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Spillover effects of domestic law enforcement policies

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ABSTRACT

In the war against drugs, local and state governments in the United States have spent millions of dollars in law enforcement with the aim of reducing drug consumption in their territories. These independent efforts by local or state governments contrast with a more global structure of illegal drug markets where drug lords sell and distribute drugs simultaneously in different territories.

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1. Introduction

In the war against drugs, local and state governments in the United States have spent millions of dollars in law enforcement with the aim of reducing drug consumption in their territories. These independent efforts by local or state governments contrast with a more global structure of illegal drug markets where drug lords sell and distribute drugs simultaneously in different territories.[1] For example, while Colombian traffickers distribute cocaine at the wholesale level in cities such as Boston, Miami, Newark, New York, and Philadelphia, Mexican traffickers do it in Chicago, Dallas, Denver, Houston, Los Angeles, Phoenix, San Diego, San Francisco, and Seattle. The same pattern is found in the distribution of heroin throughout the United States.[2]

It is then possible that investments in domestic law enforcement policies by local or state governments might affect illegal drug activities in other areas.[3] This seems to be the case in cities and states of the United States where patterns in drug use and drug distribution differ.[4]

That domestic law enforcement policies by local or state governments do not only affect the "host" market but also have external effects over other markets is recognized by the U.S. Federal government in the program of High Intensity Drug Trafficking Areas (HIDTA), where it assumes that drug trafficking in certain areas of the United States affects other areas in the country. Understanding these external effects and the incentives that governments may have to coordinate their policies is then an important issue for explaining patterns in drug distribution, drug consumption and prices in different legal jurisdictions and also explaining their global trends. This is the contribution of the present paper.

The paper studies the effect that these policies may have on a vertically structured drug industry, where drug suppliers buy drugs from an upstream market and simultaneously sell and distribute them in downstream markets where arbitrage is not possible.[5] Our model predicts that increases in domestic law enforcement policies in one market affect the optimal decision by drug suppliers and have consequences not only at the level of drug distribution, drug consumption and drug prices in the domestic market, but also in other markets. We find two reasons for these effects. First, a reduced available demand for illegal drugs in one downstream market can push down the wholesale price "internationally" and lead to increased consumption in other downstream markets. Second, if the illegal drug industry, or "drug lords", adapt market investments, such as drug distribution activities, to the governments' domestic law enforcement policies, this interaction can also contribute to local drug policies spilling over to other markets.

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[1] The same pattern may also apply to national governments.

[2] See DEA reports (2006) for further references on the structure of these markets. At a national level, traffickers also distribute drugs simultaneously in different countries.

[3] In a more general context, investments by national governments might also affect illegal drug activities in other countries. This might explain, for example, the different trends in cocaine consumption and drug distribution between the United States and some European countries.

[4] See Lang and Johnson (1997) for evidence on differences in crack use between large cities, and the FBI (2001) and DEA reports (2006) for differences in drug arrests, drug related violent crime, and drug seizures in the United States, all correlated with their distribution. See also Reaves and Hickman (2002) for trends in the size of Police Departments in large cities.

[5] Some evidence on price differences between cities and regions in the United States support this assumption. See Caulkins (1995) and Reuter and Greenfield (2001) for further references.

The model captures the spillover effects of domestic law enforcement policies in other markets and may help to explain the pattern of trends in drug consumption and drug distribution between cities and states in the United States (or countries in a more general context), and also the simultaneously declining drug prices in both upstream and downstream markets. The result is that stricter domestic law enforcement policies in one market tend to increase drug distribution activities in other markets, while having a non-monotonic effect on these activities in the "host" market. Hence, drug consumption in the "host" market is reduced while increased in other markets and drug prices in both upstream and downstream markets are reduced.

When these external effects are present, the local or state governments' decisions on spending in domestic law enforcement policies in those drug markets are also linked. Their optimal policies are analyzed in Section 3. We assume that governments minimize a loss function in terms of the level of drug consumption and domestic law enforcement policy. The existence of externalities opens up the possibility for coordination between governments with the aim of reaching efficiency in the allocation of public resources at a global sphere. Even though coordination between governments creates a lower spending of resources, it also results in a higher level of global drug consumption. Conversely, policies set by independent governments create a lower global drug consumption but a higher spending of resources. These results are found to be robust to differences in the degree of competition in both the upstream and the downstream markets.

Sections 1–3 assume a monopolistic market structure in both the upstream and the downstream market. Section 4 extends the benchmark model to allow for competition in the downstream markets.[6] We find that governments with identical loss functions are more likely to coordinate their policies, if the level of competition in their downstream markets is also similar. However, if the level of competition differs substantially between their markets, one of the governments may find it optimal to independently set its level of domestic law enforcement policies. In other words, coordination among cities or states' governments in the United States depends on the level of drug competition in their markets.

This result implies that we should find lack of coordination between cities and states in the United States where the level of competition differs substantially. Hence, differences in drug competition within cities and states should create different degrees of coordination among their governments. Evidence from the United States supports this conclusion.

On the one hand, the existence of federal programs such as The High Intensity Drug Trafficking Areas (HIDTA) to enforce coordination at the local and state level may be seen as an evidence of the lack of incentives to coordinate among local and state governments. Regions[7] in the United States have a different amount of HIDTA areas,[8] which might indicate differences in the degree of coordination in a region. On the other hand, according to the National Grand Threat Assessment (2009) regions in the United States differ in the number of gangs[9] and according to SAMHSA (2007) they also differ in the percentage of people between 18 and 25 years who have used any illicit drug in the past month. Both indicators, together with the total population between 18 and 25 years in each region, will give

us a number of potential drug users per gang in the region, a proxy for competition between gangs in each region. The evidence shows that regions in the US also differ in the level of drug competition.[10]

With this brief introduction to the present paper, we may now review some of the related literature.

In the last years, there have been few theoretical papers related to the issues analyzed here.[11] Jacobsson and Naranjo (2009) provide the basic theoretical framework used in this paper. However, they do not consider the effect of drug policy in a global context with a vertical structure industry. Among other results, by accounting for these features, we are able to explain how an increase in domestic law enforcement policies will reduce drug prices without relying on increasing marginal costs of drug production, as it is the case in their model.

Poret (2009) studies the optimal law enforcement policy in a model of a vertically organized distribution network. She is interested in finding what type of sellers authorities must pursue and which sanction a seller has to pay in case of arrest. Unlike her study we are interested in the external effects of optimal law enforcement policies due to the vertical organization of the illegal drug industry and their effects on drug consumption, drug distribution and prices in related markets.

Chiu, Mansley, and Morgan (1998) analyze the location of optimal enforcement efforts between both the upstream and the downstream drug markets. They find the effect on this location to be of no relevance for minimizing the consumption of drugs. Although assuming the same vertical structure, this paper studies the effect of policies between downstream markets. We find that due to the negative externalities from implementing domestic law enforcement policies in downstream markets the location of these policies matter.

Konrad (1994) explores why rational local governments use supply restricting drug policies (i.e. prohibition) to fight the illicit drug industry. Since supply restriction gives addicts an incentive to migrate, it has an external effect, which makes the policy individually rational but leads to socially inefficient results in a federal system. Instead, we focus on the effect of policies on drug suppliers and find that external effects leads also to inefficient allocation of resources at a global sphere.

