

Cocaine Production and Trafficking:

What Do We Know?

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Abstract

The main purpose of this paper is to summarize the information currently available on cocaine production and trafficking. The paper starts by describing the available data on cocaine production and trade, the collection methodologies (if available) used by different sources, the main biases in the data, and the accuracy of different data sources. Next, it states some of the key empirical questions and hypotheses regarding cocaine production and trade and takes a first look at how well

the data match these hypotheses. The paper states some of the main puzzles in the cocaine market and studies some of the possible explanations. These puzzles and empirical questions should guide future research on the key determinants of illicit drug production and trafficking. Finally, the paper studies the different policies that producer countries have adopted to fight against cocaine production and the role consumer countries play in the implementation of anti-drug policies.

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 dmejia@uniandes.edu.co.

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Cocaine Production and Trafficking: What Do We Know?*

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INTRODUCTION

The nature of illegal and black markets makes it very difficult to collect data such as quantities transacted, intermediate and final goods' prices, and other relevant market characteristics like the quality of the product being dealt and the distribution of profits within the industry. Illegal drug markets are not the exception.¹ For instance, in measuring consumption “buyers cannot report a price in dollars per standardized unit, but only how much they spent on some quantity of white powder, the contents of which is unknown.” (Reuter and Greenfield, 2001, p. 169). Notwithstanding the difficulties of collecting accurate data, the market's numbers on the size, quantities, prices, etc. always attract a good deal of

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¹ See Reuter (2001) and Thoumi (2005a).

attention, not only among policy makers who want to request appropriations, governments that want to measure the success of anti-drug policies and analysts who want to identify the claimants of the business' profits, but also from journalists who want to impress the public. Many times the numbers are, voluntarily or not, misused "to buttress preconceived and personal agendas" and "the emotional and ideological charge carried by most data users leads to widespread data misuse." (Thoumi, 2005a, p. 186).

This paper describes the available data to measure the incidence and prevalence of cocaine production and trafficking. It also describes the main data sources, the collection methodologies, if available, and examines the accuracy and biases of different data sources. Based on the description of the data and data biases, the paper states some key empirical questions and hypotheses that should drive future research into our understanding of the determinants of cocaine production and trafficking, and of the outcomes and side effects of the war against illegal drugs. Some of the questions and hypotheses that are addressed in this paper are: If the price elasticity of demand is a crucial parameter of the effectiveness of the war on drugs, what are the short- and long-term price elasticities of demand for cocaine? What are the productivity parameters behind the estimation of potential cocaine production? Have illegal drug producers made technological advances in the production of cocaine that counteract the measures taken in the war on drugs? What are the results of the war against illegal drugs? Is this war sustainable in the long run? What are the side effects of this war?

The paper also studies the outcomes of the war against the production of cocaine in the producer countries, the role of consumer countries (mostly developed) in the implementation of specific anti-dug policies, and examines the effectiveness of these policies and some of their possible

side effects. Finally, the paper briefly discusses the sustainability of policies aimed at reducing the production of cocaine in source countries. Before describing the data and collection methodologies, we turn to describing some basic information about the main topic of this paper: cocaine.

A BRIEF INTRODUCTION TO COCAINE

Cocaine is a powerful addictive drug that is produced in large quantities in only a few Latin American countries. These are Bolivia, Colombia, and Peru.² The main ingredient to produce cocaine is the cocaine alkaloid, a chemical compound that can be extracted from the leaves of coca plants.³ Coca was grown in the Andes long before the arrival of European settlers. Its leaves were (and, in some cases, still are) chewed by the local indigenous population in the Americas to help relieve fatigue caused by altitude sickness and for its mild stimulant effects. Today, prevailing indigenous populations in Bolivia and Peru still use coca leaves in religious and social ceremonies.⁴

The coca plant is a very hardy, medium-sized bush that grows in a tropical rainforest climate anywhere between 100 and 1700 meters above sea level. The time between planting and harvesting ranges from six and nine months depending on the coca variety, climate and geographical conditions. Coca bushes can be grown and harvested year-round, but most growth occurs from December to April. Coca is harvested, on average, four times per year (minimum – three and maximum – eight,

² The purpose of this chapter is not to explain why illegal drug production takes place in some countries while not in others. Francisco Thoumi has extensively examined this topic (see Thoumi 2003, 2005a, b).

³ The cocaine alkaloid was first isolated in the West in 1855 by German chemist Friedrich Gaedcke. Five years later Albert Niemann described an improved isolation process of the cocaine alkaloid for his Ph.D. thesis and named it “cocaine” (see <http://cocaine.org/> and the references there cited).

⁴ See Thoumi (2005c) for a detailed explanation of how anti-drug policies create a cultural clash between government agencies interested in fighting cocaine production and local native populations that have grown and used coca in traditional cultural and religious ceremonies for a long time.

depending on the variety and location of the coca) and requires up to 300 man-days to harvest one hectare – about 2.5 acres – for one year (CIA, 2004).

Although there are over 250 different varieties of the coca plant, only a few are widely used today to produce cocaine for the illegal drug markets.⁵ Cocaine production is a relatively simple process that can take place in small local workshops. The process of producing cocaine consists of three main steps: after being harvested and dried, the coca leaves are converted into coca paste, then into cocaine base, and then into the final product, cocaine (cocaine hydrochloride). The manufacturing process requires a few chemicals (precursors) such as sulfuric acid, potassium permanganate, ether, hydrochloric acid, acetone and ethyl ether, plus water, filters, and microwave ovens.

Depending on different factors such as coca variety, geography, bushes per hectare, etc., one hectare planted with coca bushes produces, on average, between 1,000 and 1,200 kg of fresh coca leaf per hectare per harvest. Between 1.1 and 1.4 grams of cocaine can be produced from 1 kg of coca leaf. Using an average of four harvests per year, and the yields described above, we can arrive at a ballpark production estimate between 5 and 6 kg of cocaine per hectare per year.⁶

Cocaine hydrochloride, a white crystalline powder,⁷ is a highly potent and addictive stimulant.⁸ It is either snorted or dissolved in water and injected.

⁵ These are the Huanuco coca (in Bolivia and Peru), the Amazonian coca (in the Amazon River Basin), and Colombian coca (in Colombia, primarily) (https://www.cia.gov/saynotodrugs/cocaine_b.html).

⁶ These yields numbers were taken from different reports (CIA, 2004 and UNODC, 2005). The number used by UNODC to calculate potential production of cocaine in Colombia was 4.7 kg of cocaine per hectare per year until 2004, which, according to the source, is taken from a study undertaken by the US government under the name of “Operation Breakthrough”. However, recent field research carried out by UNODC in Colombia has found a large increase in this productivity estimate. In fact, for the 2006 report, UNODC uses a productivity estimate of 7.7 kg of cocaine per hectare per year. We will elaborate on this below.

⁷ Commonly used street terms for cocaine are: *blow*, *coke*, *snow*, *nose candy*, *flake*, *big C*, *lady*, *snowbirds*, and *wicky stick* (see www.dea.gov/concern/cocaine_factsheet.html, and www.streetdrugs.org).

Due to the high price of cocaine, by the late 1970s and beginning of the 1980s drug dealers discovered a new and cheaper alternative for low income users: crack, a rocky crystal that is obtained by mixing cocaine, baking soda, and water in a saucepan, and whose name derives from the crackling sound produced when the ingredients are being burned to smoke the resulting vapors (see Levitt and Dubner, 2005, and NIDA, 2005). Cocaine is the second most consumed illegal drug in the US (after marijuana) and the third in most European countries (after marijuana and heroin). Cocaine consumption triggers different physical effects. In moderate doses it causes disturbances in heart rates, elevated blood pressure, dilated pupils, decreased appetite, irritability and argumentative behavior, among others. In large doses it causes loss of coordination, collapse, blurred vision, dizziness, anxiety, heart attacks, chest pain, respiratory failure, strokes, seizures and headaches, abdominal pain, nausea, and paranoia.⁹ The duration of the euphoric effect of cocaine (“the high”) depends on the route of administration. With faster absorption, the high is more intense, but does not last as long. When snorted, “the high” can last from 15 to 30 minutes; when smoked it can last from about 5 to 10 minutes (NIDA, 2006).

DATA SOURCES

There are two main sources of data for illegal drug production, prices, extent of cultivation of illegal crops, seizures of drug shipments, etc. These are the United Nations Office on Drugs and Crime (UNODC) and the US government’s White House Office of Drug Control Policy (ONDCP). In

⁸ The stimulation produced by cocaine consumption comes from its interference with the reabsorption process of dopamine, which is a chemical messenger that is associated with pleasure and movement (National Institute of Drug Abuse – NIDA).

⁹ NIDA, 2006 and www.streetdrugs.org/cocaine.htm.

addition to these two sources, other institutions, many times government departments in producer countries, either gather their own statistics or collaborate in the gathering of data with UNODC and/or ONDCP.

Established in 1997, UNODC has become the main source for data on illegal drug markets. It employs about 500 staff members worldwide and has 21 field offices located in the main producer countries, as well as in those countries used as traffic corridors. The mandate of UNODC is to assist member countries in their struggle against illegal drugs, crime, and terrorism.¹⁰ UNODC relies on voluntary contributions – mainly from just a few countries – for almost 90% of its budget.¹¹ UNODC works jointly with the respective government institutions in the producer countries to undertake the “Coca Cultivation Survey” each year. Through the Illicit Crop Monitoring Programme (ICMP), UNODC uses the interpretation and processing of satellite images to monitor illegal crops in producer countries: coca in the three Andean producer countries and opium poppy in South and East Asian countries.¹² Also, using surveys and studies on yields, this institution produces an estimate of potential cocaine production, gathers prices of intermediate goods such as dry coca leaf and coca base, and collects other crucial statistics such as eradication measures, drug shipments seizures, and the number of cocaine processing

¹⁰ More information on the mandate of UNODC, as well as its main goals, can be obtained at: <http://www.unodc.org/unodc/en/about.html>

¹¹ Jensema and Thoumi (2004) argue that UNODC’s large proportion of earmarked funding from a few donor countries biases the type of projects where the funds are spent, hampers its policy evaluation efforts as criticisms can easily translate into a fund shortage, and prevents the organization from experimenting with programs that are not in line with the donor countries’ position on illegal drug issues. Available at: http://www.drug-policy.org/documents/Thoumi_Jensema_paper

¹² The analysis of these images includes a number of corrections for cloud cover, spraying, dates of acquisition, etc. For a detailed explanation the reader is referred to the methodological description available in the Survey Reports for each of the Andean countries available at: www.unodc.org/unodc/en/crop_monitoring.html).

laboratories destroyed as reported by different governmental institutions in producer countries.¹³

ONDCP's data on coca cultivation are prepared by the US Director of Central Intelligence, Crime and Narcotics Center (CNC), and are published each March in the *International Narcotics Control Strategy Report* as part of the US President's determination of whether to provide assistance to drug producer and transit countries. In preparing its estimates of coca cultivation, CNC analyzes black and white, high-resolution satellite imagery and aerial photographs. These are taken only between November and January of each year, weather permitting. The satellite images and aerial photographs cover a representative area of the producer countries' known or suspected drug growing areas. The technique for analyzing the satellite images and aerial photographs is similar to the one used to estimate agricultural crops throughout the United States (see GAO, 2003 and ONDCP, 2005). However, according to a study conducted by ONDCP in 2002, the CNC's methodology had not adopted a "statistically rigorous accuracy assessment, commonly known as an error rate" in its methodology to measure coca cultivation. Also, the technology used by CNC was inappropriate as it did not account for image distortions or variations in the terrain and the atmosphere, such as cloud cover. Following the recommendations made by the ONDCP's study, CNC expected to have many of the recommended changes in place for its 2002 analysis (see GAO, 2003).

¹³ Thoumi (2005a) argues that UNODC does not have enough personnel and claims that "it simply does not have the capability to conduct significant critical studies and to evaluate in detail the quality of the data it collects" (Thoumi, 2005a, p. 189). This claim, however, is backed up only by a specific criticism on a figure of the size of the illegal drug business (\$500 billion, which was a clear overestimation) produced by UNODC back in 1997 when this organization was first established. The author also asserts that for the production of UNODC's main substantial product, *The World Drug Report*, the organization relies on several consultants who are hired to write chapters and sections for the report, which, in some sense, contradicts the claim that UNODC lacks the human resources to produce significant quality statistics and analysis.

