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TECHNICAL REPORT

Estimating the size of the global drug market

A demand-side approach

Report 2

Beau Kilmer, Rosalie Liccardo Pacula

Prepared for the European Commission

RAND EUROPE

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Preface

The European Commission contracted RAND Europe and the Trimbos Institute to analyse in detail the operation of the world market in illicit drugs and the policies aimed at curtailing it. This was in the context of the European Union's Strategy on Drugs 2005-2012 which calls for evidence-based policies and in turn responds to the EU Resolution adopted by the UN's Commission on Narcotic Drugs, calling for '… an objective, scientific, balanced and transparent assessment by Member States of the global progress achieved and of the difficulties encountered in meeting the goals and targets set by the General Assembly at its twentieth special session…'.

The resulting study provides a dispassionate overview of the true nature and extent of the problem today, and to assist policy makers at national and regional levels to deal with it. It was suggested that the drugs market be looked at as if it were licit, in order to get a clearer picture of the way that it works.

This document is the second of five reports published by RAND under this contract. It is accompanied by a main report which draws on the documents' findings to assess changes in global drug problems from 1998 to 2007 (Reuter and Trautmann, 2009). This second report looks specifically into the size of the global drug market, using a demand-side approach. RAND Europe and the Trimbos Institute anticipate that it will be of interest to policy-makers from the European Commission, as well as other governmental bodies which are concerned with drug markets. It is also believed to be of value to NGOs and private organisations which are involved in one way or another in tackling the drugs market and its impacts.

RAND Europe is an independent not-for-profit policy research organisation that aims to improve policy and decision making in the public interest, through research and analysis. RAND Europe's clients include European governments, institutions, NGOs and firms with a need for rigorous, independent, multidisciplinary analysis. This report has been peer-reviewed in accordance with RAND's quality assurance standards.

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This report uses data on the prevalence of drug use, retail prices, and consumption patterns to generate country-level consumption and retail expenditure estimates for cannabis, heroin, cocaine, and amphetamine-type substances. Inadequate information is available for generating credible estimates for every country or making comparisons between 1998 and 2007, but the estimates presented here offer an important starting place for future work and comparisons. Given the substantial uncertainty of these figures, a range of estimates is provided rather than one specific number. Even with this uncertainty, there are useful insights for both policymakers and researchers. Major findings include:

- Global retail expenditures on cannabis to range from €40B-€120B. Our best estimate is close to half of the previous global estimate of approximately €125B.
- Exporting cocaine hydrochloride from Colombia to consuming countries generates a value of no more than €10B annually (import price-replacement cost). The equivalent value for opiates exported from Asia and the Americas is no more than €20B.
- Surprisingly little is known about typical quantities consumed of illicit drugs, which makes generating demand-side estimates difficult. This report summarizes the small literature on this topic and highlights actions that could be taken to improve understanding of both consumption patterns and retail expenditures. For cannabis, much could be learned by adding a few questions to existing surveys. For harder drugs, arrestee surveys can provide a wealth of information.

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The authors are solely responsible for the views in this book.

CHAPTER 1 Introduction

The size of a market is based on factors influencing both demand and supply. Changes in market size, therefore, provide valuable information about the net effects of movements in both parts of the market. For example, while the number of users may decrease in response to a prevention policy targeting initiation, total expenditures may simultaneously increase due to factors shifting more light users into heavy use or an increase in supply. Therefore, estimating the size of the market, in terms of both participants and expenditures, is critical to fully understanding the impact of interventions intended to influence demand and/or supply.

Further, understanding the size of the market for specific illicit drugs is critical for improving government decision-making and evaluating alternative policy approaches. On one hand, knowing how much revenue is generated for different substances within a country can help decision makers target enforcement resources. On the other hand, knowing the size of a market is necessary but not sufficient for projecting the revenue from a legalisation and tax regime. Information about drug markets may also be used to guide decisions in other policy areas. For example, Reuter & Greenfield (2001) suggest that before September 11, 2001, the focus on international money laundering controls was largely based on what was known about the size of the international drug trade. Additionally, understanding the magnitude of the opium trade in Afghanistan and how it has changed may improve military strategies for addressing opium-funded insurgents.

The goal of this report is to generate country-level consumption and retail expenditure estimates for cannabis, heroin, cocaine, and amphetamine-type substances. Unfortunately, most of the information required for such an effort is unavailable and the data that do exist are often not comparable across countries and time. This confines researchers to simplifying assumptions that make it easy and appropriate to question the validity of the results. It also means that most of the focus is on countries with well-developed data collection systems.

There are a variety of methods for calculating the size of an illicit drug market. The supply-side approach uses estimates about production and how much is seized or lost on the way to its final destination. Combining these figures with information about prices generates estimates of the total size of the market. There are at least two different methods on the demand side. One is based on self-reported information about what individuals spend on illicit drugs, and the other uses prevalence estimates and combines them with assumptions about quantity consumed and retail prices to generate expenditure estimates. Each method has its own advantages and drawbacks, but in most cases the decision regarding which

approach to use is a practical one determined by the available data for the market considered. It is important to note that the methods are not mutually exclusive and ideally multiple methods could be used to try to triangulate available information from each, as has been done in previous attempts to measure the size of the drug market (e.g., Abt, 2001; UNODC, 2005).

Given the objective to estimate the size of the drug market for individual countries, this report adopts the prevalence-based approach for calculating country-specific consumption and retail expenditure estimates. The focus is on a handful of readily available parameters and evidence-based assumptions about quantity consumed to generate estimates that are reasonably close to what is available in the peer–reviewed and grey literatures. This approach may prove most insightful for developed countries for which drug data are relatively scarce or where efforts are currently under way to collect information, as it could guide them on what type of information is necessary for constructing a similar estimate. This approach remains hampered by the lack of information about typical quantities consumed, so it is necessary to draw on a broad array of sources about drug user behaviour and evidence-based assumption to fill in gaps using this method.

This report contributes to the literature on sizing drug markets in at least four different ways. First, it presents country-specific estimates for countries which account for the major share of consumption and/or retail expenditures for cannabis, heroin, cocaine, and amphetamine-type substances (ATS). Previous studies either provide expenditure estimates for different regions of the world or for a specific country. With respect to the latter, many of these studies only include cannabis. Second, it presents most results in term of ranges, not just point estimates. In doing so, it enables readers to better understand the uncertainty associated with generating any point estimate for these markets. Third, it presents statistics from a variety of international data sources (published and unpublished) that should be useful to other researchers in this field. Fourth, throughout the text insights are given regarding data elements that could be improved to generate a better understanding of global consumption and retail expenditures. As better data are collected, there should be less reliance on controversial assumptions.

Given the popularity of cannabis across the globe, there is relatively more information available about cannabis prevalence and consumption patterns. Thus, more confidence can be placed in these estimates than those for the other drug markets. Furthermore, direct comparisons of results for cannabis can be made to those by other researchers given growing number of studies which focus on the size of the retail cannabis market in specific countries (e.g., Bramley-Harker 2001; ABT, 2001; Wilkins *et al.* 2002; Wilkins *et al.* 2005; Clements & Zhao, 2005; Pudney *et al.* 2006; Gettman, 2007; Hakkarainen *et al.*, 2007; Legleye *et al.*, 2008). The general comparability of findings across studies provides additional confidence that the results generated for cannabis here are indeed reasonable. Because of the lack of data and the stigma associated with self-identifying as a cocaine user in surveys, less confidence can be placed in our best cocaine estimates for Europe. The large differences in our low and high estimates reflect this uncertainty, and it is imperative that efforts be made to improve the available data given the growth in European cocaine use in recent years (EMCDDA, 2007b).

It is also important to note that this report does not provide country-specific estimates for every country in the world. Such an effort would be impossible given the relatively poor data collection in some countries. Nonetheless, estimates are generated for those countries that represent the major share of consumption and/or retail expenditures for each substance. Since retail prices are larger in developed countries (and hence the currency value of the market is larger), most of the focus is on Europe, North America, and Oceania.

The report proceeds as follows. The second section discusses some of the methodological issues associated with using demand-side estimates to generate consumption and expenditure figures. The third section focuses on the retail market for cannabis and is followed by the markets for heroin, cocaine, and amphetamine-type substances. The final section discusses some of the results and ideas for obtaining information that would improve these estimates.[1]

[1] We also include a brief section on farm-gate and international trade values for cocaine and opiates in Appendix A.

CHAPTER 2 Methodological issues associated with demand-side estimates

Demand-side estimates of illicit drug markets are usually based on self-report information about expenditures and consumption. This information can be obtained from a variety of populations, including those in treatment, those involved in the criminal justice system, students attending school, and respondents to general population surveys. Since many developed countries conduct nationally representative drug use surveys of the general populations (often based on households), we rely heavily—but not exclusively—on these figures for our consumption and expenditure estimates.

The obvious advantage of using information from general surveys is that we can generate country-specific estimates for a large number of countries. There are, however, three important drawbacks: 1) The survey collection/analysis methods often differ across borders, 2) Respondents are not always honest, and 3) general population surveys often miss heavy drug users who are in treatment, in jail/prison, in an unstable housing situation, hard to locate, or unwilling to talk about their substance use. The latter is more likely to be a concern for highly addictive drugs (e.g., heroin) compared to those that are commonly used in the general population (e.g., cannabis). Each section discusses how these missing populations are addressed, but in some cases we are only able to provide estimates from those covered by the general population surveys.

As for underreporting, a number of studies have examined this by comparing self-report information with information from a drug test, usually urinalysis. Much of this research has occurred in North America, and here we highlight a large U.S. study examining concordance for almost 4,000 individuals aged 12-25 who participated in the 2000/2001 National Household Survey on Drug Abuse (Harrison *et al.*, 2007a). Based on the results of this study, Table 1 presents the share of those testing positive who actually reported using the substance in the previous thirty days (this is known as sensitivity of the test).[2] While these tests are not 100% accurate (e.g., there are false positives), they provide useful insight into the honesty of those reporting information about drug consumption in surveys. As we would expect, the sensitivity of the test is inversely related to the stigma (and legal penalties) associated with the substance. These results suggest that nearly 80% of

[2] There were not enough heroin users in the sample to make comparisons and the study was unable to distinguish between legal, illegal, and OTC amphetamines.

tobacco users in the household population were honest about their use; the comparable figures for cannabis and cocaine are close to 60% and 20%, respectively.

Table 1 Share of those testing positive who self-report use in previous 30 days in the United States

	Household survey respondents aged 12-25 in 2000/2001 (N=~4,000)	Male arrestees in 2003 (N=9,000)
Tobacco	80%	na
Cannabis	61%	82%
Cocaine	21%	56%
Sources: Harrison *et al.*, 2007a (pages: 30, 61, and 84); Author's analysis of ADAM (NIJ, 2004)		

For comparison, Table 1 also presents the sensitivity rates for a large sample of arrestees. While there are several differences between these two populations (e.g., arrestee rates are only based on men, arrestees are older, do not cover the same time period), the magnitude of the difference is still striking. It appears as if these arrestees were more honest about their drug use than the household population, which is consistent with other studies (e.g., Hser *et al.*, 1999). Whether or not this pattern holds outside of the United States is an empirical question.

As noted in the previous section, another drawback to the demand-side approach is that little is known about the typical quantities consumed per use day. Thus, even if we did not have to worry about underreporting and missing populations, there would still be uncertainty. While this report makes a useful contribution by reviewing the available international evidence on quantity consumed for each substance, large uncertainty remains. We address this uncertainty (for this measure and others) by presenting low and high estimates for all of our calculations In most cases we provide a best estimate, but we are not comfortable doing this for ATS in Europe given the extremely large ranges for quantity consumed. Readers should consider these ranges as extreme values that allow us to understand the order of magnitude.[3]

[3] We seriously considered using a simulation approach, which would involve making assumptions about the distributions for the values and then picking a range for the estimates; however, we ultimately decided against this approach since we wanted the readers to understand that the large uncertainty comes from different, but reasonable assumptions about the values. We did not want readers to associate this range with uncertainty coming from a simulation.

CHAPTER 3 Cannabis

There is a growing literature on the size of retail cannabis markets in particular countries and/or regions. Most studies either provide expenditure estimates for a specific country (micro approach) or for different regions of the world (macro approach). Each study relies on idiosyncratic assumptions, which has led to wildly different estimates of the size of this market even within the same country. This section uses a demand-side model that makes it easy to combine micro and macro approaches to produce country- or region-specific estimates with readily available prevalence and price data. While this approach is not without its own limitations and caveats, it can be broadly and consistently applied to most countries and hence should help advance our understanding of the size of world cannabis market.

Table 2 presents the published retail cannabis market estimates for individual countries and the world. Since each study employs different assumptions and methodologies, extreme caution should be used when making comparisons. The UNODC (2005) estimates that the world retail market for cannabis was about €125 Billion[4] circa 2003; more than the retail markets for cocaine and opiates combined. The US is believed to be the largest contributor to this estimate, but the exact size of that market is far from settled. Indeed, some of the estimates of the US market vary by a factor of 10.

[4] Unless noted, all monetary values are in €2005.

Table 2 Existing estimates of the retail market for cannabis

Country	Source	Year	Amount (Metric Tons)	Nominal Value	2005 Euros (Billions)	% GDP
Australia	Clements & Zhao 2005	1998	339	AU$ 5.35 B	4.14	0.90%
Finland	Hakkarainen *et al* 2007	2004	1.7 – 4.3	--	--	--
France	Legleye *et al*. 2008	2005	--	€ 746-832 M	0.75-0.83	0.05%
NZ(1)	Wilkins *et al*. 2002	1998	--	NZ$ 131-170 M	0.09-0.11	0.15%
NZ(2)	Wilkins *et al*. 2005	2001	--	NZ$ 190 M (131-249 M)	0.12	0.16%
UK(1)	Bramley-Harker 2001	1998	486	GBP 1.58	2.55	0.29%
UK(2)	Pudney *et al*. 2006	2003/4	412 +/- 155	GBP 1.031 B +/- 0.433 B	1.55	0.09%
US (1)	ABT 2001	2000	1,047	US$ 10.5 B	9.92	0.10%
US (2)	DEA, unpublished	2000	4,270	--	--	--
US (3)	Drug Availability Steering Committee, 2002[5]	2001	10,000– 24,000 *	--	--	--
US (4)	Gettman 2007	2005	9,830	US$ 113 B	99.97	0.91%
World (1)	UNDCP 1997	1995	--	US$ 75 B	80.10	0.25%
World (2)	UNODC 2005	2003	35,663	US$ 142 B	125.6	0.38%

Notes: *Based on estimates of availability, not necessarily consumption (e.g., some could be exported or confiscated by local authorities). Estimates not directly comparable because of different populations and methods. Nominal values are inflated using the CPI published by the OECD and then converted to Euros using the conversion rate for July 1, 2005 from xe.com/ict. GDP figures were obtained from EconStats.com.

The UNODC's macro estimates indicate that North America and Western/Central Europe account for 45% and 28% of the world cannabis market, respectively. The UNODC's input-output model suggests that each past year user in North America consumed 165 grams of cannabis herb at almost €10 per gram. With approximately 25 million past-year users in the US during this time, the UNODC calculations imply that retail cannabis expenditures in the US exceeded €40 billion. This is more than four times the retail estimate generated by the White House's Office of National Drug Control Policy for 2000. There are obvious differences in the methodologies employed by the ABT and UNODC (e.g., the former focused on past-month users and the latter focused on past-year users), but the large discrepancies raise important questions about how to generate reliable market estimates. This particular discrepancy is especially disturbing since we know more about drug use patterns and markets in the US than in most countries. While Abt suggests that its estimate may be low and the UNODC suggests the error in their estimate could be significant, it is important to note that neither source provides a range for their estimates. Thus, it is difficult to know how much confidence one should place on either of these point estimates.

3.1 Calculating total consumption of cannabis

We begin with a simple formula for calculating the number of grams consumed in country (c):

$$(1)\ \text{TotalGrams}_c = \sum_u \text{Users}_{cu} * \text{UseDays}_u * \text{GramsPerUseDay}_u,$$

[5] Publicly available at: www.whitehousedrugpolicy.gov/publications/drugfact/drug_avail/ as of April 16th, 2009

Where u denotes the type of user. In the model, we consider consumption separately for two different types of users: recent users who report use in the past month and users who report use in the past year but not in the past month. There are two reasons for distinguishing consumption between these two groups: 1) To better reflect the fact that heavy users of cannabis may consume cannabis far more frequently and/or in higher doses than individuals who do not use cannabis regularly, and 2) Most countries collect data for these two groups. Total consumption, therefore, is constructed as the sum of user-specific amounts consumed in a given year. The amount consumed, in turn, is the product of the number of days in which the drug was reportedly consumed, the typical amount consumed on those days, and the number of users who fall into a specific user-group category. We now consider the estimation of each of these in turn.

3.1.1 Number of users

Most developed countries regularly collect and report information on past year and past month consumption from surveys conducted of their household populations. This information is used to create two mutually exclusive user types (u): 1) User in the past month and 2) User in the past year but not in past month. These figures, along with retail prices which will be discussed shortly, are reported in Table 3.