Rasmussen, Benson, and Sollars (1993) empirically examine the effect of drug law enforcement on violent crime, in the context of spatial competition in illicit drug markets. They assume drug sellers' costs to vary geographically with differences in policing efforts between drug markets, thereby changing the relative probability of being arrested. Their results suggest that stricter drug enforcement in one jurisdiction increases the size of the drug market in an adjoining jurisdiction, resulting in a higher violent crime rate.[12] Under a different approach, our paper provides a theoretical explanation for their findings if drug distribution activities are positively correlated with violent crime.

The paper is structured as follows. Sections 2 and 3 set up the basic model, study the governments' decisions and show the key results. Section 4 extends the baseline model allowing for competition in the downstream market. The last section discusses the results and gives suggestions for future research.

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[6] All the results in this paper are robust to competition in the upstream market.
[7] These regions are: Central, East, New England, Northwest, Pacific, Southeast, and Southwest.
[8] The Central regions has 6 HIDTA areas, the East region has 2, the New England region has 1, the Northwest has 2, the Pacific has 5, the Southeast has 5, and the Southwest has 2.
[9] In the Central region there are 5800 gangs, in the East region 2900, in the New England region 640, in the Northwest 640, in the Northwest 2090, in the Pacific 6900, in the Southeast 9871, in the Southwest 5297 gangs.

[10] In the Central region a gang may serve to 227 drug users, in the East to 390, in the New England to 571, in the Northwest to 138, in the Pacific to 123, in the Southeast to 111, and in the Southwest to 142.
[11] For a general reference to the methodology in this paper, see Venables (1990). For a similar idea in the light of the optimal law enforcement literature, see Garoupa (1997).
[12] See Marceau (1997) for a paper on competition between juridictions in the eradication on crime and Bronars and Lott (1998) for a paper related to geographic spillovers in crime.

2. The model

In the benchmark model, there are one upstream and one downstream monopolist.[13] The upstream drug lord produces the drug at a constant marginal cost, β, and sells it to the downstream drug lord who in turn, chooses the level of distribution activities in order to effectively reach the potential demand for drugs and sells the drug to final users in two segmented markets, i and j.

For simplicity, following Mansour, Marceau, and Mongrain (2006) and Poret (2009), we assume that the potential demand for illegal drugs in market $k = i, j$ is given by a linear aggregate demand function $a^k - bp^k$, where $a^k \geq 0$, $b \geq 0$,[14] and the price of drugs $p^k > 0$.[15]

Furthermore, we assume that the actual demand for drugs in market k depends on how much the downstream monopolist invests in distribution activities in that market, x^k, relative to how much the government spends on domestic law enforcement policies, d^k. We assume that the bulk of the downstream monopolist's resources are spent on hiring dealers which then make up the distribution activities.[16]

Note that the cost of distribution activities, x^k, does not depend on the amount of drug sales. The reasons are that profits made by small quantities are sufficiently large in this business to cover costs of a certain size for a drug lord and that this size seems to be sufficiently large so it does not depend on the amount of drugs distributed. It is clear that at lower levels of the drug market structure drug quantities sold are smaller and drug prices higher than at higher levels.[17] This also applies to different levels within the wholesale drug market where drug lords may buy the drug in the production site and sell it to other drug lords who in turn may sell it to others who are locate closer to the final destination. Therefore, the closer we are to the retail drug market the lower the quantities sold and the higher the drug price. Hence, at higher levels in the wholesale market drug distribution activities will tend to depend more on the level of drug output since in order to deliver the larger quantities of drugs drug lords need larger organizations.[18] On the other hand, closer to the retail drug market (where local governments set domestic law enforcement policies) distribution activities become more independent of the drug output since quantities sold are lower and prices are higher. This is the case we assume in the present paper.

By investing in distribution networks, the drug lord "secures" a number of users that the government seeks to "eliminate" through domestic law enforcement. If there were no domestic law enforcement policies implemented by a government, $(a^k - bp^k)$ would be the demand faced by drug lords and demand policies such as treatment and prevention programs will then shift this demand. However, the government spends resources on domestic law enforcement policies, d, with the aim of reducing the share of available demand the drug lord can access. These domestic law enforcement policies are, for example, expenditures to chase, catch and prosecute drug dealers and drug users.[19] For simplicity, spending on these policies is equally effective between downstream markets.

We define the share of demand that can be reached by the drug lord by $z \in [0, 1]$. All else equal, more domestic law enforcement will decrease z. As more domestic law enforcement increases the risk of punishment more potential users are dissuaded from actually buying drugs. z is hence the share of demand that is not dissuaded from buying drugs while $(1 - z)$ is the share of dissuaded demand. The available aggregate demand function then becomes $q^k = z^k(a^k - bp^k)$, or expressed in terms of inverse demand:

$$p^k = \frac{a^k}{b} - \frac{q^k}{bz^k}. \tag{1}$$

Specifically, let the share of aggregate demand available to the downstream monopolist, z^k, be the ratio of total resources spent by the drug lord to the sum of drug lord and government domestic law enforcement spending[20]:

$$z^k = \frac{x^k}{x^k + d^k}. \tag{2}$$

Apart from investing in distribution activities, the downstream monopolist buys drugs from an upstream monopolist at the input drug price, s. Therefore, its profits are

$$\pi^D = \sum_{k \in \{i,j\}} ((p^k - s)q^k - x^k). \tag{3}$$

The profit for the upstream monopolist is

$$\pi^U = sQ - \beta Q, \tag{4}$$

where $Q = q^i + q^j$ are drug sales in both markets from the upstream monopolist.

The timing of the model is as follows: in the first stage, the upstream monopolist produces and sells drugs to the downstream monopolist; in the second stage, the downstream monopolist chooses the level of spending on drug distribution activities in both downstream markets, i and j, and the quantity of drugs to be sold in them. In other words, x^k is assumed to be variable in the short term and the downstream monopolist can quickly adjust its distribution activities. The justification for this timing relies on the fact that drug lords at the retail and wholesale level in the United States have become very flexible in order to react to domestic law enforcement. For instance, Levitt and Venkatesh (2000) show that the income paid to drug dealers is very low compared to the risk they face. This fact supports the idea of a fast replacement due to the low costs of doing it. Hence, this flexibility makes drug lords to vary the level of distribution activities, x, in the short term.[21]

We solve the game backwards, beginning with the second stage.

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[13] An oligopolic structure in both the downstream and the upstream market does not affect our results but make their interpretation a bit more complicated. For that reason the choice of this benchmark model.

[14] The fact that b is not related to the market k is because we are interested in the relationship between drug lords' behavior and domestic law enforcement independently of the marginal effect that the drug price sensitivity may have over this relationship. Our main results do not change qualitatively with this assumption.

[15] As opposed to a constant elastic demand, the linear demand function gives the possibility of having an additive relationship between input and output drug prices in equilibrium, in support of the findings by Desimone (2006) and Caulkins and Reuter (1998).

[16] Levitt and Venkatesh (2000) show that almost 30% of the total cost of selling drugs by a gang comes from gang wages and other 30% comes from costs associated to the size of the organization (e.g. weapons, tributes, funerals, and mercenaries).

[17] See Caulkins and Reuter (1998) for further reference.

[18] See Mansour et al. (2006) for this analysis.

