CSEF
Centre for Studies in Economics and Finance

WORKING PAPER NO. 253

Cocaine: The Complementarity Between Legal and Illegal Trade

Francesco Flaviano Russo

June 2010

University of Naples Federico II | University of Salerno | Bocconi University, Milan

CSEF - Centre for Studies in Economics and Finance
DEPARTMENT OF ECONOMICS – UNIVERSITY OF NAPLES
80126 NAPLES - ITALY
Tel. and fax +39 081 675372 – e-mail: csef@unisa.it

WORKING PAPER NO. 253

Cocaine: The Complementarity Between Legal and Illegal Trade

Francesco Flaviano Russo*

Abstract
The smuggling cost of an imported illegal good decreases as the volume of legally imported goods increases. First because more imports are typically associated to an increased number of transporters, which is an increased supply of potential smugglers. Second because, as the number of shipments increases, the individual inspection probability decreases, lowering the risk born by the smugglers and thus their compensation. I test this theory using data on the market for cocaine, finding empirical support: in a panel of countries, an increased volume of imports is robustly associated to a decreased price of cocaine. Legal and illegal trade appear to be complementary.

JEL Classification: F10, K42

Keywords: Illegal Trade, Smuggling Cost, Illegal Drugs

Acknowledgement: I would like to thank Tullio Jappelli, Larry Kotlikoff, Robert Margo, Laura Moretti, Andy Newman, Daniele Paserman, Adrien Verdelhan and the seminar participants at the CSEF for helpful comments on earlier drafts. All remaining errors are mine.

* University of Naples Federico II and CSEF. E-mail: russoffr@gmail.com

Table of contents

“ [...] *She Don't Lie*”

J.J.Cale, Cocaine (1976)

1 Introduction

The price of cocaine has decreased substantially over the past 15 years. In the US, the World's biggest destination market, the average price of a gram in 1990 was 184 dollars; 16 years later, the same gram fetched only 94 dollars. Adjusting these figures for inflation results in a price decline of more than two thirds. The pattern is similar in Western European countries, the second biggest cocaine market. In Spain, for instance, the average retail price decreased from 110 dollars per gram in 1990 to 56 in 2002. In Italy, it decreased from 160 dollars per gram in 1992 to 84 in 2002.

I show that part of this price decline is explained by a decreased cost to bring the cocaine to market, which is itself a consequence of an increased volume of international trade. The intuition behind the theory lies in the way an imported illegal good is smuggled inside a country, typically hidden in the shipment of some other imported good.

Namely an increased inflow of imports is normally associated to a bigger number of transporters at the entry ports, which implies a bigger supply of potential drug smugglers and thus a reduced drug transportation cost. But the increased number of transporters is also associated to a smaller individual inspection probability, simply because a careful inspection of all freights becomes increasingly costly and difficult as their number grows. Thus, for a constant enforcing effort of the authorities, the risk born by the drug smugglers decreases as the volume of imports increases, driving down their equilibrium compensation and so the smuggling cost. In addition, the lower inspection probability induces also more transporters to become smugglers, further reducing the drug transportation cost.

I test this theory with a panel of data on the cocaine market in 15 OECD countries from 1990 to 2006. The empirical test entails a regression of the price of cocaine on a measure of imported goods, controlling for transportation costs, for the enforcing efforts of the police and for the market power of the drug dealers. I find that the import variable is a statistically significant determinant of the price of cocaine.

The main theoretical insight of the paper is that legal and illegal trade are complementary: it is not possible to open a country to international trade without providing incentives to engage in illegal trade as an unintended consequence.

The rest of the paper is organized as follows: Section 2 provides a simple model that clarifies the conceptual framework. Section 3 describes the market for cocaine. Section 4 summarizes all the regression results. Section 5 discusses the identification of the empirical model, some alternative explanations of the cocaine price decline and an analysis of the interaction between the cocaine market and the market for opiates. Section 6 concludes. The appendix proposes a fully specified model and briefly summarizes all the production steps needed to transform coca leafs into cocaine.

2 Conceptual Framework

In this section I propose a simple model that clarifies the conceptual framework behind the estimation. The model makes explicit the source of the link between the level of legal imports and the price of illegal drugs and therefore the complementarity between legal and illegal trade. In appendix, I discuss a fully specified model that delivers the log linear relationship between cocaine prices and inputs that I estimate.

