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Evo, Pablo, Tony, Diego, and Sonny:

General Equilibrium Analysis of the Market for Illegal Drugs

Rómulo A. Chumacero

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Abstract

This paper presents a general equilibrium model for the production, trafficking, and consumption of illegal drugs which endogenously determines relative prices and quantities. The model is calibrated to characterize the market for cocaine and is used to analyze the effects of three types of policies: making the illegal activities riskier, increasing the penalties for conducting illegal activities, and legalizing previously illegal activities. Assessing the effects of these policies using the powerful tool of a general equilibrium model provides illuminating (and in cases surprising) results.

This paper—a product of the Growth and the Macroeconomics Team, Development Research Group—is part of a larger effort in the department to understand the development consequences of crime and conflict. Policy Research Working Papers are also posted on the Web at http://econ.worldbank.org. The author may be contacted at rchumace@econ.uchile.cl.

Evo, Pablo, Tony, Diego, and Sonny: General Equilibrium Analysis of the Market for Illegal Drugs*

Rómulo A. Chumacero†

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†Department of Economics. University of Chile. *E-mail address*: `rchumace@econ.uchile.cl`

"**Cronauer**: Speaking of things controversial, is it true that there's a marijuana problem here in Vietnam?

Funny voice: NO, it's not a problem, everybody HAS it."

(Good Morning Vietnam, 1987)

1 Introduction

Drug use is widely blamed for a broad range of personal and social ills. Drug users are said to suffer diminished health and decreased earnings. Similarly, the market in illegal drugs is said to promote crime and corrupt law enforcement officials and politicians (Miron and Zwiebel, 1995).

The most common response to these perceptions is the belief that governments should prohibit production, sale, and use of illegal drugs. Policy measures often adopted to decrease the demand of illegal drugs include stiffer penalties to consumers, treatment on heavy users, and educational campaigns. Policies intended to reduce the supply include crop eradication, interdiction, and stiffer penalties to producers and traffickers. While significant resources have been allocated to these activities, the results appear not to be encouraging. A small but vocal minority suggests that prohibition causes many of the problems associated with illegal drugs and policies other than prohibition (including legalization) might be preferable.

According to the Office of National Drug Control Policy, between 1986 and 2003 the United States government has spent an average of almost 13 billion dollars a year (in dollars of the year 2000) in policies intended to control the production and consumption of illegal drugs (marijuana, cocaine, crack, stimulants, LSD, PCP, and heroin). These expenditures increased rapidly from 1986 to 1992, growing at an annual rate of 22%. From 1992 until 2001, the average annual growth rate of these expenditures was of 2%. Beginning in 2002 these expenditures have declined significantly (by almost 7 billion dollars between 2001 and 2003), reaching levels comparable to the ones of 1989-1990 (Table 7 of the Appendix).

On average, 34% of the expenditures were destined to policies intended to decrease the demand of illegal drugs (prevention and treatment) and the remaining 66% to policies intended to reduce the supply of illegal drugs (domestic law, interdiction, and international expenditures).[1] These shares have not been constant, and beginning in the year 2002, the participation of expenditures on treatment and expenditures outside the US have increased.

According to the FBI and the Department of Justice, the number of drug users has remained stable since 1989 (approximately 31 million persons).[2] Furthermore, in the year 2004, 12.5% of the arrests made in the United States (1.7 million out of 14 million) were for drug abuse violations. This figure does not consider crimes that may have been drug related.

Despite the prevalence and magnitude of the problem, the methodological framework

[1] The main difference among these components is that Domestic Law expenditures are incurred inside the United States, Interdiction expenditures are incurred in the United States border, and International expenditures are incurred outside the United States (see the Appendix).

[2] The preferences of drug users in the United States have changed in the past years. Cocaine use has decreased and has been substituted by consumption of synthetic drugs that are more potent, addictive, cheaper, and easier to produce. On the other hand, consumption of cocaine in Europe and Latin America has continued to increase.

commonly used to analyze it relies on partial equilibrium models.[3] In a market with complex interactions, key aspects that can help to better understand how different policies shape prices and modify incentives are certain to be missed with this approach. By its own nature, a partial equilibrium approach will ignore the feedback effects between prices, policies, and the consequent reactions of the agents. In general equilibrium, prices and actions are endogenous to policies.

This paper presents a general equilibrium model that can be used to assess the effects of alternative policies. The model is dynamic, stochastic, and internally consistent. Optimal actions and prices are determined as a result of how agents perceive the laws of motion of the state variables and the policies undertaken by the authority. Furthermore, the model assumes that markets are competitive but that there are risks involved in devoting resources to illegal activities.

The paper is organized as follows. Section 2 presents the dynamic general equilibrium model used. Section 3 calibrates the model and specializes it to the cocaine market.[4] Section 4 reports the long-run effects of alternative policies. Finally, Section 5 concludes.

2 A General Equilibrium Model

The dynamic stochastic general equilibrium model presented below considers the existence of five representative agents:

- Crop Producer (Agent E)
- Drug Producer (Agent P)
- Drug Trafficker (Agent T)
- Drug Consumer (Agent D)
- Government or Law Enforcement Agency (Agent S)

Next, we describe the optimization problem faced by each agent, the optimality conditions, and the equilibrium conditions that jointly determine actions and prices.

2.1 The Crop Producer

This model generalizes the acreage supply response model of Chavas and Holt (1990). At any point in time the representative agent can devote his time to produce a good (crop) that is used as an input for producing a drug or to produce a good that is directly consumed.

[3] Examples of theoretical and empirical papers dealing with drug consumption are Becker and Murphy (1988), Becker et al (1991), Orphanides and Zervos (1995), Grossman et al (1998), and Beherens et al (1999). Examples of models for drug trafficking (distribution) are Caulkins (1993, 1997). Models that discuss optimal allocations of resources for preventation, treatment, and enforcement are Rydell et al (1996), Behrens et al (2000), and Tragler et al (2001).

[4] The choice of this drug is due to the availability of information. The model is general enough so that it can be used to study other illegal markets.

The first activity is illegal and the second is not. His consumption of the legal good is $c_{0,t}^E$ if he is not caught producing the illegal crop and $c_{1,t}^E$ if he is. With π_t^E denoting the probability of getting caught producing the illegal crop, we have:

$$c_t^E = \begin{cases} c_{0,t}^E & \text{with probability } 1-\pi_t^E \\ c_{1,t}^E & \text{with probability } \pi_t^E \end{cases},$$

$$\begin{aligned} c_{0,t}^E &= p_t y_t^E + h_t^E \\ c_{1,t}^E &= \left(1-\tau_t^E\right) p_t y_t^E + h_t^E, \end{aligned} \tag{1}$$

where p is the price (relative to the legal good) at which the illegal crop is sold to the drug producer, y_t^E is the amount of the illegal crop produced, h_t^E is the amount of the legal good produced, and $0 < \tau_t^E \leq 1$ is the penalty that is paid if caught producing the illegal crop.