UNODC's methodology for collecting data on coca cultivation covers almost the entire territories in the producer countries, whereas ONDCP's only covers a representative sample. UNODC also makes more corrections than ONDCP for possible biases and mistakes in the interpretation of aerial imagery. Finally, UNODC has been actively involved in conducting the "Coca Cultivation Surveys" in each one of the producer countries, which are complemented by continuous efforts to undertake field studies to update parameters such as yields per hectare, an important parameter for coming up with and estimating potential cocaine production. Although UNODC stands as a more reliable source of data on coca cultivation, cocaine production, and related issues, we will be referring to the two data sources in the following section of the paper in order to compare them to each other (if possible).

COCAINE PRODUCTION: STYLIZED FACTS

i. Coca Cultivation

According to ONDCP, coca cultivation in the three Andean countries remained relatively stable throughout the 1990s. On average, coca was cultivated in about 200,000 hectares in the three producer countries, but the share of each country in total coca cultivation changed dramatically during the decade. While Peru had the largest number of hectares in 1990 (about 57% of the total) and Colombia the lowest (19%), by 1999 these shares had completely reversed, with Peru having 21% of the total, Bolivia 12%, and Colombia 67% (Figure 1). On one hand, this change was, in part, a result of increasing eradication efforts undertaken by the Bolivian and Peruvian governments, and of aerial interdiction efforts undertaken by the Peruvian government to close the air bridge between coca producing

centers in Peru and cocaine processing laboratories in Colombia. On the other hand, in Colombia, after the demise of the Medellin and Cali cartels by the middle of the 1990s, the Fuerzas Armadas Revolucionarias de Colombia (FARC) and the Autodefensas Unidas de Colombia (AUC), their historical origins as leftist guerrillas and right-wing paramilitaries notwithstanding, started to get increasingly involved in the production and commercialization of cocaine to finance their insurgent activities against each other and against the Colombian state.¹⁴ As a result, coca cultivation reached its highest levels ever recorded in Colombia (about 163,000 hectares) by 2001. The response of the Colombian government to the large increase in coca cultivation was the implementation of Plan Colombia in 2001, the official name of a multi-year, comprehensive strategy designed and implemented to bring about lasting peace by reducing the production of illegal drugs. As a result, from 2000 to 2003 coca cultivation in Colombia decreased by more than 30%, whereas in Bolivia and Peru it remained relatively stable. According to the latest UNODC and ONDCP reports, total coca cultivation in the three producer countries has remained relatively stable in the last three years reported (Figure 2 (a) and (b)). Nevertheless, ONDCP's figures should be handled with care as they expanded by 81% the size of the landmass that was imaged and sampled for coca cultivation and, when the new areas covered are taken into account, there is an increase of 39,000 has. cultivated with coca.¹⁵ As ONDCP claims in a recent press release, "Because these areas were not previously surveyed, it is impossible to determine for how long they have been under coca cultivation...The higher cultivation figure in this year's estimate does not necessarily mean that coca cultivation increased in the last year; but rather reflects an

¹⁴ See Rangel (2000) and Grossman and Mejía (2008).

¹⁵ Figures 1 and 2(b) present ONDCP's estimates of total coca cultivation preserving the sample fixed, that is, they do not take into account for 2005 the 81% increase in the fields surveyed.

improved understanding of where coca is now growing in Colombia.” Summarizing, according to the two sources, total cultivation in the three Andean countries shows a large decrease between 2001 and 2003, in large part due to the large decrease observed in Colombia after the implementation of Plan Colombia. And, if anything, coca cultivation has remained relatively stable during the last three years reported. Although the observed figures for the last few years are not enough evidence to conclusively support a ballooning effect, where a decrease in cultivation in one area due to “effective” anti-drug policies would lead to the reallocation of crops to new areas and, as a result, total cultivation remains unchanged (or increases), it does send a warning signal of the potential for large increases in Bolivia and Peru if anti-drug policies and monitoring are not maintained in all areas where coca can and has been grown in the past (see Department of State, 2005).

Since UNODC only started the Illicit Crop Monitoring System in Colombia in 1999, in Peru in 2000, and in Bolivia in 2003, data between the two main sources of information can be compared only for those years. Figure 3 shows the evolution of coca bush cultivation in Colombia according to the two main sources. Although the levels are different, with an almost constant average difference between the two sources of 30,000 hectares, the tendency is the same: first increasing between 1999 and 2000, and then decreasing until 2004. The same pattern is observed for Bolivia and Peru, that is, an almost constant level of coca cultivation with a small increasing tendency in the last year. However, while ONDCP’s estimate of coca cultivation in Colombia is larger than UNODC’s in the last four years, the opposite is true for Bolivia and Peru for those years when the two sources gathered data separately.

ii. Intermediate Prices

While in Bolivia and Peru there is an active market of coca leaf, in Colombia the market for coca leaf is very limited because most farmers process the coca leaves into coca base themselves in small “kitchens” located on their farms. Thus, UNODC collects monthly data on prices of sun-dried coca leaf in Bolivia and Peru and of coca base in Colombia based on semi-structured interviews of farmers, storekeepers, and others who participate in the cultivation of coca and the production of coca base. In many instances these prices are collected only in a few regions where coca is grown and, as a result, the selected sample may be far from representative and should be handled with care. For instance, during 2004 the prices of coca leaf in Bolivia were collected only in the Yungas of La Paz in Bolivia by UNODC and in the Chapare region (also in Bolivia) by DIRECO, in 13 different points in Peru, and in 5 departments in Colombia.

The price of dried coca leaf in Bolivia and Peru increased dramatically from 1996 to 2001. This increase in prices was the result of eradication measures taken by the Bolivian and Peruvian governments, as well as the efforts of the Peruvian government during the second half of the 1990s, partially financed with US funding, to close the air bridge that connected the coca and coca paste-producing centers in Peru and the Colombian laboratories that are specialized in processing the coca paste into cocaine. Figures 4 (a) and (b) show the evolution of coca leaf prices in Bolivia and Peru respectively along with potential coca leaf production as calculated by UNODC based on yields per hectares. While in Bolivia, the price of dried coca leaf has decreased due to increased production in the last three years recorded (2003 through 2005), in Peru dried coca leaf prices have risen in the last few years. In Colombia, however, despite the large decrease in coca cultivation between 2001 and 2004 described

above, neither the price of coca base nor coca base production has shown any increasing tendency between 2000 and 2005 (see Figure 5). According to UNODC (2005) the price of coca base increased between 2001 and 2003. However, this is true only in nominal terms. The price of coca base has been stable (when seen in dollar terms) or decreasing (in real pesos) ever since the beginning of the implementation of Plan Colombia in 2001, precisely the moment when coca cultivation started to decrease rapidly. According to some sources, this apparent puzzle – of lower cultivation of coca and lower prices of coca base – can be partially explained by the offsetting effects of larger imports of coca paste from Peru and the large increases in productivity per hectare in the production of coca base.¹⁶ The next section will elaborate on this and on a “twin puzzle”, namely the stability of prices of cocaine in the US market despite the large decrease in aggregate coca cultivation between 2000 and 2003 in the three producer countries and a relatively stable aggregate demand for cocaine in the consumer countries.

iii. Potential Cocaine Production

Using yields per hectare as well as technical coefficients for each of the main links in the cocaine production chain, UNODC produces an estimate of potential manufacture of cocaine for each one of the three producer countries in the Andean region. Until 2004 UNODC’s estimates relied on information of technical coefficients from other sources, the main one being *Operation Breakthrough*, a DEA project designed to estimate the amount of cocaine produced in the Andean region by examining the

¹⁶ Despite the successful closure of the air bridge between Peru and Colombia, the organizations involved in coca cultivation and cocaine production figured out other ways (perhaps less efficient but still profitable, such as transportation by river, or using mules to travel jungle paths) to move coca paste from Peru to Colombia (see Kawell, 2001).

yield and alkaloid content of coca crops and the efficiency of clandestine cocaine producing laboratories. In 2004, however, UNODC started a series of field studies to complement its crop monitoring system by estimating coca leaf yields per hectare, average weight loss for sun-dried and oven-dried leaves, and conversion rates from coca leaf to cocaine, among others (see the Coca Cultivation Surveys for the three producer countries produced by UNODC in 2005 and 2006.) The implementation of these surveys, however, is often hampered by the social tensions prevailing in the coca producing regions and by the farmers' reluctance to collaborate with the interviewers. Despite the difficulties in carrying out these studies, their implementation is of the greatest importance, not only to better understand coca and its derivatives' markets, but also to be able to evaluate the efficiency of anti-drug programs and monitor changes in each link of the cocaine production process.¹⁷

Not surprisingly, according to UNODC the main trend of potential cocaine production is very similar to that described above for coca cultivation, that is, a relatively stable total potential production of cocaine from 1990 to 1999 (at about 850 metric tons) and then decreasing between 2000 to 2003. By 2003 cocaine production had reached a minimum level of about 800 metric tons due, almost completely, to the large decrease in potential production in Colombia (see Figure 6 (a)). For 2004 and 2005, however, new estimates of coca leaf yields per hectare obtained by UNODC and the Colombian government point to worrisome results, namely, that

¹⁷ For instance, in 2004 the media reported the discovery, in the Sierra Nevada (in the northern part of Colombia), of a new coca variety which supposedly had higher cocaine content, a higher level of purity, and was also resistant to glyphosate. This new variety was seen as the response of drug traffickers to the intensive aerial spraying efforts by the Colombian government, with strong financial and technical support from the US (see McDermott, 2004). However, the Transnational Institute (TNI) has questioned the validity of this report arguing that "A few scientific facts provide grounds for questioning the credibility of this report about the cocaine alkaloid content of the coca leaf...The report's claim that the plant is resistant to glyphosate is equally ambiguous" (see TNI, 2004).

productivity per hectare has increased from 4.7 to 7.7 kg per hectare per year (a 63% increase)¹⁸. This new estimate – plus the sustained high prices of coca leaf in Bolivia (above \$5/kg) and Peru (above \$2.5/kg), which likely created an incentive for farmers in these two countries to increase coca cultivation – have resulted in a large increase in the estimated potential cocaine production between 2003 and 2004. While in Bolivia, potential cocaine production increased by 35% in 2004 and by 23% in Peru (in the same year), in Colombia it increased by 16%, despite the reduction in the number of coca cultivated hectares.

Based on the most recent CNC cultivation estimates, along with the DEA's coca yield and laboratory efficiency data, the US State Department also produces an estimate of potential cocaine production. According to this source, after reaching a peak of more than one thousand metric tons in 2001, total cocaine production in the Andean countries declined between 2001 and 2004 (see Figure 6 (b)). For 2005, potential cocaine production is not comparable to prior years due to the fact that ONDCP includes in its calculation those newly surveyed fields that were not included in previous years. In fact, our own calculations suggest that potential cocaine production would have been 431 metric tons (the same as in 2004) if one does not include the new surveyed areas. While potential cocaine production according to this source has remained relatively stable during the last three years in Bolivia and Peru (at 60 metric tons and 140 metric tons per year respectively), in Colombia it decreased very rapidly until 2004 and it remained stable during 2005. By 2004 and 2005 potential cocaine production in this country (430 MT) was about 50% of what it was in 2001 (840 MT).¹⁹ According to an ONDCP report (ONDCP, 2005), the fact that potential cocaine production declined more rapidly

¹⁸ See UNODC (2006).

¹⁹ Again, without including in the calculations the 39,000 has of new surveyed fields of 2005 to make the data comparable to previous years.

than coca bush cultivation is explained by the fact that, since intense aerial spraying started in Colombia in 2001, there are an increasing proportion of coca fields that are newly planted, and these are known to be less productive than more mature fields. However, as we will see below, although it might be true that aerial spraying decreases the average age of coca fields, and this, in turn, decreases the yields, there is new evidence of an increase in yields per hectare coming from different strategies implemented by illegal groups engaged in cocaine production in response to the increase eradication measures taken by the Colombian and US governments.