Table 3 Prevalence of cannabis use and retail cannabis prices circa 2005 (Imputed values in italics)

Country	Past month users (000s)	Past year users (000s)	Price per bulk gram[6]
Austria	211	416	4.58
Belgium	204	340	5.90
Cyprus	7	11	9.47
Czech	331	641	6.92
Denmark	92	184	*8.00*
Estonia	13	41	8.38
Finland	56	101	12.12
France	1,968	3,525	5.60
Germany	1,604	3,254	6.57
Greece	64	121	3.22
Hungary	75	209	8.84
Ireland	71	136	*3.36*
Italy	2,246	4,338	6.41
Latvia	29	60	14.30
Lithuania	17	54	7.52
Luxembourg	*9*	*16*	7.48
Netherlands	367	600	5.28
Norway	66	139	15.20
Poland	346	745	6.73
Portugal	168	231	2.81
Slovakia	66	158	4.74
Slovenia	*82*	*159*	6.33
Spain	2,386	3,072	3.47
Sweden	46	115	8.49
Switzerland	*135*	225	*6.00*
United Kingdom	2,250	3,738	3.36
Canada	*2,049*	3,414	6.75
Mexico	*1,210*	2,017	1.50
United States	14,626	25,375	4.82
Australia	1,104	1,848	12.58
New Zealand	*224*	373	7.14

Notes: Unless noted below, all European price and prevalence data are based on the EMCDDA's *2007 Statistical Bulletin*. For the UK, the EMCDDA specifies whether the estimate is for England & Wales, Northern Ireland, or Scotland. For 2004, this figure is reported for the United Kingdom. The prevalence rate is multiplied by 2005 population aged 15-64 except in these instances: Czech Republic (18-64), Denmark (16-64), Germany (18-59), Hungary (18-54), Malta (18-64), Poland (16-64), and Sweden (16-64). Swiss prevalence is for those 15-64 in 2002 (Drewe *et al.*, 2004). Sources for the number of users outside of Europe: Australia (14+, 2004; Australian Institute on Health and Welfare), Canada (15+, 2004; Canadian Addiction Survey), Mexico (15-64, 2005; UNODC 2007), New Zealand

[6] To account for the highly skewed nature of drug price data, we use the geometric mean instead of arithmetic mean when generating price information.

(13-64, 2005/2006; Slack *et al.* 2008), and US (12+, 2005; NHSDA 2005). Missing price data was imputed based on neighbouring countries: Switzerland (geometric mean[7] of France, Germany, and Italy), Denmark (geometric mean of Germany and Sweden), and Ireland (UK). Missing prevalence data was also imputed based on neighbouring countries: Luxembourg (Belgium) and Slovenia (Italy). Past month prevalence was not available for Switzerland, Mexico, New Zealand, and Canada. In these cases we multiplied the annual prevalence rate by 60%, which is close to what we saw for many of the other countries.

3.1.2 Number of use days

Information from a variety of surveys suggests that the average number of days in which cannabis is consumed is fairly similar across developed countries. Rigter & van Laar (2002) find that the frequency of past month cannabis consumption in the Netherlands compares well with the US and footnote that "Roughly similar frequency distributions have been reported for Australia, France, and Germany" (29). Cannabis users in the US and Australia also appear to have similar number of use days in the past year. A detailed frequency distribution based on the 2004 Australian household survey yields a mean number of consumption days for past year users to be 87 to 98 days, depending on whether one assumes weekly but non-daily users use 2 or 3 times a week.[8] Micro data analysis of past-year users in the 2005 US household survey suggests the average number of use days reported in the household survey is 98.8 days.

While there are clearly similarities across countries in the frequency of cannabis use, there are also clearly differences in terms of the time frame in which cannabis use is measured across countries. In an attempt to make the estimates more consistent we make use of US data which provides detailed information regarding the frequency of use by types of user groups. In light of the aforementioned similarities across countries, the reliance on US data for identifying the number of days used in the past year among each user group should introduce only a small amount of measurement error into the model. Table 4 presents the median and mean estimates of the number of days in which cannabis is used for the two user groups using data from the 2005 National Survey on Drug Use or Health (NSDUH).

Table 4. Number of days of cannabis use per year, for different types of users, as reported in the 2005 U.S. NSDUH Survey

	Median	Mean	95% CI L	95% CI H
Reported use in past month	104	150.3	146.86	153.69
Reported use in past year but not past month	5	29.8	28.04	31.66

Sources: A 95% confidence interval "is an interval computed from sample data by a method that has probability [95%] of producing an interval containing the true value of the parameter" (Moore & McCabe, 2003, p 420). Weighted mean and 95% CI values were calculated using the 2005 National Survey on Drug Use and Health (US) on-line analysis tool at www.icpsr.umich.edu/cocoon/ICPSR/DAS/04596.xml. The weighted median was calculated using the "pctile" function with the weighting option in Stata 9.2.

Given the potential bias that could be introduced by relying on information from a household population for an illegal activity, it is important to consider how similar these estimates are to those obtained from other relevant populations. Surprisingly, these past-

[7] To account for the highly skewed nature of drug price data, we use the geometric mean instead of arithmetic mean when generating price information from ranges.

[8] 98 days = (365 days * 0.164) + (52 weeks * 3 days * 0.228) + (12 months * 1 day * 0.119) + (6 days * 0.178) + (1.5 days * 0.331).

month use day estimates are indeed similar to those derived from a national sample of arrestees in the United States. Approximately 10,000 male arrestees in the most recent ADAM survey (2003) reported using cannabis in the month before arrest, with a median and mean equal to 10 and 13.5 days, respectively. If we assume that past month consumption is consistent with use in the previous 11 months, we can generate estimates of past year use days that are reasonably similar to what is derived from the household population (For arrestees: Median=120 days; Mean=162 days).

England conducts a similar arrestee survey, and like the US ADAM program, it includes voluntary drug tests. An analysis of these data published by the US National Institute of Justice (the research arm of the Department of Justice) found that after controlling for a host of demographic and criminal offense variables, there was no statistically significant country difference in the rate of positive tests for cannabis (n=4,833; Taylor & Bennett, 1999). Since a urinalysis for cannabis can either identify recent users or heavy users who recently quit, we cannot definitively state that the levels of cannabis use are similar among arrestees in the US and England. However, this is consistent with the household survey data indicating that quantity consumed among past month users is fairly similar for the US and other Western developed countries.

3.1.3 Quantity consumed per use day

The lack of information about typical quantities consumed on a use day (for cannabis and other drugs) severely limits the accuracy of demand-side estimates. Not only is this information hard to find, differences in consumption patterns make international comparisons difficult (e.g., joints vs. bongs, resin vs. herbal, with or without tobacco). For lack of better information, Pudney *et al.*'s UK market estimates (2006) rely on daily consumption estimates from an Australian household survey. For those who used cannabis >= 3 times in the previous week, Pudney *et al.* assumed that the mean quantity used per day of use was 1.2 grams +/- 0.4 for individuals consuming cannabis in the UK. For everyone else in the UK, the quantity assumed was 0.55 grams +/- 0.4. Similarly, Bouchard (2008) uses Pudney *et al.*'s (2006) figures to estimate the size of the cannabis retail market in Quebec. The need to draw on estimates from Australian data to predict market estimates for the UK and part of Canada demonstrates the dearth of country-specific information even in countries that have relatively developed monitoring systems.

Before 1995, the National Household Survey on Drug Abuse (NHSDA) in the United States asked past-month marijuana smokers how many joints they consumed on a typical day. In the 1994 NHSDA the average was 2.5 (95% confidence interval 1.91 and 3.09). To compare this to the figures used by Pudney *et al.* (2006), we must make an assumption regarding the consistency in amount consumed over time as well as an assumption about the average amount of marijuana in a typical joint. No data exist from which to assess the appropriateness of the first assumption (regarding consistency in amount consumed per use day), so it will just be assumed from illustrative purposes. Data do exist for considering the assumptions regarding average amount of marijuana in a typical joint. Table 5 highlights a variety of estimates of marijuana grams per joint for different countries, with many of the estimates hovering between 0.3 and 0.5 grams per joint. Rigter and van Laar's (2002) review of cannabis consumption in Europe note: "The corresponding number of 'units of use' depends on the manner of consumption, users' preferences, and the type,

origin and perhaps strength of the cannabis. When smoked with tobacco, for instance, one gram may be processed into two to five joints"; thus suggesting 0.2 to 0.5 grams per joint in Europe. This is consistent with a more recent estimate from France (0.29-0.37g; Legleye *et al.*, 2008).

Table 5. A variety of assumptions about the number of cannabis grams per joint

Cannabis grams/joint	Country/Continent	Source
0.2-0.5g of cannabis in joint with tobacco	Europe	Rigter & van Laar (2002)
0.29-0.37g	France	Legleye *et al*. (2008)
0.33g	New Zealand	Slack *et al*. (2008)
0.39g	United States	Abt (2001)
0.4-0.5g	United States	MacCoun & Reuter (2001)
0.5g	New Zealand	Wilkins *et al*. (2005)
Slightly less than 0.5g	Canada	Bouchard (2008)
~0.5g	New Zealand	Wilkins & Sweetur (2007)
0.75g	United States	Gettman (2007)

Using the joints per day range from the U.S. and reasonable range about the grams of cannabis per joint from the international literature, we generate figures that are consistent with Pudney *et al*. (2006). Using 0.4 grams as our best estimate, this suggests that past-month users consumed about 1 gram of marijuana a day (2.5 joints * 0.4 grams). We would expect this figure to be somewhat smaller than Pudney *et al.*'s estimate for intensive users (1.2 grams) since they focus on the far right tail of the distribution (>=3 times in the previous week). We are most comfortable using 0.3 grams and 0.5 grams as our low and high estimates, which gives us a range 0.57 grams (1.91 joints * 0.3 grams) and 1.55 grams (3.09 joints * 0.5 grams).

Since we do not have grams per joint estimates for non-monthly users, we simply divide the number of joints by two. Although arbitrary, it is important to note that this is an inconsequential assumption as past month users account for the vast majority of consumption and expenditures. It also generates a range (~0.3-0.9g) that is consistent with Pudney *et al* (0.15-0.95g).

While much of the previous discussion focused on joints, this does not mean that we are excluding consumption via other mechanisms (e.g., bongs, pipes, blunts, one-hitters). Our estimates of the number of users, type of users, and number of use days are independent of the delivery mechanism. Further, the consumption estimates used by Pundey *et al.* (2006) were not specific to joints. Ultimately the main focus on grams consumed, but we do examine the joint consumption distribution since is the only information we have to help us develop 95% confidence intervals.

3.1.4 Underreporting

Table 6 suggests that nearly 40% of the young marijuana users in the household population lied about their use. This is higher than most figures in the literature and so we consider this our upper bound. For the lower bound we assume no underreporting (0%) and for the best estimate we assume 20%. This is not only conveniently the midpoint between these bounds, but also consistent with other estimates: Fendrich *et al.*'s (2004) household survey in Chicago suggests 78% of cannabis users were honest, and this is similar to the 82% calculated for adult male arrestees in 2003 (Table 6). This adjustment assumes that underreporting is not correlated with intensity of use.

3.1.5 Assessing the face validity of these consumption assumptions

Table 6 summarizes the information used in the construction of each country's estimate of total consumption of cannabis. The goal here is to make explicit where assumptions have to be made for the construction of an estimate, so that these assumptions can be tested when new information and data become available.

Table 6. Key Assumptions about cannabis consumption

		Low	Best	High
All users	Grams per joint	0.3	0.4	0.5
Past month users	Days used in 2005	146.86	150.27	153.69
	Joint per use day	1.91	2.5	3.09
	Grams per use day	0.573	1	1.545
Past year users, but not in past month	Days used in 2005	28.04	29.85	31.66
	Joint per use day	0.955	1.25	1.545
	Grams per use day	0.287	0.5	0.773
All users	% underreporting	0.0%	20.0%	39.1%

The assumptions yield results that are consistent with the existing literature. The expected number of grams any past month user would consume in a year would be 150.3 days * 2.5 joints * 0.4 grams = 150.3 grams. A similar calculation for those who used in the past year but not the past month yields 29.9 days * 1.25 joints * 0.4 grams = 15 grams. Table 6 suggests that approximately 60% of past-year cannabis users used in the previous month in the US, Australia, and Western/Central Europe. Using a weighted average of the annual consumption for these two types of users (past month; past year but not past month), we estimate that the average number of grams consumed for any past year user in one of these countries (US, Australia and Western/Central Europe) would be 0.6 * 150.3 + 0.4 * 15 = 96.2 grams. This figure is consistent with the "100 grams-per-user benchmark" suggested by Bouchard (2007). Bouchard calculates that past year users in Quebec, on average, used 94 grams in 2003 and notes that this is consistent with studies from other countries (e.g., Pudney *et al.*, 2006; Childress, 1994). Additionally, this is also consistent with data from New Zealand which suggests an average annual consumption to be 98 grams per user (89.3 occasions * 1.1. grams per occasion; Slack *et al.*, 2008). These similarities are surprising considering the variety of sources and countries used to inform the input parameters. They also provide some reassurance that at least for developed countries the assumptions being imposed in this model are not unreasonable.

3.2 Calculating total retail expenditure

Once an estimate of total consumption is produced for each country, an estimate of the expenditure in the retail market for each country (c) can be constructed by multiplying total consumption by the average price per gram. Eq. 2 presents a mathematical model for calculating the total amount spent on cannabis in the retail market:

(2) $\text{Expenditures}_c = \text{TotalGrams}_c * \text{PricePerGram}_c$.

This simple formula masks two important and interrelated complexities in cannabis markets: Quantity discounts and the importance of gifts. Most cannabis users do not pay

for their cannabis and those who buy in bulk receive discounts (Wilkins *et al.*, 2005; Caulkins & Pacula, 2006).[9] These two factors can complicate the calculation of total expenditures considerably. If the goal is to try to estimate the value of cannabis consumed, a value must be placed on the free cannabis. In some instances, this is not difficult because the value of the last transaction is a reasonable proxy. For example, if person A buys a gram for €6 and shares it equally with person B, the value of the free cannabis given to B is €3.[10] Even though person B did not actually spend money on the cannabis, information of the last transaction in which the cannabis was purchased provides information on the value of the cannabis consumed. However, if person A instead bought in bulk (e.g., an ounce instead of a gram), then the average price paid per gram would likely be substantially lower due to quantity discounts than if he bought only one gram. If this person sells part of their ounce and gifts another portion, then using the full amount of this one transaction might lead to double counting (at least for the portion that gets resold). To obtain the ideal estimate of average price paid per gram, one would want to only consider those transactions for which the consumers purchased it for their own consumption or gifted it to others (no resale). Unfortunately, it is only possible to get this sort of detailed information regarding what purchasers did with the amount they purchased in a few countries.

As with the prevalence estimates, the European price data are derived from the EMCDDA's *Statistical Bulletin 2007* (EMCDDA, 2007a). Average price data are available for both cannabis herb and cannabis resin, but prevalence estimates do not distinguish between the two. The UNODC reports almost similar amounts of herb and resin were available for consumption in Western and Central Europe in 2003 (3.16M and 2.89M kg cannabis equivalents, respectively); thus we simply take the geometric mean of the mean estimates. If a country reports only one value for herb and resin, we calculate the geometric mean of these two values. If the high and low estimates are reported for both types (and no mean), the geometric mean is based on these four values.

The price data for other countries come from a variety of sources.[11] For the United States, our analyses of the 2005 NSDUH (the only nationally representative price estimate available for the U.S.) suggest that the average price paid per gram for all purchases by non sellers up to one pound was €4.82.[12] Wilkins *et al.* (2005) perform a relatively similar

[9] Similar to the section on the previous number of use days, there is some evidence suggesting that U.S. purchase patterns may be similar to the purchase patterns in other developed countries. Data from the 2001 HH survey in New Zealand suggests that 59% of past-year cannabis users purchased at least some of their cannabis (Wilkins *et al.*, 2005). Analyses of the 2001 HH survey also find that 59% (10,944,1610 / 18,650,770) of past year users made a cannabis purchase in the previous year (Caulkins & Pacula, 2006; Table 3). In addition, there is evidence from an international survey of young detainees and dropouts in four cities (Amsterdam, Montreal, Philadelphia, and Toronto) which suggest similarities in how cannabis is obtained (Harrison *et al.*, 2007b).

[10] If the free cannabis was received from someone who never originally purchased it in the marketplace (e.g., they grew it themselves at home), it is difficult to know the actual value of the cannabis consumed.

[11] Since herbal cannabis dominates the markets in Oceania and North America, resin prices are ignored for these countries.

[12] Limiting this to purchases by non sellers <= 1 ounce slightly increases the price to €5.12.

calculation for New Zealand and generate an average price paid per gram of €7.14. Although their figure may include dealers who presumably get larger quantity discounts (thus deflating these estimates), this figure is consistent with other retail estimates for New Zealand.[13] The Australian price data are based on findings from the 2006 Illicit Drug Reporting System (O'Brien *et al.*, 2006). The lack of retail price information for Canada required using information from the UNODC's ARQ: €6.75 per gram. While this estimate is generally consistent with the impressions of a Canadian cannabis scholar (M. Bouchard, personal communication), we would much prefer to generate price estimates from micro data or statistics from micro data as opposed to a single response to an administrative survey.

Data on the price of retail cannabis in Mexico are not readily available, but the UNODC does report a wholesale price per kilogram equal to €66. This is lower than the wholesale ranges provided for neighbouring Belize (€104-€167) and Guatemala (€91-€96) in 2005. The UNODC also provides ranges for the retail price of one gram in Belize and Guatemala, and for lack of better information, we take the geometric mean of these values to calculate a value for Mexico (which will likely be an overestimate of the retail price in Mexico). Doing so yields a price per gram equal to €1.50.