[19] Domestic law enforcement policies can have a supply and demand effects. In this paper we abstract from the supply effects (i.e. increasing marginal costs) of these policies and focus on the demand effects (i.e. reducing the available demand by breaking up the trade between users and dealers).

[20] For mathematical convenience, we assume x and d to be infinitely divisible. Moreover, this is the standard contest success function; see Skaperdas (1996) and Tullock (1980) for further references.

[21] Moreover, the same timing assumption was made by Salinger (1988). See Salinger (1989) for a discussion of alternative timing structures.

2.1. Stage 2: decision at the downstream market

Inserting Eqs. (1) and (2) into (3), the problem facing the downstream monopolist is

$$\max_{x^i, x^j, q^i, q^j} \pi^D = \sum_{k \in \{i,j\}} \left(\left(\frac{a^k}{b} - \frac{q^k}{b((x^k/(x^k + d^k)))} - s \right) q^k - x^k \right). \tag{5}$$

From the downstream monopolist's perspective, the two markets are independent. Hence, we can derive two independent pairs of first-order conditions. Solving these equation systems for x^k and q^k yields[22]:

$$x^k = \frac{b}{2} \left(\frac{a^k}{b} - s \right) \sqrt{\frac{d^k}{b}} - d^k \quad \text{for } k = i, j. \tag{6}$$

Consequently, drug distribution activities in market i have a non-monotonic relationship to domestic law enforcement policies in that market, but are not affected by these policies in market j, since both downstream markets are segmented. The non-monotonicity reflects a trade-off between the direct increase in distribution activities and the indirect decrease in the amount of drugs sold in the market. Moreover, notice that drug distribution activities in market i decrease in the input drug price, s.

Now, the optimal drug sales for the downstream monopolist in market k are

$$q^k = \frac{b}{2} \left(\frac{a^k}{b} - s \right) - \sqrt{bd^k} \quad \text{for } k = i, j. \tag{7}$$

Hence, drug sales in market i decrease with domestic law enforcement policies in that market but are not affected by these policies in market j, since the downstream markets are segmented. Moreover, domestic law enforcement policies reduce the size of the market, an effect that is partially, but not fully, off-set by increased spending on distribution activities.

Notice that domestic law enforcement policies in market i shift the upstream monopolist's inverse demand affecting the upstream drug price and, consequently, drug prices in both downstream markets.

2.2. Stage 1: decision at the upstream market

Since aggregate drug sales, $Q = q^i + q^j$, constitute the inverse demand for the upstream monopolist, from Eq. (7) we have:

$$s = \frac{1}{2} \left(\frac{a^i}{b} + \frac{a^j}{b} \right) - \frac{1}{\sqrt{b}} \left(\sqrt{d^i} + \sqrt{d^j} \right) - \frac{1}{b}(q^i + q^j). \tag{8}$$

Hence, the wholesale drug price s decreases with domestic law enforcement policies in both markets, as well as with aggregate drug sales. Inserting Eq. (8) and maximizing Eq. (4), we derive the equilibrium drug sales for the upstream monopolist

$$Q^* = \frac{1}{2} \left(\frac{1}{2}(a^i + a^j) - \sqrt{b} \left(\sqrt{d^i} + \sqrt{d^j} \right) - b\beta \right). \tag{9}$$

Not surprisingly, drug sales by the upstream monopolist decrease with domestic law enforcement policies in downstream markets. The intuition is simple. Since these policies reduce final demand, the downstream drug lord demands less drugs which, in turn, reduces the drug sold by the upstream drug lord.

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[22] The second-order conditions, in terms of variables x^k and d^k, always hold since $1 \geq d^k/(x^k + d^k)$.

2.3. Equilibrium and comparative statics

Inserting Eq. (9) into (8), we get the equilibrium upstream drug price

$$s^* = \frac{1}{2b} \left(\frac{1}{2}(a^i + a^j) - \sqrt{b} \left(\sqrt{d^i} + \sqrt{d^j} \right) + b\beta \right). \tag{10}$$

Thus, tougher domestic law enforcement policies in a downstream market decrease the upstream drug price in equilibrium. Stricter policies in market i reduce the available demand for drugs in that market. However, if this only meant that the upstream monopolist faced a steeper inverse demand function, the upstream drug price would not be affected. This is due to the fact that increased spending on domestic law enforcement policies also affects drug distribution activities, shifting down the inverse demand faced by the upstream monopolist, that the wholesale price of drugs falls in equilibrium. Hence, the result in Proposition 1 follows from the complementarity between both the output and the drug distribution activity decisions.

Proposition 1. *Increased spending on domestic law enforcement policies in market k reduces the upstream drug prices* in equilibrium.*

Given the upstream drug price, we can proceed to solve for the amount of drugs sold in each downstream market, using Eqs. (7) and (10)

$$q^{*i} = \frac{1}{4} \left(\frac{1}{2}(3a^i - a^j) - b\beta + \sqrt{bd^j} - 3\sqrt{bd^i} \right). \tag{11}$$

Notably, drug sales in market i decrease with domestic law enforcement policies in that market, but increase with the implementation of policies in market j.

Increased spending on domestic law enforcement policies in the downstream market i has two counteracting effects on drug sales in that market: a negative direct effect of reducing market access, z^{*i}, but a positive indirect effect of reducing the upstream drug price, s^*. In equilibrium, the direct effect prevails and drug sales in market i decrease.

In contrast, tougher policies in market j only affect market i via the reduction in the upstream drug price, which results in higher drug sales in the downstream market i.

Furthermore, global drug consumption is equal to

$$Q^* = q^{*i} + q^{*j} = \frac{1}{2} \left(\frac{1}{2}(a^i + a^j) - b\beta - \sqrt{bd^j} - \sqrt{bd^i} \right).$$

These findings are summed up in the following proposition.

Proposition 2. (*i*) *Drug consumption in market i decreases in spending on domestic law enforcement policies in that market but increases in spending on these policies in market j.* (*ii*) *Global drug consumption decreases in domestic law enforcement policies.*

Once we know the amount of drugs sold in each downstream market, we can proceed to solve for drug distribution activities in the second stage, using Eqs. (6) and (10):

$$x^{*i} = q^{*i} \sqrt{\frac{d^i}{b}}. \tag{12}$$

Hence, domestic law enforcement policies in the downstream market i have a non-monotonic effect on drug distribution activities in that market. While there is no need for drug distribution activities in the absence of these policies, at low levels of domestic law enforcement policies, these expenditures can profitably be countered with positive drug distribution activities. However, increasingly higher spending in these policies from one downstream market reduces the return to such activities.

In contrast, higher spending on domestic law enforcement policies in market j unambiguously increases spending on drug dis-

tribution activities in market i. The reason is that stricter domestic law enforcement policies in market j reduce the upstream drug price, which increases the return on drug distribution in market i. The following proposition sums up the main finding.

Proposition 3. *Distribution activities in market i: (i) increase with domestic law enforcement policies in market j and (ii) have a non-monotonic relationship with domestic law enforcement policies in market i: at low levels, the relationship is positive while turning negative at high levels.*

Proof. See Appendix A for (ii). □

Given drug distribution activities, the downstream monopolist's market access to downstream market i, z^i, is given by

$$z^{*i} = \frac{A - 3\sqrt{bd^i}}{A + \sqrt{bd^i}}, \tag{13}$$

where $A = (1/2)(3a^i - a^j) + \sqrt{bd^j} - b\beta > 0$. Hence, the downstream monopolist's access to market i decreases in domestic law enforcement policy expenditures in that market, but increases in the spending of these policies in market j.