Although UNODC's and the State Department's estimates of potential cocaine production show a similar proportional decrease between 2001 and 2003, the latter source shows a reversion of the decreasing trend for 2004 and 2005 due to higher yields per hectare, while the former shows an increase in 2005 that is only due to an increase in the fields surveyed, and, as a result, the number for 2005 is not really comparable to the numbers observed for previous years.

iv. Average Purity

UNODC and ONDCP also gather statistics on the average purity of cocaine by using information from laboratories and cocaine shipment seizures in producer and transit countries respectively, as well as the information at the retail level from street seizures in consumer countries. On one hand, between 2002 and 2004 the average purity of cocaine in the producer countries ranged between 82% and 95% (UNODC, 2006). On the other, because purity levels in consumer countries are obtained from drug seizures, many times done at the retail level, the average purity of cocaine varies very widely, even for a given transaction size in a given

city and year (Caulkins, 1994). Also, the spread in expected purity does not decrease as the quantities being transacted increases, and, as a result, the interpretation of simple averages should be handled with care (ONDCP, 2004). According to ONDCP, the average expected purity of cocaine²⁰ in the US market increased rapidly throughout the 1980s for all quantities being transacted, then decreased during the first few years of the 1990s and remained relatively stable during the 1990s. Finally, in the last few years, expected purity of powder cocaine has increased, reaching levels of about 70% for purchases of less than two grams, 67% for purchases of 2 to 10 grams, and 62% for purchases of 10 to 59 grams and of more than 50 grams (see Figure 7).²¹ Although one would expect increasing purity levels as the quantities being transacted increases (as was in fact observed in the 1980s), purity differences across quantity levels had almost disappeared in the 1990s, mainly because purity levels at the highest quantities transacted fell. According to ONDCP (2004) this suggests that diluting cocaine was not as common a practice in the 1990s as it was in the 1980s. In fact, after 1998 one observes higher purity levels for the lowest quantity purchases, which may come from the compositional effects from the aggregation of different number of transactions from higher and lower purity transactions, markets, and cities, and not because distributors inside the US refine cocaine across the distribution chain (UNODC, 2004).

According to evidence cited by Caulkins and Reuter (1998), purity levels do not seem to affect transaction prices at the retail level in consumer countries. This apparent puzzle, however, is explained by the authors with the observation that illegal drugs are experience goods, where the price

²⁰ Expected purity levels are based on observations obtained through purchases only and do not include observations from seizures and other enforcement activities (ONDCP, 2004).

²¹ The same patterns are observed when information on purity levels obtained through seizures and other enforcement activities are also included (see Figure 8).

paid is in part determined by the purity the buyer expects at the time of purchase based on information such as the size of the purchase, location, and other observable characteristics. Given the lack of official regulation in illegal drug markets, sellers can deceive costumers about the purity of the product being transacted. At the same time, buyers can later argue that the product was of lower quality than that agreed at the time of the transaction. These disputes, not surprisingly, end up many times generating a substantial amount of violence.²²

A BRIEF LOOK AT CONSUMPTION TRENDS

Although this paper concentrates on cocaine production and trafficking, in order to say anything meaningful about the price of cocaine in world markets, we must briefly review demand.

The United States, where cocaine is the second-most consumed illegal drug after marihuana is the main consumer country in the world. In most European countries, cocaine is the third illegal drug consumed, after marihuana and heroin.²³ While in the US, the annual prevalence rate of abuse in the 15 to 64-year-old population is about 2.8%, in European countries, on average, this rate is 2.7% in Spain, 2.4% in the UK²⁴, 1.1% in the Netherlands, Italy and Ireland, and less than 0,3% in countries such as France, Sweden and Poland.

Cocaine consumption in the US decreased rapidly between 1985 and 1993; since then it has remained relatively stable. While in 1985 the annual prevalence rate among the 12-year-olds in the general population and

²² This is not the only link in the trafficking chain where violence arises as a method to resolve disputes. In fact, the recourse to violence is one prominent characteristic of organizations involved in illegal drug trafficking.

²³ According to UNODC (2005a) there are approximately 13.4 million cocaine users in the world. Two-thirds are in the Americas (about 6.5 million in the US and 1.9 in South America).

²⁴ For the population between 16 and 59 years of age.

above was about 5.1%, by 1993 this rate had decreased to about 2%. Among high school students, prevalence rates also decreased rapidly between 1985 and 1992: from 13.1% to 3.1%. In the second half of the 1990s, the prevalence rate among 12th graders in the US has fluctuated between 3% and 6% (UNODC, 2005a, using information from SAMHSA). The percentage of the population reporting current (during the month before the interview) and occasional (one to eleven times during the twelve months before the interview) use of cocaine also shows the same pattern (see Figure 9). Other indicators, such as the trend in cocaine treatment admissions, show a decreasing tendency of cocaine use between 1992 and 2002 (the last year recorded). While the primary admission rate²⁵ for cocaine per 100,000 inhabitants (age 12 or older) was about 125 in 1992, by 2002 it had decreased by approximately 24% to about 100 (SAMHSA, 2005).²⁶ Among high school students, the evidence on cocaine consumption trends is somehow mixed. While measures of 30-day prevalence rates for cocaine use among 12th graders began to increase and then peaked in 1999 and then decreased until 2003 (see Figure 10), the perception of harmfulness of cocaine consumption²⁷—as perceived by 12th graders—seems to have declined in the last few years recorded (University of Michigan (2004)).

In Europe, however, cocaine consumption, according to most estimates, has been on the rise over the last few years.²⁸ For instance, in Spain, the country that shows the highest rates of cocaine consumption in Europe, the prevalence of cocaine use among the general population (age 15 to 64) increased from 1.5% in 1995 to 2.7% in 2003; in the Netherlands it

²⁵ The primary substance is the main substance reported at the time of admission.

²⁶ Cocaine admissions as percent of all admissions also declined from about 17.5% in 1992 to about 13% in 2002.

²⁷ When they respond to the question: *How much do you think people risk harming themselves (physically or in other ways), if they try cocaine powder once or twice, and occasionally.*

²⁸ European countries, probably with the exception of Spain, show prevalence rates of consumption much lower than those in the US.

increased from 0.7% in 1997 to 1.1% in 2001; in Switzerland, cocaine use among 15- and 16-year-olds increased from 0.9% in 1994 to 2.5% in 2002; Germany experienced an increase of cocaine use of the population between 18 and 64 years of age from 0.2% in 1990 to 1% in 2003 (UNODC, 2004).

COCAINE PRICES

The price per pure gram of cocaine decreased from more than \$500 for purchases of two grams or less, and \$200 for purchases of more than 50 grams in 1980, to about \$200 and to about \$38, respectively, in 2001.²⁹ Since 2001 the price of cocaine in the US has been increasing at a relatively slow pace. These patterns are observed for both the US and Europe for cocaine at street purity (Figure 11). According to UNODC, cocaine prices, at the retail and wholesale level, have followed similar trends over time (Figure 12).

THE MAIN PUZZLE (and its resolution...)

According to most measures available until 2005, potential cocaine production showed a decreased of about 30% or more between 2000 and 2004, while demand in the consumer countries, if anything, had remained relatively stable. Yet, prices of intermediate inputs (coca leaf and coca base) in producer countries and of cocaine in the consumer

²⁹ Caulkins and Reuter (1998) study the relative importance of the cost components in determining cocaine prices at the retail level. According to their estimates, a little over 50% of the cost can be attributed to risk (for incarceration about 24%, and for death about 30%), whereas import costs only account for about 12% of the retail value of cocaine, labor costs for about 13%, and costs of product and assets seizures for about 10%. The same study also highlights the huge variability of prices across time and market levels and explains why enforcement interventions create only temporary spikes in prices, due to the response (in their words, adaptation) of suppliers.

countries had been stable or decreasing until then.³⁰ With a roughly stable demand (except in many European countries where cocaine consumption is rising, but is still “low” when compared to the prices observed in the US), lower production estimates and increasing seizures, increasing interception of drug shipments, and destruction of cocaine processing laboratories, cocaine prices would have been expected to rise or remain stable, and not fall as seems, in fact, to have been the case (at least until new information became available recently). Or, as Reuter (2001, p. 18) puts it, “If thorough enforcement did not raise drug prices, then it might still claim success if it lowered availability. But the data, mostly from surveys of high school seniors, show no decrease”. However, in the process of writing this chapter, UNODC released the results of field research done in Colombia where they found a large increase in productivity estimates. Specifically, they found that, on average, the number of kilograms produced by one hectare of coca in one year increased from 4.7 to 7.7 (UNODC, 2006). This corresponds to a 40% increase in the yields per hectare. When this new estimates of productivity are used to calculate potential cocaine production they find that, although there has been a large decrease in the number of coca cultivated hectares in Colombia (of more than 30% between 2001 and 2005), each hectare is now found to be more productive. As a result of these two factors, and as explained before, potential cocaine production in Colombia has not decreased as much as was thought before.

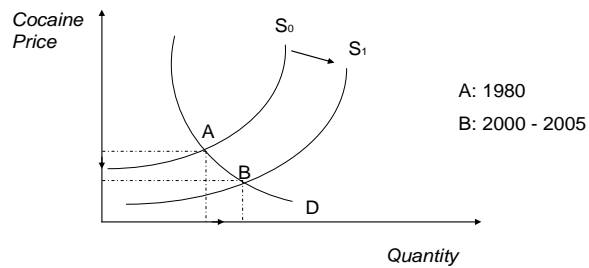
Diagram 1a below summarizes the main changes in the market for cocaine between 1980 and 2005, and Diagram 1b summarizes the two opposing forces that have kept cocaine supply relatively stable during the last five years: first, eradication measures, by destroying coca crops, tend to decrease cocaine supply and, second, increases in productivity in

³⁰ A very small increase in cocaine prices at the retail level in consumer countries (at “street purity”) is perceivable in the last few years recorded by UNODC (see Figure 12).

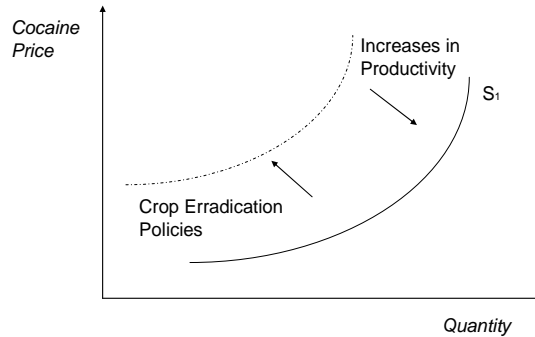
the production of coca leaf and cocaine have counteracted anti-drug policies in producer countries. Despite the large amount of resources spent on the war on drugs, a relatively stable demand together with the stability of cocaine supply described above have kept quantities and prices of cocaine about constant in the last 5 years.

Diagram 1

(a) The Market for Cocaine: 1980-2006



(b) The Stability of Cocaine Supply: 2000-2005



The next three subsections elaborate on possible sources of bias in the data, and draw attention to how the data on cocaine production and consumption should be read and analyzed carefully.

Possible biases on the supply side \hat{s} estimates

Although neither UNODC or ONDCP have any evidence of large-scale coca cultivation or cocaine production in countries other than the traditional three Andean countries, there exists some evidence concerning efforts undertaken by cocaine producing organizations and individuals to counteract the effects of anti-drug policies (such as aerial and manual eradication) in producer countries. For instance, peasants intermingle coca crops with legal crops to avoid the former from being detected by satellite imagery. By doing this, they avoid both monitoring and eradication. Also, they induce a bias in the figures of coca cultivation gathered by UNODC and ONDCP (and on their respective estimates of

potential cocaine production). Another source of bias has to do with the assumptions on yields and technical coefficients of transformation that UNODC and ONDCP use in order to come up with an estimate of potential cocaine production. The possible biases could be the result of a higher density of coca crops, more efficient planting techniques, the use of fertilizers, and the development of genetically modified coca plants with much higher yields. For instance, Colombian authorities have recently argued that coca yields have increased as a result of the introduction of a new, genetically modified, coca variety, which is supposedly much taller, of a much higher quality and higher percentage of hydrochloride (more cocaine and cocaine of higher purity can be extracted from each leaf), and which is glyphosate resistant (McDermott, 2004).³¹ The implementation of more efficient planting techniques and the introduction of new fertilizers and new chemicals in the manufacturing process would also result in more cocaine being produced from fewer coca fields. For instance, after the successful operations to stop the diversion of potassium permanganate (a precursor used in the manufacture of cocaine) in Colombia during the end of the nineties, drug producers adapted and started using an alternative chemical (sodium hypochlorite), which may have resulted in higher rates of extraction and yields (UNODC, 2005b).