The economy is populated by a representative consumer with utility defined over an illegal drug d and an imported composite good; by a set of transporters, whose job is to bring the imported good inside the country; and by a drug dealer that dominates the entire domestic market. The consumer's demand for drug is a function f of income M and of the drug price p. I assume that the illegal drug is produced abroad and then smuggled inside the country, as it is the case of cocaine for Europe and the US. The drug dealer buys smuggling services from the transporters, in exchange for a smuggling fee p_s for each unit of drug. However not all transporters accept the job, since there is a probability π that they will be inspected and sentenced to jail. The supply of drug smugglers is thus a function of the potential number of smugglers, given by the actual number of transporters, of the auditing probability π and of the fee p_s. Since the number of transporters is a direct function of the level of imported good I, the supply of transporters/smugglers can be written as $S = g(I, \pi, p_s)$. I assume that the dealer supplies all the drug demanded and simply charges a markup $(1 + \gamma)$ over the sum of smuggling fee plus any physical transportation cost τ, so that $p = (1 + \gamma)(p_s + \tau)$. I also assume, for simplicity, that 1 smuggler is needed to transport 1 unit of drug. Then the demand for smugglers is given by $d = f(M, (1 + \gamma)(p_s + \tau))$ and it is a decreasing function of the smuggling price. The smuggling price is then determined as the equilibrium of the smuggling market:

$$f(M, (1 + \gamma)(p_s + \tau)) = g(I, \pi, p_s)$$

Which is simply the intersection between a downward sloping demand and an upward sloping supply. This equilibrium relationship, combined with the pricing rule, implies the following expression that relates the drug price to imports, to income, to the inspection probability and to the physical transportation cost:

$$p = P(\underset{-}{I}, M, \underset{+}{\pi}, \underset{+}{\tau}) \tag{1}$$

Where the imports are an increasing function of income and a decreasing function of transportation costs $I = I(M, \tau)$. The last part of the model entails the inspection probability π. For a given level of effort e of the anti-drug authorities, it decreases as the number of transporters that cross the border increases, since a careful inspection of all the freights becomes increasingly costly and difficult (or simply impossible) as their number increases. It follows that π is an decreasing function of the volume of imports and an increasing function of enforcing, $\pi = h(I, e)$.

A higher auditing probability translates in a lower number of smugglers and thus in a contraction of the supply curve that will increase the drug price. An increased inflow of imports needs and increased number of transporters that will increase the number of smugglers, decreasing the smuggling fee. For a given level of enforcing effort, the increased imports will also determine a decreased inspection probability, which will further increase the supply of smugglers and decrease the drug price. The direct effect of a transportation cost increase is an increased final price of the drug. However an increased transportation cost will also induce a lower demand for imports, and therefore a smaller supply of transporters that will further increase the drug price. An increased income will increase the demand for imports and so the supply of transporters, indirectly reducing the drug price. Nevertheless the final effect of income depends crucially on the income elasticity of the drug demand. Given the addictive nature of the drug, it is reasonable to predict an almost inelastic demand, mostly driven by a group of regular users, that will result in a combined negative effect. But a drug like cocaine is also an "upscale" drug and it is not implausible to have a substitution away from other illegal drugs in favor of cocaine as the income level increases, or simply an increased demand coming from occasional richer users. An increased drug demand will be then associated to an increased demand for smugglers, that will lead to a higher smuggling fee and a higher drug price, with an uncertain combined effect.

3 The Cocaine Market

There are two features of the cocaine market that make it ideal for testing the theory. First, the coca bush, from which the leaves are harvested, grows only in Colombia, Peru' and Bolivia[1] and thus must be imported in all destination markets. Second, The United Nations Office on Drug and Crime (UNODC) reports detailed data on production, seizures and prices, for a relatively long time series and a good number of countries.

Figure (1) gives an idea of the supply side of the cocaine market. The estimate of

[1] There is also a small cocaine production in Ecuador, right across the border from Colombia, that accounts for less than 1% of the total World production.

potential production of cocaine powder (or cocaine HCI) is plotted alongside the estimated cocaine availability, which is simply computed as the difference between the total estimated production and the total amount of worldwide cocaine seizures. As the picture shows, both production and availability are stable until 2002. After that, there is both an increased production[2] and an increase in seizures, that imply, overall, a significative lower potential cocaine availability[3]. Moreover, since emerging cocaine markets, such as Australia and South Africa, are absorbing increasing drug quantities, the cocaine availability on the North American and European markets after 2002 should be even lower that suggested by figure (1).

But the estimates of potential cocaine production are only a proxy for the total quantity of cocaine that is brought to market by the drug cartels (excluding seizures). In other words, it is perfectly plausible that the cocaine production capacity is not fully exploited, which implies that a lower total cocaine potential production can be also associated to a higher quantity of cocaine on the market (which is then subject to random seizures). This is especially true if we think about drug cartels as monopolists that decide the quantity sold on the basis of the elasticity of (wholesale) demand. This is also the reason why the stable or decreased cocaine availability highlighted in figure (1) can be perfectly consistent with an increased cocaine consumption.