There are at least two major caveats that need to be kept in mind when comparing cannabis prices across countries. First, it is unclear to what extent these prices approximate actual retail-level prices per gram. Given the relative scarcity of information on drug prices in most countries, it is unclear whether the price estimates reported to the EMCDDA and other organisations exclude purchases made by drug sellers. Second, these prices are not explicitly adjusted for potency. For retail expenditure estimates, the number of raw grams consumed in a country is multiplied by the average retail price paid per gram for the entire country. In theory, this average is a weighted average of the prices paid for high-, typical-, and low-quality cannabis, and accounts for within-country differences in price. But whether or not the prices reported actually reflect these differences for each country is an empirical question. Future data collection efforts will hopefully consider these factors when collecting and reporting information for the price of cannabis.

Table 3 presents the price estimates used to generate our expenditure estimates. There is large variation in prices as well as in the ratio of past month to past year users. While one might be tempted to draw comparisons regarding the relative price per gram of cannabis across countries, the reader is reminded that no adjustments are made for the prevalence of quantity discounts reflected in the data or the average potency of the cannabis consumed. Thus, it would be unwise to make direct comparisons. However, one would expect that the average potency of cannabis within specific regions (e.g. Europe) to be less variable then across regions (e.g. Europe versus Australia or the North American). Nonetheless we still

[13] Interviews with three different groups of frequent drug users (methamphetamine, ecstasy, and IDU; Wilkins *et al.*,, 2006) in NZ in 2006 suggest a mean and median price for 1.5 grams (a "tinny") equal to NZ$20. For small purchases, "tinnies" are much more common than joints (Wilkins *et al.*, 2005b). While heavy drug users probably know the market better than the general public and might be expected to pay lower prices, the fact that the median and mean equal $20 for each of the three groups suggests that this is probably close to the typical market price. Converting this to Euros and dividing by 1.5 generates €7.6.

see substantial variation in the average price paid per gram. For example, in the Scandinavian countries the average price is highly variable, as indicated by an average price per gram in Sweden of €8.49 and an average price per gram in Norway of €15.20. This variation might reflect differences in the typical purchases made to obtain information on the price of cannabis within these countries, or differences in the quality (potency) of the typical purchase made within these countries.

3.3 Results

To generate country- and regional-level estimates of the retail cannabis market, we use a simple spreadsheet model and populate it with the data from Table 3 and Table 6 and apply the aforementioned assumptions about quantity consumed and expenditures. For each country, we generate a best, low, and high estimate of the total grams consumed and total amount spent on cannabis at the retail level in 2005. Recall that we do not vary the price within countries since we are, in essence, using a weighted average of the prices paid for high-, typical-, and low-quality cannabis when using the average price.

Table 7 presents an example of the model using the United Kingdom as an example. In our best estimate for the UK, the share of total grams consumed that are attributable to those who used in the past year but not the past month is only 6 percent.

Table 7. Cannabis consumption and expenditures in the United Kingdom, 2005

		Low	Best	High
Past month users (PM)	Number of users	2,250,200	2,250,200	2,250,200
	Days used in 2005	146.86	150.27	153.69
	Joint per use day	1.91	2.5	3.09
Past year, but not past month users (PY)	Number of users	1,488,035	1,488,035	1,488,035
	Days used in 2005	28.04	29.85	31.66
	Joint per use day	0.955	1.25	1.545
Total amount consumed	Grams per joint	0.3	0.4	0.5
	Total grams--PM	189,356,067	338,137,522	534,312,303
	Total grams--PY	11,954,072	22,208,928	36,393,401
	% underreporting	0.0%	20.0%	39.1%
	Total grams--All	201,310,140	450,433,062	937,119,383
Total retail expenditures	Price per gram (€)	3.36	3.36	3.36
	Total expenditures	676,402,070	1,513,455,090	3,148,721,126

Table 8 presents the total grams consumed and total expenditures for each country in Western and Central Europe, North America, and Oceania.

Table 8. General population estimates of the size of the retail cannabis market circa 2005 (Euros in millions; MT=Metric Tons Consumed)

Country					
		Low	Best	High	Best/GDP[14]
WESTERN AND CENTRAL EUROPE					
Austria	€	88.8	199.0	414.4	0.08%
	MT	19.4	43.4	90.4	
Belgium	€	107.9	241.3	502.1	0.08%
	MT	18.3	40.9	85.1	
Cyprus	€	6.2	13.8	28.7	0.10%
	MT	0.7	1.5	3.0	
Czech	€	209.8	469.8	978.3	0.45%
	MT	30.3	67.9	141.4	
Denmark	€	67.7	151.6	315.8	0.07%
	MT	8.5	19.0	39.5	
Estonia	€	10.8	24.4	51.0	0.21%
	MT	1.3	2.9	6.1	
Finland	€	61.4	137.4	285.9	0.08%
	MT	5.1	11.3	23.6	
France	€	997.3	2232.5	4646.7	0.12%
	MT	178.1	398.7	829.8	
Germany	€	974.1	2182.2	4545.2	0.09%
	MT	148.2	332.0	691.5	
Greece	€	18.9	42.3	88.0	0.02%
	MT	5.9	13.1	27.3	
Hungary	€	65.2	146.4	305.5	0.16%
	MT	7.4	16.6	34.6	
Ireland	€	21.7	48.6	101.3	0.03%
	MT	6.5	14.5	30.1	
Italy	€	1319.8	2955.7	6154.4	0.20%
	MT	205.8	461.0	959.8	
Latvia	€	38.1	85.4	177.9	0.64%
	MT	2.7	6.0	12.4	
Lithuania	€	13.2	29.6	61.9	0.14%
	MT	1.8	3.9	8.2	
Luxembourg	€	6.3	14.0	29.1	0.04%
	MT	0.8	1.9	3.9	

[14] GDP values are reported in Appendix B.

Country		Low	Best	High	Best/GDP[14]
Malta	€	0.6	1.4	2.9	0.03%
	MT	0.1	0.3	0.5	
Netherlands	€	172.9	386.9	804.9	0.07%
	MT	32.8	73.3	152.4	
Norway	€	93.7	210.0	437.4	0.08%
	MT	6.2	13.8	28.8	
Poland	€	217.4	487.2	1015.2	0.19%
	MT	32.3	72.4	150.9	
Portugal	€	41.2	92.0	191.2	0.06%
	MT	14.7	32.8	68.1	
Slovakia	€	29.7	66.6	138.8	0.17%
	MT	6.3	14.0	29.3	
Slovenia	€	47.7	106.9	222.6	0.36%
	MT	7.5	16.9	35.2	
Spain	€	715.9	1599.6	3323.8	0.17%
	MT	206.3	461.0	957.9	
Sweden	€	37.7	84.6	176.4	0.03%
	MT	4.4	10.0	20.8	
Switzerland	€	72.5	162.2	337.5	0.05%
	MT	12.1	27.0	56.3	
UK	€	677.0	1514.8	3151.6	0.08%
	MT	201.3	450.4	937.1	
NORTH AMERICA					
Canada	€	1237.7	2769.4	5761.8	0.29%
	MT	183.4	410.3	853.6	
Mexico	€	162.4	363.5	756.2	0.06%
	MT	108.3	242.3	504.1	
US	€	6348.6	14208.6	29567.8	0.14%
	MT	1,317.1	2,947.8	6,134.4	
OCEANIA					
Australia	€	1243.8	2783.2	5790.6	0.47%
	MT	98.9	221.2	460.3	
New Zealand	€	143.1	320.3	666.4	0.35%
	MT	20.0	44.9	93.3	

3.4 Discussion

Although this table focuses on 2005 and most of the market studies listed in Table 2 cover different years, there are some noteworthy similarities. Pudney *et al.* (2006) estimate the total number of grams consumed in the UK circa 2004 is 412 MT +/- 155 MT grams.

Our best estimate of 450 MT for the UK clearly falls within this range. Similarly, our best estimate of the total UK expenditures (€1.5B) is very close to the value generated by Pudney *et al.* (€1.55B +/- 0.649).

Not surprisingly, our expenditure estimate for the United States (€14.2B) is about 50% larger than the estimate generated by Abt (2001) for 2000 (€9.92B). We estimate that ~3,000 MT of cannabis were consumed in the U.S. compared to their ~1,000 MT; however, our expenditure estimates are not three times as large since we apply a lower price per retail gram. The discrepancy in total grams consumed makes sense since we 1) do not focus exclusively on past month users, 2) assume the average past month user paid for 96 grams a year instead of 88 grams, and 3) make adjustments for underreporting. [15] The interagency Drug Availability Steering Committee[16] (DASC; 2002) expressed concern that the Abt figures were too low for cannabis, and referred readers to an unpublished estimate by the DEA Statistical Services Section which suggested that 4,270 metric tons of cannabis were consumed in 2000. A table published later in the DASC text (5-8) suggests that this 4,270 MT figure was based on this estimation formula: "11,700,000 x 1 gram x 365", where 11,700,000 is labelled as the "User value" (a number that is very close to the 10.7 million past month marijuana users reported in 2000 NHSDA) and the "1 gram x 365" presumably means these users consume a gram a day on average. If interpreted correctly, this implies that the vast majority of past month users consumed approximately two joints a day for an entire year. This seems unusually high and it is not clear whether DASC strongly prefers this unpublished estimate. It is somewhat reassuring, however, that our best estimate (2,948 MT) falls nicely in this range discussed by DASC.

It appears that our approach may overestimate the size of the retail market in France in 2005 (Legleye *et al.*, 2008: €746-832 M; Estimate from Table 8: €2,232 M). There are a few possible explanations for this discrepancy. First, the French estimate is based on past month users while ours includes anyone who consumed in the previous year. Second, the French estimate assumes €4 per gram whereas we use €5.60 based on the EMCDDA data.[17] Third, we adjust the final estimates to account for underreporting.

There is also a difference between our expenditure estimate our methodology produces for New Zealand (€320.3) and what was reported by Wilkins and colleagues for 2001 (€120). Besides adjusting for underreporting, another reason for the discrepancy is that our figures are based on Slack *et al.*'s (2008) estimate for all users in the country aged 13-64 in 2005/2006 whereas the Wilkins *et al.* estimates are for those aged 13-45 covered by the household population survey in 2001.[18] An additional reason for the discrepancy is the

[15] The Abt (2001) estimate is based on a projection for 2000. A correction using 2000 data by the Drug Availability Steering Committee (2002) put the figure at 927 MT

[16] Members of the DASC included senior-level executives from the following organisations: Office of National Drug Control Policy, Department of Justice, Department of Defence, Department of Treasury, Drug Enforcement Administration, Crime and Narcotics Center, the U.S. Interdiction Coordinator's office, U.S. Customs Service, and U.S. Coast Guard.

[17] The geometric mean is based on €4.90/gram for resin and €6.40/gram for herbal.

[18] The Slack *et al.* figure is based on a weighted average for occasional and frequent users from the household survey and the Illicit Drug Monitoring System.

implied difference in the estimates for typical amount consumed for a user. Whereas our best estimate assumes that the average amount consumed for anyone who used in the previous year is approximately 96 grams, figures published in Wilkins *et al.* (2005) imply that this figure is lower for the population they examine.[19] As noted earlier, the Slack *et al.*'s (2008) estimate for New Zealand suggests an average annual consumption to be 98 grams per user, much closer to our estimate.

At the beginning of this chapter we noted that the UNODC figures imply that retail cannabis expenditures in the U.S. are close to €40B—more than three times the figure we generate as our best estimate. This is not entirely surprising since the UNODC assumes that every past year user consumes on average 165 grams whereas we assume an average of 96 grams. Further, the UNODC applies an average retail price that is more than twice as high as the figure we use (€4.8 and €12.5, respectively). We prefer our price figure since it is based on self-reported information from cannabis buyers who consumed or gave their cannabis away, and hence has been purged of individuals who might have also resold some of their cannabis. Further, our estimate accounts for the quantity discounts that often occur at the retail level. In both the United States and New Zealand, the typical amount purchased is greater than one gram (Wilkins *et al.*, 2005; Caulkins & Pacula, 2006)

Summing the country estimates by region allows us to make crude comparisons with the macro estimates generated by the UNODC. Table 9 displays the results by region as well as estimates published in the World Drug Report. While the UNODC estimates are inflated from €2003 to €2005, they are not directly comparable to the RAND results since they cover different years. Still, the differences in the estimates are striking. For expenditure and consumption in all three regions, the spreadsheet model produces results that are dramatically smaller than what is reported in the World Drug Report (WDR). For example, the UNODC estimates that over 6B grams of cannabis were consumed in North America and our best is substantially lower.

Table 9 Estimates of the Size of the Retail Cannabis Market

Region		UNODC circa 2003	RAND Low	RAND Best	RAND High
North America	Expenditures (Billions)	€56.6	€7.8	€17.3	€36.1
	Metric Tons Consumed	6,034	1,609	3,600	7,492
Oceania	Expenditures (Billions)	€5.5	€1.4	€3.1	€6.5
	Metric Tons Consumed	684	119	266	554
West/Central Europe	Expenditures (Billions)	€35.2	€6.1	€13.5	€28.5
	Metric Tons Consumed	6,051	1,165	2,607	5,424

While Table 9 only includes countries from three of the 16 regions used in the UNODC macro estimates, the UNODC estimates that these 33 countries account for 78% of the

[19] Wilkins *et al.* (2005) estimate the value of total purchases for their sample to be $NZ 576,253, with the average annual purchase amount to be $1,313. This suggests that there were approximately 439 purchasers in their sample. With this population purchasing a total of 48,717 grams, this suggests that the average purchaser purchased about 111 grams throughout the year. If we multiply this by the number of purchasers aged 13-45 believed to be in the household population (144,665), the total grams purchased by the household population would be 16,057,815. If we divide this by the total number of past year users (not just purchasers) in full household population (362,140=0.19*1906000), we generate an average of 44 grams per user. Note that this figure is low since it does not consider all of the home-grown cannabis that is consumed by growers and shared with those in the houseful population. Further, Wilkins *et al.* (2005) suggest the NZ household survey underestimates heavy cannabis users. This accounts for a large share of the discrepancy.

global cannabis retail market and hence represent the bulk of their global estimate. Because adequate data are not available for the other 13 regions (22%), the work presented in this report focuses on improving the estimates for the three regions and takes as correct those estimates constructed by the UNODC for the other 13. Inflating the 2002/2003 estimates for these 13 regions to €2005 and aggregating them generates a base estimate of the size of the retail cannabis market of €35B.[20] Assuming that consumption patterns have remained relatively stable in these 13 regions between 2002/2003 and 2005 (not an unreasonable assumption), adding this figure to the sum of the best estimates for North America, Oceania, and Western and Central Europe generates a global estimate of the retail market for cannabis of approximately €70B—about half of what the UNODC estimated for 2002/2003. A similar computation employing the low and high estimates for the three main regions generates an approximate range for the global retail market of €40B and €120B.[21]

[20] €28B * 1/(1-0.2) = €35B.

[21] €28B * 1/(1-0.391) + €36.1B + €6.5B + €28.5B = €117B.

CHAPTER 4 Heroin

This section presents country-specific consumption and retail expenditure estimates for heroin circa 2005. Unlike our quantity consumed estimates for other drugs which are based on average number of use days and average amount consumed per use day for different types of users, this section relies upon new consumption estimates based upon a recent international literature review (Paoli, Greenfield, & Reuter, 2009). Since these new estimates are presented in terms of pure grams consumed for a user over the course of a year but prices are not available on a purity adjusted basis, the final expenditure estimates are presented for different potential values of retail purity.

The following subsections discuss the data sources and assumptions made to generate our expenditure and consumption figures. We highlight the major sources of uncertainty and note peculiarities in the available data. The final section will compare our results with the small number of studies that have attempted to calculate the size of the retail market for particular countries. Since these results are calculated differently than our estimates for the cannabis and cocaine markets, readers should exercise caution when making comparisons or attempting to sum the figures to generate one figure for the size of the global market for the major illicit drugs.

4.1 Prevalence data

For the majority of countries with sizable retail opiate markets (in terms of users and/or expenditures), we rely on prevalence data collected by the UNODC which come from a variety of sources and often do not cover the same time periods (Table 10). For example, the most recent estimate for France is from 1999, for Spain it is 2002, and for the United States it is 2000 (based on the aforementioned Abt study). This makes it virtually impossible to assess country-specific trends in opiate consumption in most places (especially for the 1998-2007 period). These opiate estimates from the UN include opium, heroin, and synthetic opioids but the UNODC estimates that almost all of the consumption (at least 95%) in Western and Central Europe, Canada, and the United States is for heroin (Table 10). Thus, for the calculations we will assume that all opiate purchases are for heroin. Since heroin accounts for a smaller share of opiate consumption in other regions and the price data for opium and synthetics are sparse, we do not present estimates for these regions (Table 11). Consumption information on the major markets excluded from this section is available in Appendix C.