Although these possible sources of bias in the estimation of coca cultivation and potential cocaine production are hard to verify, the current efforts undertaken by UNODC to conduct field studies in each of the producer countries, in order to have better estimates of coca yields and, in general, of the technical coefficients of the cocaine production process, are headed in the right direction. Because profit margins are extremely high in the cocaine market, cocaine producers respond and

³¹ TNI (2004) quickly responded to this information by questioning its scientific validity.

adapt to anti-drug policies in different and, many times, smart ways. Monitoring their responses using field studies is crucial not only to keep track of the right numbers on the supply side, but also to evaluate the effectiveness of the anti-drug policies implemented.

Trends in the composition of the demand for cocaine

While aggregate figures show that cocaine consumption has, if anything, remained relatively stable in the last few years in the US, and has been on the rise in Europe (although the prevalence rates are still much lower than in the US), the long-term trends in the composition of demand may shed some light on understanding the patterns of illegal drug use. Reuter (1999) argues that "While the general population surveys have shown very stable prevalence figures throughout the 1990s, aggregate stability masks a great deal of change in patterns of drug use."

As was the case with opium in the past, patterns of cocaine consumption may exhibit a life cycle. There are many reasons to expect a life cycle for drug consumption. Among the most obvious ones are fashion and learning. As Levitt and Dubner (2005, p. 109) put it when they analyze the financial structure of drug gangs in the US, "In the 1970s, if you were the sort of person who did drugs, there was no classier drug than cocaine. Beloved by rock stars, moviemakers, ballplayers and even the occasional politician, cocaine was a drug of power and panache." According to Reuter (2001), the low prices of cocaine have not led to a new epidemic of cocaine consumption because cocaine is no longer a fashionable drug. Cocaine consumption is seen now as a dangerous drug and "there are enough miserable looking cocaine addicts on the streets of bad neighborhoods to make the case for the drug's perils to any moderately rational youth." (Reuter, 2001, p. 18). Statistics such as the average age of

cocaine users in the US (the biggest market for cocaine) favor this explanation. For instance, hospital and coroner data show the aging of cocaine users. Also, trends in the Arrestee Drug Abuse Monitoring (ADAM) data show that the average cocaine-using offender is not only getting older, but also sicker. This evidence, together with increasing incarceration rates, has led to a slowly declining number of cocaine (and heroin) addicts.³² Additional evidence also suggests that “a greater proportion of cocaine-using population is dependent—a finding that is consistent with the observation that cocaine users developed their habits over time and are now experiencing the problems that stem from long-term use” (see Reuter, 1999). What this evidence—the composition of cocaine demand by age groups and by occasional vs. dependent users—suggests is that the problem of cocaine use, at least in the US, is “increasingly a problem of long term users who developed their habits in the early stages of the epidemic” (ADAM report, 1997, cited in Reuter, 1999). However, it should be noted that the low prices of cocaine currently being observed, when compared to historical prices, might be inducing new users to try cocaine and may spur its consumption once again in the near future. The latest available indicators of cocaine consumption among 8th to 12th graders in the US show a worrisome picture: trends in 30-day and annual prevalence of cocaine and crack use increased for 10th and 12th graders in 2004, and the disapproval among 12th graders of people using cocaine occasionally or regularly, as well as their perception of risks in using cocaine, have decreased (University of Michigan, 2004).

The long-term trends in the composition of cocaine demand by age group and by occasional vs. dependent consumers illustrates an important issue, namely, that the consumption of cocaine, as observed in

³² See the analysis in Reuter (2001).

the past for other drugs such as opium, may exhibit a life cycle. Furthermore, if the life cycle hypothesis is true, the relative stability of cocaine demand aggregate figures, plus the aging of cocaine consumers, at least in the US, might indicate future declines in the consumption of cocaine in this country.

Other sources of bias in the numbers

After the demise of the Medellin and Cali cartels during the 1990s, new players entered the cocaine production and commercialization business in Colombia by the end of the decade (when Colombia was already the largest producer of cocaine). These new cartels, such as the Norte del Valle cartel, the Costa cartel, and the different guerrilla and paramilitary fronts, are characterized for being smaller and having a relatively more widespread command structure. In other words, it is no longer true that the production and commercialization of cocaine is controlled by a few drug lords such as Pablo Escobar or the Rodriguez Orejuela brothers. Instead, one can argue (based on "informed" anecdotal evidence) that after the demise of the Medellin and Cali cartels, cocaine production and commercialization is controlled by a larger group of less visible organizations. This, in turn, may have induced greater competition between the new groups in control of the cocaine trade, lower profit margins (but still huge), and lower prices. Greater competition in the initial stages of the cocaine trafficking chain may have counteract the effects of anti-drug policies implemented in producer countries and, as a result, may have prevented cocaine wholesale prices (that is, prices recorded at consumer countries' borders) from going up.

Yet another, perhaps related, explanation posed by UNODC (2005a) is the use of cocaine stocks to "fuel" drug markets while the actual surge in anti-drug policies lasts. In other words, organizations involved in cocaine

commercialization have been running down their stocks of cocaine with the expectation that the current level of anti-drug policies cannot last much longer. However, there is no significant evidence to support this explanation. In any case, if it were true, the stocks “should be soon exhausted and a contraction of the market should then become visible.” (UNODC, 2005a).

While it is very hard, if not impossible, to directly verify some of the above explanations due to obvious reasons including the lack of price records and transaction quantities at each of the different commercialization stages (or the lack of access to the drug traffickers’ accounting books), the availability of better and more reliable data on coca cultivation, yields, consumption, etc.—as it becomes available—will help clarify the validity of other possible explanations. Specifically, field studies in coca growing regions such as the ones currently being conducted by UNODC, will continue to help clarify whether there has been an increase in yields, better planting techniques, etc. In other words, better assessments of productivity parameters (and how they change over time) are key to understanding the cocaine market. And, going back one step in the cocaine production chain, field studies would be very helpful to confront the measures of coca cultivation obtained from satellite images with those that would be obtained directly in the fields. This is because, as explained above, there is anecdotal evidence that coca growers have found ways to avoid being detected by the satellite images, and therefore, the measures obtained from satellite pictures might be biased downwards. Random, in-the-field measures will provide an estimate of this bias. Also crucial for the analysis of the cocaine market is the understanding of the response of drug producers to anti-drug policies. The following section elaborates this point.

ANTI-DRUG POLICIES IN PRODUCER COUNTRIES

Anti-drug policies in the three producer countries have had different emphases in the past few years. In Colombia, anti-drug policies have focused on a combination of strategies: from attempts to prevent coca cultivation (using aerial spraying of herbicides over coca fields and alternative development and crop substitution programs), to disrupting the cocaine manufacture and commercialization chain (by interdicting drug shipments, destroying the infrastructure used for cocaine production and transportation such as cocaine processing laboratories, landing strips and small airplanes). In Bolivia and Peru, where aerial spraying of herbicides is forbidden by the law, anti-drug policies have focused mainly on alternative development programs and manual (forced or voluntary) eradication campaigns. Interdiction of drug shipments, especially of coca paste, has been an important component in the fight against cocaine production in Peru and Bolivia, especially in the last few years where interdiction has increased rapidly, probably due to the increased cultivation triggered by higher prices of coca leaf in these two countries. Peru also made huge efforts at the end of the nineties by disrupting the air bridge between coca base producers and Colombian manufacturers of cocaine. According to most sources, it was the combination of these policies, together with a set of well-targeted alternative livelihood programs in coca growing regions that reduced coca cultivation in Peru from 115,000 hectares in 1995 to about 48,000 in 2005.

In Bolivia and Peru, where many farmers' livelihood depends on coca cultivation, the government has implemented alternative development programs in well-defined coca growing regions. These programs seek to provide the necessary incentives so that farmers abandon coca cultivation and engage in the cultivation of legal crops. These incentives

take the form of monthly payments for not engaging in coca cultivation and/or assistance in the development of new (legal) agricultural activities. Although these programs have been relatively successful at the local level, their dependence on continuing national and international funding undermines their potential success in the long run. Governments in the three producer countries often rely on funding from developed countries to finance alternative livelihood programs and have to decide which regions to allocate the scarce funding, at the expense of experiencing increases in coca cultivation in those regions that cannot be targeted with these programs (UNODC, 2005a). For instance, after the implementation of alternative development programs in Aguatya and Bajo Huallaga (the two regions in Peru with the largest proportion of coca cultivation during the 1990s), coca cultivation had almost disappeared by 2004. Nevertheless, the high prices of coca leaf induced coca growers in other regions without any form of government attention (in the form of alternative programs, health and education services, etc.) to increase coca cultivation. As a result, coca cultivation, if anything, has remained relatively stable in Peru during the last six years.

UNODC together with government agencies in producer countries collect statistics on the number of eradicated hectares of coca crops. As explained before, in Peru and Bolivia eradication is done manually, whereas in Colombia it is mostly done by aerial spraying of herbicides in the coca fields.³³ This accounts for the difference between the average number of eradicated hectares per year in Bolivia (about 10,100 has per year between 1999 and 2005) and Peru (about 9,800 has per year), compared to Colombia (close to 110,000 has per year). Eradication in the three countries is undertaken by governmental entities (DIRECO in Bolivia, DIRAN—Antinarcotics Police—in Colombia, and CORAH and DEVIDA for

³³ See González (2006) for a thorough description of aerial eradication programs in Colombia.

forced and voluntary eradication respectively in Peru) with technical and financial support from the US government. Figures 13 (a, b, and c) show the number of eradicated hectares, as reported by each of the governmental entities in charge of eradication in Bolivia, Colombia and Peru respectively, together with the estimated number of hectares cultivated with coca bush for the each of three producer countries, as reported by UNODC.

As the aerial eradication campaigns in Colombia were intensified after the implementation of Plan Colombia, those individuals and organizations who benefit from coca cultivation (and cocaine production) have figured out ways of counteracting these campaigns. Because spraying with aerial herbicides is prohibited in national parks in Colombia, there has been a rapid increase in coca cultivation in National Parks.³⁴ The same pattern has been observed in Bolivia and Peru, where farmers have sought remote or protected areas for coca cultivation as a result of the government's pressure to reduce coca cultivation in the existing centers of cultivation. According to UNODC (2005b), between 2003 and 2004, cultivation in national parks in Bolivia increased by more than 70% and, during the same time, cultivation increased by 53% in protected and forest areas in Peru (see UNODC (2005b) for Bolivia and Peru).

Individuals involved in the cocaine production business have created many other ways of counteracting eradication campaigns: prune operations right after aerial spaying (where the coca plant is cut at one foot above the ground and then grows rapidly), intermingling coca crops with legal crops to avoid being detected, spraying coca plants with substances such as molasses to prevent the herbicide from destroying the leaves of the plant, and the development of genetically modified coca plants that supposedly are resistant to the herbicides currently being used.

³⁴ However, at the time this chapter was being written, the Colombian government was evaluating the possibility of lifting the ban on aerial eradication campaigns in national parks.

But aerial spraying, forced eradication, and alternative development programs are not the only measures taken by producer countries to fight illegal drug production and trafficking. Other policies include, but are not limited to: curtailing the flow of raw materials used in the cultivation of coca and the processing of cocaine, discovering and destroying the small local workshops and laboratories where coca base is processed, destroying the landing strips used by trafficking organizations to ship drugs, interdicting drug shipments, dismantling the drug cartels and the networks and (many times fake) firms that are created for the money laundering of the proceeds obtained from the (huge) profits derived from illegal drug trafficking.