The agent is endowed with one unit of time and derives no utility from leisure. This unit of time can be devoted to produce the illegal crop ($l_{1,t}^E$), to produce the legal good ($l_{2,t}^E$), or to reduce the probability of getting caught in the production of the illegal crop ($l_{3,t}^E$).[5] The production functions y^E and h^E are increasing and strictly concave in $l_{1,t}^E$ and $l_{2,t}^E$ respectively. Finally, $\pi_t^E = \pi^E\left(g_t^E, l_{1,t}^E, l_{3,t}^E\right)$ is increasing in the first two arguments and decreasing in the third, where g^E is the level of government expenditures destined to detect the illegal activity.[6]

The problem of the representative agent can be summarized by the value function that satisfies:

$$V\left(x^E\right) = \max_{l_1,l_2,l_3} \left\{\pi^E u\left(c_1^E\right) + \left(1-\pi^E\right) u\left(c_0^E\right) + \beta \mathcal{E}\left[V\left(x_{+1}^E\right)\right]\right\},$$

subject to (1) and the perceived laws of motion of the states x^E, where $u(\cdot)$ is the utility function that is increasing and concave in consumption, and $\mathcal{E}$ is the conditional expectation operator.[7]

The first-order optimality conditions are:

$$\begin{aligned} \frac{\partial \pi}{\partial l_1^E}\left[u\left(c_1^E\right) - u\left(c_0^E\right)\right] + p\frac{\partial y^E}{\partial l_1^E}\left[\pi^E\left(1-\tau^E\right)\frac{\partial u}{\partial c_1^E} + \left(1-\pi^E\right)\frac{\partial u}{\partial c_0^E}\right] &= Z^E \\ \frac{\partial \pi^E}{\partial l_3^E}\left[u\left(c_1^E\right) - u\left(c_0^E\right)\right] &= Z^E, \end{aligned} \tag{2}$$

where

$$Z^E = \frac{\partial h^E}{\partial l_2^E}\left[\pi^E \frac{\partial u}{\partial c_1^E} + \left(1-\pi^E\right)\frac{\partial u}{\partial c_0^E}\right].$$

The intratemporal optimality conditions state that the marginal benefits of devoting time to produce the illegal crop, to reduce the probability of getting caught producing it, and to produce the legal good must equate.

[5] This variable can be seen as proxying activities such as violence, corruption of law enforcement officials and politicians, etc.

[6] The timming of uncertainty is such that once the agent commits resources to each activity, a fraction π^E is caught and $1-\pi^E$ is not. Note that π^E is, in equilibrium, a function of the decisions of the agent. The same is true for the problems faced by the other agents.

[7] For brevity, time t subscripts are eliminated.

2.2 The Drug Producer

The representative drug producer (agent P) demands the illegal crop from the crop producer (y^P). He can devote his time to combine with y^P in order to produce the illegal drug or to produce the legal good. His consumption of the legal good can be $c_{0,t}^P$ or $c_{1,t}^P$ depending on not whether he is not or is caught producing the illegal drug (which happens with probability π_t^P). Then:

$$c_t^P = \begin{cases} c_{0,t}^P & \text{with probability } 1-\pi_t^P \\ c_{1,t}^P & \text{with probability } \pi_t^P \end{cases},$$

$$\begin{aligned} c_{0,t}^P &= q_t w_t^P + h_t^P - p_t y_t^P \\ c_{1,t}^P &= \left(1-\tau_t^P\right) q_t w_t^P + h_t^P - p_t y_t^P, \end{aligned} \tag{3}$$

where q is the price at which the illegal drug is sold to the trafficker (relative to the legal good), w_t^P is the amount of drug produced, h_t^P is the amount of the consumption good produced, and $0 < \tau_t^P \leq 1$ is the penalty that is paid if caught producing the illegal drug.

The agent is endowed with one unit of time and derives no utility from leisure. This unit of time can be devoted to produce the illegal drug ($l_{1,t}^P$), to produce the legal good ($l_{2,t}^P$), or to reduce the probability of getting caught ($l_{3,t}^P$). The production function h^P is increasing and strictly concave in $l_{2,t}^P$. The production function $w^P = w\left(l_1^P, y^P\right)$ is increasing and strictly concave in both arguments. Finally, $\pi_t^P = \pi^P\left(g_t^P, l_{1,t}^P, l_{3,t}^P\right)$ is increasing in the first two arguments and decreasing in the third, where g^P is the level of government expenditures destined to detect the illegal activity.

The problem of the representative agent can be summarized by the value function that satisfies:

$$V\left(x^P\right) = \max_{l_1, l_2, l_3, y} \left\{\pi^P u\left(c_1^P\right) + \left(1-\pi^P\right) u\left(c_0^P\right) + \beta \mathcal{E}\left[V\left(x_{+1}^P\right)\right]\right\},$$

subject to (3) and the perceived laws of motion of the states x^P.

The first-order optimality conditions are:

$$\begin{aligned} \frac{\partial \pi}{\partial l_1^P}\left[u\left(c_1^P\right) - u\left(c_0^P\right)\right] + q\frac{\partial w^P}{\partial l_1^P}\left[\pi^P\left(1-\tau^P\right)\frac{\partial u}{\partial c_1^P} + \left(1-\pi^P\right)\frac{\partial u}{\partial c_0^P}\right] &= Z^P \\ \frac{\partial \pi}{\partial l_3^P}\left[u\left(c_1^P\right) - u\left(c_0^P\right)\right] &= Z^P \\ \pi^P \frac{\partial u}{\partial c_1^P}\left[\left(1-\tau^P\right) q\frac{\partial w^P}{\partial y^P} - p\right] + \left(1-\pi^P\right)\frac{\partial u}{\partial c_0^P}\left[q\frac{\partial w^P}{\partial y^P} - p\right] &= 0, \end{aligned} \tag{4}$$

where

$$Z^P = \frac{\partial h^P}{\partial l_2^P}\left[\pi^P \frac{\partial u}{\partial c_1^P} + \left(1-\pi^P\right)\frac{\partial u}{\partial c_0^P}\right].$$

The first two optimality conditions state that the marginal benefits of devoting time to produce the illegal drug, to reduce the probability of getting caught, and to produce the legal good must equate. The third equation states that the marginal benefit from demanding an extra unit of the illegal crop must equate the marginal cost of acquiring it.

2.3 The Drug Trafficker

The representative drug trafficker (agent T) demands the illegal drug from the drug producer (w^T). He can devote his time to sell the illegal drug or to produce the legal good. His consumption of the legal good can be $c_{0,t}^T$ or $c_{1,t}^T$ depending on whether he is not or is caught trafficking the illegal drug (which happens with probability π_t^T). Then:

$$c_t^T = \begin{cases} c_{0,t}^T & \text{with probability } 1-\pi_t^T \\ c_{1,t}^T & \text{with probability } \pi_t^T \end{cases},$$

$$\begin{aligned} c_{0,t}^T &= r_t n_t^T + h_t^T - q_t w_t^T \\ c_{1,t}^T &= \left(1-\tau_t^T\right) r_t n_t^T + h_t^T - q_t w_t^T, \end{aligned} \tag{5}$$

where r is the price at which the illegal drug is sold to the drug consumer (relative to the legal good), n_t^T is the amount of drug transformed by the trafficker,[8] h_t^T is the amount of the legal good produced, and $0 < \tau_t^T \leq 1$ is the penalty that is paid if caught trafficking the illegal drug.

