, when will targeted conditionality facilitate low-violence pacts? Targeted conditionality is more difficult to analyze than are the policies studied thus far. The principal complication is that Lemma 1 no longer holds: cartels no longer split aggregate profits according to their shares of smuggling routes. Because the targeted

[38] When demand is sufficiently elastic, indiscriminate conditionality lowers violence.

cartel (the one subject to higher interdiction $\bar{e}$) now uses its routes less efficiently than other cartels do, its share of profits will be smaller than its share of routes. As a result, routes are divided asymmetrically: routes shift away from the targeted cartel toward other cartels. This, in turn, complicates analysis of the relationship between interdiction and aggregate supply reaching consumers (and thus prices) because cartels no longer purchase the same quantities of drugs per route.

To make the analysis tractable, we impose an additional assumption on the production function q. Rather than allowing $q(x,R,e)$ to depend freely on e, we assume that interdiction affects production according to $q(x,R,e)=\tilde{q}[x,\theta(e)R]$, where $\theta(e)$ is a decreasing function.[39] This restriction rules out the possibility that the same government investment in interdiction has different consequences for cartels that control different numbers of smuggling routes.

Under this restriction, we show in Appendix A.12 that targeted conditional interdiction will facilitate low-violence pacts—and thus reduce the equilibrium level of violence—unless demand is extremely inelastic. Specifically,

Result 1. *Let $\bar{s}$ denote the share of supply provided by the targeted (punished) cartel, and let S denote the ratio of aggregate productive profit to aggregate revenue ($S=\pi^A/p_cQ$). A necessary condition for violence to increase with $\bar{e}$ is*

$$\epsilon_c > -\frac{\bar{s}}{S} \tag{10}$$

We prove in Appendix A.12 that Result 1 holds under Nash reversion, and we verify numerically that it holds under maximal punishment.

In order for targeted conditionality to backfire—in other words, in order for targeted conditionality to hamper low-violence pacts—demand would have to be more inelastic than $-\bar{s}/S$. Consider some plausible magnitudes for this threshold. In drug markets, S is typically close to one because the cost of drug purchases is small relative to the revenue from drug sales (i.e., cartels' main cost is smuggling) (Reuter 2004). And $\bar{s}$, the share of supply provided by the targeted cartel, will certainly be less than $1/n$, where n is the number of cartels in the market. For a market with six cartels, then, ϵ_c would have to exceed $\approx -1/6$ in order for targeted conditionality to backfire. Even the most pessimistic estimates of the price elasticity of demand in cocaine markets do not exceed this threshold (Gallet 2014). This means that targeted conditional interdiction is very likely to facilitate low-violence pacts among cartels.[40]

Similarly, *targeted conditional beheading* evades the problems of indiscriminate conditional beheading. Consider a policy in which the government steps up beheadings only against the cartel that breaks an agreement, thereby reducing that cartel's discount factor to a level $\check{\beta}$ after deviation (but leaving other cartels' patience unaltered). Kleiman (2011) argued that this would "condition the traffickers' ability to remain in business on their willingness to conduct their affairs in a relatively nonviolent fashion" (101). In Appendix A.12, we show that this policy also facilitates cooperation among traffickers. Targeted conditional beheading unambiguously discourages deviation, lowering the level of violence in equilibrium (under the agreement) and also reducing the discount rate required to maintain peace.

These findings provide a possible mechanism behind recent empirical results about the use of conditional repression in Latin America. In Mexico, Trejo and Ley (2018) find that state-government agents served as a "third-party enforcer" for intercartel agreements (915). Gubernatorial political alternation disrupted this enforcement, requiring cartels to "develop their own private militias to protect their drug trafficking routes." In Brazil, the government of Rio de Janeiro rolled out a security policy that was explicitly directed at violence reduction. The city's security secretary repeatedly emphasized that the goal of the new Pacification program was not to eliminate drug trafficking but rather to retake territory from armed gangs and "bring peace to the residents" (Lessing 2018, 195). Magaloni, Franco-Vivanco, and Melo (2020) find that this policy also reduced intergang conflict—but only in areas where multiple gangs contested turf (36). Our model suggests an explanation. By threatening to arrest or kill only those gang leaders who broke low-violence pacts, the Pacification program facilitated gangs' efforts to share the retail drug market peacefully.

Table 1 summarizes our results for the six policies we consider. When cartels are forward-looking enough that they are able to sustain a peaceful agreement (that is, share the market with no violence), that peace is surprisingly resilient to changes in profits, including those changes induced by interdiction. But when cartels are too impatient to sustain peace, the traditional policy tools of prohibition enforcement—interdiction and the pursuit of high-profile traffickers—are counterproductive in that they fuel intercartel violence. The same problem plagues naively conditional policies in which the government simply cracks down on all cartels in response to rising violence. Only by targeting interdiction and/or beheadings against the cartel that breaks a low-violence agreement can the government facilitate the reduction of violence through intercartel cooperation.