Furthermore, the drug price in the downstream market i can then be found by inserting Eqs. (11) and (13) into (2):

$$p^{*i} = \frac{1}{4b} \left(\frac{1}{2}(5a^i + a^j) - \sqrt{b} \left(\sqrt{d^j} + \sqrt{d^i} \right) + b\beta \right). \tag{14}$$

The downstream drug price in market i thus decreases in the spending on domestic law enforcement policies from both downstream markets. In sum:

Proposition 4. *The downstream drug price in market k, p^{*k}, decreases with domestic law enforcement policies in both markets.*

Finally, we derive the equilibrium profits for both types of drug lords. Inserting Eqs. (9) and (10) into (4), yields the equilibrium profit for the upstream monopolist[23]:

$$\pi^{*U} = \frac{1}{4} \left(\frac{1}{2}(a^i + a^j) - \sqrt{b} \left(\sqrt{d^i} + \sqrt{d^j} \right) - b\beta \right)^2. \tag{15}$$

Not surprisingly, domestic law enforcement policies in either downstream market decrease the upstream drug lord's profits, due to the fact that policies reduce downstream demand which results in both lower drug sales and a lower upstream price in equilibrium.

Inserting Eqs. (10)–(12) and (14) into (3), gives us the downstream monopolist's profits:

$$\pi^{*D} = \sum_{k=i,j} \pi^{*i} = \sum_{k=i,j} \left(\frac{b}{16} C_k^2 - \frac{3}{2} C_k \sqrt{bd^k} + \frac{9}{16} d^k \right), \tag{16}$$

where $C_k = (1/2b)(3a^k - a^{-k}) + \sqrt{(d^{-k}/b)} - \beta > 0$ where, in turn, $-k = i$ if $k = j$ or $-k = j$ if $k = i$ for $k = i, j$.[24]

If spending on domestic law enforcement policies is low, increased spending reduces profits in the market where they are implemented, since drug use decreases and the drug price falls while spending on distribution activities increases. Since investments in these policies are sufficiently low, the increase in drug use in the other market does not off-set the reduction in profits. However, with high levels of investments in these policies, the increase will still reduce the profits in the market where they are implemented, but now the increase in drug use in the other market (and the consequent decrease in the upstream drug price) is such that

profits in that market increase. The net effect will then be the result of the relative strength of both forces in the profit function.

In this section, we have examined a model where a downstream and an upstream drug monopolist interact in a vertical structured drug industry and make their economic decisions given the level of domestic law enforcement policies in downstream markets. As a result of this interaction, domestic law enforcement policies do not only affect the downstream market where they are implemented but also the other downstream market, in terms of drug consumption, drug prices and distribution activities.

Due to the presence of these external effects, the following section studies the optimal decisions by governments and their incentives to coordinate or not policies.

3. Optimal domestic law enforcement policies

In making decisions on public policies, governments must balance the potential benefits of diminishing social problems against the potential "private" costs of implementing these policies. However, when external effects of policies implemented in different markets are present, their costs do not only include the "private" costs of these policies, but also the external costs incurred by other governments as a consequence of their implementation.

Since we are interested in the external effects of domestic law enforcement policies, we assume a simple loss function to be minimized by "paternalistic" governments. Therefore, the benefits to drug participants from selling and consuming drugs are not taken into consideration and governments are only interested in reducing the level of drug consumption in their own markets, which is assumed to be positively correlated with the social cost of abusing drugs.[25]

In this section, we study the effect of domestic law enforcement policies under two different regimes. In regime *I*, governments set these policies independently, disregarding the external effects, and in regime *II*, governments coordinate domestic law enforcement policies. We will also consider the governments' incentives for engaging in policy coordination.

In most cases, government anti-drug initiatives are long-term commitments to which the illegal drug industry adapts. Hence, in the model, we assume that governments move first, choosing domestic law enforcement policies, before drug lords choose drug sales and drug distribution activities.

3.1. Regime I – independent domestic law enforcement policies

Suppose that a benevolent government wishes to reduce drug consumption by investing in domestic law enforcement policies. For simplicity, we normalize the government's objective function by the marginal value of a tax dollar spent on these policies and we assume the marginal value of drug consumption per tax dollar spent on these policies to equal *one*.[26]

Under this regime, we assume that government i chooses domestic law enforcement policy spending, d^i, to minimize the

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[23] Since $s^* > \beta$ then $\pi^U > 0$.

[24] From $x^{*k} > 0$, $q^{*k} > 0$, we know that $C_k > 3\sqrt{(d^k/b)} > 0$.

[25] For estimations of these costs see the Office of National Drug Control Policy (2004).

[26] In particular, governments will need to trade-off the social cost of drug consumption, $\phi^i q^{*i}$ against the total cost of public funds, $\delta^i d^i$. By normalizing over the marginal cost of public funds and assuming this ratio to be equal to *one*, we are comparing governments with similar rates. In the case of the United States, this assumption implies that states or cities face equal marginal value of drug consumption per marginal value of a tax dollar spent on these policies. Relaxing this assumption to allow for different ratios does not qualitatively change our main results and simplifies their interpretation.

following loss function[27]:

$$\min_{d^i} L^i = q^{*i} + d^i. \tag{17}$$

Inserting Eq. (11) into expression (17), getting the first-order conditions and solving for d^k yields

$$d_I^{*k} = \frac{9b}{64}, \tag{18}$$

where d_I^{*k} represents the solution under regime I (independent governments) in market $k = i, j$. Notice that the optimal domestic law enforcement policy is not affected by the size of the drug market, a^k. This is explained by the fact that the policy spending affects the actual demand for drugs expressed in percentage, which is independent of market size.

Global spending on domestic law enforcement policies under this regime will then be equal to

$$E_I^* = d_I^{*i} + d_I^{*j} = \frac{9b}{32}. \tag{19}$$

Furthermore, inserting Eq. (18) into (11) gives us the equilibrium drug consumption in the downstream market i under this regime:

$$q_I^{*i} = \frac{1}{4}\left(\frac{1}{2}(3a^i - a^j) - b\beta - \frac{3b}{4}\right), \tag{20}$$

where $i \neq j$. The global drug consumption in equilibrium, Q_I^*, is thus

$$Q_I^* = q_I^{*i} + q_I^{*j} = \frac{1}{4}\left((a^i + a^j) - 2b\beta - \frac{3b}{2}\right). \tag{21}$$

Finally, let us calculate the government's loss function under this regime. Later, we will compare this result with the corresponding loss function under the coordinated policy regime to determine the incentives for policy coordination. Inserting Eqs. (18) and (20) into expression (17) yields the minimum loss for government i in regime I:

$$L_I^{*i} = \frac{1}{4}\left(\frac{1}{2}(3a^i - a^j) - b\beta - \frac{3b}{16}\right). \tag{22}$$

3.2. Regime II – domestic law enforcement policy coordination

In regime II, we assume that governments coordinate domestic law enforcement policy spending to minimize the sum of both governments' loss functions. Since we give governments equal weights, in terms of the marginal value of drug consumption/marginal value of a tax dollar, the problem becomes[28]

$$\min_{d^i, d^j} L^i + L^j = \sum_{k \in \{i,j\}} (q^{*k} + d^k). \tag{23}$$

Solving Eq. (23), finding the first-order conditions with respect to d^i and d^j, and solving the system of equations yields

$$d_{II}^{*k} = \frac{b}{16}, \tag{24}$$

where d_{II}^{*k} represents the optimal solution in market $k = i, j$.