Table 10. Heroin consumption and retail prices

Country	Pop 15-64 2005	Year for estimate	% using in past year	Total users	Assumed pure grams per year	Assumed total pure grams consumed	Price per raw gram heroin (#3/NA)	Price per raw gram heroin (#4)
Austria	5,547,285	2004	0.5	27,736	30	832,093	72.3	106.9
Belgium	6,809,199	1999	0.4	27,237	30	817,104	32.3	
Cyprus	528,292	2006	0.1	528	30	15,849	129.1	180.1
Czech	7,278,024	2005	0.2	14,556	30	436,681	47.2	
Denmark	3,592,694	2001	0.5	17,963	30	538,904	123	210.9
Estonia	901,877	2004	1.5	13,528	30	405,845		94.3
Finland	3,488,259	2005	0.2	6,977	30	209,296		113.2
France	40,993,279	1999	0.4	163,973	30	4,919,193	50.3	62.9
Germany	55,010,226	2004	0.3	165,031	30	4,950,920	47.6	
Greece	7,126,364	2004	0.3	21,379	30	641,373	72.3	78.6
Hungary	6,916,700	2003 (18-54)	0.4	27,667	30	830,004	49.2	65.6
Ireland	2,712,234	2001	0.5	13,561	30	406,835	251.6	
Italy	38,729,045	2005	0.8	309,832	30	9,294,971	68.4	102.7
Latvia	1,590,148	2003	0.9	14,311	30	429,340	179.9	
Lithuania	2,471,090	2002/4	0.6	14,827	30	444,796	36.4	
Luxembourg	311,380	2000	0.9	2,802	30	84,073	102.7	
Malta	274,203	2005	0.6	1,645	30	49,357	76.8	
Netherlands	11,118,809	2005	0.3	33,356	30	1,000,693	37.7	
Norway	3,015,905	2005	0.3	9,048	30	271,431	220.2	
Poland	27,183,009	2003	0.2	54,366	30	1,630,981	44	
Portugal	7,007,623	2000	0.7	49,053	30	1,471,601	52.1	
Slovakia	3,858,319	2005	0.4	15,433	30	462,998	32.6	
Slovenia	1,419,708	2001	0.5	7,099	30	212,956	50.3	

Spain	27,427,043	2002	--	71,964	30	2,158,920	80.1	
Sweden	5,895,309	2004	0.2	11,791	30	353,719	91.6	125.9
Country	**Pop 15-64 2005**	**Year for estimate**	**% using in past year**	**Total users**	**Assumed pure grams per year**	**Assumed total pure grams consumed**	**Price per raw gram heroin (#3/NA)**	**Price per raw gram heroin (#4)**
Switzerland	5,092,909	2000	0.6	30,557	30	916,724	65.7	
United Kingdom	40,185,134	2005	0.9	361,666	30	10,849,986	101.9	
Canada	22,229,669	2005	0.3	66,689	12	800,268	201.6	282.3
United States	198,238,508	2000	0.6	1,189,431	12	14,273,173	195	207.5
Sources: UNDOC, 2007; UNODC, 2008; Spanish National Focal Point, Unpublished; Paoli, Greenfield, & Reuter, 2009								

Table 11 Share of opiate use attributable to heroin, 2005

AREA	**%**
EUROPE	84.2
West & Central Europe	96.5
South-East Europe	70.1
Eastern Europe	76.1
AMERICAS	69.5
North America	95.0
South America	27.8
ASIA	63.1
OCEANIA	33.3
AFRICA	100
TOTAL	71.3
Source: UNODC, 2007a	

The EMCDDA has encouraged and collected estimates of problematic drug use from member countries, but these data are also not available for all countries for the same year. While some of these estimates only report the number of IDUs (which could include amphetamine and cocaine), some countries do report problematic opiate use separately. While detailed comparisons of the methodologies employed to create the EMCDDA and UN estimates are beyond the scope of this report, there is one important discrepancy worth noting. The UN data for Spain in 2002 suggest that the number of opiate users was less than 55,000 (WDR, Table 1), but the 2002 range for problematic users of opiates reported to the EMCDDA ranges from 71,964 to 102,822; a difference of 30% to almost 100% (Spanish National Focal Point, unpublished). For now, we will use the lower bound of this range for the Spanish calculations and recognize that future work must delve deeper into these inconsistencies.

4.1.1 Quantity consumed

As with cannabis, we know relatively little about the typical quantities consumed, especially with respect to pure grams of heroin. For quantity consumed, we rely on the consumption estimates generated from Abt (2001) and Paoli *et al.*'s (2009) recent international literature review, which focused heavily on Europe. Based on Abt's (2001) calculations for 2000, we assume that the average heroin user consumes about 12 grams of pure heroin a year[22]. This also has face validity since we would expect the figures for the U.S. to be much lower than Europe because of the relatively high price in the former.

Based on a sophisticated analysis of heroin consumption among arrestees in the UK by Singleton *et al.* (2006), Paoli *et al.* (2009) calculated that users, on average, consume approximately 29 pure grams per year. Paoli *et al.* (2009) also discussed Bramley-Harker's (2001) estimate for the UK which is closer to 40g per year, and note that this figure is likely to be high since it assumed that none of the heroin users spent any time in the previous year in prison or jail. Based on these findings and their review, Paoli and colleagues conclude: "We believe that an estimate of 100 pure milligrams per user per day—consistent with an annual estimate of about 30 pure grams—for countries with opiate prices that are, relative to average earnings, much lower than the United States, is reasonable and not inconsistent with judgments of experts."

The assumption of 30 grams for users in Europe is much smaller than the figure offered by UNODC (58 grams). As Paoli *et al.* (2009) note, there are several reasons to believe that this figure of 58 grams is too high:

> "UNODC (2005d) reports a global average of 28 grams per annum and a European average of 58 grams. For validation of the higher figure, UNODC cites the results of a U.K study on people entering treatment in 1997, which it states implies 68 grams (Gossop *et al.*, 1997). However, treatment research (e.g., Anglin & Hser, 1990) has consistently found that users enter treatment at times of peak use; thus, reports of use in the period immediately before treatment entry will overstate average use rates. Moreover, treatment entry is itself not randomly distributed across dependent users; those with more severe problems

[22] 13.3 pure metric tons / 1.1 million heroin users.

have a higher probability of being referred to treatment as a consequence of arrest. Thus we believe that the figure is too high."

4.1.2 Price

The price data for raw grams of heroin are pulled from the *World Drug Report* and in most cases they cover 2005. As reported in Table 2, most countries report only one price for heroin and it can be presented as unspecified (NA), Number 3 (brown heroin—less refined); or Number 4 (white heroin—more refined). Some countries do report prices for more than one type of heroin. Our estimates assume that all of the heroin consumed is purchased at the retail price published by UNODC and that there is no gifting. While sharing does occur, it is less likely for expensive drugs where heavy users often have to worry about having their drugs stolen from them (Simon & Burns, 1997). The risk of theft also creates a disincentive for making large bulk purchases at the retail level.

4.1.3 Purity

Purity-adjusted price series are not readily available outside of the U.S. and Australia and this is one of the most significant limitations to estimating the size of the market and understanding how it works. The UN does provide some purity data at the retail level, but this is available for less than 25 countries (in the 2007 WDR) and many of the ranges are too wide to be useful (e.g., Canada: 1-100%; UK: 1-87%; U.S.: 12-95%). There are also examples of ranges that are so small that they do not seem credible (e.g., France: 2-10%). When ranges are provided, point estimates are not. Despite the lack of systematic data, we do know that there is large amount of variation across and within countries. Further, there is also a lot of variation within countries over time. For example, in Germany the variation in recorded purity is large within any one year and rapidly changing, as indicated in Table 12.

Table 12 Purity of German Heroin Seizures in 1997 and 2001

Percent purity	Percent of seizures 1997	Percent of seizures 2001
0-10	51	36
>10-20	34	28
>20-30	8	17
>30-40	3	11
>40-50	2	4
>50	2	4
Source: Unpublished data from the Bundes Kriminal Amt		

Since our quantity consumed measure is based on pure grams and prices are not available purity adjusted, we present country-specific expenditure estimates for three different levels of purity at the retail level: 20%, 40%, and 60%. This is not intended to suggest that retail purchases are never below 20% or above 60%;[23] rather, we present these scenarios to display how sensitive results can be to assumptions about purity. To calculate the prices for

[23] For example, the EMCDDA suggests that brown heroin purchases range from 15-25% purity and white heroin ranges between 45-70% in most Member States.

the 20% level, we use the lowest price reported for heroin; for 40% we use the geometric mean when more than one price is reported; and for 60% we use the highest price reported. For Asia, we use a weighted average based on the share of opiate consumption attributable to opium and heroin.

4.2 Results and discussion

Table 13 presents retail expenditures for the countries believed to account for the vast majority of the market.

Table 13 Heroin expenditures by assumed purity at retail level (€2005 millions)

Country	20% pure	40% pure	60% pure	40% purity estimate/GDP
Austria	250.7	152.4	123.5	0.06%
Belgium	110.0	55.0	36.7	0.02%
Cyprus	8.5	5.0	4.0	0.04%
Czech	85.9	42.9	28.6	0.04%
Denmark	276.2	180.8	157.9	0.08%
Estonia	159.5	79.7	53.2	0.68%
Finland	98.7	49.4	32.9	0.03%
France	1,031.0	576.5	429.7	0.03%
Germany	981.9	491.0	327.3	0.02%
Greece	193.2	100.7	70.0	0.05%
Hungary	170.2	98.2	75.6	0.11%
Ireland	426.5	213.2	142.2	0.13%
Italy	2,649.1	1,623.0	1,325.8	0.11%
Latvia	321.8	160.9	107.3	1.20%
Lithuania	67.5	33.7	22.5	0.16%
Luxembourg	36.0	18.0	12.0	0.06%
Malta	15.8	7.9	5.3	0.16%
Netherlands	157.2	78.6	52.4	0.01%
Norway	249.0	124.5	83.0	0.05%
Poland	299.0	149.5	99.7	0.06%
Portugal	319.5	159.7	106.5	0.10%
Slovakia	62.9	31.4	21.0	0.08%
Slovenia	44.6	22.3	14.9	0.08%
Spain	720.5	360.3	240.2	0.04%
Sweden	135.0	79.1	61.9	0.03%
Switzerland	251.0	125.5	83.7	0.04%
UK	4,606.7	2,303.4	1,535.6	0.12%
Canada	672.2	397.7	313.8	0.04%
US	11,597.0	5,981.4	4,113.4	0.06%

Notes: Prevalence and price figures from UNODC. Consumption information from Abt (2001) and Paoli *et al.* (2009).

There are some important similarities between these figures and others in the literature. First, the 40% estimate for the UK (€2.3 B in 2005) is reasonably close to the point estimate generated by Pudney *et al*. for heroin in 2003/4 (€1.8 B +/- .342). Second, the 40% estimate for the US (€7.2B in 2005) is reasonably close to the point estimate generated by Abt for heroin in 2000 (€9.45B). Part of this discrepancy can be attributed to the 13% decrease in the price for a pure gram of heroin in the United States from 2000 to 2005 (Arkes, personal communication). Third, the sum of the figures for US and Canada at 40% (€7.6 B) is very close to what the UNODC found for North America in 2002/2003 (€7.9 B). Finally, our estimate of the total pure grams consumed in the U.S. (14.3 MT; Table 3) is consistent with the DASC's (2002) estimate that there is between 13 and 18 MT of pure heroin available of in America. Of course, the amount consumed will be less than the DASC estimates since some of this heroin is confiscated, but it is encouraging to know that our crude calculations are reasonably close.

But the glaring discrepancy between these figures and the UNODC estimates is with Western and Central Europe. Our calculations for this region for 60% and 20% purity are roughly €5 B and €14 B, respectively, while the UNODC puts estimates expenditure to exceed €22 B. This is largely attributable to the aforementioned fact that UNODC estimates suggest the average user uses 58 pure grams a year, whereas we assume a value of 30 grams.

CHAPTER 5 Cocaine

This section focuses on expenditure and consumption estimates for the nine countries believed to account for most of the world's retail cocaine market (seven in Europe, two in North America). While the data used to estimate the size of the global retail market for cannabis are limited, they are much richer than what is available for cocaine. This is especially true for Europe where some countries appear to be in the early stages of a cocaine epidemic (The U.S. was at its peak nearly 25 years ago).[24] The lack of data requires us to make strong assumptions about large markets and we are not comfortable making assumptions for the smaller markets for which there is even less information. Still, we hope that generating ranges for these nine major countries will improve understanding of the size of the retail market. Furthermore, this exercise will highlight the data gaps that need to be filled to calculate more precise estimates.

5.1 Cocaine consumption in Europe

The subsection focuses on the seven European countries that account for roughly 90% of current past-month cocaine users in Europe: France, Germany, Italy, Netherlands, Poland, Spain, and the United Kingdom (EMCDDA, 2007b). Similar to the cannabis section, we attempt to generate country-specific ranges using readily available country-specific prevalence and price data as well as region-specific assumptions about quantity consumed. Pudney *et al*. (2006) provide a rigorous estimate of the size of the powder and crack cocaine markets in the UK in 2003/4; one reasonable approach for the UK would be to update this to reflect 2005. But since we are tasked with generating estimates for multiple countries, we will use a different methodology that can be applied to all European countries and then use Pudney *et al*. (2006) to assess the face validity of our estimates.

[24] A useful description of how to think about drug epidemics is presented by Paoli *et al*. (2009): "In contemporary discourse, the concept of "epidemic" is often used to describe the initial and usually precipitous but limited, phase of illicit drug demand creation and particularly the sudden expansion of heroin demand in a variety of contexts from the 1960s onwards. The notion of a drug use epidemic captures the fact that drug use is a learned behaviour, transmitted from one person to another. Contrary to the popular image of the entrepreneurial "drug pusher" who hooks new addicts through aggressive salesmanship, it is now clear that almost all first experiences are the result of being offered the drug by a friend. Drug use thus spreads much like a communicable disease; users are "contagious," and some of those with whom they come into contact become "infected."

While crack cocaine is available throughout Europe, powder cocaine dominates the market in all countries except the UK (EMCDDA, 2007b). The EMCDDA special report on cocaine notes, "In Europe, crack cocaine use seems to be stable at a low level and concentrated among certain marginalized subpopulations in some cities" (2007b, 9). Pudney *et al.* (2006) estimate that crack accounts for the majority of cocaine expenditures and pure grams consumed in the UK, and more than half of cocaine treatment admissions in the UK are for crack (EMCDDA 2007a, TDI 115). Indeed, the UK appears to account for over 80% of all primary crack episodes in Europe. Thus, this European section will only incorporate information about crack for the UK; in other countries all cocaine users will be treated as powder cocaine users. This turns out to be a fairly non-consequential assumption.

As with cannabis, we use Equations 1 and 2 to estimate total consumption and retail expenditures for European countries. However, for cocaine we assume that all end users purchased their product. This is a strong simplifying assumption and we have no reason to believe that it is correct. More research needs to be conducted on the level of gifting among light and heavy users, especially in European settings. But as mentioned in the previous section, gifting is likely to be less common for the more expensive drugs.

5.1.1 Number of users

The estimate of users is based on the number of past-year cocaine users in the general population as reported in the EMCDDA's *Statistical Bulletin 2007* (Table 14). Since these figures generally exclude those not covered by the household surveys, they should be viewed as conservative. But considering that many European countries are in the early stages of an epidemic, we would expect estimates from the household surveys to be relatively more accurate than if the countries were at the end of the epidemic (as is the case in the United States).

Table 14 Self-reported cocaine users in the general population circa 2005

Country	Year of prevalence estimate	Past year cocaine users
France	2005	245,960
Germany	2003	550,102
Italy	2005	852,039
Netherlands	2005	66,713
Poland	2002	135,915
Spain	2005	822,811
UK	2005	924,258
Sources: EMCDDA, 2007a; US Census, 2008.		

5.1.2 Underreporting

For prevalence-based cocaine estimates, a large hurdle is estimating the amount of underreporting that occurs given the stigma associated with powder and crack cocaine. As cocaine is an expensive drug, this underreporting has significant implications for calculating the size of the global drug market. Some of the available European evidence on this comes from arrestee populations in the UK, and the results are inconsistent. Pudney *et al.* (2006) report that according to the 2003/2004 Arrestee Survey (England), 40% of

those testing positive for cocaine did not self-report using crack or powder cocaine within 48 hours of arrest. They also report information from a different arrestee survey conducted in England and Wales from 1999-2002 (NEW ADAM: New England and Wales Arrestee Drug Abuse Monitoring) suggesting that the rate of cocaine underreporting is 15.3%.[25] Both of these figures are higher than an earlier NEW ADAM analysis suggesting that only 3.9% of the arrestees tested positive but did not report using cocaine (Taylor & Bennett, 1999). The corresponding figures for arrestees in the United States range from 17% to more than 50%, with most of the figures near the top of the range (Hser *et al.*, 1999; Taylor & Bennett, 1999; Liu *et al.*, 2001; Authors' analyses of 2003 ADAM data).

While it is not surprising that there is underreporting among arrestees who may be suspicious of research inquiries about illicit drug use, evidence from the United States suggests that cocaine underreporting may be even higher in the household population. As noted in Table 1, Harrison *et al.*, (2007a) found that only 21% of respondents aged 12-25 who tested positive for cocaine self-reported using powder or crack cocaine in the previous thirty days (Harrison *et al.*, 2007a, Table 6.5). Whether or not it extends to those older than 25 is an empirical question; however, this high denial rate consistent with another large-scale study considering three populations in the Los Angeles area (Hser *et al.*, 1999): 1) sexually transmitted disease patients (N=1,419), emergency room patients (N=1,115), and arrestees (N=1,982). Of those testing positive for cocaine in these three groups, the share self-reporting no use within the previous three days was 69%, 59%, and 37%, respectively; this suggests that the denial rate for those in the criminal justice system may not always be smaller than it is for other populations.