The prices of dried coca leaf and of cocaine HCI in the producing countries remained stable or mildly increasing. Figure (2) summarizes the available data from the UNODC. The upper left panel refers to the price of dried coca leaf in the Chapare region of Bolivia, which accounts for 1/3 of the total Bolivian production (10% of the total World production in 2007). The price is substantially stable from 1990 to 1999. It then spikes up around 2000 as a consequence of a production shortage, partly determined by increased eradication efforts and partly by more repressing anti-drug laws. After a period of stable prices and

[2]In particular, the increased production is the result of an increased cultivation of the coca bush that is partially offset by decreased yields per hectare (World Drug Report 2008).

[3]Perhaps part of this increase in seizures can be explained by the tighter controls at the border that followed the 9/11 attacks.

production, the price decreased in 2005, following the uprising of the cocaleros lead by Evo Morales. But, regardless of this last decline, the price, at the end of 2006, was still three time as big as it used to be in 1990. The average national price of dried coca leaf in Peru' (28% of total world production in 2007) is shown in the upper right panel of figure (2). After an highly volatile period between 1990 and 1996, it appears to be steadily increasing, with a price that, in 2007, was about twice as big as it used to be in 1990.

Arguably the retail price of cocaine should not be very sensitive to the price of dried coca leaf. The cocaine industry is, in fact, essentially a service industry, since the final, retail price of cocaine is between 200 and 250 times more than the price of the raw materials (Reuter, MacCoun and Murphy (1990) and Miron (2003)). But the price of finished cocaine did not decrease as well. The lower left panel of figure (2) shows, in fact, a volatile, but stable, price for the cocaine HCI in Colombia, which accounts for 62% of the total world production in 2007. This evidence of a stable cocaine price is also corroborated by a look at the price of legal cocaine in the US, which is the cocaine manufactured by few licensed pharmaceutical companies for medical use[4]. As reported by Basov, Jacobsen and Miron (2001), this price increased in the early 90's, but remained almost flat until 2000.

Despite the constant or increased prices in the producing countries, the wholesale and retail prices of cocaine, both in the US and in Europe, decreased substantially. Figure (3) summarizes the price data relative to the 4 biggest cocaine markets: US, UK, Spain and Italy. The retail price of cocaine in the US decreased from 184 dollars per gram in 1990 to 94 dollars in 2006. In Spain, the price decreased from 100 dollars in 1990 to 52 in 2001, to then bounce back to 76 in 2006. In Italy, the price decreased from 164 dollars in 1992 to 90 dollars in 2002, to then go up again to 104 in 2006. In the

[4]Cocaine is used a topical anesthetic of the upper respiratory tract. In fact the anesthetic properties of the coca leaf are well known by the Andean populations that use them to numb the stomach and quiet the hunger. Legal cocaine is also used for scientific purposes and to develop effective drug tests. See Miron (2003) for further information.

UK, the price declined steadily from 130 dollars in 1990 to 87 in 2006. Wholesale prices followed a similar pattern. Overall, a careful look at all the available price data from the UNODC, which include 12 more European countries, suggests that the bulk of the price decrease, in almost all markets, took place between 1990 and 2001, exactly when the cocaine availability on the World's market was stable. After 2001, the increased worldwide seizures, and the consequent scarcity of cocaine, determined an increase of most wholesale and retail prices.

A joint analysis of the wholesale and retail prices reveals also the absence of a systematic decrease in the market power of drug dealers. This is in fact an unlikely event, since drug markets are not typically characterized by free entry, but by few dominating cartels, often at war with each other. The only notable change in the market structure observed in the past decade has been a switch from Colombian to Mexican cartels, but without a significative impact on the market concentration. It is also unlikely that an increase in the number of street pushers that could have decreased their compensation and so the distribution costs of the cartels. The reason is that, as stressed by Levitt and Venkatesh (2000), their salary is already very low and there is no further reduction margin that can explain a significant cost reduction.

To give a graphical idea of the retailers' market power, figure (3) plots, in addition to the prices, the cocaine markup, simply computed as the percentage difference between the retail and the wholesale price. In the US, the markup decreased from 1990 to 1994 but, between 1994 and 2002, in a period of sharp decline of the retail price, it actually increased. In fact the correlation between retail price and markup, over all the sample, is negative (-0.15). Similarly, the correlation between retail price and markup, in Italy, is very close to 0. Spain and UK, on the other hand, are characterized by a positive but small value of the correlation (0.23 and 0.33, respectively). A closer look at the time series of these two countries reveals the presence of many years characterized by a decreased retail price and an increased markup (and viceversa). Looking at other European countries, the evidence is mixed. While some of them show negative or mildly positive values of the correlation, Germany, France, Austria, Netherland and Belgium are characterized by a positive and high value.