Available measures of the efforts undertaken in these other fronts on the war on drugs show an increasing number of operations against the different links in the cocaine production and trafficking chain. For instance, coca base and cocaine seizures have increased in the past few years in all the producer countries. Figures 14 (a) and (b) show coca base and cocaine seizures in Bolivia and Colombia respectively. Other measures such as the number of destroyed illegal laboratories used for processing coca paste and cocaine also show increasing efforts to combat illegal drug production (see Figures 15 (a) and (b) for Bolivia and Colombia respectively³⁵).³⁶ Cocaine seizures have increased rapidly in the three producer countries as well as in the US in the last few years (see Figure 16).

Side effects of anti-drug policies

³⁵ For Peru, the numbers of illegal laboratories destroyed are: 964 in 2003 and 861 in 2004.

³⁶ See the UNODC (2005b - Coca Cultivation Surveys for each of the producer countries) for other measures of recent success in the war against cocaine production and trafficking. For the case of Colombia, the Dirección Nacional de Estupefacientes – DNE publishes every year a summary of results in the war against illegal drug production in Colombia (see DNE, 2004).

The implementation of anti-drug policies has important side effects in producer countries. Forced eradication measures (either manual or through aerial spraying campaigns) target, by definition, the first link in the cocaine production chain. But one can argue, perhaps convincingly, that of all those involved in cocaine production and commercialization, the peasants are perhaps the ones who receive the fewest benefits. Most coca cultivation in the three producer countries takes place in remote and isolated areas that lack any form of government infrastructure, public education, or health services.³⁷ In other words, eradication measures target those who are most vulnerable to negative income shocks and, as a result, have created social pressure against them, which has many times resulted in uprising and riots such as the ones recently observed in Bolivia.³⁸ As Sherret (2005) suggests, the lack of coordination between aerial spraying campaigns (or any form of forced eradication), alternative development programs, and state-financed development infrastructure in the coca growing areas evidences “a larger pattern of neglect and disregard for those affected by centrally directed policies.” (Sherret, 2005, p. 164).

One of the most debated issues regarding the side effects of anti-drug policies has to do with the environmental effects of aerial spraying of herbicides to destroy coca bushes in Colombia. Considerable debate has been generated, in Colombia and abroad, over the use of aerial spraying of herbicides to combat illegal drug production. As Lauret Sherret noted recently, “The controversy over the health effects of the use of glyphosate herbicides often centers on anecdotal evidence gathered from people living in the areas subject to fumigation versus the scientific evidence obtained from laboratory experimentation..., and when the political agendas (of the interested parties) are taken into account, the layers of

³⁷ See Contraloría General de la República (2001).

³⁸ See Stoner (2004) and Lindsay (2003).

complexity around this problem are only exacerbated" (Sharret, 2005, p. 157).

The Anti-Narcotics Police in Colombia have used aerial fumigation for more than a decade, but since the implementation of Plan Colombia (with strong funding from the US) aerial spraying campaigns have intensified, especially in the southern part of the country where most of the coca is produced. A formula known as Roundup (a mixture of glyphosate, the active ingredient in the herbicide, and Cosmo-Flux, a surfactant that is used to aid the herbicide in penetrating the waxy cuticle of coca leaves) is used by the Antinarcotics Police in the aerial eradication campaigns. It affects the leaves of the coca plants, but not its roots or the soil, and as a result, "the bush can be subject of a prune operation at about one feet over the ground to obtain a renewal of the bush in about six months." (UNODC, 2005b). With an herbicide concentration of 10.4 liters per hectare of coca approved by the Colombian Anti-Narcotics Council, the spraying effectiveness is estimated to be above 90%. Common effects on humans, as reported by those people affected, are fever, eye irritation, gastrointestinal irritation and diarrhea, skin irritation, and dizziness.

However, the available evidence regarding the effect of aerial spraying of Roundup is quite diverse. A recent study by OEA (2005) argues that the health effects on people from the use of glyphosate and Cosmo-Flux are minimal, and the exposure and frequency of exposure are very low. The same study also argues that the effects on wildlife, mammals, and birds are negligible. This study only finds evidence of a moderate adverse effect on some aquatic animals in those localities where coca is grown and where still water is present. Yet, another report prepared by the Center for International Policy (CIP) and NGOs from Colombia and Ecuador, argues against the use of the Roundup formula for aerial

eradication of coca crops because it “has not been subject to scientific studies to determine its effects on the environment and human health, which goes against the principle of environmental precaution” (CIP, 2004, p. 139, author’s translation). The study cites evidence from peasants who claim to have been affected by aerial spraying campaigns in different ways: skin irritation, allergies, eye, nose and throat irritations, nausea, and diarrhea.³⁹ The study also repeatedly argues that the aerial campaigns in Putumayo and Caqueta, the departments in southern Colombia with the highest density of coca cultivation in the peak years of 2000 and 2001, have been indiscriminate and many times have destroyed legal crops, such as yucca, sugar cane, and plantains, which, according to anecdotal evidence from the peasants cited in the report, leaves them without any means of subsistence. Although CIP’s report extensively describes the effects of aerial fumigation with glyphosate on human health and the environment, it barely mentions the negative environmental effects that coca cultivation and cocaine production themselves have on the environment.

Perhaps the most independent and thorough review on the environmental and health effects of aerial spraying of glyphosate is that of Sherret (2005). This study explains the crucial distinction between the active herbicide (glyphosate) and its commercially available formulations. The distinction is important because the formula (which, as explained before, is a combination of glyphosate and surfactants) exhibits *synergism*—when the observed effects of two chemicals being used together is greater than the effects of those chemicals used individually. Many times, the instructions for use of glyphosate and its formulations are

³⁹ According to Sherret (2005), “The governments of Colombia and the US have claimed on numerous occasions that supporters of the insurgent and counterinsurgent groups, who derive much of their income from the narcotics industry, are responsible for most of the health complaints that have received so much attention.”

violated, a point that is shared by most of the studies (see, for instance, Sherret, 2005 and CIP, 2004), and it is precisely the misuse of the herbicide that causes harmful health and environmental effects. For instance, among the many instructions stated by the manufacturer of the formula used in Colombia, it is stated that Roundup should be applied at distances not longer than 2 to 3 meters from the tallest plant, a recommendation that is many times violated, not only because of difficult topographic conditions, but most of the times to reduce the probability of airplanes used for spraying campaigns being hit by gunfire from the illegal organizations that benefit from the cocaine production and trafficking business. As a result of being unable to spray coca crops from the recommended height, oftentimes the herbicides end up affecting legal crop plantations, water sources, and other sites not targeted by the aerial eradication campaigns.

The study by Sherret (2005) also emphasizes the fact that the most harmful environmental effects, so far identified by scientific evidence, are on aquatic organisms and amphibians, when glyphosate formulations are, perhaps mistakenly, applied to aquatic ecosystems.

The environmental costs of cocaine production are also an important side effect of anti-drug policies. More precisely, the criminalization of coca cultivation and cocaine production also create environmental costs because. Because cocaine production is illegal, it is an activity which is not subject to government environmental regulations. According to John Walters, the director of ONDCP, "600 million liters of so-called precursor chemicals are used annually in South America for cocaine production. To increase yields, coca growers use highly poisonous herbicides and pesticides, including paraquat. Processors also indiscriminately discard enormous amounts of gasoline, kerosene, sulfuric acid, ammonia, sodium bicarbonate, potassium carbonate, acetone, ether, and lime onto the

ground and into nearby waterways.” (Walters, 2002). Although John Walters uses this evidence to complain to those who criticize the aerial eradication campaigns, both the environmental costs of aerial eradication, and of coca cultivation and cocaine production have a more fundamental root: the illegal nature of these activities. If cocaine production were legalized, the cultivation of coca and the production of cocaine would be managed as any other crop. They would be regulated, and no chemicals would have to be sprayed to destroy the crops. Further and independent research is needed to estimate and better understand not only the environmental effects of aerial spraying of glyphosate, but also the environmental costs of cocaine production. Together they will provide a picture of the environmental costs of the criminalization of coca cultivation and cocaine production.

But eradication measures are not the only measures that generate resistance and controversy due to its side effects. Policies such as those implemented by the Peruvian government during the second half of the 1990s, which aimed at closing the air bridge used to transport unrefined coca paste from coca growing regions in Peru to refining laboratories in Colombia, did not escape fatal accidents. Closing the air bridge not only involved destroying landing strips (which were easily constructed somewhere else at a relatively low cost) but also shooting down small airplanes suspected of carrying illegal drugs. However, the airplanes that were shot down by the Peruvian Air Force (using information provided by US surveillance planes) were not always carrying illegal drugs, and sometimes resulted in deadly accidents involving innocent people.⁴⁰

THE SUSTAINABILITY AND FUTURE PROSPECTS OF ANTI-DRUG POLICIES

⁴⁰ See, for instance, Kawell (2001).

There are perhaps too many issues regarding the sustainability of anti-drug policies in producer countries to be discussed in this chapter. However it is worth mentioning a few. On one hand, there is the question of who should bear the costs of alternative livelihood programs and eradication activities? Producer or consumer countries? While governments in the producer countries face internal pressure from farmers who claim, perhaps sincerely, that their only way of subsistence is the cultivation of coca⁴¹, they also face external pressure from the consumer countries to fight against the production of illegal drugs (in the form, for instance, of the threat of being labeled a “narco-state” by the international community, or of not being “certified” by the United States’ State Department each year). But, besides being an illegal activity, cocaine production and trafficking have had direct links with terrorist and insurgent activities, especially in the case of Colombia. Most probably, if producer countries stop fighting the drug trade and consumer countries do not penalize them for doing this, the price of cocaine would drop dramatically and the drug business would no longer be a source of financial resources for illegal armed groups in producer countries. There is enough evidence of the involvement of guerrilla and paramilitary groups in illegal drug production and trafficking to finance their war against each other and against the Colombian state.⁴²

The funds to fight against the production of illegal drugs are limited and many times the governments in producer countries have to sacrifice other, perhaps more productive, investments in order to finance the war against drugs. Also, funds provided by consumer countries (mostly developed economies) are often earmarked to be spent on predetermined activities, which leave little or no room for governments to

⁴¹ See CIP (2004).

⁴² See, among others, Rangel (2000), Rabasa and Chalk (2001), Thoumi (2003), Bottía (2003), and Diaz and Sanchez (2004).

allocate the funds to its most productive use in the war against drugs. In Colombia, for instance, most of the support provided by the US government comes in the form of small airplanes that can only be used for the spraying of herbicides in coca fields, in training programs for the pilots, and in the form of technical support to identify coca fields. These imposed political constraints create inefficiencies in the allocation of funds,⁴³ as well as environmental and social problems in the producer countries, which are not taken into account by the producer countries at the time of earmarking the aid for specific anti-drug policies.

The last section posed some questions regarding the side effects (costs) of anti-drug policies (on health, the environment, and the fiscal sustainability), but any analysis of their sustainability should also evaluate their results. The fact that cocaine is an addictive drug is perhaps the crucial determinant of how effective the reduction of cocaine supply is in decreasing the availability of illegal drugs in the consumer countries. As Echeverry (2004) argues, “the efficacy (of the war on drugs) lies on a variable that measures consumer’s responsiveness to price increases, i.e. the price elasticity of demand”.⁴⁴ The rationale for this argument is very simple: if the elasticity of demand for illegal drugs – which captures the percentage increase in demand due to a 1% decrease in the price – is low enough (which, at first sight, seems to be the case for those goods that create addiction) so that any decrease in the supply would translate into a sufficiently large increase in the price of illegal drugs, then those policies aimed at reducing illegal drug production may be self-defeating, as they create a greater incentive for producing (and trafficking) the good. In other words, the same policies that aim to reduce the supply of illegal drugs, by inducing further increases in the price, fuel more

⁴³ See Grossman and Mejía (2008) and Mejía and Restrepo (2008).