While it is beyond the scope of this project to precisely estimate the denial rate for each country (and impossible to do with existing data), we would be remiss if we did not attempt to incorporate this into our estimates given these extremely large discrepancies. Thus, for our low estimate we will assume that there is no underreporting and for our best estimate we will assume that survey information only captures 66% of total cocaine consumption within a country (i.e., we will multiply the total grams consumed in our high estimates by 1.5). We use this highly speculative figure for a few reasons: 1) Data from Abt (2001) suggests that "about 65 percent of cocaine users were deemed truthful" (p. 39), and 2) while the intra-country ranges presented above are wide, assuming that two-thirds of the respondents were honest is consistent with some of the studies in the UK and US. For our high estimate we will assume that only 50% of those respondents honestly report their powder or crack cocaine use. We fully acknowledge that applying this figure to the high estimate dramatically increases our range and makes it difficult to be confident about the true value.

5.1.3 Heavy versus light users

We follow the useful modelling convention developed by Everingham & Rydell (1994) and used by others (e.g., Caulkins *et al.*, 2004) of classifying past-year users as either heavy

[25] Ultimately, Pudney *et al.* (2006) did not make adjustments for underreporting in their final estimates of the UK retail market. They note: "No adjustment has been made for under-reporting by survey respondents. If made, such an adjustment would increase the estimates, with a larger impact on "hard" than "soft" drugs" (75).

or light users. Those who use cocaine less than three times a month are defined as light users and everyone else is considered a heavy user.

While it is easy to obtain information about the share of past-year users who used in the past month, obtaining more detailed information regarding the frequency of drug use in the past year or month from the household surveys in Europe is difficult. Indeed, the EMCDDA asked member states to include a special section about cocaine use for their 2006 national report and the UK (which has a relatively large cocaine-using population and strong data infrastructure) report noted:

> Even with the large numbers surveyed by the BCS [British Crime Survey], numbers using recently [past 30 days] are too small to provide reliable evidence of frequency of use and therefore are not considered in this report" (171).[26]

Frequency data based on the 2003 Household Survey in Italy suggest that among past-year users, 78% used once or less in a month, 13% used 2-4 times in a month, 6% used 2-3 times in a week, and 4% used 4 times in a week. Unfortunately, these data do not fall nicely into the same categories used in the Everingham & Rydell modelling convention. If we first assume that the distribution of users within the 2-4 times a month category is uniform, then we can calculate that 82.3% of past year users (= 78% + 1/3 *13%) and 17.7% of past year users are heavy users. If instead we assume that most of the people reporting in the 2-4 times category use at the lower end, say 50%, then we can get a lower estimate of heavy users given by 16.5% (=6% + 4% + ½ * 13%). Given the similarities, we will multiply the number of past year users by 17% to generate the number of heavy users.

If one is willing to assume that the distribution of light to heavy users for other European countries can be approximated by the shares for Italy, then we can use these fraction of past year users as parameters to determine the number of light and heavy users in each country using the country-specific annual prevalence rate for cocaine. Of course, there is good reason to doubt the validity of this assumption, but without country-specific data on frequency of cocaine use in the past month in the HH population, there is no better information available on which to build an alternative assumption.

5.1.4 Consumption days for heavy and light users

Preinzleve *et al.*'s (2004) multi-city study of cocaine use in Europe inquired about consumption days in the past 30 days for three different groups of users: Those in treatment (mainly opioid substitution maintenance), socially marginalized users not in treatment, and socially integrated users not in treatment. The sample for the nine cities is relatively large (1855 users, roughly 600 in each group), but the estimates are neither representative nor precise. The mean number of use days in the previous month (standard deviation in parentheses) was 11.2 (11.1) for the treatment group, 13.9 (12.6) for the marginalized group, and 7 (6.7) for the integrated group. If we assume the same level of consumption for the entire year (by multiplying each figure by 365/30), we get annual use-day estimates of 136, 169, and 85 days, respectively. For the lack of better information

[26] The report does include information about the share of past-month users aged 16-24 years who used cocaine more than once.

about use in Europe, we assume that the average number of use-days for a heavy user is uniformly distributed between 85 and 169 days.

We are currently unaware of data sources that provide the annual number of use days for either past month users or light users in Europe. This is troubling since these lighter users tend to account for most cocaine consumption early in an epidemic. For the lack of better estimates, we focus on the extreme values for the low and high values. For the low value, we assume that the user only used once in the previous year. For the high value, we assume they used twice a month (still technically a light user) for the previous year. Assuming a uniform distribution, the average light user will use approximately once a month [12.5 days= (1 day+24 days)/2].

5.1.5 Consumption per use day

The EMCDDA's (2007b) special report on cocaine and crack use noted that data about quantities of cocaine "are limited and vary between studies (15)." Indeed, the lack of data is evidenced by the fact that the EMCDDA's report references only one study about quantity consumed, and this was based on a magazine survey of UK clubbers that was sourced as personal communication. For powder cocaine, Pudney *et al.* (2006) assumes that intensive users use 0.8 raw grams per use day (+/- 0.2 grams) and non-intensive users consume 0.55 raw grams per use day (+/- 0.2 grams).[27] The authors generate these figures based on information from Australian household data, personal communication with the NCIS, and the Drugscope website. For this estimate, an intensive user is defined as someone who used in the previous week, which roughly corresponds to our definition of heavy user (used more than 2 times in the previous month).

Gossop *et al.* (2006) interviewed past-month cocaine users in clinical and non-clinical settings outside of London to learn more about how cocaine consumption during an episode changed when alcohol was also consumed. Typical amounts of powder cocaine consumed ranged from 0.2 grams when alcohol was not consumed to 0.9 grams when alcohol was also consumed. While the paper does not explicitly report the share of cocaine episodes involving alcohol, other passages in the text imply this is over 90%; suggesting that the 0.9 gram figure is more likely to be representative of a typical amount consumed. Since this sample included those in clinical settings as well as that not in treatment, one could argue that it is probably a reasonable estimate of the amount consumed for an intensive user.

As for crack cocaine, Pudney *et al.* argue that there is little systemic evidence about quantity consumed and that unreliable[28] arrestee evidence "suggests a level only slightly lower than that for powder cocaine" (66). They suggest that this difference may attributable to the fact that crack has a higher level of purity than powder cocaine. Gossop *et al.* (2006) find that typical amounts of crack consumed do not dramatically differ when

[27] Consumption is based on raw grams, as that is all that people are able to report. Although the raw amounts appear close, the average purity of cocaine consumed may differ between light and heavy users if heavy/regular users are better at evaluating the probable purity of the drug upon physical inspection or have regular sellers from which they know they can get a purer product.

[28] Their term, not ours.

alcohol is consumed (1.1 grams) or not (0.9 grams). Since they find that concurrent crack and alcohol use was far from the norm in their snowball sample, we should give more weight to the lower bound estimate (0.9 grams). Since this is well within the range we are using for powder cocaine, we do not include separate quantity consumed estimates for crack and powder cocaine. Thus, for the upper bound estimate we assume 1 raw gram per use day.[29]

5.1.6 Price

Purity-adjusted prices are not available for Europe, so our results are based on average price per raw gram as reported by the EMCDDA (Table 15). When only a high and low estimate is presented, or the mean is simply the midpoint of the high and low estimate, we use the geometric mean of these values for the price. Otherwise, we simply use the reported mean. All prices are for powder cocaine except for the UK which is the geometric mean of powder and crack cocaine.

Table 15 Price per raw gram of cocaine

Country	Price per raw gram (€)
France	58.5
Germany	60.5
Italy	86.2
Netherlands	45.0
Poland	44.8
Spain	70.4
UK	100.0
Sources: Author calculations based on EMCDDA, 2007a.	

5.2 Cocaine consumption and expenditure in North America

Whereas we believe that those covered by the household surveys currently account for the vast majority of cocaine consumption in Europe, this is definitely not the case in the United States (Abt, 2001; Caulkins *et al.*, 2004). Accordingly, this requires using a different methodology for constructing price information in North American than what is used for Europe.

5.2.1 United States

There have been two major attempts to generate cocaine consumption estimates for the United States (Everingham & Rydell, 1994; Abt, 2001). Each used a different strategy to 1) account for cocaine users not covered by the household population and 2) estimate the share of "heavy" or "chronic" users. Everingham and Rydell's (1994) model of cocaine initiation and demand is based on the household survey and they attempted capture

[29] For a U.S. treatment sample that used cocaine 20 or more days out of the last 30 and who used at least 4 days out of each week, Simon *et al.* (2001) found that the typical consumption during a use day was 1.09 grams.

"missing" heavy users by incorporating prevalence information for homeless and incarcerated populations. Abt's (2001) model also used survey data from the household population, but it is primarily based on arrestee surveys. Since arrestee surveys were only conducted in select jurisdictions (as part of the DUF/ADAM program), advanced statistical techniques were used to extrapolate these results and generate national estimates.[30]

Despite these different methodologies, recent work by Caulkins *et al.* (2004) highlights that there are considerable similarities in the total number of users for the overlap years (1988-1993).[31] For example, in 1993 Everingham & Rydell calculated there were 6.29 million past year users (Light=4.05, Heavy= 2.24) whereas Abt calculated 6.41 million (Occasional=3.33, Chronic=3.08). However, there is a difference for the share of frequent users. Recall that Everingham and Rydell define "heavy" as anyone using more than two days in the past month; for Abt, a user is considered "chronic' is they used more than nine days in the previous month. Thus, the fact that the Abt estimate for chronic users exceeds the E&R estimate for heavy users suggests that the Abt approach would likely lead to a larger estimate of total grams consumed. However, this is not the case. Despite using different methodologies with different limitations, the Abt estimate for 1993 was 331 pure MT[32] which is almost identical the 332 pure MT we derive from E&R for 1993 (4050000 users*16.42g + 2240000*118.9g).[33]

The work by Caulkins *et al.* (2004) is also important because they update some of the parameters used in Everingham & Rydell's model of cocaine initiation and demand as well as make consumption projections through 2012 (thus covering 2005, our year of interest). Assuming a constant rate of cocaine initiation between 2000 and 2005 (based on the average of 850,000 new initiates each year), Caulkins *et al.* (2004) projected 3.84 million light users and 1.6 million heavy users in 2005. Changes in the sampling methodology used by SAMHSA to generate the household survey between 2000 and 2002 make it difficult to compare initiation rates (or any other measure) over this period,[34] but if the post-2000 rates of cocaine use (converted to population numbers in Table 16) are not substantially influenced by changes in the design and implementation of the household survey, then figures based on 850,000 initiates a year would likely underestimate the total

[30] Related work was conducted by Brecht *et al.* (2003).

[31] Caulkins *et al.* (2004) note "on average E&R reported 0.985 times as many total users as did Abt/ONDCP" (p. 320).

[32] Abt (2001) bases this total consumption figure on total expenditure estimates from arrestees (adjusted for in-kind payments) and price per pure gram of cocaine from the DEA's STRIDE database.

[33] As for grams consumed by type of user, Everingham and Rydell assumed that heavy and light users consumed 118.93 and 16.42 pure grams of cocaine per year, respectively. This led to the widely-cited statistic that heavy users consumed 7.25 more per capita than light users (Caulkins *et al.*, 2004).

[34] From the 2002 NSDUH: "Several improvements to the survey were implemented in 2002. In addition to the name change, respondents were offered a $30 incentive payment for participation in the survey starting in 2002, and quality control procedures for data collection were enhanced in 2001 and 2002. Because of these improvements and modifications, estimates from the 2002 NSDUH should not be compared with estimates from the 2001 or earlier versions of the survey to examine changes over time. The data collected in 2002 represent a new baseline for tracking trends in substance use and other measures."

number of users. Interestingly, Caulkins *et al.*'s past-year prevalence projection for 2005 (5.44 million users = 3.84 million light users + 1.6 million heavy users) is remarkably close to the figure reported in the 2005 NSDUH (5.5 million).

Table 16 Cocaine users covered by the household survey in the United States

Year	Past-year users (000s)	New initiates (000s)
1999	3,742	917
2000	3,328	1,002
2001	4,186	1,140
2002	5,902	1,073
2003	5,908	1,094
2004	5,658	998
2005	5,523	872
Notes: Includes powder and crack cocaine users. Important changes to survey methodologies in 2001 and 2002.		

Future work should incorporate these newer prevalence and initiation estimates into these Markov models, especially since they seem to be much higher than what was estimated in the past. NSDUH 2002 notes:

"Several improvements to the survey were implemented in 2002. In addition to the name change, respondents were offered a $30 incentive payment for participation in the survey starting in 2002, and quality control procedures for data collection were enhanced in 2001 and 2002. Because of these improvements and modifications, estimates from the 2002 NSDUH should not be compared with estimates from the 2001 or earlier versions of the survey to examine changes over time. The data collected in 2002 represent a new baseline for tracking trends in substance use and other measures."

Additionally, the fact that NSDUH generates accurate numbers of those on probation and parole suggest that the new methods may increase the share of "marginalized" populations that account for a large share of drug use.

The other important issue at hand is how to account for the vast majority of cocaine users near the age of initiation who lied about their cocaine use. The average age for initiation is about 20 years (NSDUH 2004) and recall that Harrison *et al.* (2007a) compared self-report and drug tests results for nearly 4,000 respondents aged 12-25 in the household survey. Harrison *et al.* did not report the validity results by initiation status and there are initiates older than 25, so the results may not be directly comparable. As noted earlier in the report, our approach to address this underreporting is to assume that it is zero for the low estimates and multiply the high estimate by 2.

The estimate for the retail price of a pure gram of cocaine in 2005 was generated using micro data from the DEA's STRIDE database (€86.67).

5.2.2 Canada

The most recent household survey in Canada was for 2004 and it was estimated that 1.9% of the household population used cocaine or crack in the previous year (CCSA 2005). Multiplying this by the population aged 15-64 in 2005 generates 422,000 past year users. Given its proximity to the world's largest cocaine market and its similar per capita income, we assume a similar ratio of heavy to light users and employ the same assumptions and ranges as used for the United States (including price).

5.2.3 Results and discussion

Table 17 demonstrates how we generate our consumption and retail figures for European countries, using Spain as the example. After separating the past year users in the household into light and heavy users, we multiply these figures by the annual grams consumed (use days*average grams used per use day), which is different for the low, best, and high estimates. We then make an adjustment for underreporting and multiply this figure by the retail price per gram. Recall that the calculations are slightly different for the United States and Canada since annual grams consumed is not based on use days multiplied by average grams used per use day. Further, we only calculate a range for the United States and Canada.

Table 17 Cocaine consumption and expenditures in Spain, 2005

		Low	Best	High
	Total users	822,811	822,811	822,811
	Fraction heavy users	17%	17%	17%
Light users	Number of users	682,933	682,933	682,933
	Days used in 2005	1	12.5	24
	Grams per use day	0.35	0.55	0.75
Heavy users	Number of users	139,878	139,878	139,878
	Days used in 2005	85	125	169
	Grams per use day	0.6	0.8	1
Total amount consumed	Total grams--Light	239,027	4,695,167	12,292,801
	Total grams--Heavy	7,133,774	13,989,021	23,639,368
	% underreporting	0.0%	33.0%	50.0%
	Total grams--All	7,372,801	27,886,848	71,864,338
Total retail expenditures	Price per raw gram	70.4	70.4	70.4
	Total retail (Euros)	519,045,160	1,963,234,101	5,059,249,400

Table 18 presents the estimates of the size of the retail cocaine market circa 2005. Our results suggest that the UK has the largest cocaine market in Europe, with retail expenditures on powder and crack cocaine ranging from €.8-€8.1 Billion. This includes Pudney *et al.*'s UK range of €2.7-€4.7 Billion. Despite using different methodologies (e.g., we incorporate underreporting, they include information from arrestee surveys), our ranges for total consumption (raw) are fairly similar (Pudney *et al*: 6M to 60M; [35] RAND: 8M to 81M). What is most notable, however, is the size of the range for both studies. This highlights how little we actually know about cocaine markets in Europe.

[35] Calculated by summing the point estimates and uncertainty bounds for powder and crack cocaine. For powder they report 17.7 +/- 13.72 and for crack they report 15.58 +/- 13.29.

Table 18 Estimates of the size of the retail cocaine market circa 2005 (€ in millions)

Country		Low	Best	High	Best/GDP
France	€	128.9	487.7	1,256.7	0.03%
	MT	2.2	8.3	21.5	
Germany	€	298.2	1,128.0	2,906.8	0.05%
	MT	4.9	18.6	48.0	
Italy	€	658.1	2,489.2	6,414.8	0.17%
	MT	7.6	28.9	74.4	
Netherlands	€	26.9	101.7	262.2	0.02%
	MT	0.6	2.3	5.8	
Poland	€	54.6	206.4	531.8	0.08%
	MT	1.2	4.6	11.9	
Spain	€	519.0	1,963.2	5,059.2	0.21%
	MT	7.4	27.9	71.9	
UK	€	828.2	3,132.5	8,072.5	0.17%
	MT	8.3	31.3	80.7	
Canada*	€	1,716.2	2,561.5	3,432.4	0.27%
	MT	19.8	29.6	39.6	
US*	€	22,123.5	33,020.1	44,246.9	0.32%
	MT	255.3	381.0	510.5	

Notes: *All values are for adulterated (raw) cocaine except for the values for Canada and the U.S., which are for pure cocaine.

As expected, the U.S. accounts for the vast majority of global expenditures and grams consumed. While our low estimate for consumption in the United States (255 MT) is similar to what Abt (2001) calculated for 2000 (250 MT), our expenditure estimates are notably lower (€22B and €33B, respectively). This is not surprising since the price per pure gram of cocaine at the retail level dropped about 30% from 2000 to 2005 (RAND analyses of STRIDE). Our best estimate of 381 MT is generated by multiplying this low figure by 1.5 to account for 33% underreporting. Whether or not this is the most appropriate inflation factor is clearly an empirical question deserving of additional research.

The uncertainty associated with cocaine markets is not limited to demand-side estimates.