The cocaine demand appears to be stable in the US, but substantially expanding in Europe. According to the he National Survey on Drug use and Health (NSDUH), the percentage of the US population that reported use of cocaine fluctuated between 0.5% and 1%, without any systematic trend. A substantial stability of the North American market emerges also from two other sources that report contrasting results. The first is the "Monitoring the Future" survey administered by the National Institute of Drug Abuse (NIDA), which reports an increased cocaine use among high school students in the US and Canada. If, in 1990, only 3% of US 12th graders reported cocaine use, in 2006 the percentage doubled to 6%. Also younger students, between 8th and 12th grade, reported an increase from 2% to 3.5%. The second source is Quest Diagnostic, which reports a steadily decreasing percentage of the US national workforce that tested positive for cocaine, from a 0.9% of the population in 1997 to 0.58% in 2007.

Conversely, according to the UNODC, the cocaine consumption in Spain spiked from 0.9% of the population in 1994 to 3.7% in 2004. In Italy, the consumption rose from 0.6% in 1996 to 2.1% in 2005, while in the UK from 0.3% in 1993 to 2.4% in 2006. In fact all the European countries exhibit an increased consumption, with only few exceptions. This increasing trend in consumption in Europe is also stressed by the European Monitoring Center for Drugs and Drug Addiction in its latest annual report (2009) and confirmed by the experts responses to the Annual Questionnaires administered by the UNODC, which identified European countries as the main contributors to the worldwide growth in cocaine consumption. Unfortunately, all data sources do not report systematically the average quantity of cocaine consumed or the breakdown of the consumers increase into occasional users and addicts, so that it is difficult to infer the total quantity of cocaine consumed.

The last piece of evidence on the cocaine market comes from the analysis of seizures data. Essentially the US and the big European markets show a similar pattern: an increased number of seizures cases and an increased quantity of cocaine seized, but a decreasing average quantity seized. Under the assumption of constant enforcing effort by the authorities, this pattern is consistent with an increased number of drug consumers and/or drug dealers. Both of which highlight, in line with the consumption data, an expansion of the cocaine market. However, even assuming an increased demand, the data do not rule out the possibility of an increased enforcing effort, which would also exclude the possibility that the price decline was actually an effect of decreased enforcing. Another possible interpretation of the lower average quantity seized is that the typical drug shipment intercepted at the border is lower. This implies, for a constant quantity of cocaine smuggled, an increased number of drug transporters. Comparing the seizures data with the trade data, it also appear that, in some countries (US, Germany, Switzerland), the quantity of cocaine seized grew less than the growth of imports, with a resulting decreasing quantity of cocaine seized per unit of imported good. But this last quantity is increasing in some markets (Spain, UK, Netherlands) and constant in others.

An increasing enforcing is also confirmed by the data on eradications and spraying[5] of coca cultivations, which increased sharply over the years (World Drug Report (2008)). In addition, as Basov, Jacobson and Miron (2001) point out, the budget of the American Drug Enforcement Administration (DEA), which is arguably the best equipped and financed authority to fight narco-traffickers, increased considerably over the past years, as the number of drug arrests did. Minimum sentence laws, especially in the US, also contributed to raise the risk faced by drug dealers.

In conclusion, the data suggest a movement down the demand curve of cocaine. I claim that this pattern can be partly explained by a lower cost to bring the cocaine to market.

[5]The practice to spray herbicidals from airplanes was recently abandoned for the high level of risk for the indigenous populations, whose staple crops have often been contaminated. This left room to a manual crop eradication.

4 Regression Results

I test the main implications of the theory on a panel of annual data (1990-2006) for the US and 14 European countries[6], which covers most of the worldwide cocaine market (World Drug Report (2008)). The full specification of the empirical relationship is the following:

$$p_{it} = \beta_0 + \beta_1 I_{it} + \beta_2 e_{it} + \beta_3 \tau_{it} + \beta_4 M_{it} + \eta_i + \delta t + \varepsilon_{it}$$

where the indexes i and t denote, respectively, the country and the time period, and where η_i is a country fixed effect and δ the coefficient on a time trend. The data on the retail and wholesale prices of cocaine p are from the UNODC and they are adjusted for inflation. I put more emphasis on retail prices because they are much more reliable than wholesale ones, being collected by police officers that routinely buy drugs on the streets[7]. The measure of imports I that I use in the regression is the ratio between the value of imported goods and GDP as reported in the OECD statistical database. As a crude proxy for the level of enforcing e, I use the amount of cocaine seized by each country as reported by the UNODC. As a measure of transportation costs τ, I use the relative difference between the c.i.f. (cost, insurance and freight) and f.o.b. (free on board, or custom) values of imports from Feenstra, Romalis and Schott. Since these data are available only up to 2001, I am forced to run the regressions that include transportation costs on a restricted sample. The income M is simply proxied by the GDP from the OECD statistical database. To avoid collinearity problems, whenever the GDP is included as a dependent variable, I use the value of imports instead of the ratio of imports to GDP. All

[6]UK, Spain, France, Germany, Italy, Ireland, Portugal, Greece, Switzerland, Netherlands, Belgium, Austria, Denmark and Norway.