⁴⁴ See Becker et al. (2006) and Mejía (2008).

production and lead to more violence.⁴⁵ However, the scarcity of data on prices and quantities of cocaine transacted makes available estimates of the price elasticity of demand unreliable. While most available empirical studies have found a short-run elasticity of demand less than one in absolute value (Saffer and Chaloupka, 1999; Chaloupka et al., 1999; DeSimone and Farrelly, 2003), other studies have found evidence of a higher response of cocaine demand to price changes (Caulkins, 1996). Using a rational addiction framework (where, in addition to the goods being addictive, peer pressure to consume the good plays an important role, and current consumption does not only depend on past but also on future consumption),⁴⁶ Grossman and Chaloupka (1998) estimate a long-run price elasticity of demand for cocaine of about -1.35 .⁴⁷ Whether the price elasticity of demand for cocaine is higher than one in absolute value, or whether this is true in the short or in the long run, should be on the agenda for future research as better data becomes available. But, even if it were true that cocaine demand is elastic to price changes in the long run, there is still the question of whether producer countries can sustain the high levels of expenditures (in eradication programs, alternative development projects, interdiction efforts, etc.) observed in the last few years in the war against cocaine production and trafficking.⁴⁸ Also important is the evaluation of the results and, as mentioned above, the understanding of those measures taken by drug producers and traffickers to counteract anti-drug policies. As we saw before, although eradication measures undertaken under Plan Colombia have decreased the number of cultivated hectares, drug producers have responded with better

⁴⁵ See the framework developed in Becker et al. (2006) for the case of consumer countries, Mejía and Restrepo (2008) for the case of producer countries, and Mejía (2008) for a unified framework that combines the interactions and effects of anti-drug policies in consumer and producer countries.

⁴⁶ See Becker and Murphy (1988).

⁴⁷ However, when individual-specific fixed effects are included, this elasticity reduces to about -0.67 . See also a related explanation in DeSimone and Farrelly (2003).

⁴⁸ See Echeverry (2004).

planting techniques, have moved to new territories, have come up with coca plants that have a much higher yield, etc. The reason for these responses is very simple: because cocaine production and trafficking is illegal, the profit margins are huge (the price of 1 gram of cocaine in producer countries is approximately one-tenth of its weight in gold and that same gram in the streets of Chicago or New York sells for as much as ten times its weight in gold) and, thus, the resources that drug producers are willing to invest in counteracting anti-drug policies are also huge.

Yet another argument for the limits of supply side controls says that these policies are doomed from the beginning, because prices of coca leaf are just a negligible fraction of retail prices in consumer countries (the costs of coca leaf required to produce one kg of cocaine is between \$300 and \$500, whereas that kilogram at the retail level could sell at \$150.000 in the US at average purity levels).⁴⁹ The argument is that even if refiners had to pay twice or three times as much to purchase the coca leaf required to produce one kilogram of cocaine, and if this extra cost is passed along, the increase in retail prices would be negligible. As a result, "if retail prices do not rise, then total consumption in the United States will not decline as a consequence of eradication." (Reuter, 2001, p. 19). According to the same author, alternative development programs are also subject to the same incompleteness as that for eradication, because they assume that cocaine refiners will not increase the price sufficiently to tempt farmers back to coca growing.

On one hand, any sound and sustainable policy that aims at reducing cocaine production and trafficking by fighting the first link in the chain (coca cultivation) should, at least, coordinate strategies between the carrots (such as the provision of incentives to farmers to abandon coca cultivation through alternative livelihood opportunities, and better

⁴⁹ See Reuter (2001).

education and public health provision) and the sticks (the credible commitment on the part of the government of being not only willing, but also able, to take measures such as forced eradication and interdiction measures to sufficiently increase the costs of engaging in the production of cocaine). On the other hand, if consumer countries are unwilling to take measures such as legalizing the use of illegal hard drugs (as seems to have been the case), but at the same time want to reduce the inflow of these illegal drugs to their markets, increasing amounts of funds will be necessary, not only to finance the implementation of anti-drug policies to curtail production and trafficking in producer countries, but also to implement policies aimed at reducing the demand for illicit drugs. Policies aimed at teaching potential cocaine users about the dangers induced by the consumption of cocaine, and at treating hard core cocaine users seem to be much more cost effective than trying to curtail the supply of cocaine at its source. A recent study by Caulkins, et al. (2005) finds that consumption can be reduced more cheaply in the United States by treating heavy users than by three alternative enforcement measures usually carried out: control of supply in the producer countries, interdiction of drug shipments and drug seizures, and conventional enforcement measures. Demand reduction programs have a wide range of action. Among others they seek to prevent and reduce the use of illicit drugs, treat the addicted and reduce the consequences of drug abuse, and increase the public's awareness of vulnerability and risks associated with drug consumption by disseminate information regarding the harmful effects of drugs in local communities and schools. Policies aimed at reducing consumption also make it less likely that drug users switch to alternative drugs when the one they are using is not available.

If the legalization of drugs is not possible, perhaps due to political agendas in consumer and producer countries, efforts to reduce the

supply and the demand should be undertaken together. That is, each one carried out in isolation will not work because they are complementary. For instance, in times of supply shortages drug prices may increase and purity levels decline, and it is more likely that, first, chronic users will seek treatment, and, second, potential new users will have less opportunity to obtain drugs. Also, as the demand for cocaine goes down as a result of programs to reduce consumption, there are fewer addicts and the criminal networks in charge of selling drugs might be weakened, which in turn makes it more costly for drug traffickers to smuggle illicit drugs and to make them available to consumers. Drug substitution therapies and personalized therapeutic programs decrease the cost to drug addicts of seeking treatment and decrease the number of users under the influence of criminal organizations, which, in turn has implications for the cost to criminal organizations of supplying drugs.⁵⁰

CONCLUDING REMARKS

“Many tens of billions” is probably the right figure for cocaine expenditures per year in consumer countries.⁵¹ Close to 14 million people are cocaine consumers in the world. Two-thirds of these are in the Americas. Only three countries in the world produce cocaine: Bolivia, Colombia and Peru. Potential cocaine production in 2004 was estimated to be about 650 metric tons. A pure gram of cocaine is worth, at the retail level in consumer countries, as much as ten times its weight in gold. In producer countries, the same gram is worth, on average, slightly more than one-tenth of its weight in gold. While these figures might be striking enough by themselves to generate interest in the topic, they hide huge complexities.

⁵⁰ See INCB, 2004.

⁵¹ \$35 billion is the low-end estimate and \$115 billion the high-end estimate (see Reuter and Greenfield, 2001)

Clearly, a thorough understanding of those complexities requires accurate data and relevant information about the market for cocaine.

The main purpose of this paper was to provide a thorough review of what we know (and what we do not) about cocaine production and trafficking.

By describing the available data on cocaine production and trafficking, the collection methodologies, and some of the possible biases (and what may cause them), we have taken an important step toward understanding the complexities and puzzles that should drive future research into our knowledge of illegal drug production and trafficking. Additionally, the paper described some puzzles that arise from the available data, and studied some of the hypotheses that may help explain these puzzles. Furthermore, the paper explained the policies to fight against cocaine production and trafficking implemented in producer countries, the results of these policies, and the role of consumer countries in their implementation. Finally, the paper reviews and studies the side effects, sustainability, and future prospects of anti-drug policies.

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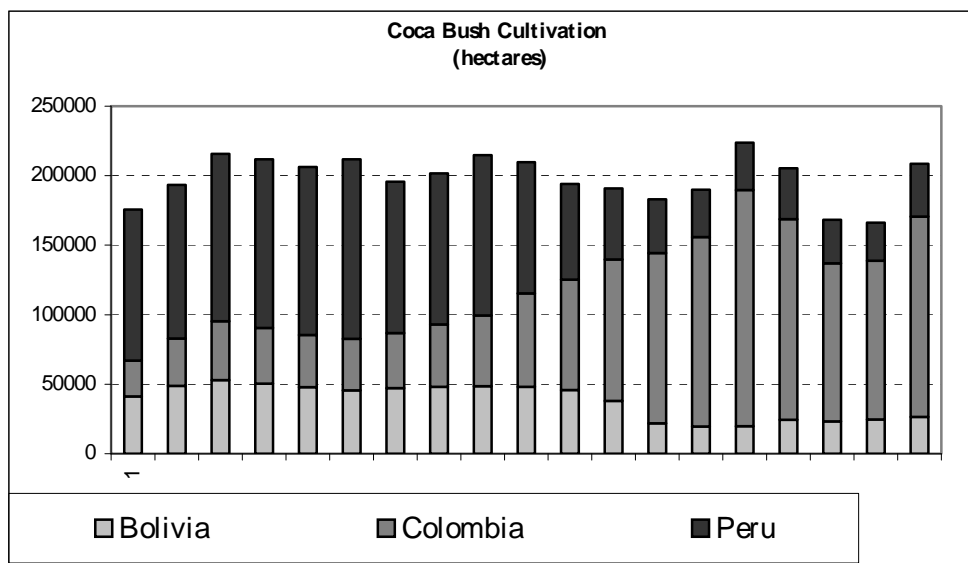
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Figure 1

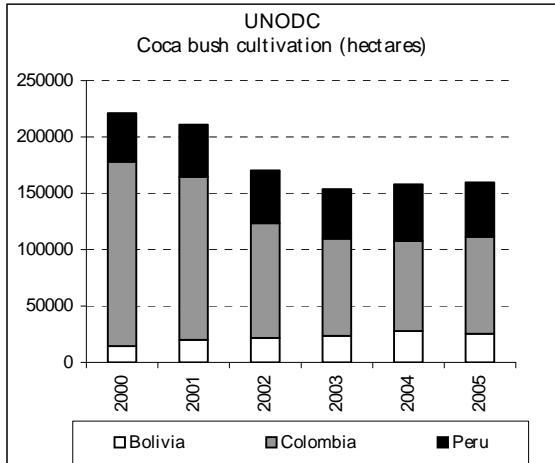


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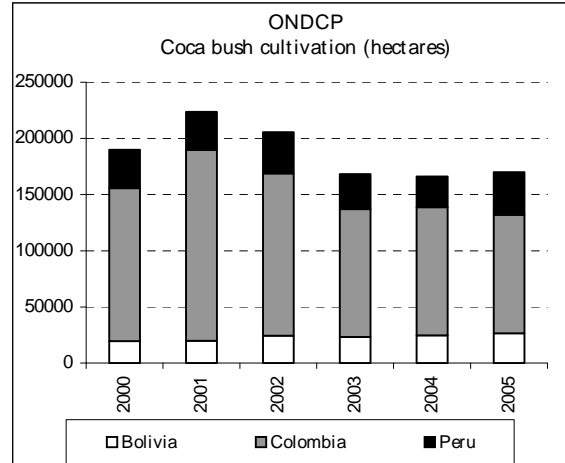
Figure 2

(a)

(b)

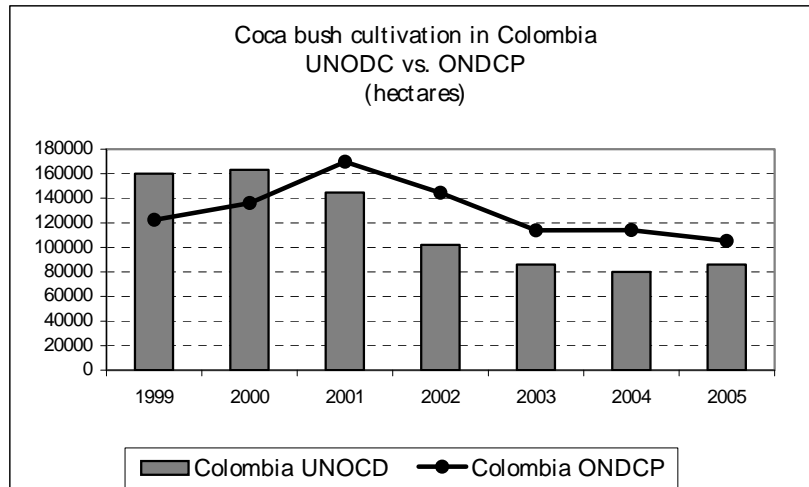


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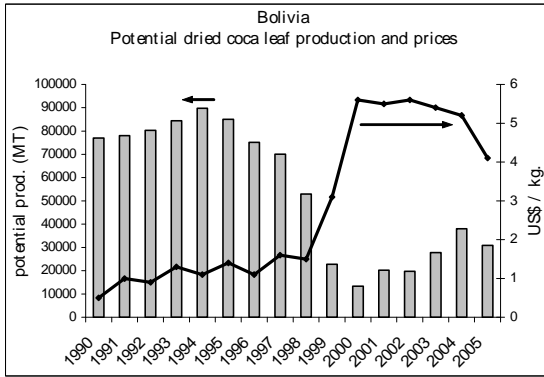
Figure 3