The agent is endowed with one unit of time and derives no utility from leisure. This unit of time can be devoted to traffic the illegal drug ($l_{1,t}^T$), to produce the legal good ($l_{2,t}^T$), or to reduce the probability of getting caught ($l_{3,t}^T$). The production function h^T is increasing and strictly concave in $l_{2,t}^T$. The production function $n^T = n\left(l_1^T, w^T\right)$ is increasing and strictly concave in both arguments. Finally, $\pi_t^T = \pi^T\left(g_t^T, l_{1,t}^T, l_{3,t}^T\right)$ is increasing in the first two arguments and decreasing in the third, where g^T is the level of government expenditures destined to detect the illegal activity.

The problem of the representative agent can be summarized by the value function that satisfies:

$$V\left(x^T\right) = \max_{l_1,l_2,l_3,w} \left\{\pi^T u\left(c_1^T\right) + \left(1-\pi^T\right) u\left(c_0^T\right) + \beta \mathcal{E}\left[V\left(x_{+1}^T\right)\right]\right\},$$

subject to (5) and the perceived laws of motion of the states x^T.

The first-order optimality conditions are:

$$\begin{aligned} \frac{\partial \pi}{\partial l_1^T}\left[u\left(c_1^T\right) - u\left(c_0^T\right)\right] + r\frac{\partial n^T}{\partial l_1^T}\left[\pi^T\left(1-\tau^T\right)\frac{\partial u}{\partial c_1^T} + \left(1-\pi^T\right)\frac{\partial u}{\partial c_0^T}\right] &= Z^T \\ \frac{\partial \pi}{\partial l_3^T}\left[u\left(c_1^T\right) - u\left(c_0^T\right)\right] &= Z^T \\ \pi^T\frac{\partial u}{\partial c_1^T}\left[\left(1-\tau^T\right) r\frac{\partial n^T}{\partial w^T} - q\right] + \left(1-\pi^T\right)\frac{\partial u}{\partial c_0^T}\left[r\frac{\partial n^T}{\partial w^T} - q\right] &= 0, \end{aligned} \tag{6}$$

where

$$Z^T = \frac{\partial h^T}{\partial l_2^T}\left[\pi^T\frac{\partial u}{\partial c_1^T} + \left(1-\pi^T\right)\frac{\partial u}{\partial c_0^T}\right].$$

These optimality conditions have similar interpretations to the ones for the drug producer.

[8] We assume that n is different from w as the trafficker may modify the properties of w (such as 'quality').

2.4 The Drug Consumer

The problem of the drug consumer is more complex. It relies on the 'rational addiction' literature pioneered by Becker and Murphy (1988). The model generalizes the framework of Orphanides and Zervos (1995). The representative drug consumer (agent D) demands the illegal drug from the drug trafficker (n^D). His consumption of the legal good can be $c_{0,t}^D$ or $c_{1,t}^D$ depending on whether he is not or is caught consuming the illegal drug (which happens with probability π_t^D). Then:

$$c_t^D = \begin{cases} c_{0,t}^D & \text{with probability } 1-\pi_t^D \\ c_{1,t}^D & \text{with probability } \pi_t^D \end{cases},$$

$$\begin{aligned} (1+\phi_t)\, c_{0,t}^D &= h_t^D - r_t n_t^D \\ (1+\phi_t)\, c_{1,t}^D &= h_t^D - \left(1+\tau_t^D\right) r_t n_t^D, \end{aligned} \tag{7}$$

where h_t^D is the amount of the legal good produced, ϕ_t is a consumption tax levied by the government, and $0 < \tau_t^D \leq 1$ is the penalty that is paid if caught consuming the illegal drug.

At each period, the agent is endowed with one unit of time and derives utility from leisure.[9] This unit of time can be devoted to demand leisure ($l_{1,t}^D$), to produce the legal good ($l_{2,t}^D$), or to reduce the probability of getting caught ($l_{3,t}^D$). The production function h^D is increasing and strictly concave in $l_{2,t}^D$. The probability $\pi_t^D = \pi^D\left(g_{1,t}^D, n_t^D, l_{3,t}^D\right)$ is increasing in the first two arguments and decreasing in the third, where g_1^D is the level of government expenditures destined to detect the illegal activity.

As the illegal drug is potentially addictive, the long-lasting effects of past consumption of n^D are summarized by the stock variable d^D that has the following law of motion:

$$d_{t+1}^D = (1-\delta)\, d_t^D + n_t^D, \tag{8}$$

where $0 < \delta < 1$ acts as a depreciation rate.

The momentary instantaneous utility of the individual is:

$$\pi^D u\left(c_1^D, n^D, l_1^D\right) + \left(1-\pi^D\right) u\left(c_0^D, n^D, l_1^D\right) + \theta^D k^D,$$

where $u(\cdot)$ is increasing and concave in leisure and in the consumption of the legal and illegal goods. The third term is itself composed by two terms. The first is $\theta_t^D = \theta\left(g_{2,t}^D, d_t^D\right)$ and denotes the probability that the agent will experience the detrimental effects of the consumption of the illegal good and is decreasing in g_2^D and increasing in the stock of illegal drugs.[10] The second is $k_t^D = k\left(n_t^D, d_t^D\right)$ and represents the detrimental side effects of past consumption. It is increasing in the first argument and decreasing in the second. Thus, the second reflects the fact that the agent is rationally addicted in the sense that he knows that there are negative side effects to increased consumption.

[9] As this agent does not have to devote resources to produce illegal goods, we force him to derive utility from leisure to avoid trivial solutions for the labor supply.

[10] The difference between g_1^D and g_2^D is that the first considers expenditures that the demand of the illegal good riskier for the consumer, while the second deals with expenditures that diminish the effects of its use (for example through educational campaigns or treatment for heavy users).

The problem of the representative agent can be summarized by the value function that satisfies:

$$V\left(x^D\right) = \max_{l_1,l_2,l_3,n} \left\{\pi^D u\left(c_1^D, n^D, l_1^D\right) + \left(1-\pi^D\right) u\left(c_0^D, n^D, l_1^D\right) + \theta^D k^D + \beta \mathcal{E}\left[V\left(x_{+1}^D\right)\right]\right\},$$

subject to (7), (8) and the perceived laws of motion of the states x^D.

The first-order optimality conditions are:

$$\begin{aligned}
\frac{\partial u}{\partial l_1^D} &= Z^D \qquad (9)\\
\frac{\partial \pi}{\partial l_3^D}\left[u\left(c_1^D\right) - u\left(c_0^D\right)\right] &= Z^D\\
\frac{\partial \pi}{\partial n^D}\left[u\left(c_1^D\right) - u\left(c_0^D\right)\right] + \frac{\partial u}{\partial n^D} + \theta \frac{\partial k}{\partial n^D} &= \lambda + M^D\\
\beta \mathcal{E}\left[(1-\delta)\lambda_{+1} + \frac{\partial \theta_{+1}^D}{\partial d_{+1}^D} k_{+1}^D + \theta_{+1}^D \frac{\partial k_{+1}^D}{\partial d_{+1}^D}\right] &= \lambda,
\end{aligned}$$

where

$$\begin{aligned}
Z^D &= \frac{1}{1+\phi}\frac{\partial h^D}{\partial l_2^D}\left[\pi^D \frac{\partial u}{\partial c_1^D} + \left(1-\pi^D\right)\frac{\partial u}{\partial c_0^D}\right]\\
M^D &= \frac{r}{1+\phi}\left[\pi^D\left(1+\tau^D\right)\frac{\partial u}{\partial c_1^D} + \left(1-\pi^D\right)\frac{\partial u}{\partial c_0^D}\right].
\end{aligned}$$

The first two optimality conditions state that the marginal benefits of devoting time to leisure, to reduce the probability of getting caught, and to produce the legal good must equate. The third and fourth equations determine the optimal demand of the addictive good where the agent considers all benefits and costs (including the detrimental effects of becoming addicted).