[7]The retail level transactions refer to the typical street level transactions of 1 or two doses, or between half a gram and one gram. However the wholesale level transactions refer to different transaction sizes, which are potentially associated to very different markets. In fact the price at which a street dealer buys from a city wholesaler is typically different from the price at which the city wholesaler buys from national distributors. In this respect, the classification of the prices proposed by the UNODC is unsatisfactory, which is another reason to put more emphasis on retail prices.

variables are in logs.

Table (1) summarizes the regression results for the retail price of cocaine. The import variable is always statistically significant and enters always with a negative sign in all the estimated equations. In the baseline model specification, the elasticity of the effect is -1.03, regardless of the control for the enforcing effort, that does not explain at all the cocaine price.

One problem with the use of seizures data is the presence of big outliers, which are the consequence of infrequent exceptional cocaine seizures. In fact purging the sample from the 3 countries were the outliers problem is worse (Ireland, Greece and Austria) results into a (10% level) significant coefficient of 0.06 on seizures and into a significant, but smaller, coefficient on the import variable of -0.54. However, this last result is just the byproduct of the smaller panel on which I run the regression, since, not controlling for the seizures, the (significant) coefficient is equal to -0.65.

Taking into account income effects does not significantly alter the value of the elasticity of the cocaine price to imports. This last result is interesting, since it is reasonable to associate a higher income both to an increase in international trade (Feenstra (2004)) and, at the same time, to an increased demand for cocaine, traditionally identified as an upscale or "Champagne-like" drug. However, controlling for transportation costs reduces the coefficient on imports to -0.63. The reason is that lower transportation costs are not only associated to a lower price of cocaine, but also to a lower price of the other imported goods, which, by increasing their equilibrium quantity, further reduces the cocaine price.

To account for the dependency of the retail price of cocaine on the market power of the drug dealers and on their commercial strategies, I also included the cocaine markup in the regression. Unfortunately, I have to exclude some observations as a consequence of reporting errors in the wholesale prices dataset, ending up with an unbalanced panel. The inclusion of the markup still delivers a statistically significant coefficient on the import variable, but of a lower magnitude, -0.68. However, the smaller magnitude is entirely dependent upon the sample on which I run the regression. Since the markup is computed as the percentage difference between the retail and the wholesale price, it is actually endogenous by construction. Nevertheless, the correlations between markups and and retail prices are actually negative for 11 out of 15 countries. In practice, it looks like retailers, in response to exogenous shocks that raise the wholesale prices, tend to compress their profit margin to avoid raising the retail prices too much. On the basis of this evidence, it is possible to show that the estimator of the marginal effect of imports is upward biased, so that the interpretation of the main result is still valid. However, under the same assumption, the estimator on the markup variable is actually positively biased and, since I have a positive coefficient, I will refrain from any interpretation.

To check for robustness, I implemented the regressions also with unadjusted retail prices of cocaine, without any significant change in he results. I also checked if the regression results were somehow driven by the conversion of domestic cocaine prices in dollars, by including the exchange rate in the regression equation. The cocaine wholesale transactions are, in fact, typically carried out in dollars (at least until the recent Euro overtake), but the retail transaction are not. Thus part of the behavior of the retail price can be driven by movements of the exchange rate with respect to the dollar and, since the exchange rate can also influence the size and composition of imports, there is the possibility of spurious results in the regression. The result is that the coefficient on the exchange rate is very small and not statistically significant. I also considered, as dependent variable, the import penetration rate, which is the ratio between imports and domestic demand (GDP-exports+imports), reaching very similar conclusions. Even allowing for country specific time trends does not alter significantly the results[8]. Including the lagged cocaine price in the regression and estimating the resulting equation with an Arellano-Bond type estimator, also delivered very similar results (details available upon

[8]The strategy to estimate such a model consists in first-differencing the data to eliminate the country fixed effects and then estimating the resulting equation using standard fixed effects (which are now the country specific coefficients on the time trend) techniques. Since all the data are in logs, the results from this estimation procedure can also be interpreted as saying that a positive growth rate of the ratio of imports to GDP predicts a negative growth rate of the price of cocaine.

request).

The left panel of table (2) summarizes the empirical results for the wholesale price of cocaine. Overall, the results are stronger in the full sample specification (that excludes the observations reported with errors), but weaker in the smaller samples. In particular, in the benchmark specification the coefficient on the import variable is equal to -0.57 and significant at the 1% level regardless of the control for enforcing. Controlling for income effects results into a slightly smaller coefficient (-0.47). However, controlling for transportation costs, results into an insignificant coefficient, that is a consequence of the smaller sample on which I am forced to run the regression.