Source: UNODC and ONDCP

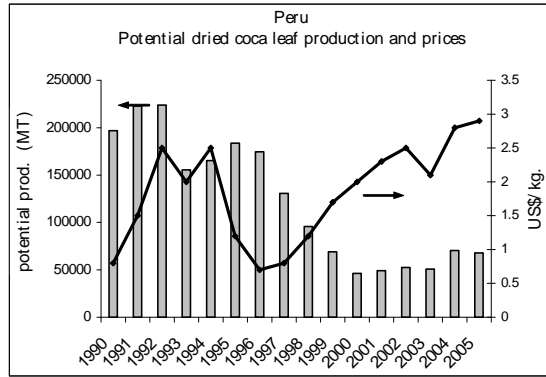
Figure 4

(a)



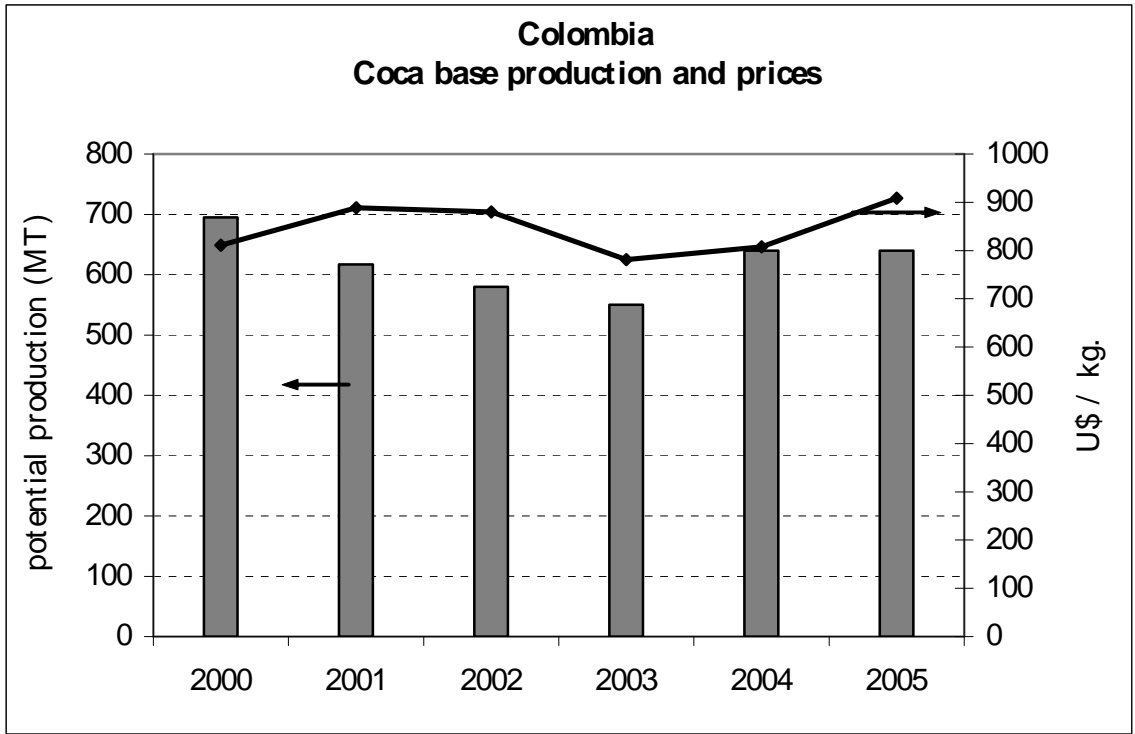
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(b)



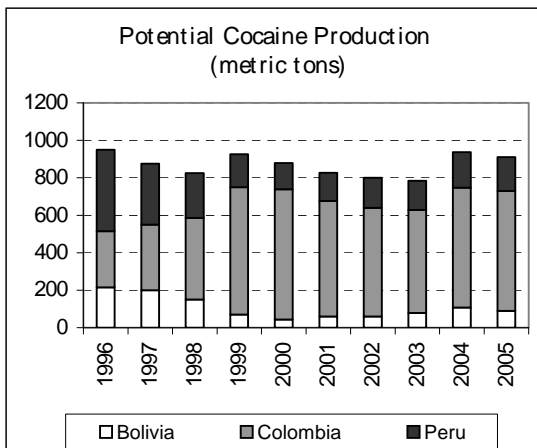
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Figure 5

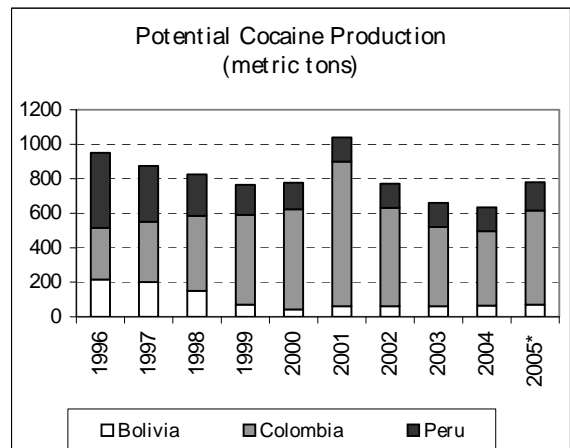


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Figure 6



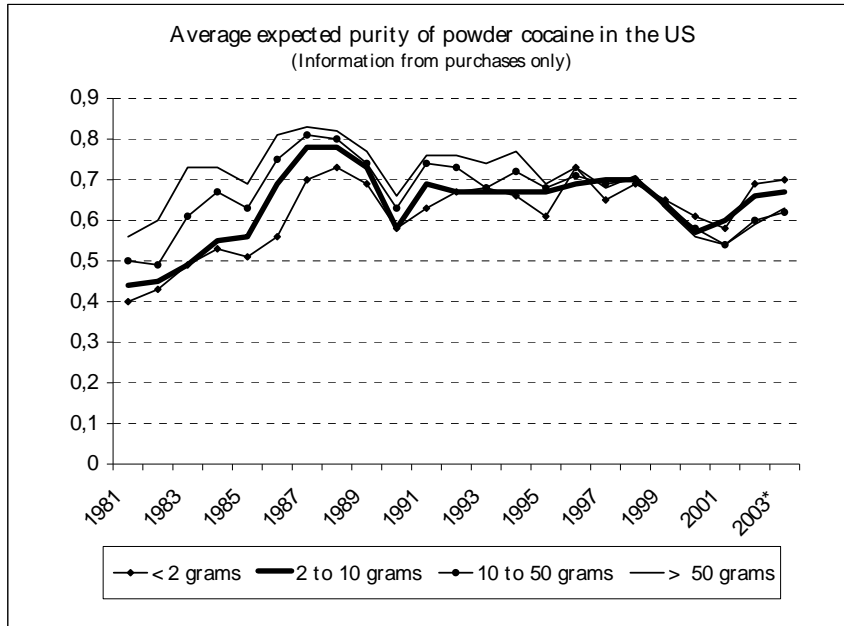
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Source: ONDCP

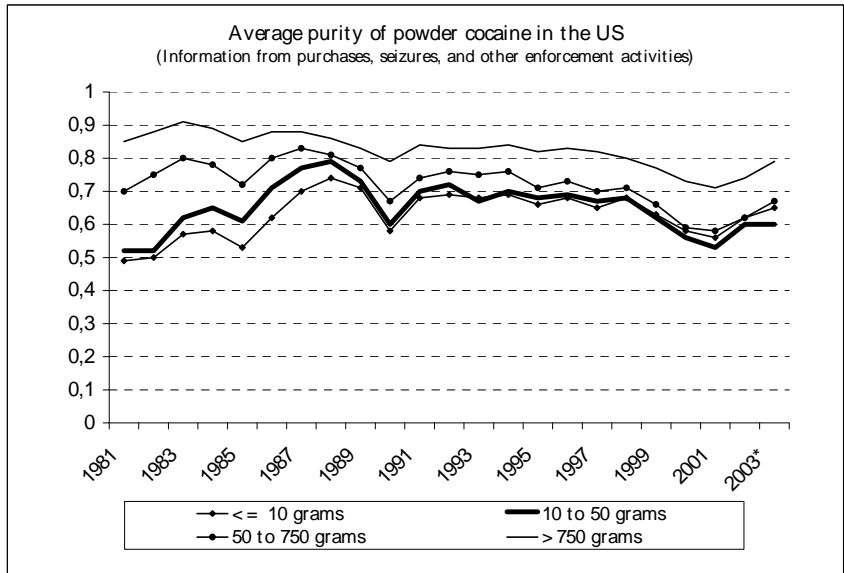
* ONDCP's figures on potential cocaine production in 2005 for Colombia include new surveyed fields and, as a result, potential cocaine production is not comparable with years prior to 2005.

Figure 7



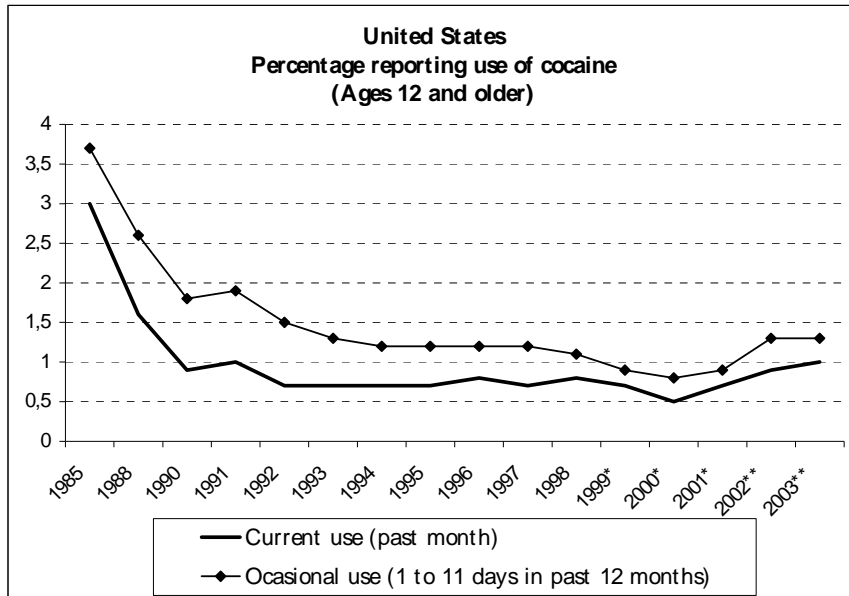
* Based on information from only the first two quarter of this year.
Source: ONDCP (2004), based on STRIDE.

Figure 8



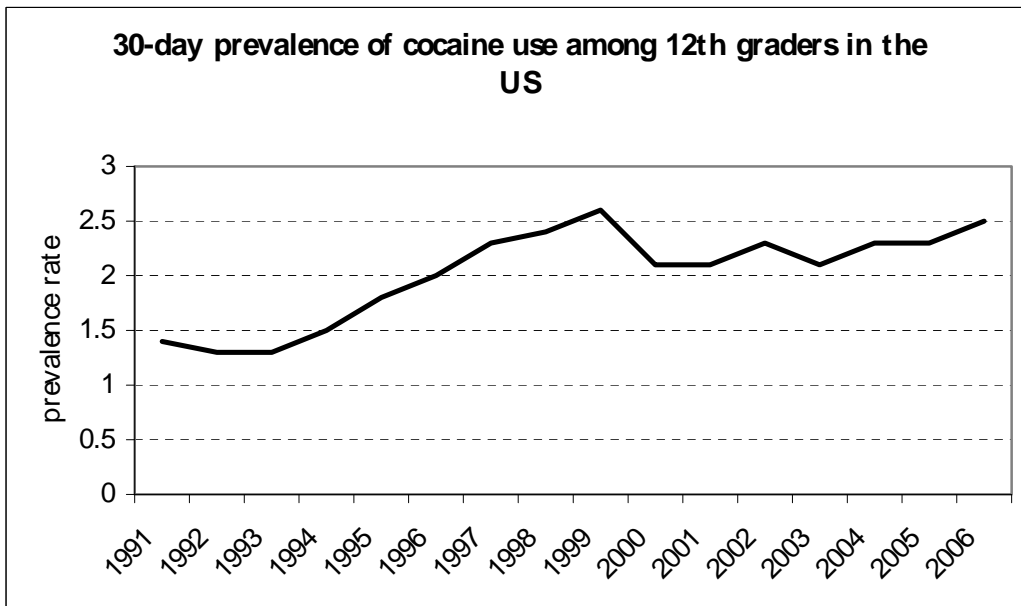
* Based on information from only the first two quarter of this year.
Source: ONDCP (2004), based on STRIDE.