2.5 The Government

The government (agent S) has no explicit objective function to maximize. It chooses the tax rate (ϕ) on the consumption of the legal good by agent D (C^D) that is necessary to finance its total expenditures:

$$G_t^S \equiv g_t^E + g_t^P + g_t^T + g_{1,t}^D + +g_{2,t}^D + g_t^S = \phi_t C_t^D, \qquad (10)$$

where g^S denotes other expenditures made by the government that do not affect the probabilities of detecting illegal activities.

As the production and consumption of the illegal goods that are confiscated by agent S are assumed to be destroyed (not taxed), they do not constitute a source of revenue for the government.

2.6 Market-Clearing Conditions

The market clearing conditions are:

$$
\begin{aligned}
\left(1-\tau_t^E \pi_t^E\right) y_t^E &= y_t^P, \\
\left(1-\tau_t^P \pi_t^P\right) w_t^P &= w_t^T, \\
\left(1-\tau_t^T \pi_t^T\right) n_t^T &= n_t^D,
\end{aligned} \tag{11}
$$

that state that the supply and demand of the illegal crop, illegal drug produced, and illegal drug trafficked must equate.

2.7 Competitive Equilibrium

A competitive equilibrium is a set of allocation rules $l_i^j = L_i^j(x)$, for $i = 1, 2, 3$ and $j = E, P, T, D$, a set of pricing functions $p = P(x)$, $q = Q(x)$ and $r = R(x)$, and the laws of motion of the exogenous state variables $x_{+1} = X(x)$, such that:

- Agents E, P, T, and D solve their respective optimization problems taking x and the form of the functions $P(x)$, $Q(x)$, $R(x)$, and $X(x)$ as given, with the equilibrium solution to this problem satisfying $l_i^j = L_i^j(x)$, for $i = 1, 2, 3$ and $j = E, P, T, D$.

- The market clearing conditions (11) hold each period, and the legal good market clears:

$$
h_t^E + h_t^P + h_t^T + h_t^D = C_t^E + C_t^P + C_t^T + C_t^D + G_t^S + \tau_t^D \pi_t^D r_t n_t^D. \tag{12}
$$

The last equation states that the amount produced by all agents must equate the sum of private consumption, government expenditures, and the resources lost when agent D is detected consuming the illegal good. Thus, the equilibrium consumption of the legal good for each agent is given by:

$$
C_t^j = \left(1-\pi_t^j\right) c_{0,t}^j + \pi_t^j c_{1,t}^j, \text{ for } j = E, P, T, D.
$$

3 Functional Forms and Calibration

The model just described can be used to analyze any illegal market. Next, we focus on the analysis of the cocaine market. The reasons are: First, the cocaine market has agents in different locations (coca leaves are mainly produced in Bolivia, Colombia, and Peru; cocaine is mainly produced in Colombia and transported to consumption centers in the United States and Europe). Second, a relatively comprehensive data base that includes prices and quantities is available for this market (see the Appendix). Finally, due to the heterogeneity of agents involved, several supply and demand policies have been implemented or proposed.

Tables 1 and 2 present the functional forms and parameters used in the exercise. The utility functions of all agents display constant relative risk aversion (CRRA) with respect to the consumption of the legal good (with the risk aversion coefficient set equal to 2 in all cases). Agent D's utility also depends on leisure and on the stock and flow of consumption

Agent E
$u\left(c_i^E\right)=\frac{\left(c_i^E\right)^{1-\gamma_E}}{1-\gamma_E},\ \text{for } i=0,1$
$y^E=A_E\left(l_1^E\right)^{\upsilon_E}$
$h^E=B_E\left(l_2^E\right)^{\varphi_E}$
$\ln\left(\frac{\pi^E}{1-\pi^E}\right)=\alpha_1^E+\alpha_2^E\ln g^E+\alpha_3^E l_1^E+\alpha_4^E l_3^E$
Agent P
$u\left(c_i^P\right)=\frac{\left(c_i^P\right)^{1-\gamma_P}}{1-\gamma_P},\ \text{for } i=0,1$
$w^P=A_P\left(l_1^P\right)^{\upsilon_P}\left(y^P\right)^{1-\upsilon_P}$
$h^P=B_P\left(l_2^P\right)^{\varphi_P}$
$\ln\left(\frac{\pi^P}{1-\pi^P}\right)=\alpha_1^P+\alpha_2^P\ln g^P+\alpha_3^P l_1^P+\alpha_4^P l_3^P$
Agent T
$u\left(c_i^T\right)=\frac{\left(c_i^T\right)^{1-\gamma_T}}{1-\gamma_T},\ \text{for } i=0,1$
$n^T=A_T\left(l_1^T\right)^{\upsilon_T}\left(w^T\right)^{1-\upsilon_T}$
$h^T=B_T\left(l_2^T\right)^{\varphi_T}$
$\ln\left(\frac{\pi^T}{1-\pi^T}\right)=\alpha_1^T+\alpha_2^T\ln g^T+\alpha_3^T l_1^T+\alpha_4^T l_3^T$
Agent D
$u\left(c_i^D,n^D,l_1^D\right)=\frac{\left(c_i^D\right)^{1-\gamma_D}}{1-\gamma_D}+\psi_1\ln n^D+\psi_2\ln l_1^D,\ \text{for } i=0,1$
$k^D\left(n^D,d^D\right)=\zeta\ln d^D+(1-\zeta)\ln n^D$
$\ln\left(\frac{\theta^D}{1-\theta^D}\right)=\vartheta_1+\vartheta_2\ln g_2^D+\vartheta_3\ln d^D$
$h^D=B_D\left(l_2^D\right)^{\varphi_D}$
$\ln\left(\frac{\pi^D}{1-\pi^D}\right)=\alpha_1^D+\alpha_2^D\ln g_1^D+\alpha_3^D n^D+\alpha_4^D l_3^D$

Table 1: Functional Forms

of the illegal drug.[11] Consistent with the empirical literature on rational addictions, the depreciation rate is high and set equal to 80%.

The production functions of the legal good are identical for all agents and the share of labor is set equal to 0.3 (a number consistent with the macro literature). The production functions of the illegal goods for agents E, P, and T differ. Illegal crop production is assumed to be more labor intensive than the production of the illegal drug or the legal good. The production of w and n are less labor intensive. The parameters A_j (for $j=E,P,T$) are calibrated to match the average relative prices q/p and r/q observed on the data (7.19 and 17.45 respectively, see the Appendix).[12]

[11] It is assumed that agent D is the only demander of the illegal good. Furthermore, it is assumed that the illegal crop is used exclusively to produce the illegal drug. GTZ (a German technical cooperation agency) estimates that no more than 6% of the total production of coca leaves is used for traditional consumption in Bolivia, Colombia, and Peru.

[12] The model assumes perfect competition in every market. Thus, mark-ups in each stage are due solely to technological and risk factors.