There is also considerable debate about the amount of the land used to grow coca in Colombia in 2005 (by far the world's largest producer). While the UNODC estimates that 99,000 hectares were dedicated for coca cultivation in 2007, the U.S. State Department estimates this figure to be over 157,000 hectares. We address this in more detail in Appendix A.

CHAPTER 6 Amphetamine-type substances

Our final section focuses on amphetamine-type substances (ATS), namely amphetamines, methamphetamines, and ecstasy. Despite the popularity of these substances (especially in Europe), we know very little about typical quantities consumed, which makes generating demand-side estimates very difficult. These substances take many forms (especially across countries), come from a variety of sources, and unless the drug is diverted from a legal source or tested by the user (e.g., at a rave), most users only have a vague idea about what they are actually consuming. Further complicating our understanding is that many authors do not explicitly state whether they are discussing the consumption of pure or raw milligrams of methamphetamine.

The uncertainty about ATS consumption and the size of the retail market is evident in the various estimates generated by the UNODC over the past five years (Table 19). In the *2008 Global ATS Assessment*, the UNODC calculates the global ATS retail market in 2006 to be $63.4 billion, virtually identical to their $63.7 billion estimate for 2001.[36] Both of these estimates are different from UNODC's previous ATS market estimate for 2002/2003 which is considerably lower ($44bn) and based on a different methodology.[37]

[36] It is also unclear how the $63.4 B estimate was estimated. The algorithms used to generate these figures are not listed and the half page of text that accompanies this table only makes a brief comment about the methodology. For example, the report notes that the average price for pure methamphetamine at the retail level in North America was $100.10. The formula is not listed, but our calculations suggest that the authors may have taken the typical price reported in Canada ($87.7) and the United States ($112.5) from the 2008 World Drug Report and calculated the raw average [$100.10 = ($112.5+$87.7)/2]. This appears to be same methodology used for Eastern Europe ($19; Belarus=$33, Moldova=$5) and East Asia ($640; Japan=$389.70, Republic of Korea=$892.1). We do not know if this methodology was employed for all regions and substances, but consumers of this research should know that the results may be different if a weighted average was used to calculate the regional retail prices. Further, it is also important to note that the regional results will be sensitive to the countries actually included in the calculation (e.g., based on our calculations it appears that Mexico is not included in the retail price estimates for North America).

[37] An entire chapter of the 2005 World Drug Report is devoted to describing the results of the UNODC's input/output model of the global drug market.

Table 19 Various UNODC estimates of the global retail market for ATS

Source	Quote and/or Figure
UNODC (2003). Ecstasy and Amphetamines: Global Survey 2003. Page 47.	For 2001: "[T]he retail market is valued at about **$65 billion**, based on 42 million ATS users worldwide, and average retail prices"
UNODC (2005). 2005 World Drug Report. Page 127.	For 2002/2003: "The ATS markets together (methamphetamine, amphetamine, and ecstasy) amount to **US$44 bn**."
UNODC (2007c, December). UNODC's Experience in Sizing the Drug Markets. Presentation by T. Pietchman, Notes on Slide 4.	For 2002/2003: Global estimate for ATS is **$44 billion**
UNODC (2008b). 2008 Global ATS Assessment. Page 111.	For 2006: "Reveal a size of the ATS retail market of around **$63 billion (or $65 billion if rounded)**, which is practically unchanged from five years ago"
UNODC (2008d, September 9). UNODC Warns of Growing Abuse of Synthetic Drugs in the Developing World. Page 1.	"The global market for amphetamine-type stimulants (ATS) is estimated at **US$65 billion**, **wholesale and retail combined**."

This section briefly reviews the small literature on ATS consumption for each substance. Given the large uncertainty about the consumption of ATS (namely consumption days and average amounts consumed on a use day), we are reluctant to generate a "best" estimate for ecstasy and amphetamines. Instead, we only offer low and high estimates based on the very thin literature. In the final subsection we include low, best, and high estimates of the methamphetamine market in the United States for the household population.[38]

6.1 Quantity consumed

There is a lot of variation in the estimates of the quantity of ecstasy consumed. The UNODC input/output model suggests that past year users used, on average, 10 pure grams of Ecstasy in Western and Central Europe, and 9 pure grams in North America. The 2008 Global ATS Assessment assumed a global average of 100mg of Ecstasy per tablet, with a lower bound of 60-70mg. This would suggest a range of 100 tabs (10g/100mg) to 154 tabs (10g/.65g) for Western and Central Europe and 90 to 139 tabs for North America.

The UNODC estimates are larger than those generated elsewhere. Pudney *et al.* (2006) calculate that in 2004 between 32.6 M and 86.4 M tabs of ecstasy were consumed. With roughly 700,000 ecstasy users in the household population (EMCDDA, 2007a), this suggests a range of 47 tabs (32,600,000/700,000) to 123 tabs (86,400,000/700,000) per past year user.[39] Additionally, in an assessment of the global ecstasy market, Blickman (2004) refer to a study by the Dutch National

[38] While methamphetamine is not popular in Europe, it does have a strong presence in the Czech Republic and Slovakia. According to the EMCDDA (2008c): "Methamphetamine is the most widely abused synthetic psychotropic drug, particularly in North America and countries of the Far East. Among European countries, methamphetamine is most frequently consumed in the Czech Republic and in Slovakia, although the availability or use of the drug is sporadically reported by other countries. In 2006 in the Czech Republic there were estimated to be approximately 17 500–22 500 methamphetamine users (2.4 to 3.1 cases per 1 000 aged 15–64 years) and in Slovakia around 6 200–15 500 (1.6 to 4 cases per 1 000 aged 15–64 years)" www.emcdda.europa.eu/publications/drug-profiles/methamphetamine

[39] Pudney *et al.* (2006) assumed an average purity of 65mg in their calculation of the UK market, which is similar to the low purity estimate offered by UNODC.

Criminal Investigation Services[40] which suggests "that the consumption per user is more likely in the range of 20-40 pills per year, based on studies in Canada, the UK, Germany and The Netherlands" (8). To generate the largest, but still defensible range, we use the 154 as the high estimate and the 30 from the Dutch National Criminal Investigation Services as the low estimate for Western and Central Europe. For the U.S. and Canada we use a high estimate of 139 tabs.

There is even less information available for amphetamines. The UNODC input/output model for West and Central Europe (2005) suggests that past year amphetamine users average 12 pure grams per year. Based on data from 2006, the UNODC assumed that they purity of a retail gram of amphetamine in Western and Central Europe was 38% (UNODC 2008). If we divide the 12 pure grams by the 38% purity rate, we get a consumption figure of 31.6 raw grams annually.

We are only aware of one estimate of the retail amphetamine market for a European country (Pudney *et al.*'s UK), and it relies on consumption information from the Australian 2001 household survey. This is problematic since most of the amphetamines used in Australia in 2001 were *meth*amphetamines, which is a different substance.[41] The figure is also troubling since no distinction was made for intensive and non-intensive users (1 raw gram +/- 0.2 is used for both). Alas, this is the only figure we could find in the published literature for amphetamine use per use day in Europe and the authors suggest that it is "broadly consistent with anecdotal evidence. . . (66)."

Pudney *et al.* (2006) estimate that 36.7 MT were consumed in 2004 and with approximately 600,000 users in the UK.[42] This equates to approximately 60 grams per user, and assuming 1g per use day this would suggest that the average user used 60 days in 2004. Interestingly, this is similar to the average number of days used for stimulant users (excluding methamphetamine) in the United States (Mean: 59.11 days, 95%CI: 50.41-67.81). Assuming the same distribution for the United States, the UK, and the rest of the region, applying the daily use figures for the 95% confidence interval generates a low and high estimate of 40.3 raw grams (50.41*0.8) and 81.4 raw grams (67.81*1.2), respectively. To generate the largest, but still defensible range, we use this 81.4 as the high estimate and the 31.6 from the UNODC as the low estimate.

6.2 Number of users and price

In most cases the past-year prevalence figures are from the EMCDDA, but in a handful of cases these numbers were pulled from the WDR. The figures for amphetamine also include methamphetamine, which really only matters for the Czech Republic and Slovakia (Pervitin). Most of the price information is obtained from the EMCDDA and when the mean is not listed or is purely the

[40] IVVan der Heijden, A.W.M. (2003), De Nederlandse drugsmarkt, Dienst Nationale Recherche Informatie (DNRI), Zoetermeer, November 2003.

[41] As noted by Dunn *et al.* (2007): "Throughout the 1990s, the proportion of amphetamine-type substance seizures that were methamphetamine (rather than amphetamine sulphate) steadily increased, until methamphetamine dominated the market. In the financial year 2000/01, the vast majority (91%) of all seizures of amphetamine were methamphetamine (Australian Bureau of Criminal Intelligence 2002).

In Australia, the powder traditionally known as 'speed' is generally methamphetamine rather than amphetamine" (p 44).

[42] Estimate 544403 for those aged 16-59. Those <=15 and not covered by the household survey likely put this figure above 600,000.

midpoint, we calculate the geometric mean.[43] In some cases, we use price data from the WDR and this is noted with an asterisk.

6.3 Underreporting

Little is known about underreporting for ATS, but we think it is reasonable to assume that the stigma (and subsequently the underreporting rate) associated with amphetamines and ecstasy falls between cannabis and powder cocaine/crack. Thus, to create a range we consider the best for cannabis (20%) as the low estimate and the high estimate for cocaine (50%) as the high estimate.

6.4 Results

Table 20 presents ecstasy consumption and expenditures in Western and Central Europe as well as in the U.S. and Canada circa 2005.[44] The range for total expenditures in Western and Central Europe is €778M-€6,391 M, which comfortably includes the €2,175 M generated by the UNODC input/output model. Similarly, the range for U.S. and Canada (which account for the vast majority of ecstasy consumption in North America) ranges from €1,614 M - €12,171 M easily includes the UNODC North America estimate of €7,522 M. And once again by virtual construction, Pudney *et al.*'s (2006) best estimates for consumption (59.5 M tabs) and expenditures (€402 M) fall into the middle of the ranges we produce.

Table 21 presents amphetamine consumption and expenditures in Western and Central Europe circa 2005. The range for total consumption range is 78-321 MT, and for retail expenditures it is €1,154 M - €4,756 M. This range includes the amount generated for this region by the UNODC input/output model (€1,668 M). And virtually by construction, Pudney *et al.*'s (2006) best estimates for consumption (36.7 MT raw) and expenditures (€468 M) fall in the large ranges we produce. That being said, we are not comfortable using the midpoint or any other figure as the best estimate.

[43] The EMCDDA ecstasy prices are consistent with those some of the published qualitative literature. Massari's (2005) price estimates from the field in the early 2000s for Amsterdam was €2.5-5 per pill, €6-7 for Barcelona, and €7-15 for Turin. The EMCDDA estimates for 2005 were €3 for the Netherlands, €10 for Spain, and €19 for Italy.

[44] We do not normalize by GDP since we do not generate a best estimate. Those wishing to makes these comparisons for 2005 may consult our Appendix B.

Table 20 Ecstasy consumption and expenditures in Western and Central Europe, Canada, and the U.S. circa 2005

	Past year ecstasy users circa 2005	% Under-reporting LOW	% Under-reporting HIGH	Mean tablets consumed per user LOW	Mean tablets consumed per user HIGH	Total tablets LOW	Total tablets HIGH	Price per tablet (€)	Retail spending LOW (000s €)	Retail spending HIGH (000s €)
Austria	49,926	20%	50%	30	154	1,872,209	15,377,074	11.0	20,594	169,148
Belgium*	74,901	20%	50%	30	154	2,808,795	23,069,566	4.2	11,825	97,123
Cyprus	5,283	20%	50%	30	154	198,110	1,627,139	11.6	2,304	18,920
Czech	241,131	20%	50%	30	154	9,042,414	74,268,364	7.3	66,010	542,159
Denmark	10,591	20%	50%	30	154	397,171	3,262,096	6.6	2,621	21,530
Estonia	15,332	20%	50%	30	154	574,947	4,722,228	7.0	4,037	33,153
Finland	17,441	20%	50%	30	154	654,049	5,371,919	15.5	10,132	83,221
France	163,973	20%	50%	30	154	6,148,992	50,503,720	6.7	41,198	338,375
Germany	377,313	20%	50%	30	154	14,149,244	116,212,458	6.6	93,385	767,002
Greece	14,253	20%	50%	30	154	534,477	4,389,840	14.1	7,559	62,082
Hungary	74,879	20%	50%	30	154	2,807,978	23,062,857	4.7	13,302	109,251
Ireland	29,835	20%	50%	30	154	1,118,797	9,189,049	5.9	6,590	54,123
Italy	193,645	20%	50%	30	154	7,261,696	59,642,729	19.1	138,742	1,139,535
Latvia	12,721	20%	50%	30	154	477,044	3,918,125	4.3	2,045	16,793
Lithuania	9,884	20%	50%	30	154	370,664	3,044,383	3.5	1,290	10,594
Luxembourg*	1,557	20%	50%	30	154	58,384	479,525	10.0	584	4,795
Malta	515	20%	50%	30	154	19,294	158,469	9.2	177	1,452
Netherlands	133,426	20%	50%	30	154	5,003,464	41,095,118	3.2	15,822	129,954
Norway	15,080	20%	50%	30	154	565,482	4,644,494	12.5	7,069	58,056
Poland	53,229	20%	50%	30	154	1,996,097	16,394,608	2.1	4,206	34,546
Portugal	28,030	20%	50%	30	154	1,051,143	8,633,392	3.6	3,742	30,735
Slovakia	46,300	20%	50%	30	154	1,736,244	14,260,347	8.8	15,285	125,540
Slovenia*	12,777	20%	50%	30	154	479,151	3,935,431	10.0	4,792	39,354
Spain	329,125	20%	50%	30	154	12,342,169	101,370,351	9.8	121,200	995,457
Sweden*	23,097	20%	50%	30	154	866,129	7,113,803	12.0	10,394	85,366
Switzerland*	40,743	20%	50%	30	154	1,527,873	12,548,928	13.7	20,962	172,171

	Past year ecstasy users circa 2005	% Under-reporting LOW	% Under-reporting HIGH	Mean tablets consumed per user LOW	Mean tablets consumed per user HIGH	Total tablets LOW	Total tablets HIGH	Price per tablet (€)	Retail spending LOW (000s €)	Retail spending HIGH (000s €)
UK	689,577	20%	50%	30	154	25,859,151	212,389,825	5.9	152,310	1,250,976
Total						**99,921,165**	**820,685,837**		**778,175**	**6,391,412**
Canada	244,526	20%	50%	30	139	9,169,738	67,978,328	9.9	90,964	674,345
United States	1,960,000	20%	50%	30	139	73,500,000	544,880,000	21.1	1,550,850	11,496,968
Total						**82,669,738**	**612,858,328**		**1,641,814**	**12,171,313**

Notes: Consumption rates and price information for Europe is from EMCDDA (2007a) unless noted with an asterisk, which denotes coming from the World Drug Report. Canadian and U.S. data are from CAS 2004 and NSDUH 2005.

Table 21 Amphetamine consumption and expenditures in Western and Central Europe circa 2005

	Amphetamine users in 2005	% Under-reporting LOW	% Under-reporting HIGH	Mean grams consumed per user LOW	Mean grams consumed per user HIGH	Total grams LOW	Total grams HIGH	Price per raw gram	Retail spending LOW (000s €)	Retail spending HIGH (000s €)
Austria	44378	20%	50%	31.6	81.4	1,751,774	7,222,299	20	35,035	144,446
Belgium*	34046	20%	50%	31.6	81.4	1,343,921	5,540,781	10	13,238	54,577
Cyprus	1585	20%	50%	31.6	81.4	62,561	257,929	12	759	3,131
Czech	48226	20%	50%	31.6	81.4	1,903,666	7,848,526	33	61,869	255,077
Denmark	24713	20%	50%	31.6	81.4	975,507	4,021,868	23	22,275	91,836
Estonia	11724	20%	50%	31.6	81.4	462,805	1,908,076	7	3,249	13,396
Finland	20930	20%	50%	31.6	81.4	826,167	3,406,159	19	15,999	65,960
France	40993	20%	50%	31.6	81.4	1,618,156	6,671,410	13	21,360	88,063
Germany	424477	20%	50%	31.6	81.4	16,755,684	69,081,137	12	199,393	822,066
Greece*	14253	20%	50%	31.6	81.4	562,608	2,319,546	6	3,328	13,723
Hungary	53485	20%	50%	31.6	81.4	2,111,261	8,704,410	12	25,969	107,064
Ireland	10849	20%	50%	31.6	81.4	428,247	1,765,599	15	6,308	26,007
Italy	154916	20%	50%	31.6	81.4	6,115,112	25,211,679	18	110,868	457,090
Latvia	17492	20%	50%	31.6	81.4	690,459	2,846,658	14	9,660	39,827
Lithuania	7413	20%	50%	31.6	81.4	292,629	1,206,465	7	2,037	8,397
Luxembourg*	1246	20%	50%	31.6	81.4	49,165	202,701	10	484	1,997
Netherlands	33356	20%	50%	31.6	81.4	1,316,701	5,428,558	5	7,212	29,733
Norway	33175	20%	50%	31.6	81.4	1,309,538	5,399,025	35	46,299	190,884
Poland	186302	20%	50%	31.6	81.4	7,354,041	30,319,592	9	63,980	263,780
Portugal	7008	20%	50%	31.6	81.4	276,617	1,140,449	17	4,819	19,867
Slovakia	11575	20%	50%	31.6	81.4	456,906	1,883,755	33	14,849	61,222
Slovenia*	2839	20%	50%	31.6	81.4	112,082	462,098	10	1,144	4,715
Spain	191989	20%	50%	31.6	81.4	7,578,525	31,245,107	17	132,018	544,290
Sweden*	11791	20%	50%	31.6	81.4	465,419	1,918,852	26	12,101	49,890
Switzerland*	40743	20%	50%	31.6	81.4	1,608,287	6,630,723	14	22,495	92,744

	Amphetamine users in 2005	% Under-reporting LOW	% Under-reporting HIGH	Mean grams consumed per user LOW	Mean grams consumed per user HIGH	Total grams LOW	Total grams HIGH	Price per raw gram	Retail spending LOW (000s €)	Retail spending HIGH (000s €)
UK	544403	20%	50%	31.6	81.4	21,489,599	88,598,350	15	316,542	1,305,054
TOTAL						77,922,357	321,262,034		1,153,538	4,755,863
Notes: Consumption rates and price information for Europe is from EMCDDA (2007a) unless noted with an asterisk, which denotes coming from the World Drug Report.										