Figure 9



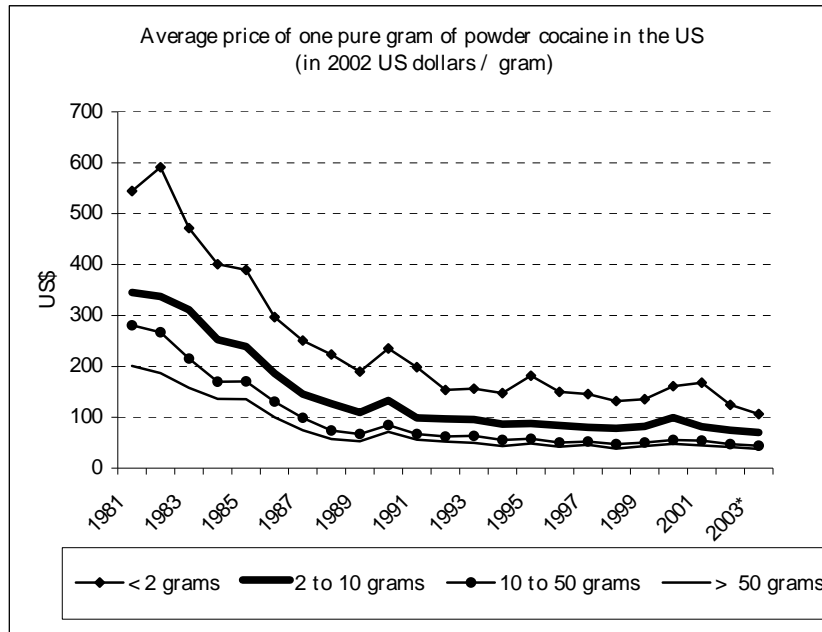
* change in methodology: from paper-and-pencil to computer assisted interviews.
 ** methodological changes in the survey
 ***, : results prior to 1999 and the ones after 2002 are not comparable to other years.
 Source: ONDCP.

Figure 10



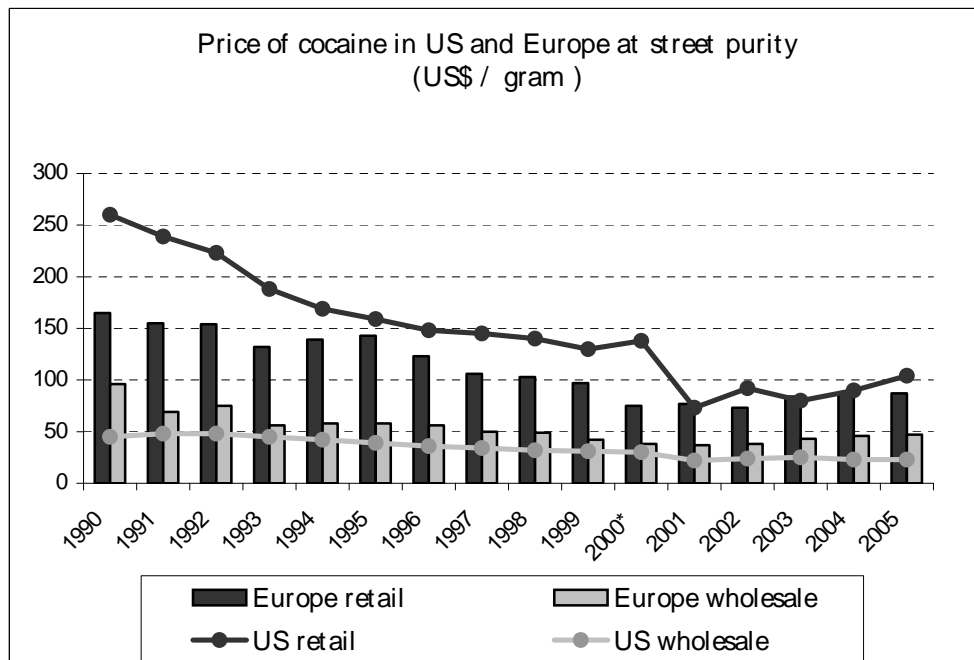
Source: Monitoring the Future Study (University of Michigan)

Figure 11



* Based on information from only the first two quarter of this year.
Source: ONDCP

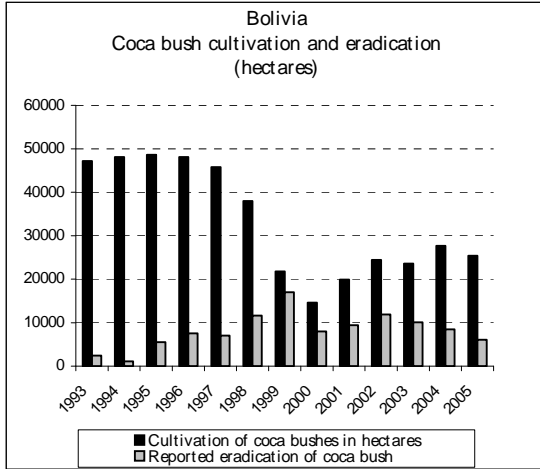
Figure 12



Source: UNODC

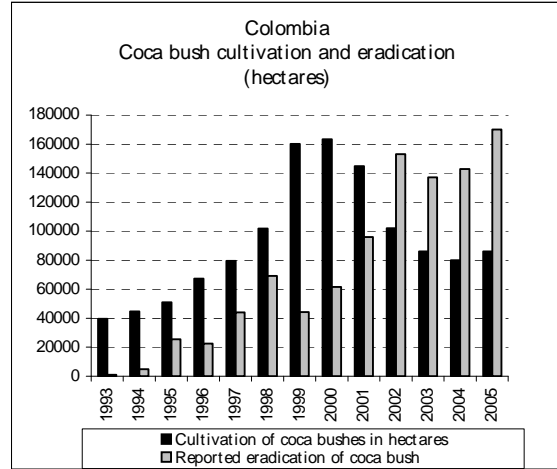
Figure 13

(a)



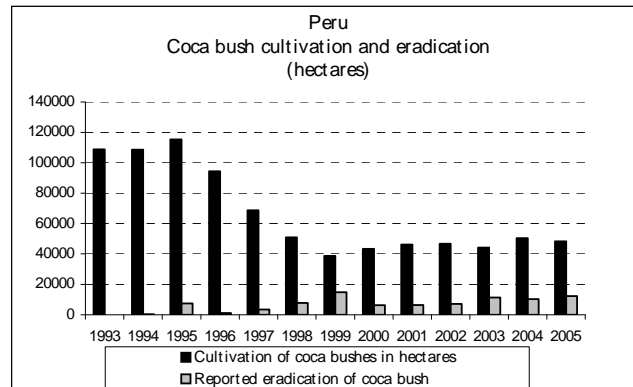
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(b)



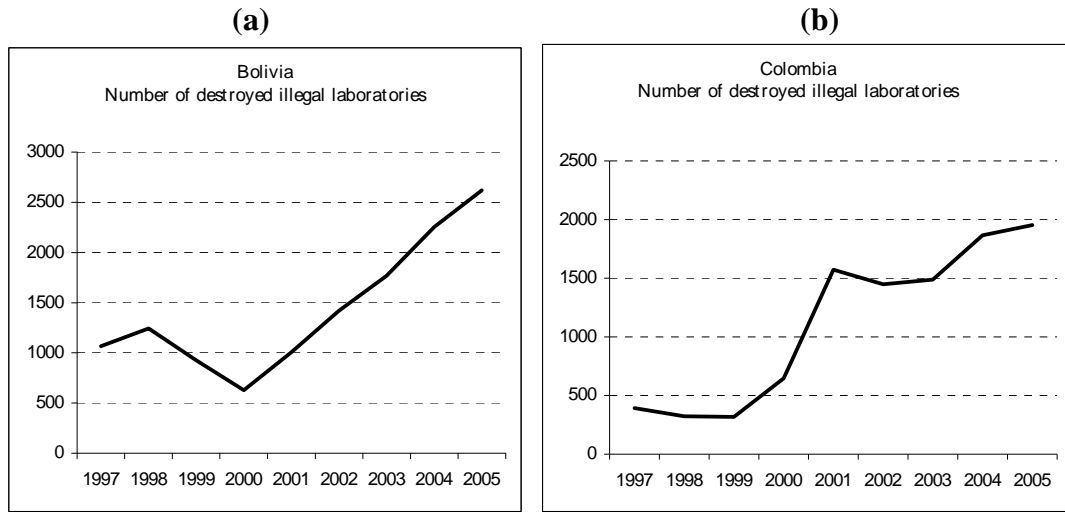
Source: UNODC

(c)



Source: UNODC

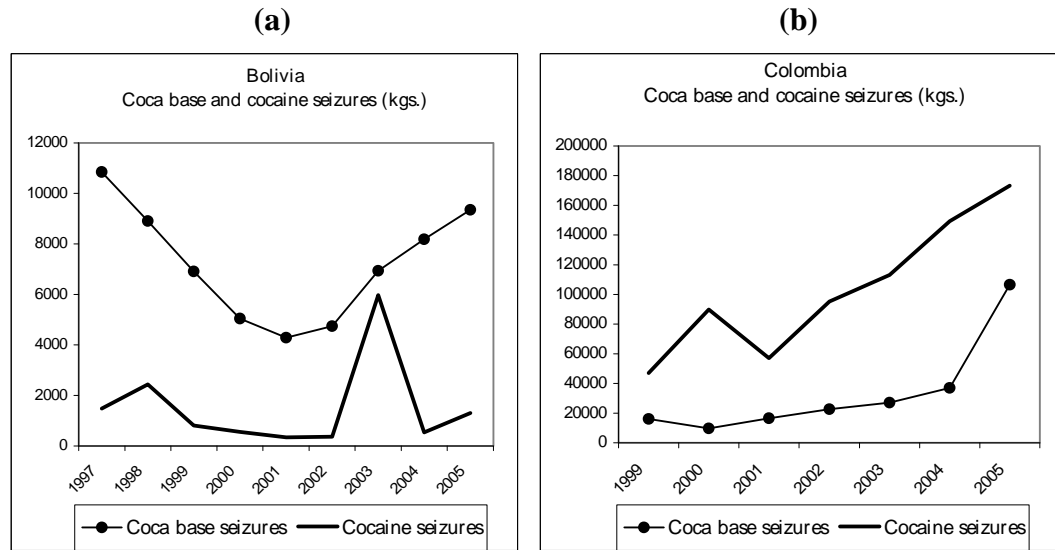
Figure 14



Source: UNODC and FELCN.

Source: UNODC and DNE.

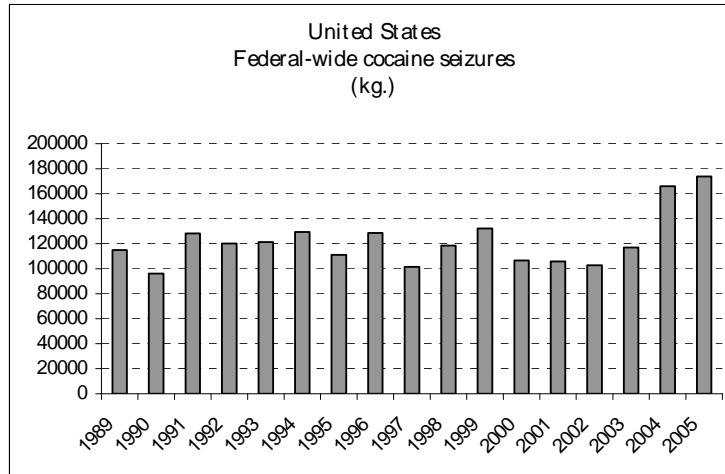
Figure 15



Source: UNODC

Source: UNODC

Figure 16



Source: ONDCP and DEA.