Preferences
$\beta = 0.95$, $\gamma_E = \gamma_P = \gamma_T = \gamma_D = 2$
$\psi_1 = \psi_2 = 0.1$, $\delta = 0.8$, $\zeta = -0.3$
Illegal Goods Production Functions
$A_E = 1$, $A_P = 0.24$, $A_T = 0.12$
$\upsilon_E = 0.4$, $\upsilon_P = 0.2$, $\upsilon_T = 0.1$
Legal Good Production Functions
$B_E = B_P = B_T = B_D = 70$
$\varphi_E = \varphi_P = \varphi_T = \varphi_D = 0.3$
Government
$\tau^E = 0.6$, $\tau^P = 0.8$, $\tau^T = 0.9$, $\tau^D = 0.2$

Table 2: Parameter Values

Government expenditures (G^S) are set such that, in steady state, ϕ is equal to 0.0025 (0.25%) which corresponds to the ratio between total expenditures on drug control and private consumption for the year 2000.

Finally, the parameters that describe the laws of motion of the probabilities π^j ($j = E, P, T, D$) and θ^D, were obtained by estimating econometric models with proportions data. To do so, times series realizations of proxies for the probabilities must be constructed. We proxied π_t^E using the ratio between the surface of coca eradicated and the surface cultivated in Bolivia and Colombia; π_t^P was proxied by the ratio between the cocaine seized and estimated to have been produced in Colombia; π_t^T was proxied by the ratio between the cocaine seized and estimated to have been produced excluding Colombia; π_t^D was proxied by the ratio between the number of people arrested for drug possession and the number of drug users; and θ^D was proxied by the percentage of chronic and occasional cocaine users.[13]

Agent E
$\alpha_2^E = \underset{(0.83)}{1.771}$, $\alpha_3^E = \alpha_4^E = 0$
Agent P
$\alpha_2^P = \underset{(0.56)}{1.139}$, $\alpha_3^P = \alpha_4^P = 0$
Agent T
$\alpha_2^T = \underset{(0.15)}{0.621}$, $\alpha_3^T = \alpha_4^T = 0$
Agent D
$\vartheta_2 = \underset{(0.35)}{-0.890}$, $\vartheta_3 = \underset{(0.28)}{1.288}$
$\alpha_2^D = \underset{(0.22)}{0.760}$, $\alpha_3^D = \alpha_4^D = 0$

Table 3: Probabilities. Standard Errors in parenthesis

Once time series of the probabilities were obtained, econometric models using variables proxying g^j were estimated. Table 3 reports the results of the models in which π^j ($j =$

[13] The Appendix presents the time series constructed and sources used.

E, P, T, D) were made to depend only on variables exogenous to the agent. In particular, π^E and π^P were found to depend on the component of international expenditures, π^T on expenditures on interdiction and domestic law, and π^D only on expenditures on domestic law.[14] For the estimation of the parameters that determine the probability of addiction, we need to construct time series for the stock of addictive good (d). We do it as follows:

$$d_t \simeq \sum_{i=0}^{2} (1-\delta)^i \, n_{t-i},$$

where (as noted above) δ was set equal to 0.8 and n_t is the consumption of cocaine. Finally, the constants on the specifications of the probabilities were set so that in equilibrium they matched the average probabilities of Table 9.[15]

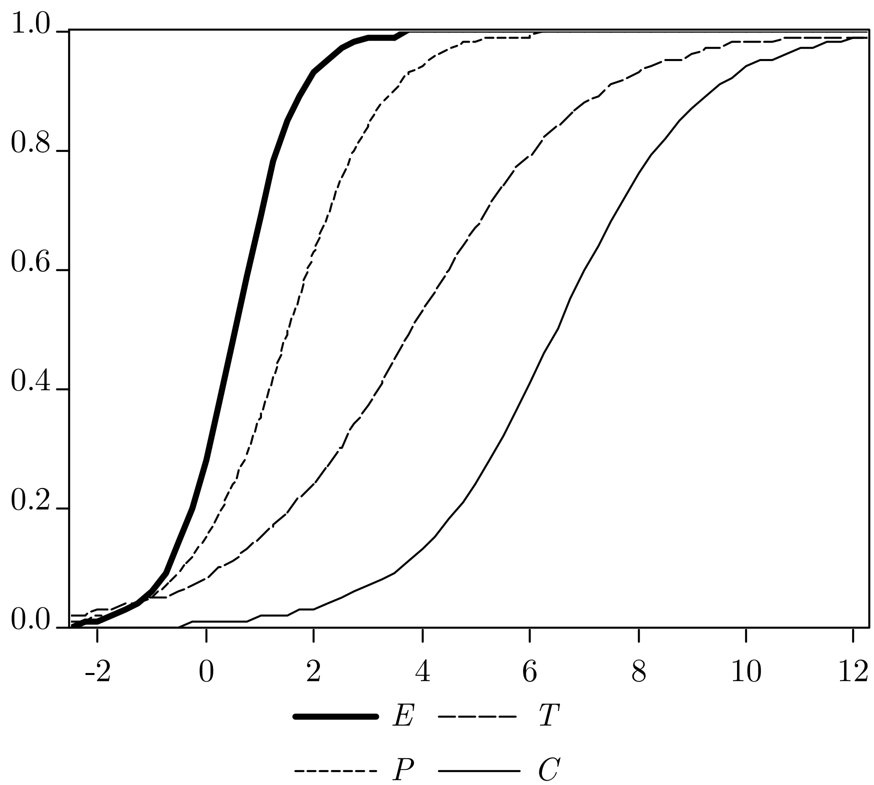

Figure 1: Fitted Probabilities and Expenditures (logs of billions of US$)

[14]As the coefficients α_3^j, α_4^j are restricted to be equal to 0 (avoiding strategic interactions), the optimization problem of the agents with respect to the choice of l_3^j is trivial ($l_3^j = 0$), because there are no benefits on devoting resources to reduce the probability of getting caught. Models with endogenous probabilities are not considered here.

[15]In particular, the constants were set so that in steady state $\pi^E = 0.169$, $\pi^P = 0.075$, $\pi^T = 0.242$, $\pi^D = 0.032$, and $\theta^D = 0.020$.

Figure 1 presents the fitted probabilities π^j for each agent given different values of $\ln g$. As can be inferred from the coefficients reported on Table 3, almost uniformly, expenditures are more effective in detecting crop production, then drug production, drug trafficking, and lastly drug consumption. The estimated probabilities imply that to obtain $\pi^E = 0.5$, the value of international expenditures should be 3 times higher (1.7 billion US$) than it has been on average, to obtain $\pi^P = 0.5$, the value of international expenditures should be 8.1 times higher (4.6 billion US$) than it has been on average, to obtain $\pi^T = 0.5$, the value of expenditures on interdiction and domestic law should be 5.8 times higher (46.3 billion US$) than they has been on average, and to obtain $\pi^D = 0.5$, the value of domestic law expenditures should be 107 times higher (653.9 billion US$) than it has been on average. Of course, these figures only convey an idea of the resources that would be needed to make this activities riskier without assessing the means by which they would be financed and their impact on welfare. This is addressed in the next section.