6.5 Methamphetamine

This section estimates methamphetamine consumption and expenditures for the household population in the United States.

While methamphetamine is a popular stimulant in much of Asia, the lack of data makes it impossible to generate reliable estimates for the region.[45] First, the UNODC does not distinguish between types of amphetamines for prevalence estimates in the WDR. Second, it is not clear whether the retail prices reported to the UNODC are for a pure or raw gram. Third, the price ranges reported for some Asian countries seem extremely large. For example, the retail price range for a gram of methamphetamine in Japan ranges from €70 to €557 (UNODC, 2008a). Since the retail purity is not reported for Japan and the typical amount reported is just the midpoint (€313), it is very unclear how much stock we should put into this estimate. Another example is the Republic of Korea reports a typical gram of methamphetamine costing €720, with a range from €251 to €921. Fourth, it is unlikely that the consumption patterns are the same across countries given the different incomes. Thus, future work should focus on generating country-specific estimates in Asia based on country-specific information about quantity consumed.

Generating estimates for the typical quantity of methamphetamine consumed is not only difficult because of heterogeneity in purity, but also because most studies do not report whether they are talking about raw or pure grams. Cho & Melega's (2002) technical discussion of the pharmacokinetics of methamphetamine suggest that chronic users ("periodic self-administration throughout the day") use between 0.7 and 1 grams during a use day and during a binge consumption can range from 2-4 grams (26); however, there is no discussion about whether these are pure grams. But in the same volume, Simon *et al.* (2002) present self-report information from a treatment population and note that "used from .5 to 1 gram on a typical (24 hour) day and spaced out the use to cover the waking hours." Since the questions did not ask about pure grams and most users do not know the precise purity of the methamphetamine they consume, we believe that these estimates are for raw grams.

- These ranges are consistent with a variety of sources covering different populations:
- There is information from the U.S. National Highway Traffic Safety Administration (no date) suggesting that the typically abused doses are 100-1000 mg of 60-90% pure methamphetamine: "Purity of methamphetamine is currently very high, at 60-90%, and is predominantly d-methamphetamine which has greater CNS potency than the l-isomer or the racemic mixture. Common abused doses are 100-1000 mg/day, and up to 5000 mg/day in chronic binge use."
- The 100-1000mg range is consistent with Semple *et al.*'s (2004) survey results of 194 methamphetamine-using HIV positive men who have sex with men. Among those who injected methamphetamine, they had used meth on average for 12 days in the previous

[45] Since the meth users in Czech Republic and Slovakia are included in Table 5.3, we do not include them here. Since meth is more expensive and more addictive than most amphetamine-type substances, the estimates for these countries are probably low, but surely not enough to have a dramatic impact on the range presented in Table 5.2 (especially given the focus on generating a very large range).

month and an average of 7.8 grams, for an average quantity consumed per use day 0.65 grams. The comparable figure for those who used but did not inject was 0.275 grams (8 days and 2.2 grams in the previous 30 days). Once again, since this was self-reported use by the consumer, it is more likely that they are reporting in raw grams.

- A report from the Canadian Department of Justice (2007) suggests that "Novice users can obtain a high by ingesting 1/8 gram (125mg) of methamphetamine, while a regular user ingests more to get this effect (250 mg)."[46] While this passage does not indicate that these are daily doses, they are consistent with the NHSTA range and the 250mg is consistent with the 275mg per use day for regular using non-injectors from Semple *et al.* (2004).
- This is also consistent with a report from a non-profit in Oklahoma City (an area with a very large methamphetamine problem) which suggests that the "typical dosage is anywhere from .2 grams to .4 grams" (Council of Neighborhoods, 2008).

Based on these various sources, it seems reasonable to assume that those who used in the past year but not in the past month consumed 0.25 grams per use day. We also use this as the low estimate for those who used in the past month. For a best and high estimate for the past month users we use 0.4 and 0.7, respectively. Since Simon *et al.* (2002) generated their 0.5 to 1 gram range from a treatment population, we would like the best estimate to be lower than this range. The 0.7 is the lower bound range for the chronic use described Cho & Melega (2002) and is close to 2 to 3 times the typical dosage.

The prevalence and days consumed in the previous year come from the 2005 U.S. household survey. Harrison *et al.*'s (2007a) validity study of those aged 12-25 in the household population did examine stimulants, but they were unable to distinguish consumption of amphetamines, methamphetamine, and prescription drugs. This, in addition to the small samples (in terms of positive tests and self reports) led them to conclude that "it is difficult to draw meaningful conclusions about the validity of self-reported stimulant use." Since it would be hard to argue that methamphetamine consumption is not as stigmatized behaviour as cocaine consumption in the United States, it seems reasonable to apply our cocaine inflation factors. The purity figures come from ONDCP which suggested that meth purity hovered around 70% in 2005. The price estimates were calculated by RAND to be $107 per pure gram in 2005 and converted to Euros assuming a conversion rate of 1 Euro per $1.20 in 2005.

Table 22 reports the results and our best estimate of methamphetamine expenditures by the U.S. household population €2.9B. As we would expect, this is lower than the €5.1B estimated by Abt (2001) for 2000 since we do not consider those not covered by the household surveys. Additionally, our estimates should be lower since the price per pure gram at the retail level dropped by roughly 50% between 1999 and 2005 (RAND analyses of STRIDE). The ONDCP reports that retail methamphetamine prices nearly doubled between 2005 and 2006 (ONDCP, 2007), which further highlights the fact that remarkably different estimates can be generated depending on which year is examined.

[46] See: www.justice.gc.ca/eng/dept-min/pub/meth/p2.html#1.3 as of April 16th, 2009

Table 22 Methamphetamine consumption and expenditures by the U.S. Household Population circa 2005

		Low	Best	High
Past month users (PM)	Number of users	512,000	512,000	512,000
	Days used in 2005	87.6	113.75	139.9
	Raw grams per use day	0.25	0.4	0.7
Past year, but not past month users (PY)	Number of users	785,000	785,000	785,000
	Days used in 2005	29.96	40.65	51.34
	Raw grams per use day	0.25	0.25	0.25
Total amount consumed	Total raw grams--PM	11,212,800	23,296,000	50,140,160
	Total raw grams--PY	5,879,650	7,977,563	10,075,475
	Mean purity in 2005	70%	70%	70%
	% underreporting	0%	33%	50%
	Total pure grams--All	11,964,715	32,673,871	84,301,889
Total retail expenditures	Price per pure gram	89.2	89.2	89.2
	Total retail (Euros)	1,067,252,578	2,914,509,317	7,519,728,499

CHAPTER 7 Conclusions

This report uses data on the prevalence of drug use, retail prices, and consumption patterns to generate country-level consumption and retail expenditure estimates for cannabis, heroin, cocaine, and amphetamine-type substances. Inadequate information is available for generating credible estimates for every country or making comparisons between 1998 and 2007, but the estimates presented here offer an important starting place for future work and comparisons. Given the substantial uncertainty of these figures, a range of estimates is provided rather than one specific number.

Surprisingly little is known about typical quantities consumed of illicit drugs, which makes generating demand-side estimates difficult. Fortunately, there are some simple actions that could be taken to improve understanding of both consumption patterns and retail expenditures. While the most obvious action would be to include new survey modules about purchases and quantity consumed, adding new sections to surveys can be expensive, burdensome, or both. However, adding only four questions per substance of interest to the European School Survey Project on Alcohol and Other Drugs (ESPAD) or to the general household surveys would dramatically improve the precision of country-specific demand-side estimates, especially for cannabis: 1) How many days did you use "Drug X" in the previous month? 2) On the last day you used "Drug X", how much did you use? 3) Was this amount more than, less than, or the same as what you typically use on a typical use day? and 4) How much would it cost to purchase that amount?

Another mechanism for improving the consumption and retail expenditure estimates would be for the EMCDDA to collect information about quantity consumed from the National Focal Points (REITOX) for a forthcoming annual report. The Focal Points could report their best estimates of the typical quantity consumed for light and heavy users for a variety of substances. Related to this, a few questions could be added to the UNODC's Annual Review Questionnaire about typical quantities consumed and whether this amount was in pure or raw grams. Even if this information is imperfect, it would improve country-level consumption and retail expenditure estimates for illicit drugs.

States and sub-state jurisdictions should also consider implementing arrestee-based surveys similar to the Arrestee Drug Abuse Monitoring (ADAM) programs that have been adopted in a handful of countries (e.g., Australia, New Zealand, UK, South Africa, and the United States). These surveys generate information about consumption patterns and market activities among heavy users that are often missed in school-based and general population surveys, especially for hard drugs like heroin and cocaine. This would improve knowledge about heavy drug users who are not in the treatment population as well as serve as an early

warning system for new substances of abuse. Additionally, work by Abt (2001) and Brecht *et al*. (2003) demonstrates that arrestee drug use data from sub-state jurisdictions, in conjunction with traditional arrest statistics, can be used to generate state and national estimates of hard drug users. This information form arrestee is useful for sizing the market as well as improving estimates of other important indicators (e.g., actual and potential demand for treatment).

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APPENDICES

Appendix A: Farm-gate and international trade values for cocaine and opiates

This appendix discusses the production and trafficking of cocaine and opiates, with a focus on the value of the global farm-gate market and the value associated with exporting cocaine and opiates to consumer countries. The key findings are as follows:

- The annual global farm-gate value for opium and coca combined is likely to be no more than $3 billion. While this is a very small fraction of total retail spending, cultivation does account for a non-negligible share of GDP in some producing countries (e.g., Afghanistan, Bolivia).
- While Mexico accounted for only 0.5% of total opium production in 2006, it accounted for at least 25% of the global farm-gate revenue.
- There is substantial disagreement about the amount of coca cultivated in Colombia, the world's largest producer. While other scholars have noted this difference, the growing size of the discrepancy is noteworthy. In 2007, the United Nations Office on Drugs and Crime estimate (99,000 hectares) was dramatically lower than the estimate offered by the United States Government (157,200 hectares).
- Exporting cocaine hydrochloride from Colombia to consuming countries generates a value of no more than €10B annually (import price-replacement cost). We think that the value of the opium trade is close to the upper bound of this range, but there is difficulty in generating reliable estimates for the import values.

1. Cocaine

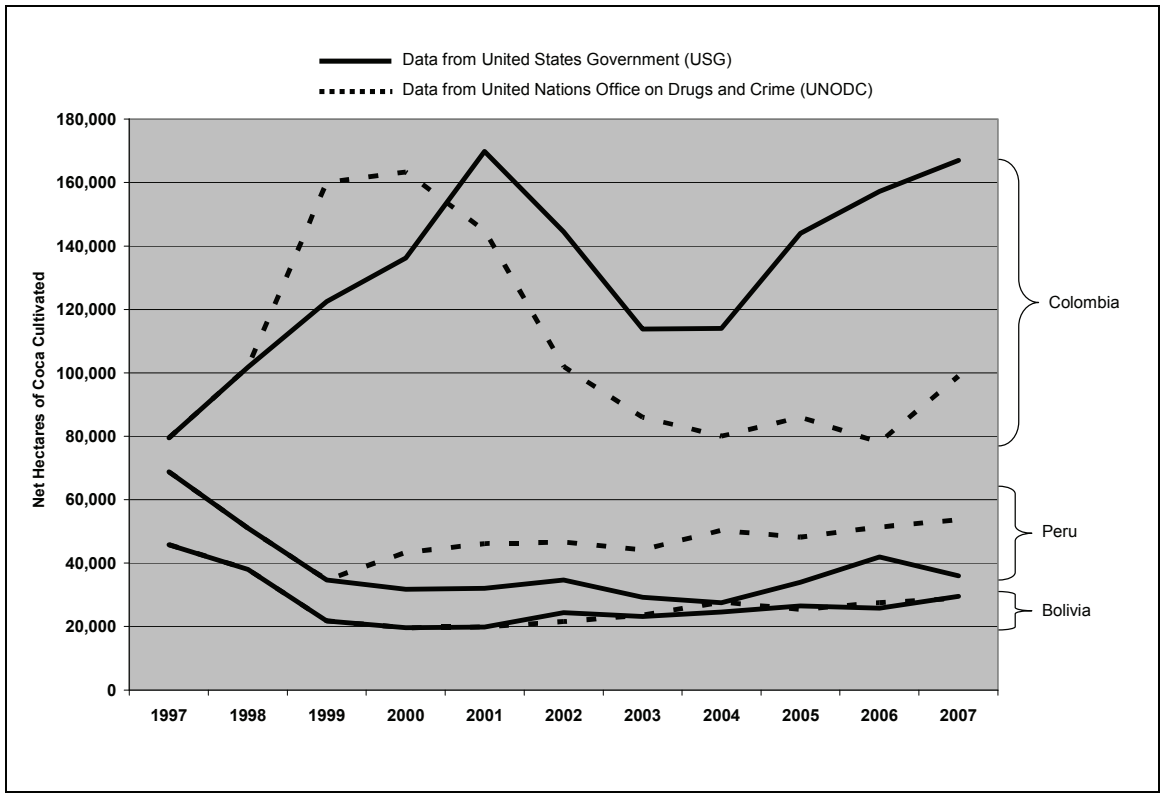
Three nations in South America account for the vast majority of the global production of coca: Bolivia, Colombia, and Peru. Colombia cultivates and processes most of the coca, and much of the cocaine hydrochloride consumed in Europe and North America passes through Colombia at some point (UNODC, 2008a). Over 90% of the cocaine destined for the United States and Canada also passes through Mexico. As for Europe, Spain and Portugal serve as the main entry points (UNODC, 2008a).

1.1 Farm-gate

While Colombia's dominant role in the cocaine trade is undisputed, there is substantial disagreement about the amount of coca cultivated in Colombia. Noting the difference between official figures for the United Nations Office on Drugs and Crime (UNODC)

and the United States Government (USG) is not novel (see e.g., Thoumi, 2005), but the growing size of the discrepancy is noteworthy. Figure A1 displays the hectares of cultivated coca in Colombia from 1997 to 2007, with the solid line representing USG estimates and the dotted line representing UNODC. Text

Figure 1 Estimates of Net Coca Cultivation from the UNODC and USG, 1997-2007



Notes: The UNODC uses the figures from the U.S. State Department for the following years: Bolivia (97-01), Colombia (97-98), Peru (97-99).

The estimates for 1997 and 1998 are identical since the UNODC uses the USG's figures for those years. For 1999 and 2000, the UNODC figures of 160,000 hectares exceeded USG estimates by 40,000 hectares. But beginning in 2001, the USG estimates exceeded the UN and the difference has grown over time. In 2007—the most recent year for which we have data from both sources— the UNODC estimate (99,000 hectares) was dramatically lower than the estimate offered by the USG (157,200 hectares). While the USG did make methodological changes in 2006 (increased the survey area by 19% over the survey area for 2005), these changes do not explain why the gap increased 70% between 2004 and 2005.

Figure A1 also presents the estimates from Bolivia and Peru and it helps put the Colombian discrepancies into context. The difference in the UNODC and USG figures for coca in 2004 is comparable to the entire output of Bolivia; in 2006 the difference is greater than the output of Bolivia and Peru. There is also a discrepancy in the figures for Peru, but it is not in the same direction. The USG figures for Peru have hovered around 33,000 hectares from 1999 to 2007 (except for a recently revised blip in 2006) while the

UNODC figures have steadily increased from 34,000 in 1999 to 53,000 hectares in 2007. The figures for Bolivia have been fairly similar over time.

While the UNODC figure for cultivated hectares in Colombia has decreased by nearly 50% since the late 1990s, the UNODC does not report a similar decrease in cocaine production. This is because the average yield has almost doubled, which has offset the reduction in hectares (UNODC, 2008; Mejia and Posada, 2008). Using regional level data collected by the UNODC and insights from the U.S. about how to convert estimates of cocaine base into cocaine, the UNODC estimated that Colombia produced 610 metric tons of pure cocaine in 2006. Interestingly, the USG also reports this 610 metric ton figure, even though its estimate of the net coca cultivation was twice the UNODC value. The USG's International Narcotic Control Report (2008) does not describe how this figure was calculated, but in all likelihood it is based on the UNODC. Perhaps more interesting, the USG's 2009 National Drug Threat Assessment (NDIC, 2008) reports this figure to be 540 metric tons for 2006. This is perplexing since one would assume that the revised USG figures would be higher, not lower, given the cultivation discrepancy. This raises important questions about how much stock should be placed into these estimates.