Unfortunately, I cannot test directly the implication of my theory for the inspection probability at the border. First because, even if I have data on the reported seizures at the country level, I don't have any information about the percentage of the seizures made at the border versus the percentage made within the country's territory. Second because it is impossible to know the effective quantity of drug that flows through a particular border, especially because many countries, like Spain and the Netherlands, are both hubs for international trade and significative final consumers. For the very same reasons, even the ratio between the total quantity of cocaine seized and the the total quantity produced is not a clear proxy for the aggregate seizures probability. Also because the same cocaine shipment can travel through different borders before arriving to its final destination and, typically, does (World Drug Report 2008).

Nevertheless I can still check if my theory predicts a decreased level of enforcing when the import to GDP ratio increases. The right panel of table (2) reports the results from this empirical exercise. Again I excluded Ireland, Greece and Austria from the panel as a consequence of the seizures outliers. In column (6), the dependent variable is the total quantity of cocaine seized. In line with the theory, the coefficient on imports is negative (controlling for income effects): the increased volume of imports is actually associated to a decreased quantity of drug seized. Column (7) refers to the ratio of the quantity of drug seized over the fraction of the total World production that can be associated to the domestic market, which can be considered as a crude proxy for the inspection probability[9]. The result is indeed very similar.

The last test of the theory concerns its cross sectional implications. The first implication is that the countries that experienced a more pronounced increase in imports must be also the ones that experienced a more sensible cocaine price decline. Given the considerable number of countries included in the sample, I do not expect to find exactly the same ranking. But I should be able at least to observe a price reduction above the median if the country experienced an import increase above the median. In fact the data consistently show this pattern, with 6 out of 7 countries above the median import/gdp increase in the sample (70% between 1990 and 2006) experiencing a retail price decrease above the median (53%). Even dividing the sample into three homogeneous groups based on the sample value of the import/gdp increases (with cutoffs 45% and 75%) results into a good prediction of 1 out 3 countries in the first group, 3 out of 6 in the second and 4 out of 5 in the third. The second, and stronger, cross sectional implication of the theory is that the countries with a bigger ratio of imports to GDP should be, everything else equal, the ones where it is easier to smuggle cocaine and, therefore, the ones with the lowest cocaine price. Dividing the sample at the median, I find again that 5 out of 7 countries with an import/gdp ratio below the median (30%) are the ones with a retail cocaine price above the median (100 usd/gram). Dividing into homogeneous groups with respect to the average imp/gdp ratio (with cutoffs 25% and 40%), I can predict 1 out of

[9]To compute the denominator of this probability, I simply assumed that, since 43% of cocaine users are in North America and 25% in Western and Central Europe (World Drug Report (2008)), the exact same fractions of the total world production can be associated to the US and to the European countries (The two important assumptions underlying this computation are that the consumption of cocaine per person is similar in all the countries in the sample and that the drug destined to Europe transits in all the European countries in the sample). Then I used the same weights used by the UNODC to compute a weighted average European price to assign the total European cocaine supply to the single countries. Finally, according to the World Drug Report (2008), I considered Spain and the Netherlands as transit countries, associating to them the entire European supply.

3 countries in the first group, 4 out of 8 in the second and 2 out of 3 in the third, which, unfortunately, it is not different than what I would get by guessing.

5 Discussion and Identification

5.1 Identification: Distance and the Cost of Trade

One potential concern about the regression results is that, if the cost of doing trade decreased between 1990 and 2006, then it is plausible to observe both a decreased price of all the imported goods and an increased volume of imports. In other words, there is the possibility that the regression results are spurious. Since I am already controlling for transportation costs in the regressions, the main source of spuriousness entails reduced communication costs and technological improvements that allow the counterparts of a commercial agreement to better monitor the transactions.

To prove that my empirical model is indeed identified, I show that the distance between two trading countries is as important as a predictor of the volume of trade in 2005 as it used to be in 1990. This will exclude the possibility that easier communications determined the increased volume of trade, since this would clearly imply a less important role of distance[10]. Methodologically speaking, I rely on the estimation of gravity equations[11], which relate the bilateral trade flows to the GDP of the trading partners and to their distance, controlling for physical, legal or cultural barriers. The typical empirical relationship is the following:

$$trade_{ij} = \beta_0 + \beta_1\, gdp_i + \beta_2\, gdp_j + \beta_3\, dist_{ij} + \Theta' X_{ij} + \varepsilon_{ij}$$

where X_{ij} is a vector of control variables specific to the country pair i, j. I assembled a dataset of bilateral trade flows among the countries included in the main panel and between them and the Central and Latin American countries that either produce cocaine

[10]See Krugman (1995) for a similar discussion.