4 Assessing the Effects of Alternative Policies

Several policies have been proposed and enacted on the 'War on Drugs'. Next, we use the model presented on Section 2 along with the functional forms and parameter values of the previous section to evaluate the long run effects of alternative policies.[16] Given the structure of the model, we consider three types of policies and evaluate their effects on the actions taken by each agent and the prices that are determined as a result:

- Increased Risk: The first set of policies evaluates the effects of increases in different components of G^S. This exercise evaluates the effect of policies that affect the risks involved in each activity but maintains the penalties (τ^j) constant. As the increased expenditure must be financed, we also compute the increases on the consumption tax of the legal good that are required.

- Stiffer penalties: Next, we consider the case in which the level of expenditure is maintained constant (thus, not changing the risks involved in each activity) but increase the penalties of the agents when they are caught.

- Legalization: There are two equivalent ways by which legalization can be modeled. One is to force π^j to be equal to 0, in which case the level of τ^j would be irrelevant. The other is to set τ^j to zero, in which case, the level of π^j would be irrelevant.

4.1 Making Illegal Activities Riskier

As our specifications of π^j depend on different components of government expenditures, we make an activity riskier by increasing the appropriate expenditure. We also compute the new level of the consumption tax required to finance this increase.

The effect of increasing risks in a partial equilibrium model can be compared to an adverse supply shock that reduces the quantity produced. In general equilibrium, an increased risk

[16] Transitional dynamics are not considered in this paper.

for one agent may actually foster illegal activities by the other (as the latter's relative risk has decreased). For example, the effects of increased risks in producing or trafficking cocaine on the production and relative price of coca leaves is not obvious.

Five experiments are conducted by increasing different components of G^S. They share the characteristic that overall expenditures are increased in 10% (Table 4). The first experiment increases all the components of G^S proportionally to their average share. In this case, the risks of producing the illegal crop, producing, trafficking, and consuming the illegal drug are all higher. As expenditures on prevention are also increased, the probability of addiction decreases. As the share of international expenditures (the most effective in increasing risk) is relatively small, a 10% increase in overall expenditures produce relatively modest increases on risks. Production of the illegal goods (and the consumption of the illegal good) decrease, and the relative prices of them with respect to the legal good increase. The net result for agent D is that it decreases its expenditures on the illegal good, providing an income effect that makes him demand more of the legal good. Even though agents E, P, and T reallocate labor from the illegal to the legal activity and produce more of the legal good, it is not automatic that their consumption of the legal good will increase.[17] As the increased consumption of the legal good by agent D is relatively modest, financing this policy would imply that the consumption tax must be almost doubled (from its original level). In terms of welfare, agents E and T would be worse off as they experience the highest increased risks and agents D and P would be better off.[18] The bottom line of this exercise is that if government expenditures continue to be distributed as they are and the structure of our model provides a reasonable approximation to the long run characteristics of this market, drug producers and consumers would be interested in continuing with this policy.

We arrive to similar conclusions with the second experiment in which the increased expenditures are destined solely to international expenditures. In this case, the risks for agents P and particularly E increase substantially, leaving the risks for other agents unchanged. In equilibrium, production and consumption of illegal goods reduce drastically, while their relative prices increase. The income effect (of reduced expenditure of the illegal good) makes agent D to consume more of the legal good than in the first experiment, thus making the increased tax on the consumption of the legal good to by smaller. However, in this experiment, the only agent that is better off now (due to favorable changes in relative prices) is agent P. Agent D is worse off because the decreased probability of addiction does not compensate the reduction of consumption of the illegal good. Summing up, a policy focused on making riskier to produce the drug may actually be desired by the drug producer (not the crop producer).

The next two experiments focus on increasing the expenditures on Interdiction (increasing the risk of the illegal activity of agent T) and on Domestic Law (increasing the risk of the illegal activities for agents T and D). These experiments can be seen as negative demand shocks for agents P and E, decreasing the relative prices of the illegal goods they produce. On the other hand, agent T reallocates labor from illegal to legal activities, but due to the

[17] Agent D actually reduces its production of the legal good given that the positive income effect of the reduced expenditure on the illegal good makes him demand more leisure.

[18] The case of agent P is interesting. The modest increase in the probability of getting caught compounded by an increase in the relative price of the price at which it sells the good he produces (q) with respect to the price at which he buys the input (p), makes him actually better off with this policy.

	Proportional	International	Interdiction	Domstic Law	Prevention
			Illegal Good		
y^E	-1.22	-5.34	-0.73	-0.77	-0.82
w^P	-4.10	-29.17	-0.99	-1.04	-1.10
n^T	-5.04	-35.73	-1.12	-1.18	-1.25
n^D	-6.20	-35.73	-3.13	-3.18	-1.25
			Prices		
p	1.52	33.00	-1.60	-1.67	-1.78
q	3.29	58.50	-1.50	-1.58	-1.67
r	4.87	48.01	2.81	2.63	-3.71
			Probabilities		
π^E	4.92	44.23	0.00	0.00	0.00
π^P	1.54	15.70	0.00	0.00	0.00
π^T	1.06	0.00	1.77	1.77	0.00
π^D	0.21	0.00	0.00	0.50	0.00
θ^D	-0.28	-0.87	-0.08	-0.08	-0.81
			Legal Good		
C^E	-0.39	-1.34	-0.34	-0.36	-0.38
C^P	0.17	2.44	-0.10	-0.11	-0.11
C^T	-0.05	-1.36	0.57	0.50	-1.37
C^D	1.43	4.24	0.33	0.61	4.28
			Welfare		
E	-	-	-	-	-
P	+	+	-	-	-
T	-	-	+	+	-
D	+	-	+	+	+
Expenditure	-1.33	-4.56	-0.07	-0.30	-4.93
Tax	0.02	0.01	0.02	0.02	0.01

Table 4: Increased Risks (in percentage points). Expenditure = Change of expenditures of agent D on the illegal good (in terms of the legal good). Tax = Change on the consumption tax needed to finance goverment expenditures.

fact that r rises and that the reduction of expenditures on the illegal good by agent D is relatively modest, agents T and D are better off in both cases.

The last experiment increases expenditures solely on Prevention (that decreases the probability of addiction). This experiment produces a reduction on the demand and relative prices of the illegal goods. It makes agents E, P, and T to reallocate labor from illegal to legal activities and makes them worse off. Only agent D is better off as the decreased expenditure on the illegal good produces an income effect that increases his demand for leisure and consumption of the legal good (more than any other of the experiments considered). This last fact, makes the increase on the consumption tax to be more modest than in the other cases.

4.2 Stiffer Penalties

The second set of policies considered does not make the illegal activities riskier, but makes them costlier if the agents are caught. We consider three experiments in which the penalties for performing illegal activities by agents E, P, and T are increased (Table 5).[19]

Stiffer penalties on the crop producer can be seen as a negative supply shock for him. Production of the illegal crop decreases and its relative price (p) increases. The increased cost for agent P makes him produce less of the illegal good (another negative supply side shock) and increases the price of the illegal good sold (q) but not to the same extent of the increase in p. The same argument is extensive for agent T. The increased price also reduces the demand for the illegal good by agent D, making him substitute it with consumption of the legal good. As government expenditures are not changed and the consumption of the legal good by agent D increases, the consumption tax decreases. Agent D is the only one that is better off in this experiment.