These discrepancies also raise important questions about the farm-gate value. The UNODC estimates that the farm-gate value of coca cultivation increased from $1.16 billion in 2006 to $1.44 billion in 2007 (UNODC, 2008c). For each country, the UNODC reports the number of cultivated hectares for a region as well as the region-specific yield (and sometimes region-specific price per kg). Focusing on 2006, the distribution for the $1.16 billion generated by the UNODC is $683 M from Colombia, $285 M for Peru, and $180 for Bolivia. Unlike Bolivia and Peru, the value for Colombia is not exclusively for coca leaf since many farmers dry and process the leaves into paste on the farms (Table 23). Thus, the actual farm-gate value for coca leaves would be lower than this estimate.

Table 23 Farm-gate prices in Colombia in 2006

	Kg	US$/Kg	US$
Coca leaf	128,858,000	1	128,858,000
Coca paste	234,000	879	205,686,000
Cocaine base	336,000	1038	348,768,000
Total			683,312,000
Note: Reproduced from UNODC (2007b).			

Value associated with exporting cocaine to consumer countries

The vast majority of cocaine is consumed in North America and Europe. Based on prevalence, North America accounts for 44% and Europe accounts for 25% of past-year users (UNODC 2008). Further, the UNODC's input/output model suggests that North America and Western & Central Europe account for over 75% of the cocaine consumed circa 2003 (UNODC, 2005).

Table 24 presents a stylized but credible model of the value of the international cocaine trade. Since we only focus on consumption in North America and Western and Central Europe, this figure is an underestimate of the total amount; however, there should not be a dramatic difference between this stylized value and the actual value of the international cocaine trade since these regions account for the vast majority of consumption and revenue for traffickers. For these calculations we use figures from the UNODC input/output

model published in the 2005 World Drug Report (UNODC, 2005) which reports the amount of cocaine intended for each region (after accounting for seizures within the source country) as well as the amount that is seized or lost in transit.

Table 24 Value of exporting cocaine hydrochloride from Colombia to consumers in North America and Western and Central Europe

Regional destination from South America	Amount transferred to region (kg)	Amount seized or lost on way (kg)	Value of kg at import	Revenue generated by international trade (billions)
North America--Low	353,000	73,000	$15,000	$3.64
North America--High	353,000	73,000	$23,000	$5.88
West & Central Europe--Low	134,000	26,000	$30,000	$3.02
West & Central Europe--High	134,000	26,000	$45,000	$4.64
Notes: Assumes export price from Colombia is $2,000.				

Since the vast majority of cocaine consumed in the world is processed in and/or transported though Colombia (UNODC, 2008a), we consider the price per kilo in Colombia to be the export price. The UNODC reports that a kilo of cocaine in Colombia in the main cities was $1,762/kg in 2006 and $2,198/kg in 2007. This is consistent with the $1,500 figure reported by Caulkins & Reuter in 1998. We use $2,000 for this stylized model and note that this figure is largely inconsequential to the value of trade since the import values are so much larger.

The import price for a kilogram of cocaine in the United States has been reported to be $15,000-$23,000 by a variety of sources (e.g., Caulkins & Reuter, 1998; Thoumi, 2005; Reuter, 2008). We use these values as our low and high estimates. Similar to the U.S., the import price in Europe will depend on the location and method. Unfortunately, we are not aware of any estimates of the average import price for a kilo of cocaine in Europe. Based on interviews with drug dealers, the Matrix Working Group (2007) estimates that a kilo of cocaine entering the UK is valued at £30,600 GBP (£2006), or ~$45,000. This is similar with figures from the Spanish police that a kilo of cocaine in Madrid in the first half of 2007 cost almost $44,000 (Schoofs & Prada, 2008), although it is not clear if this is the import or wholesale price. Since these figures are close to the average wholesale price for cocaine in Europe circa 2005 (UNODC, 2006), we consider $45,000 an upper bound for the European import price since the import price should be lower than the wholesale price because of the additional risk and possible transportation costs. Since this upper bound happens to be almost exactly twice the upper bound used for the U.S., we double the U.S. lower bound to generate a lower bound for Europe ($30,000/kg).

This stylized model suggests that the annual value of the cocaine trade (i.e., the revenue generated by shipping it from Colombia to Europe and North America) is likely to be between $7 billion and $11 billion (€6 billion and €9 billion). This value can include transportation costs, payoffs, compensation for trafficker risk, and other mark-ups. As previously mentioned, this model does not cover all consuming countries, but it accounts for those where the most of the trafficker revenue is generated.

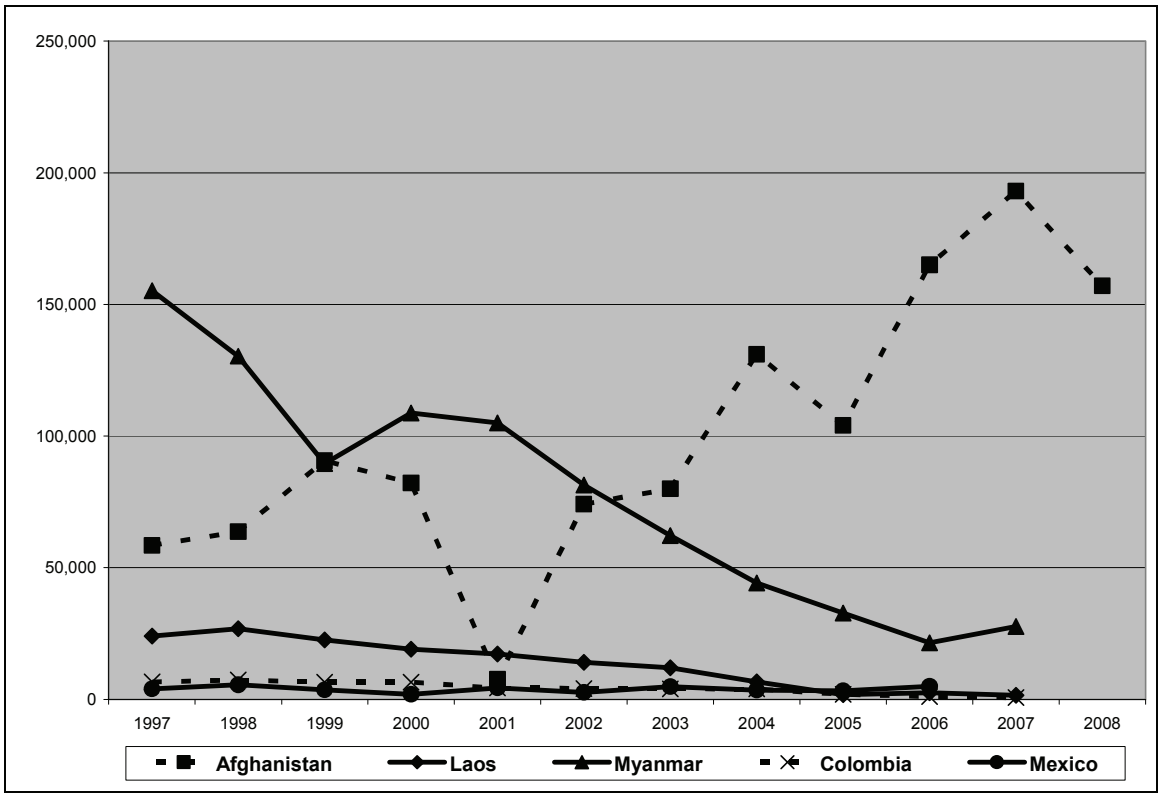
2. Opiates

Afghanistan and Burma account for over 90 percent of the global production of opium (UNODC, 2008a). Afghanistan cultivates the vast majority of opium and some claim that up 90% of it is converted to heroin or morphine in Afghanistan before it is exported throughout the world (UNODC, 2007d). While the most of the heroin consumed in North America is believed to come from Colombia and Mexico, heroin from Asia is available, especially on the East Coast of the country (NDIC, 2008; Paoli *et al.*, 2009).

2.1 Farm-gate

Figure A2 displays the net opium cultivation for Afghanistan, Burma, Laos, Colombia, and Mexico as published in the WDR. Between 1997 and 2000, well over 200,000 hectares of opium were cultivated in these countries each year, with the majority coming from Myanmar (except in 1999 when the output was similar to Afghanistan). Colombia and Mexico together accounted for 9,000-12,000 hectares during this time. With the Taliban opium ban circa 2001, opium poppy cultivation was nearly eliminated in Afghanistan, thus driving the worldwide output below 150,000 net hectares. As cultivation rebounded in the subsequent years, Afghanistan quickly overtook Burma as the cultivation leader. By 2007, Afghanistan accounted for well over 80% of the global opium cultivation. Data for 2008 are currently only available for Afghanistan and it shows a significant drop in cultivation (nearly 20%). Whether or not this is the beginning of a trend remains to be seen.

Figure 2 Estimates of Net opium cultivation from the 2008 World Drug Report (in hectares)



Not surprising, the global farm-gate value of opium is dominated by Afghanistan. The UNODC estimates the 2006 and 2007 values for Afghanistan $760M (90% Confidence

Interval: $601M - $885M) and $1B ($901M - $1090M), respectively. For Southeast Asia, the UNODC reports the "total potential value of opium production", which was $85M in 2005 and $133M in 2006.

The calculation for Mexico is slightly more involved. The 2008 WDR suggests that there were 5,000 net hectares of opium poppy cultivated in Mexico in 2006. As for the yield, the NDIC (2007) estimates approximately 20kg of opium gum per hectare circa 2006. With estimates of the farm-gate price for opium in Mexico being typically $2,000 to $5,000 per kilo (Reuter, 2008), this suggests the farm gate value can range from $200M to $500M. The UNODC reports 1,023 net hectares of opium poppy cultivated in Colombia in 2006, and 714 in 2007 (UNODC, 2008a). Based on data from the UNODC, the average farm-gate price in Colombia was much cheaper than reported for Mexico: $251/kg in 2006 and $286/kg in 2007. Assuming a yield roughly similar to Mexico (which is slightly higher than the yield in Afghanistan and Burma), this would generate a farm-gate value around $60M.

These values suggest the 2006 global farm-gate value of opium could range between $1B to $1.6B, with a midpoint of $1.3B. While Mexico accounted for only 0.5% of total opium production in 2006, it accounts for a much larger share of the global farm-gate revenue. Using the midpoints of these ranges for 2006, Mexico accounted for more than 25% of the global farm-gate revenue.

2.2 Value associated with exporting opiates to consumer countries

The section presents an estimate of the value associated with exporting opiates to consumer countries. Unlike the calculations for cocaine, one cannot simply use the export prices and quantity for one country as was basically done for cocaine. These estimates focus on two producing regions (Asia and South America) and three consuming regions (Europe, North America, and Asia). The lack of data preclude us from generating anything more than a stylized example. The goal is not to generate a precise estimate; rather, the goal is to understand the magnitude of the value added by moving the product to the consuming country.

For Afghanistan, the UNODC notes "The average export price of heroin in the border regions of neighbouring countries fell from US$ 3,860 per kg in 2005 to US$ 3,394 in 2007 and US$ 3,284 in 2008." Since the Afghan border is quite porous, it seems unlikely that the export value of heroin refined in Afghanistan would be dramatically lower. The UNODC reports that a wholesale price of a kilogram of heroin in Mexico was $35,000 in 2006 (UNODC, 2006). Given the large difference in the price estimates for the farm-gate values for opium gum in Mexico and Colombia, we would expect the heroin prices in Colombia to be lower. Indeed, the UNODC reports that the average price of a kilo of heroin was $9,070 in 2006 and $9,992 in 2007 (UNODC, 2008c).

2.2.1 Europe

We begin by considering the wholesale price in Europe, which we believe to be higher than the import price. The 2008 WDR reports the wholesale price of a kilogram of heroin in Europe is $31,000. Reuter (2008) presents a wholesale value of $50,000 in London (based on other sources), which is consistent with this estimate since the wholesale price should be larger than the import price. Based on interviews with drug dealers, the Matrix Working

Group (2007) estimates that a kilo of heroin entering the UK is valued at £20,500 GBP (£2006), or ~$30,000. Thus consider a range of $30,000-$50,000.

2.2.2 North America

The 2008 WDR reports the wholesale price of a kilogram of heroin in the United States is $88,000. This is much higher than the estimate from the DEA Albuquerque office suggesting that heroin from Mexico was $40,000 in 2002 (NDIC, 2002).[47]

2.2.3 Asia

Generating an import value for Asia is very difficult. First, many of the countries are producers as well as consumers. Second, since the Afghan borders are porous it is difficult to discern the export and import prices in some cases. Third, a significant share of opiate users in Asia use opium instead of the more expensive heroin.

Table 25 presents a stylized model of the trade value generated from exporting opiates. To generate the estimates we subtract the export value from the import value and multiply this by the amount transferred to the region. The value associated with exporting opiates to Europe and North America is at most €10 billion, with Europe accounting for the vast majority of the trade. We do not generate an estimate for intra-Asian trade because of the aforementioned complexities, but do note that approximately 210,000 kg were transferred within the region circa 2003. Few would argue that the average trade mark-up in Asia would exceed Europe, thus we apply the European trade value to generate an upper bound (approx €40,000 per kilo). Even at this extreme and implausible value, the global value of exporting opiates would not exceed €20 billion.

Table 25 Value of exporting opiates to consumers in North America, Western and Central Europe, and Asia

Routes	Amount transferred to consumer region (kilo)	Kilo value at export	Kilo value at import	Revenue generated by international trade (billions)
From Americas to North America—Low	10,000	35,000	40,000	$0.50
From Americas to North America—High		10,000	88,000	$0.78
From Asia to North America—Low	20,000	4,000	40,000	$0.72
From Asia to North America—High		3,000	88,000	$1.70
From Asia to Europe—Low	200,000	4,000	30,000	$5.20
From Asia to Europe—High		3,000	50,000	$9.40
From Asia to Asia/Transcaucasus-Low	210,000	Did not calculate		
From Asia to Asia/Transcaucasus-High				

Notes: Amount transferred to consumer region is based on WDR 2005 and accounts for product seized or lost in transit.

[47] www.usdoj.gov/ndic/pubs07/803/heroin.htm

Appendix B: GDP estimates for 2005

Country	US$2005	€2005
Austria	305.6	255.6
Belgium	376.2	314.6
Cyprus	17.0	14.2
Czech	124.7	104.3
Denmark	258.6	216.2
Estonia	13.9	11.7
Finland	196.0	163.9
France	2,137.5	1,787.5
Germany	2,796.2	2,338.4
Greece	247.4	206.9
Hungary	110.5	92.4
Ireland	201.2	168.2
Italy	1,779.4	1,488.0
Latvia	16.0	13.4
Lithuania	25.7	21.5
Luxembourg	37.4	31.3
Malta	5.9	5.0
Netherlands	634.0	530.2
Norway	302.2	252.7
Poland	304.0	254.2
Portugal	185.8	155.4
Slovakia	47.9	40.0
Slovenia	35.2	29.4
Spain	1,131.7	946.4
Sweden	367.2	307.0
Switzerland	373.0	311.9
UK	2,246.3	1,878.5
Canada	1,135.5	949.5
Mexico	767.7	642.0
US	12,433.9	10,398.0
Australia	713.2	596.4
New Zealand	109.1	91.2

Sources: GDP in current US$2005 was downloaded from www.econstats.com/weo/V004.htm and then converted to €2005 using the exchange rate for July 1, 2005 (€1 = US$1.1958) from www.xe.com/ict/.

Appendix C: Information about other major opiate markets

	Consumption						Price	
Country	**Pop 15-64 2005**	**Year**	**% using opiates**	**Total users**	**Assumed pure grams per year**	**Total pure grams consumed**	**Price per raw gram heroin (#3/NA)**	**Price per raw gram heroin (#4)**
Albania	2,344,850	2006	0.6	14,069	30	422,073	22.5	
Bulgaria	5,115,892	2001	0.5	25,579	30	767,384	43.7	
Croatia	3,012,348	2005	0.3	9,037	30	271,111	43.4	
Macedonia	1,404,639	2005	0.5	7,023	30	210,696	22	
Romania	15,528,344	2004	0.2	31,057	30	931,701	50.3	
Turkey	46,859,903	2003	0.05	23,430	30	702,899	18.2	
Belarus	6,838,937	2006	0.5	34,195	30	1,025,841	45	
Moldova	3,113,085	2002	0.3	9,339	30	280,178	57.7	
Russian Fed	101,563,215	2004/6	1.8	1,828,138	30	54,844,136	40	57
Ukraine	32,536,276	2006	0.9	292,826	30	8,784,795	85	
China	927,847,005	2005	0.3	2,783,541	30	83,506,230	36.2	

India	685,852,956	2001	0.4	2,743,412	30	82,302,355	2.7	4.2
	Consumption						**Price**	
Country	**Pop 15-64 2005**	**Year**	**% using opiates**	**Total users**	**Assumed pure grams per year**	**Total pure grams consumed**	**Price per raw gram heroin (#3/NA)**	**Price per raw gram heroin (#4)**
Iran*	44,697,355	1999/2007	2.8	1,251,526	45	56,318,667	12.7	
Pakistan	91,482,501	2006	0.7	640,378	30	19,211,325	2.7	4.2

***** There is an argument for using a higher figure for countries, notably Iran, in which a substantial fraction of the users consume opium rather than heroin; opium smoking is a less efficient way of ingesting the morphine and the historical literature reports much higher daily consumption levels. For example Chandra (2000) reports that the customers of government opium shops in the Dutch East Indies in the early 20th century consumed about 2 grams per day (equivalent to 200 milligrams of heroin).