[11]See Feenstra (2003) for a discussion of the theoretical foundations and of the empirical applications.

or are typical transit points[12], along with Nigeria, whose hub role has become increasingly important for the European market (World Drug Report (2008)). I estimated cross sectional gravity equations for 1990, 1995, 2000 and 2005. As control variables, I included two dummy variables that are equal to 1, respectively, if the countries have a border in common or if the same language is spoken. The data on the bilateral trade flows are from the OECD, while the GDP data are from the World Bank Development Indicators. The distance is from the CIA World Factbook. Table (3) summarizes the results.

As the regression results clearly show, the distance between countries is as important in 2005 as it used to be in 1990 at predicting the flow of trade. Even more persuasively, the coefficient in 2000 is actually higher than in 1990. The results do not change if the insignificant border dummy is excluded from the regression, if transportation costs or duties are explicitly added in the estimated equation or if country dummies are added (details available upon request).

A further, and closely related, assessment of the identification of the empirical model comes again from the empirical gravity equation literature. In fact, since the size of the trading partners, in terms of GDP, is consistently shown to be a good predictor of the volume of trade between them, it is possible to conclude that an increased volume of trade is just a consequence of expanding economies worldwide. Baier and Bergstrand (2001) confirm empirically this claim, by means of an empirical decomposition of the determinants of the increased volume of trade in the post World War II era. Their main result is that GDP growth explains 67% of the world trade growth, tariffs reductions 25% and transportation costs only 8%.

To check if their conclusion is still valid in my sample, I implemented their very same analysis with the multilateral trade flows of the countries that have the biggest cocaine

[12]The sample includes Bolivia, Colombia, Peru, Mexico, Brazil, Argentina, Paraguay, Panama, Venezuela, Costa Rica, Belize, Nicaragua, Dominican Republic, Ecuador and Chile. Canada is excluded from the sample since it is not so important as a transit country for the cocaine, but its inclusion in the sample is inconsequential for the results.

markets, finding very similar results (details available upon request). For instance, in the US, the decline in duties accounts for 21% of the trade increase, while the declining transportation costs for only 3%. The remaining 3 quarters of the increase is accounted for by the growth of GDP. The results are even stronger for the value of imported goods, as opposed to the total value of trade.

A further conclusion from this last analysis, which is especially true for the US economy, is that the progressive fall of the legal barriers explains the increase of trade more than the fall of the physical barriers. A result in line with Krugman (1995), who argues that "The great expansion of international trade after World War II is largely a result of the removal of protectionist measures". This is again assessing my identification assumption, providing an exogenous source of variation of the volume of imports that is safe to consider as completely unrelated to the cocaine market.

One last argument in favor of the identification of my empirical model comes from the work by Helpman (1987). Namely an additional determinant of the trade growth is the increased income of developing countries or, in general, the income convergence across trading partners, given that the trade between countries of disproportionately different sizes is necessary smaller than the trade between more equal partners[13].

5.2 Alternative Explanations of the Cocaine Price Decline

One possible explanation of the cocaine price decline entails a deliberate policy of the drug dealers: facing a higher demand elasticity, they could have reduced the price to increase the quantity sold and, therefore, their profits. In fact a sudden popularity of cocaine could have determined an increase of occasional users, for which the price elasticity of demand is higher. But the available estimates of the short run price elasticity of cocaine demand (Grossman and Chaloupka (1998) and DiNardo (1993)) already indicate very low values, most likely because a great portion of demand is accounted for by addicts. It is also

[13] See Hummels and Levinsohn (1995) and Baier and Bergstrand (2001) for more extensive empirical tests of the theory.

unlikely that the dealers decided to reduce the price to increase not only consumption but also the addiction rates, to maximize the long run profits. In fact, the uncertainty associated to their position of monopolists makes them more prone to reap immediately the benefits: after all, a turf war can rapidly subvert the order and they can die soon.

Even if the elasticity did not change, it is still possible that the dealers decreased the price to stimulate the market for occasional consumers and, to avoid compressing their profit margin, that they decided to do so by decreasing the purity of the drug. Unfortunately, the UNODC does not report systematic information about the purity level for the entire panel and the few data available for Spain, the UK and the US, are not enough to corroborate or reject this alternative theory. In fact, in the US, the typical purity level in 1999 was 55% and the typical price 118 dollars per gram, while in 2003 the market price for a 70% pure gram was just 75 dollars. In the following years (until 2006), the purity remained around 70%, and the price increased up to 96 dollars. Nevertheless, the price never reached the level paid 7 years before for a 30% less pure gram (not adjusting for inflation). At the wholesale level, the typical purity was 63% in 1999 and 68% in 2003, but the price declined from 30.8 dollars per gram to 21.5. A similar unclear pattern is observed in Spain at a retail level, where the typical purity level went up from 46% in 1997 to 50% in 2001 and 53% in 2006, but the price decreased from 68 dollars per gram in 1997 to 52 in 2001, to then go up to 76 in 2006. The UK, conversely, shows a consistently decreasing purity, from 61% in 1999 to 51% in 2003 and 42% in 2004, but the price fell from 104 dollars per gram in 1999 to 90 in 2003 and stayed constant regardless of the decreased purity.