The other two experiments are very interesting because they provide results that can only be obtained when considering general equilibrium models. The second experiment imposes stiffer penalties on the drug producer (agent P). As it makes his activity costlier, its production falls and its relative price increases (q). On the other hand, this precise experiment can be seen as a negative demand shock for agent E. The end result is that the production of the illegal crop reduces as does its relative price (p). The end result is that the relative price q/p increases and the consumption of the legal good by agent P increases making him better off, not worse off with this policy![20] Agent T is worse off given that this experiment can be seen as a negative supply shock and that the relevant relative price for him (r/q) increases. Finally, agent D is better off, given that the increased price of the illegal good makes him consume less of it and more of leisure and the legal consumption good.

The last experiment considers increasing penalties for the drug trafficker. Following the reasoning provided above, this increased cost reduces the demand and price of the drug produced by agent P, which in turn reduces the demand and price of the illegal crop produced by agent E (making them worse off). However, as the activities of agent T are costlier, the relative price r increases, and even though the volume of drug trafficked by agent T decreases, he is better off as his "terms of trade" have improved (r/q) and he can consume more of the

[19] Stiffer penalties such as "three strikes and you are out" come to mind. We do not report the case of stiffer penalties on consumption as in our model it can be seen as a consumption tax.

[20] This is the case given that π^P does not change.

	$\tau^E = 1$	$\tau^P = 1$	$\tau^T = 1$
		Illegal Good	
y^E	-2.92	-1.28	-4.65
w^P	-8.35	-1.74	-6.23
n^T	-7.59	-3.00	-7.01
n^D	-7.59	-3.00	-9.88
		Prices	
p	10.83	-2.79	-9.72
q	8.52	3.20	-9.05
r	7.15	2.70	9.55
		Probabilities	
θ^D	-0.19	-0.08	-0.25
		Legal Good	
C^E	0.47	-0.59	-2.03
C^P	-0.02	1.11	-0.56
C^T	-0.28	-0.11	3.87
C^D	0.85	0.33	1.11
		Welfare	
E	-	-	-
P	-	+	-
T	-	-	+
D	+	+	+
Expenditure	-0.98	-0.38	-1.28
Tax	-0.002	-0.001	-0.003

Table 5: Stiffer Penalties (in percentage points). Expenditure = Change of expenditures of agent D on the illegal good (in terms of the legal good). Tax = Change on the consumption tax needed to finance goverment expenditures.

legal good. As in other experiments, the consumption tax and expenditures on the illegal drug by agent D decrease making him consume more of the legal good and demand more leisure (making him better off).

4.3 Legalization

The last set of exercises considers the progressive legalization of each of the activities (Table 6). It starts by legalizing crop production,[21] then it legalizes drug production as well, it follows with also legalizing drug trafficking, and finally legalizes drug consumption. The last exercise takes into account that legalization make expenditures on everything but prevention

[21]The newly elected president of Bolivia (and acting president of the union of coca leaf producers) has been flirting with the idea of legalizing coca leaf production, although he says to vehemently oppose cocaine production and trafficking. As most of the coca crop production is destined for cocaine production, this attitude can be considered similar to that of a missile producer that favors their production but vehemently opposes their firing.

and treatment unproductive. Given that, we also consider the case of legalizing all activities and allocating all the expenditures to prevention (to reduce the probability of addiction).

	E	$E+P$	$E+P+T$	$E+P+T+D$	$E+P+T+D$ +Prevention
			Illegal Good		
y^E	1.18	2.92	18.13	18.89	12.57
w^P	10.07	12.62	35.78	36.98	27.13
n^T	9.08	17.79	45.32	46.77	34.92
n^D	9.08	17.79	85.78	87.64	72.48
			Prices		
p	-10.68	-7.36	28.34	30.51	13.69
q	-8.59	-15.55	11.37	12.99	0.41
r	-7.28	-13.24	-41.21	-40.42	-46.54
			Probabilities		
θ^D	0.23	0.46	2.36	2.41	-1.34
			Legal Good		
C^E	-0.12	0.67	9.96	10.57	6.00
C^P	0.03	-1.41	-0.76	-0.71	-1.06
C^T	0.32	0.63	-14.19	-14.18	-14.28
C^D	-0.98	-1.87	-7.71	-11.44	6.54
			Welfare		
E	+	+	+	+	+
P	+	-	-	-	-
T	+	+	-	-	-
D	-	-	-	-	+
Expenditure	1.14	2.19	9.23	11.79	-7.80
Tax	0.002	0.005	0.020	0.030	-0.015

Table 6: Legalization (in percentage points). Expenditure = Change of expenditures of agent D on the illegal good (in terms of the legal good). Tax = Change on the consumption tax needed to finance goverment expenditures.

Legalizing crop production increase the production and consumption of illegal drugs and decreases their relative prices. Notably, as p decreases significantly, consumption of the legal good by agent E decreases! Even so, as this is no longer a risky activity, welfare of the crop producer increases. Production and trafficking of the illegal good also increase and their relatively prices fall (though not as sharply as p does). Agents P and T increase their consumption of the legal good and are better off in this experiment. The only "looser" here is the drug consumer because the increased expenditure on the illegal good, forces him to demand less leisure and consume less of the legal good. Furthermore, and as a consequence of the latter, the consumption tax must also increase.

When crop production and drug production are legal, production and consumption of illegal drugs increase and their prices with respect to the legal good decrease, especially q. This in turn makes the drug producer worse off in this experiment! The winners are the crop producer and the drug trafficker that obtain more income due to the increased demand of their products. As in the first case, agent D is worse off because he expends more of the illegal good, consumes less of the legal good, demands less leisure, and is more likely to become addicted.

In the third and fourth experiments, drug trafficking and consumption are also legalized. In these cases the only winner is agent E. What happens is that as the relative price of the illegal good decreases significantly for agent D and his demand for it increases, the trafficker and the drug producer demand more of the production of agent E busting the price p. Agent E then has more resources that he can allocate to consume the legal good. On the other hand, agent P also produces more of the illegal good, increasing q, but its costs (p) increase more. As a result, agent P consumes less of the legal good and is worse off. Agent T is in an even more uncomfortable situation, as the price at which he sells his product decreases (r) while the cost of the input he uses increases (q). As in the first exercise, agent D is also worse off as he expends more on the illegal good, sees the consumption tax increased, reduces the consumption of the legal good, and is more likely to become addicted.

The previous exercises considered that even though the previously illegal activities were legalized, the government was still expending the same amounts on interdiction, domestic law, and international expenditures. As these resources would cease to be necessary, they could be used in the only "productive" activity left (prevention) that could reduce the probability of addiction of agent D. When this is done, even though the production of the previously illegal goods and their prices follow the same pattern of the previous exercise, the increased expenditure on prevention now reduces the probability of addiction. This simple difference accounts for the fact that now agent D expends less on the illegal good (even though he consumes more of the drug). This income effect makes him consume more of the consumption good, demand more leisure, and witness a reduction on the consumption tax! As a result, agents D and E benefit from this experiment, while the trafficker and drug producer are still worse off. Thus, without resorting to arguments such as imperfect competition and without (at least explicitly) considering benefits that could follow from reduced crimes, legalization is bad for traffickers and drug producers, but is good for the crop producer and may be good for the drug consumer.

5 Concluding Remarks

As drug use is blamed for a broad range of personal and social ills, governments have prohibited their production, sale, and use. Among the policy measures adopted to decrease the demand of illegal drugs are stiffer penalties to consumers, treatment on heavy users, and educational campaigns. Policies intended to reduce the supply include crop eradication, interdiction, and stiffer penalties to producers and traffickers.