Global spending on domestic law enforcement policies under this regime will then be equal to

$$E_{II}^* = d_{II}^{*i} + d_{II}^{*j} = \frac{b}{8}. \tag{25}$$

Furthermore, inserting Eq. (24) into (11) gives us the equilibrium drug consumption in the downstream market i under coordination:

$$q_{II}^{*i} = \frac{1}{4}\left(\frac{1}{2}(3a^i - a^j) - b\beta - \frac{b}{2}\right), \tag{26}$$

and thus, the equilibrium global drug consumption Q_{II}^* is

$$Q_{II}^* = q_{II}^{*i} + q_{II}^{*j} = \frac{1}{4}\left((a^i + a^j) - 2b\beta - b\right). \tag{27}$$

Finally, inserting Eqs. (24) and (26) into expression (17) yields the minimum loss for the government in downstream market i when domestic law enforcement policies are decided under coordination:

$$L_{II}^{*i} = \frac{1}{4}\left(\frac{1}{2}(3a^i - a^j) - b\beta - \frac{b}{4}\right). \tag{28}$$

3.3. Comparative analysis

Comparing equilibrium levels for global spending in domestic law enforcement policies (Eqs. (19) and (25)) and global drug consumption (Eqs. (21) and (27)) under both regimes, we set the following result[29]

Proposition 5. *Domestic law enforcement policy spending is lower under policy coordination but global drug consumption is lower under the independent policy setting.*

Proof.   See Appendix A.   □

Not surprisingly, since domestic law enforcement policies have a negative externality – they increase drug consumption in other markets – governments tend to over spend in these policies when acting independently. Hence, policy coordination reduces spending on domestic law enforcement policies, but also results in a higher global drug consumption.

In the presence of a negative externality, it is obviously the case that governments can improve the joint outcome by coordinating demand policies. However, it is not clear that they will always have an incentive to do so if policy coordination does not involve side-payments. For instance, it is easy to imagine that it may not be politically feasible for a local or state government to pay another government to induce the latter to spend less on domestic law enforcement policies, when the government's income comes from taxing its own constituency.

To determine the incentives for policy coordination, we simply compare the "payoffs" for each government under both regimes.

Comparing Eqs. (22) and (28) for government i yields $L_I^{*i} > L_{II}^{*i}$. Then, coordination between "similar" governments, in terms of marginal values of drug consumption and a tax dollar, is self-enforced between them.

In other words, when governments have similar marginal values of drug consumption and a tax dollar, the gains from policy coordination are more evenly distributed. Since the total gains from internalizing an externality always outweigh the total costs, there is then room for policy coordination.

The following proposition sums up this finding. In this section, we have found that, at the cost of higher global drug consumption, "similar" governments always have incentives to coordinate when setting their spending on domestic law enforcement policies, and

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[27] In all cases under this regime, the second-order conditions are always positive. This implies that independent governments minimize this loss function.

[28] In all cases under this regime, the second-order conditions are always positive. This implies that the international policy coordination minimizes this function.

[29] Drug consumption in each market is always lower under the independent policy setting.

global spending on these policies is always lower under that regime than under independency.[30]

Proposition 6. *When markets are sufficiently similar in terms of their marginal value of drug consumption per tax dollar spent, governments always have incentives to coordinate when setting domestic law enforcement policies*

Proposition 6 predicts, for example, that local governments will always coordinate their spending on domestic law enforcement policies. However, there is no evidence that local and/or state governments in the United States do coordinate the level of these policies. The next section studies one of the possible explanations for this.

4. Competition in downstream markets

The previous sections assumed a monopolistic structure in both a downstream and an upstream market. While differences in the level of competition in the upstream market do not affect qualitatively the results from the benchmark model, differences in the downstream market structure do have an effect and may also change the government decisions to set drug policies. In this section, we investigate the effect of competition in the downstream market on both the decision of governments to coordinate policies (or not) and the equilibrium values for global drug consumption and global domestic law enforcement policies under both regimes.

In this model, there are one upstream drug lord, m downstream traffickers in market i, and n downstream traffickers in market j. The upstream drug lord produces the drug at a constant marginal cost, β, and sells it to the downstream traffickers who in turn, choose the level of distribution activities in order to effectively reach the potential demand for drugs and sell the drug to final users in two segmented markets, i and j. Due to the symmetry in the model we focus our analysis on market i.

For simplicity, following Mansour et al. (2006) and Poret (2009), we assume that the potential demand for illegal drugs in market i is given by a linear aggregate demand function $a^i - bp^i$, where $a^i \geq 0$, $b \geq 0$, and the price of drugs $p^i > 0$. We assume that $a^i = a^j = a$.[31]

Furthermore, we assume that the actual demand for drugs in market i depends on how much the downstream traffickers invest in distribution activities in that market, $\sum_{l=1}^{m} x_l^i$, relative to how much the government spends on domestic law enforcement policies, d^i. If there were no domestic law enforcement policies implemented by a government, $(a - bp^i)$ would be the demand faced by drug lords and demand policies such as treatment and prevention programs will then shift this demand.

For simplicity, spending on these policies is equally effective between downstream markets. Specifically, let the share of aggregate demand available to the downstream traffickers, z^i, be the ratio of total resources spent by all drug lords to the sum of drug lords

and government domestic law enforcement spending:

$$z^i = \frac{\sum_{l=1}^{m} x_l^i}{\sum_{l=1}^{m} x_l^i + d^i}. \tag{29}$$

By investing in distribution networks, the drug trafficker "secures" a number of users that the government seeks to "eliminate" through domestic law enforcement. Once a drug trafficker "secures" these users, they become available to other drug lords through their oligopoly competition. Hence, investments in distribution activities have a public good feature.[32] This model assumes a state of peace between the drug traffickers where they compete within the Cournot setting.[33] A simple way to think about this is to assume that x_l is the hired number of drug dealers for drug trafficker l and d the number of police officers assigned to drug crime. If there are many drug dealers and few police officers, the risk of getting caught while purchasing drugs is low and vice versa. This setup follows from the assumption that drug users can pick any drug trafficker from which to purchase. Hence, we also abstract from any switching costs for drug users if they change their drug dealers.[34]

Hence, the available aggregate demand function in market i is $q^i = z^i(a - bp^i)$, or expressed in terms of inverse demand

$$p^i = \frac{a}{b} - \frac{q^i}{bz^i}. \tag{30}$$

Since we assume that m drug traffickers sell drugs in market i and n drug traffickers do it in market j, without loosing generality, the representative downstream trafficker l buys drugs from an upstream drug lord at the input drug price, s, and its profits are[35]

$$\pi_l^D = (p^i - s)q_l^i - x_l^i. \tag{31}$$

The profit for the upstream drug lord is

$$\pi^U = (s - \beta)Q, \tag{32}$$

where $Q = \sum_{g=1}^{m} q_g^i + \sum_{f=1}^{n} q_f^j$ are drug sales in both markets from the upstream drug lord, s is the input drug price, and β the marginal cost of production.