CONCLUSION: THE COSTS OF ANARCHY IN ILLEGAL MARKETS

In the *Theory of International Politics*, Waltz (1979) compared the struggle for cooperation among states to the pursuit of collusion among oligopolistic firms. One key difference, he noted, is that "firms need not protect

[39] $\tilde{q}$ also satisfies the main properties of q. Namely, it is concave, homogeneous of degree 1, and the cross derivative is positive. Note also that this specification is equivalent to one of the form $q(x,R,e)=\check{q}[\varphi(e)x,R]$, where $\varphi(e)$ is a decreasing function and $\check{q}$ satisfies the same properties as $\tilde{q}$.

[40] In Appendix A.12, we also study changes to the level of interdiction against complying cartels ($\underline{e}$). We find that setting $\underline{e}<e$ can further reduce violence.

TABLE 1. The Effect of Policy on Intercartel Turf War

Policy	Condition on demand elasticity ϵ_c	Effect on Violence: $\beta < \bar{\beta}^p$ (Cartels too impatient to sustain peace)	Effect on Violence: $\beta > \bar{\beta}^p$ (Cartels patient enough to sustain peace)
Unconditional interdiction, $e \uparrow$	$\epsilon_c > \hat{\epsilon}_c$	$\nu \uparrow$	No effect
Unconditional beheadings, $\beta \downarrow$	—	$\nu \uparrow$	No effect
Indiscriminate conditional interdiction, $\tilde{e} \uparrow$	$\epsilon_c > \hat{\epsilon}_c$	$\nu \uparrow$	No effect
Indiscriminate conditional beheading, $\tilde{\beta} \downarrow$	—	Ambiguous	No effect
Targeted conditional interdiction, $\breve{e} \uparrow$	$\epsilon_c > -\bar{s}/S$	$\nu \uparrow$	No effect
Targeted conditional beheading, $\breve{\beta} \downarrow$	—	$\nu \downarrow$	No effect

Note: This table summarizes the policies we analyze and their consequences for intercartel violence. Under the "indiscriminate conditional" policies, the government steps up interdiction and/or beheadings against all cartels whenever violence rises. Under the "targeted conditional" policies, the government steps up enforcement only against the deviator. If the *condition on demand elasticity* is not met, the policy has the opposite effect on violence.

themselves physically against assaults from other firms" (105). We study the struggle for cooperation among profit-maximizing firms that *do* need to protect themselves and their market share against physical assaults from competitors—traffickers in illegal markets.

One might therefore think that the struggle for cooperation among traffickers simply mirrors the problem faced by states in the anarchic international system. But this analogy is flawed. True, traffickers cannot enforce agreements in court. True, their property falls outside the scope of formal state protection. True, foundational papers in this literature model cartels interacting under anarchy (Skaperdas and Syropoulos 1995).

But of course, illegal markets are not truly anarchic. States create illegal markets, and states set policy that powerfully shapes traffickers' behavior. We study how policy affects traffickers' ability to reduce violence through cooperation.

Conventional tools of prohibition enforcement can undermine that cooperation. Jailing or killing crime bosses makes surviving capos impatient, tempting them to break low-violence pacts for short-term gain. Seizing illegal goods (interdiction) can paradoxically boost traffickers' profits, raising the stakes of the conflict and thereby weakening low-violence pacts. While previous papers have noted that interdiction raises prices and, if demand is sufficiently inelastic, increases total *revenues* (e.g., Becker, Murphy, and Grossman 2006), our model extends the analysis from revenues to profits, finding that interdiction can increase profits even when demand is slightly elastic. In other words, interdiction boosts traffickers' profits under more general conditions than previously thought. This means that interdiction fuels violence under more general conditions, too. In pursuit of one policy objective (supply reduction), the government sacrifices another (low violence).

Conditional repression puts the state's power at the service of violence reduction. Under conditional repression, the state targets those trafficking organizations that break low-violence agreements, singling out their leaders for arrest and their shipments for seizure. This allows the state to facilitate low-violence agreements, providing a kind of contract enforcement where the court itself cannot. Nor is conditional repression incompatible with the goal of supply reduction. With the right targeting, the state can reduce supply and lower violence at the same time. We therefore join the call for public consideration of conditional repression, not only as a way to change individual traffickers' incentives (Kleiman 2011) or to reduce cartel–state conflict (Lessing 2018), but also as a way to facilitate life-saving cooperation among traffickers.

SUPPLEMENTARY MATERIALS

To view supplementary material for this article, please visit http://dx.doi.org/10.1017/S0003055420000246.

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