While significant resources have been allocated to these activities, the results appear not to be encouraging. More importantly, a coherent general equilibrium approach that can help to assess the effects of alternatives policies has not been developed, and the analysis has focused on partial equilibrium models. This is dangerous because policies determine not only responses by the actors, but also modify prices and change incentives. In general equilibrium, prices and actions are endogenous to policies.

This paper develops a general equilibrium model that considers the production, trafficking, and consumption of illegal goods. The model uses characteristics of popular partial equilibrium models (such as production under uncertainty and rational addictions) and integrates them in a coherent framework.

The model is calibrated to characterize the market for cocaine and is used to analyze the effects of three types of policies: making the illegal activities riskier, increasing the penalties for conducting illegal activities, and legalizing previously illegal activities. Assessing the effects of these policies using the powerful tool of a general equilibrium model provides illuminating (and in cases surprising) results.

For example, increased expenditures destined to deter illegal activities may make drug producers better off. What appears to be robust, is that increasing the risk of any illegal activity makes crop producers worse off. On the other hand, imposing stiffer penalties on illegal activities make crop producers worse off and drug consumers better off. However, stiffer penalties on drug producers or traffickers may make them better off. Finally, legalization of previously illegal activities is good for crop producers and is generally disliked by drug producers and traffickers. As the consumption of illegal drugs can increase substantially, the drug consumer is usually worse off. Nevertheless, if resources were invested on diminishing the probability of addiction, legalization may be good for the consumer.[22]

Even though the model is quite general, it is used in a narrow context. In particular, we do not consider strategic interactions by which agents may invest resources that allow them to reduce the probability of getting caught. We also consider that all the markets are competitive. The paper also addresses steady-state (long run) effects and does not analyze transitional dynamics. Furthermore, even though this structure lends itself to incorporate more dynamic and stochastic features (technology shocks, time-to-grow constraints, etc.), these and other features are promising avenues for further research.

[22] One crucial positive effect of legalization, namely the reduction of crime and violence, is overlooked here.

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A The Data

The Appendix presents the series used to calibrate the model and estimate the probabilities.

- Government Expenditures, Table 7. (Source: The Office of the National Drug Control Policy).
  - Total: United States Government Expenditures in Marijuana, Cocaine, Crack, Stimulants, LSD, PCP, and Heroin Control (billions of US dollars of the year 2000).
  - Prevention: Development and implementation of programs that prevent illicit drug use, keep drugs out of neighborhoods and schools, and provide a safe and secure environment for all people.
  - Treatment: Includes behavioral therapy (such as counseling, cognitive therapy, or psychotherapy), medications, or their combination.
  - Domestic Law: Cocaine seizures, asset seizures, and arrests of drug dealers and their agents by federal, state, and local law enforcement agencies; imprisonment of convicted drug dealers and their agents.
  - International: Coca leaf eradication; seizures of coca base, cocaine paste, and the final cocaine product in the source countries (Bolivia, Colombia, and Peru).
  - Interdiction: Cocaine seizures and asset seizures by the Customs Service, the Coast Guard, the U.S. Army, and the Immigration and Naturalization Service (INS).

- Prices, Table 8.
  - q/p: Ratio between the price of cocaine exported from Colombia and the price of coca base.
  - r/p: Ratio between the consumer price of cocaine and the price of cocaine exported from Colombia.

- Risks, Table 9.
  - π^E: Ratio between surface of coca leaves eradicated and surface cultivated in Bolivia and Colombia. (Source: International Narcotics Control Strategy Report).
  - π^P: Ratio between cocaine seized and estimated to be produced in Colombia.
  - π^T: Ratio between cocaine seized and estimated to be produced (excluding Colombia).
  - π^D: Ratio between the number of arrests due to drug possession and the number of drug users. (Sources: What America's Users Spend on Illegal Drugs (1988-2000), Federal Bureau of Investigation, U.S. Department of Justice, Crime in the United States: Uniform Crime Reports, 1989 - 2001).
  - θ^D: Percentage of chronic and occasional cocaine users.(Source: National Institute on Drug Abuse (1979–1991)).

Year	Prevention	Treatment	Domestic Law	International	Interdiction	**Total**
1986	0.3	1.1	1.8	0.2	1.2	4.5
1987	0.8	1.4	2.7	0.3	2.0	7.2
1988	0.8	1.4	3.0	0.3	1.4	6.9
1989	1.1	1.8	3.9	0.4	2.0	9.3
1990	1.8	2.4	5.7	0.7	2.3	12.9
1991	2.1	2.6	5.8	0.8	2.6	13.9
1992	2.1	2.9	6.4	0.8	2.4	14.6
1993	2.1	3.0	7.1	0.6	1.8	14.5
1994	2.1	3.1	7.1	0.4	1.5	14.2
1995	2.0	3.3	7.9	0.3	1.4	15.0
1996	1.8	3.1	8.1	0.3	1.5	14.8
1997	2.0	3.3	8.5	0.4	1.8	16.2
1998	2.3	3.5	9.0	0.5	1.7	17.0
1999	2.0	3.0	9.1	0.6	1.9	16.6
2000	2.1	3.1	8.6	0.8	2.4	17.0
2001	2.5	3.2	9.2	0.6	2.0	17.6
2002	2.0	3.0	3.1	1.0	1.8	11.0
2003	1.8	3.1	2.8	1.0	1.8	10.5
Average	13.2	21.0	45.4	4.6	15.8	100.0

Table 7: Distribution of the United States Government Expenditures in Marijuana, Cocaine, Crack, Stimulants, LSD, PCP, and Heroin Control (billions of US dollars of the year 2000). Average = Expressed in percentage points of Total Expenditures.

Year	q/p	r/q
1981	2.57	8.13
1982	2.58	8.33
1983	1.57	14.78
1984	1.86	14.54
1985	4.65	14.91
1986	3.61	21.00
1987	4.55	19.47
1988	4.49	19.83
1989	5.26	20.55
1990	6.92	24.27
1991	7.01	20.64
1992	8.33	20.36
1993	13.20	18.09
1994	10.43	17.81
1995	10.05	18.67
1996	16.15	16.67
1997	13.46	18.57
1998	12.65	17.43
Average	7.19	17.45

Table 8: Relative Prices.

Year	π^E	π^P	π^T	π^D	θ^D
1986		1.2	16.6		
1987	2.3	2.6	17.3		
1988	2.0	5.2	20.1		
1989	3.2	8.0	22.1	2.5	
1990	9.1	10.1	23.3	2.4	2.7
1991	7.0	13.7	17.5	2.0	2.9
1992	4.7	6.3	22.5	2.5	2.2
1993	3.5	5.6	23.2	2.8	2.0
1994	6.0	6.7	35.6	3.5	1.9
1995	12.5	7.6	27.5	3.8	1.9
1996	10.2	7.1	31.4	3.7	2.0
1997	17.2	8.0	33.6	4.0	1.9
1998	24.1	15.5		3.7	1.9
1999	29.2			3.7	1.6
2000	26.7			3.7	1.3
2001	33.1				1.6
2002	44.8				2.2
2003	51.0				
Average	16.9	7.5	24.2	3.2	2.0

Table 9: Risks (in percentage points).