The timing of the model is as follows: in the first stage, the upstream drug lord produces and sells drugs to the downstream traffickers; in the second stage, the downstream traffickers choose the level of spending on drug distribution activities in their respective downstream markets, i and j, and the quantity of drugs to be sold in them. We solve the game backwards, beginning with the second stage.

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[30] These results are also true if we allow the downstream monopolist to sell in a third market. However, due to the identical governments' loss functions, adding a fourth market (or more) is not feasible, since these policies will have a higher negative external effect than their positive internal effect. This leads to optimal levels of domestic law enforcement policies equal to zero. However, by allowing domestic law enforcement policies to have a higher positive effect, our results still hold. This may be done by either allowing different levels of competition in the downstream markets or allowing the governments' loss functions to differ in their marginal values of social cost for drug consumption and/or tax dollars.

[31] Due to the complexity added in this section, for simplicity reasons we assume the fact that $a^i = a^j = a$. Since our focus is on the supply side this assumption does not affect our objectives.

[32] Therefore, in equilibrium, there is an underprovision of distribution activities. To overcome this problem, drug traffickers may be willing to coordinate. However, to my knowledge there is no evidence of such coordination between and within "drug cartels". We might also think that these investments in an illegal market play a similar role to "cooperative" advertising in legal markets, where firms increase the size of the market by investing in advertising.

[33] We are interested in the interaction between drug lords and domestic law enforcement. Obviously drug lords may have periods of war where they do not only fight against the government but also against each other. However, the effect of this war it is not part of our analysis. See Poret and Tèjedo (2006) for reasons justifying this type of competition.

[34] See Skott and Jepsen (2002) for a discussion of the effect of switching costs over drug markets.

[35] Note again that distribution activities do not depend on drug sales. Since drug suppliers must be sufficiently large to enter the market and the profits by selling small quantities of drugs such as cocaine or heroin are sufficiently large, this assumption seems reasonable.

4.1. Stage 2: decision at the downstream markets

Inserting Eqs. (29) and (30) into (31), the problem facing the representative downstream trafficker l is

$$\max_{x_l^i, q_l^i} \pi_l^D = \left(\frac{a}{b} - \frac{\sum_{g=1}^{m} q_g^i}{b\left(\sum_{l=1}^{m} x_l^i \Big/ \sum_{l=1}^{m} x_l^i + d^i\right)} - s \right) q_l^i - x_l^i. \qquad (33)$$

Solving these equation systems and assuming symmetry we get[36]:

$$mx^i = \frac{1}{(m+1)} \left(\frac{a}{b} - s \right) \sqrt{bmd^i} - d^i. \qquad (34)$$

Notice that from expression (34), an increase in competition in market i decreases the level of distribution activities in that market. In the same way, total drug consumption in market i, mq^i is:

$$mq^i = \frac{bm}{(m+1)} \left(\frac{a}{b} - s \right) - \sqrt{bmd^i} \qquad (35)$$

In expression (35), mq^i has a non-monotonic relationship with respect to the number of competing traffickers, m. At low levels of m, the relationship is positive while turning negative at high levels. Two main effects are at play here: first, a higher m decreases aggregate spending on distribution activities, that is, the free rider effect, which reduces available demand and thereby limits the amount sold. Second, the increase in (Cournot) market competition decreases the price, which increases demand. Thus, at low levels of competition, an additional drug lord means that more drugs will be sold as the competition effect dominates the free rider effect.

On the other hand, the solution for the representative downstream trafficker in market j yields:

$$nx^j = \frac{1}{(n+1)} \left(\frac{a}{b} - s \right) \sqrt{bnd^j} - d^j. \qquad (36)$$

$$nq^j = \frac{bn}{(n+1)} \left(\frac{a}{b} - s \right) - \sqrt{bnd^j} \qquad (37)$$

4.2. Stage 1: decision at the upstream market

Since total demand for drugs from the downstream traffickers in both markets is equal to $mq^i + nq^j$, the symmetric inverse demand for the upstream drug lord becomes:

$$s = \frac{1}{bD} \left(aD - \left(\sqrt{bmd^i} + \sqrt{bnd^j} \right) - (mq^i + nq^j) \right), \qquad (38)$$

where $D = ((m/(m+1)) + (n/(n+1)))$.

This inverse demand is used for the upstream drug lord in the first stage. Using Eq. (38) and the market clearing condition $mq^i + nq^j = Q$ in the upstream drug lord's problem (Eq. (32)), we then solve for the level of drug production[37] Q:

$$Q^* = \frac{1}{2} \left(D(a - b\beta) - \left(\sqrt{bmd^i} + \sqrt{bnd^j} \right) \right). \qquad (39)$$

Notice that higher competition in each market has a non-monotonic effect on the level of drug sales. It increases for low levels and decreases for high levels. The reason is that the direct

effect of competition in the downstream markets is passed to the upstream market.

Substituting Eq. (39) into (38) and using the market clearing condition, the upstream drug price in equilibrium becomes:

$$s^* = \frac{1}{2b} \left((a + b\beta) - \frac{1}{D} \left(\sqrt{bmd^i} + \sqrt{bnd^j} \right) \right). \qquad (40)$$

In this expression, increases in any of the domestic law enforcement policies will decrease the input drug price in equilibrium since these policies will shrink each downstream market. Notice that the indirect effect on the other downstream market is not yet accounted for. However, higher competition in either downstream market will have a non-monotonic effect on the upstream drug price; low levels will increase the upstream drug price but high levels will decrease it.[38] Once more, these are simple direct effects in each downstream market.

Once we have found the upstream drug price in equilibrium, we can proceed to find the equilibrium value for drug consumption in market i by inserting Eq. (40) into Eqs. (35) and (37):

$$mq^{*i} = \frac{m}{2(m+1)} \left((a - b\beta) + \frac{1}{D} \left(\sqrt{bmd^i} + \sqrt{bnd^j} \right) \right) - \sqrt{bmd^i}. \qquad (41)$$

$$nq^{*j} = \frac{n}{2(n+1)} \left((a - b\beta) + \frac{1}{D} \left(\sqrt{bnd^j} + \sqrt{bmd^i} \right) \right) - \sqrt{bnd^j}, \qquad (42)$$

where $D = (m/(m+1) + n/(n+1))$.

With these expressions, we are ready to analyze the indirect effects of domestic law enforcement policies and competition on the other downstream market. Remember that when domestic law enforcement policies increase in one market, they reduce the upstream drug price which, in turn, affects the decisions in the other downstream market. The same argument applies to changes in competition with the difference of the non-monotonic effect on the upstream drug price.

As can be seen, increases in domestic law enforcement policies in market j will increase drug consumption in market i. The reason is that with a lower upstream drug price, the demand for drugs by downstream traffickers in market i increases. Moreover, an increase in competition in market j will have a non-monotonic effect on drug consumption in market i. For low levels, it will decrease and for sufficiently high levels, it will increase. In other words, it follows the opposite effect to the upstream drug price, as can be expected.

The next two sections study the government's decision to set the domestic law enforcement policies either independently or in coordination with another government under competition in their downstream markets.

4.3. Regime I – independent domestic law enforcement policies

Under this regime, we assume that government i chooses domestic law enforcement policy spending, d^i, to minimize the following loss function[39]

$$\min_{d^i} L^i = mq^{*i} + d^i. \qquad (43)$$

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[36] The following second-order condition must hold: $4m/(m+1)^2 \geq d^i/(mx^i + d^i)$. Therefore, the size of the downstream market must be sufficiently large. In other terms, $((a/b) - \beta) > \left((m+1)^3 \sqrt{d^i}/2m\sqrt{bm} \right) \left((m+1)^3 - (2m^2/D) \right) - \left(\sqrt{bnd^j}/2bD \right)$. Moreover, $mx > 0$.

[37] The second-order condition is negative.

[38] The proof is the following: $\partial s^*/\partial m = -X$, and X is positive or negative depending on the following condition $((1/2)D(m+1)^2 - m) = f(m)\sqrt{m} = g(m) \gtrless \sqrt{nd^j/d^i}$. Since $f(m)$ is convex and $g(m)$ concave: when $m = 1$ then $f(m) = g(m) = 1$, whereas when $m > 1$, then $f(m) > g(m)$. Therefore, for a sufficiently low m, the left-hand side of this condition is lower than the right-hand side and it only becomes larger after some level.

[39] In all cases under this regime, the second-order conditions are always positive. This implies that independent governments minimize this loss function.

Using Eq. (41), and then solving for d^i we get

$$d_I^{*i} = \frac{bm}{4}\left(1 - \frac{m}{2D(m+1)}\right)^2. \tag{44}$$

Hence, increased competition in either market increases the optimal spending on domestic law enforcement policies in market i. Governments always find it optimal to increase these policies whenever competition increases, even though competition might entail a decrease in drug consumption. This is the case since increases in domestic law enforcement policies always reduce drug consumption in the same market.

Using the symmetry with market j we have that global spending on domestic law enforcement policies under this regime will then be equal to

$$E_I^* = \frac{b}{4}\left(m\left(1 - \frac{m}{2D(m+1)}\right)^2 + n\left(1 - \frac{n}{2D(n+1)}\right)^2\right), \tag{45}$$

where $D = ((m/(m+1)) + (n/(n+1)))$, $(1 - (m/2D(m+1))) > 0$ and $(1 - (n/2D(n+1))) > 0$.

Insertion of Eq. (44) into (41) and (43) yields the minimum loss under regime I for the government in the downstream market i:

$$L_I^{*i} = \frac{m(a - b\beta)}{2(m+1)}$$
$$+ \frac{bm}{4}\left(\frac{n}{D(m+1)}\left(1 - \frac{n}{2D(n+1)}\right) - \left(1 - \frac{m}{2D(m+1)}\right)^2\right). \tag{46}$$

4.4. Regime II – domestic law enforcement policy coordination

In regime II, we assume that governments coordinate domestic law enforcement policy spending to minimize the sum of both governments' loss functions. Since we give governments equal weights, in terms of the marginal value of drug consumption/marginal value of a tax dollar, the problem becomes

$$\min_{d^i, d^j} L^i + L^j = mq^{*i} + nq^{*j} + d^i + d^j. \tag{47}$$

Using Eqs. (41) and (42) and solving for d^i yields[40]:

$$d_{II}^{*i} = \frac{bm}{16}. \tag{48}$$

From this expression, an increase in competition in the downstream market i will increase the level of domestic law enforcement policies in that market. However, competition in market j does not affect these policies. This is simply because by coordinating policies, governments have already internalized the external effects. Therefore, increases in competition in the downstream market j will only have a direct effect on the level of drug consumption in market i (not indirect effects through d^i).

Using the symmetry with market j we have that global spending on domestic law enforcement policies is:

$$E_{II}^* = \frac{b}{16}(m + n) \tag{49}$$

Inserting Eq. (48) into (41) and (47), we obtain the minimum loss for the government in the downstream market i:

$$L_{II}^{*i} = \frac{m(a - b\beta)}{2(m+1)} - \frac{bm}{4}\left(1 - \frac{m}{2D(m+1)}\right) + \frac{bm}{16} + \frac{bnm}{8D(m+1)}. \tag{50}$$

4.5. Comparative analysis

Comparing global spending in domestic law enforcement policies under both regimes when competition in the downstream market is allowed (Eqs. (45) and (49)), we have that $E_I^* \gtrless E_{II}^*$ if

$$m\left(4\left(1 - \frac{m}{2D(m+1)}\right)^2 - 1\right) \gtrless n\left(1 - 4\left(1 - \frac{n}{2D(n+1)}\right)^2\right). \tag{51}$$

Since $(1 - 4(1 - m/(2D(m+1)))^2) < 0$ and $(1 - 4(1 - n/(2D(n+1)))^2) < 0$ then $E_I^* > E_{II}^*$.

Furthermore, insertion of Eqs. (44) and (48) and their symmetry version for market j into (41) gives the drug consumption in equilibrium under both regimes in market i

$$mq_I^{*i} = \frac{m(a - b\beta)}{2(m+1)}$$
$$+ \frac{bm}{2}\left(\frac{n}{2D(m+1)}\left(1 - \frac{n}{2D(n+1)}\right) - \left(1 - \frac{m}{2D(m+1)}\right)^2\right) \tag{52}$$

$$mq_{II}^{*i} = \frac{m}{2(m+1)}(a - b\beta) - \frac{bm}{4}\left(1 - \frac{m}{2D(m+1)}\right) + \frac{bnm}{8D(m+1)}. \tag{53}$$

Comparing both drug consumption levels, we have that $mq_I^{*i} \gtrless mq_{II}^{*i}$ when:

$$m\left(\frac{n - m}{(m+1)^2}\right) \gtrless \frac{2}{(n+1)}. \tag{54}$$

Drug consumption in each downstream market under both regimes now depends on the level of competition in both markets. Notice, for example, that when competition in the reference market is higher ($m > n$), we have that $mq_I^{*i} < mq_{II}^{*i}$ so in equilibrium, drug consumption will under independency be smaller in the spending on domestic law enforcement policies, since the increase in these policies will be greater under this regime, reducing the level of drug consumption relative to the coordination regime.

On the other hand, global drug consumption under both regimes is equal to

$$Q_I^* = \frac{1}{2}(a - b\beta)D - \frac{bm}{4}\left(1 - \frac{m}{2D(m+1)}\right) - \frac{bn}{4}\left(1 - \frac{n}{2D(n+1)}\right) \tag{55}$$

$$Q_{II}^* = \frac{1}{2}(a - b\beta)D - \frac{bm}{4}\left(1 - \frac{m+n}{2D(m+1)}\right) - \frac{bn}{4}\left(1 - \frac{n+m}{2D(n+1)}\right). \tag{56}$$

Comparing equilibrium levels of global drug consumption and global domestic law enforcement policies under both regimes, Proposition 5 still holds but drug consumption in each market in equilibrium is now affected by the level of competition in both markets. In addition, the incentives for each government to coordinate policies (or not) under both regimes will now depend on the degree of competition in both downstream markets.

When both optimal loss functions are compared for the government in the downstream market i (Eqs. (46) and (50)), the following condition emerges for[41] $L_I^{*i} \gtrless L_{II}^{*i}$

$$\left(\frac{m}{(m+1)^2}\right) \gtrless \frac{1}{2}\left(\frac{n}{(n+1)^2}\right) \tag{57}$$

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[40] The second-order conditions always hold since $(n/n+1) + (m/m+1) > 0$.

[41] The analogous analysis can be made for government j.

It is then clear from expression (47) that coordination between "similar" governments ($L_I^{*i} < L_{II}^{*i}$) is not always the optimal choice for a government when the level of competition between downstream markets differs. Notice that the left-hand side decreases with m and the right-hand side decreases with n. It is now optimal for a government to set its spending on domestic law enforcement policies independently of the other government ($L_I^{*i} > L_{II}^{*i}$), if the level of competition in its downstream market is sufficiently larger relative to the other government's downstream market. The intuition for this result is as follows. When competition in a drug market is high, the level of spending on domestic law enforcement policies is also high since a tax dollar invested in these policies is worth more in terms of decreasing drug consumption. For a government to be able to implement these high levels of spending, it must increasingly reduce its willingness to coordinate with the other government due to its levels of negative externalities.

The following proposition sums up this finding.

Proposition 7. *When the level of competition between drug markets is sufficiently different, the governments will be less likely to coordinate domestic law enforcement policy spending.*

In this section, we showed that competition in the downstream markets may affect the decision between governments to coordinate domestic law enforcement policies. Governments with similar degrees of competition in their drug markets are more likely to coordinate their policies than governments whose drug markets differ substantially in the level of competition.

Therefore, when the degree of competition among markets differs substantially, we will expect a lower level of coordination between governments, over spending in domestic law enforcement policies (since externalities are not internalized) and a lower level of global drug consumption.[42]

The following section discusses the main results of the paper and concludes.

5. Discussion

Since illegal drug markets are a global phenomenon, the implementation of policies by local or state governments should have effects, not only in their own markets, but also in other markets. This paper is an attempt at explaining how these externalities are created, what are their effects, and what are the incentives for the governments to coordinate their policies.

We find that an increase in domestic law enforcement policies in the downstream market i decreases the upstream drug price and drug consumption in that market, but increases drug consumption in market j. The reason is that the vertical structure of the drug market makes the downstream drug lord shift drug distribution activities from one market to another. Moreover, downstream drug prices decrease in both markets when domestic law enforcement policies in either market increase. Furthermore, an increase in domestic law enforcement policies in one market has a non-monotonic effect on its drug distribution activities but increases those in the other market. If drug distribution activities are correlated to drug related violent crime, for example, domestic law enforcement policies in one market increase violence in the other, while only increasing it in the own market below a certain level. This may help explain patterns in drug use and distribution between different cities and in particular the findings in Rasmussen et al. (1993).[43]

Since spending on domestic law enforcement policies by local or state governments produces externalities in other markets, independent efforts by these governments will over spend resources, but also reach a lower level of global drug consumption. On the contrary, if these governments coordinate their policies, global spending on domestic law enforcement policies will be lower, but at the cost of a higher level of global drug consumption. In other words, governments acting independently may reach a lowest level of global drug consumption, but at the expense of a higher allocation of resources.

In our benchmark model, governments have the same marginal social cost of drug consumption per marginal value of a tax dollar spent on domestic law enforcement, so our results in terms of optimal policies apply to local or state governments which share similar loss functions. Similar governments in this sense always find coordination to be the best regime for setting the level of spending in domestic law enforcement policies.

These results assumed monopolistic structures in both downstream markets. This assumption is relaxed in Section 4. We found that when competition differs substantially between drug downstream markets, coordination is no longer the optimal government regime. Instead, the government with higher competition may be willing to set its domestic law enforcement policies independently, since it can now increase this spending sufficiently and thus decrease its level of drug consumption even more than under coordination. The other government will have opposite incentives.

Our model predicts that in a world with substantially different levels of competition between markets, governments aiming at decreasing drug consumption by spending in domestic law enforcement policies may find coordination in policies more difficult. In this case, governments setting the level of their domestic law enforcement policies independently will over spend resources, since externalities are not internalized, but we will see a lower level of global drug consumption. Hence, we should expect that the more local governments coordinate in the implementation of these policies in their own markets the higher the level of total drug consumption. Evidence shows that the regions in the US with a higher amount of HIDTA areas might have also a higher level of drug consumption.[44]

This paper also has some limitations. Governments are assumed to be "paternalistic", so the utility from consuming drugs by users and the profits made by drug lords are not taken into consideration when they decide on the optimal level of domestic law enforcement policies. However, local and state governments, like in the United States, do have a "paternalistic" view on drugs.[45]

The other limitation of our analysis is that governments choose the optimal level of domestic law enforcement policies without facing any budget constraint. However, endogenizing this decision to allocate resources with a limited budget will certainly complicate the analysis and this issue is left open for future research.

And finally, our conclusions in Section 4 may vary if we allow for more than two local governments. However, this is part of a future research where new insights can be found due to the possible links between local governments' domestic law enforcement policies and their level of downstream drug market competition.

Nonetheless, the paper provides a reasonable starting point for formally considering the issues at hand. Further empirical research on the interdependency of drug markets and the effects of anti-drug policies at a global level should be an interesting next step

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[42] This conclusion may vary if we allow for more than two local governments since the interaction between their levels of drug downstream competition may change the incentives for governments to coordinate.

[43] See the introduction for further details on these findings.

[44] Drug consumption is proxied by the amount of population that has taken any illicit drug in the last month. This assumes that individuals in any region buy the same amount of drugs.

[45] See Poret (2009) for a different approach to optimal anti-drug law enforcement.

into the understanding of illegal drug markets, where the strategic interaction between drug participants is relevant.

Acknowledgments

Appendix A.

Proof of Proposition 3

Taking the first derivative of Eq. (14), we have:

$$\frac{\partial x^{*i}}{\partial d^i} = \frac{1}{8} \sqrt{\frac{b}{d^i}} \left(\frac{3}{2} \frac{a^i}{b} - \frac{1}{2} \frac{a^j}{b} + \sqrt{\frac{d^j}{b}} - \beta \right) - \frac{3}{4} \gtreqless 0.$$

Solving for d^i we have that:

$$\frac{b}{36} \left(\frac{3}{2} \frac{a^i}{b} - \frac{1}{2} \frac{a^j}{b} + \sqrt{\frac{d^j}{b}} - \beta \right)^2 \gtreqless d^i.$$

And the second derivative is equal to:

$$\frac{\partial^2 x^{*i}}{\partial^2 d^i} = - \frac{1}{16 d^i} \sqrt{\frac{b}{d^i}} \left(\frac{3}{2} \frac{a^i}{b} - \frac{1}{2} \frac{a^j}{b} + \sqrt{\frac{d^j}{b}} - \beta \right) < 0.$$

As from Eq. (15) we know that in an interior solution:

$$d^i < \frac{b}{9} \left(\frac{3}{2} \frac{a^i}{b} - \frac{1}{2} \frac{a^j}{b} + \sqrt{\frac{d^j}{b}} - \beta \right)^2.$$

Then, an increase in domestic law enforcement policies in downstream market i first increases distribution activities in that market and then decreases them.

Proof of Proposition 5

(ii) Comparing Eqs. (21) and (27), we have that $Q_I < Q_{II}$ since $0 < 2$, so that global drug consumption is always lower under an independent setting.

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