5.3 The Market for Opiates

Another possible explanation of the price decline is a competitive pressure coming from a decreased price of other drugs. To some extents, different drugs, having different effects, cannot really be considered as substitutes. Think about cocaine and heroin, for instance: while the first one is associated to euphoria, the second has mostly a narcotic effect. Also, once an habit is developed, the possibility of drug substitution is actually zero and a big chunk of the drug demand comes from addicts. Nevertheless, it is probably fair to assume that, for some occasional drug user, the choice of the drug comes also from a price comparison. Which actually means that, to win the market for occasional users, the cocaine prices must be sensitive to other drug prices. But it is also true that the prices of other imported drugs can behave exactly as the cocaine prices, simply because also the price to bring them to market decreased. To shed light on these issues, I propose in this section an analysis of the market for opiates drugs, heroin and morphine, since this is only one for which the UNODC reports detailed price data.

All opiates drug are derived from a resin extracted from the seed capsule of the "Papaverum Sonniferum" poppy. Opium poppies are mainly produced, for drug extraction purposes, in Afghanistan (80% of total World supply), Myanmar (12%) and marginally in Cambodia, Laos and Colombia. Like cocaine, opiates must therefore be imported in all the Western European and North American destination markets. However, unlike cocaine, the biggest consumption markets, Afghanistan, Iran and Pakistan (that account for 60% of the worldwide consumption) are now excluded from the analysis. Furthermore, the worldwide demand of these drugs appears to be stable or decreasing. In addition, the composition of the total world supply of opium poppies experienced significant changes, some of which are determined by the Taliban's regime attitude towards opium in Afghanistan. Also most of the worldwide opiates seizures are typically made closer to the production points or in Iran.

The price of opiates decreased significantly in the US and in western Europe. While a gram of heroin was sold, at the retail level, for 280 dollars in the US in 1990, the same gram was worth only about 170 dollars in 2006, with a peak low around 100 dollars in 2002. Similarly, in the UK, the largest market among all OECD countries, the price of a gram of heroin decreased from 150 dollars in 1990 to 70 dollars in 2006. All the other countries for which the UNODC reports data experienced a similar pattern.

Since the opiates price behave similarly to cocaine prices, I checked if, according to the theory, part of their decline is explained by increased imports. The first empirical result is that the theory is indeed confirmed. The first column of table (4) summarizes the results of a regression of the retail price of opiates on the ratio of imports to GDP[14]. Once again, an increase in imports is significantly associated to a decreased drug price, with an elasticity of -0.5.

To check if part of the cocaine price decline can be explained by the competitive pressure coming from heroin and morphine, I included the price of opiates in the regression of the retail price of cocaine on imports. The problem is that, since both prices are determined simultaneously, perhaps, at the retail level, by the very same dealers, it is not possible to estimate consistently the coefficient of interest. However, I can use the theory to identify exogenous instruments. The simple idea is to use the variability of a very narrow category of imports (from the OECD database) which, being very small relative to the total mass of imported goods, is unlikely to have a strong impact on the cocaine price but, being a major component of the exports of an opium producing country, is likely to have an effect on opiates prices. Afghanistan is the World's biggest producer and exporter of opium poppies, but it also exports wool, cotton, carpets and animal skins. It turns out that, in the panel, the imports of these goods (relative to GDP) are not significantly associated to the price of cocaine but they have explanatory power for the price of opiates. To avoid an indirect effect on the cocaine price working through to the total amount of imports, I purged the total amount of imports from the goods used as instruments (which account, on average, just for 0.5% of the total). As column 5 of table (4) shows, the coefficient on the opiates prices is positive, meaning that part the decreased price of cocaine can be in fact explained by a decreased price of opiates. But, regardless of this effect, the import variable still retains its explanatory power on the price of cocaine and the coefficient is very similar to the one obtained in the regression that does not control for opiates prices (column 4). Using a similar empirical strategy, I also

[14] I excluded from the sample the first 3 observations for Norway, as a consequence of data reporting errors.

included the price of cocaine in the regression of opiates prices. As instruments, I used the imports of fresh fruit and coffee, both of which are exported by the World's biggest cocaine producer, Colombia, but have no explanatory power for the opiates prices. As column 3 of table (4) shows, the coefficient on imports, controlling for the price of cocaine, is now insignificantly different from zero. Thus the negative effect of imports on the price of opiates seems to be an effect of the decreased price of cocaine.

6 Conclusion

Legal and illegal trade are complementary. Smuggling an illegal good inside a country becomes easier and less costly as the volume of imported good increases. Both because the supply of potential smugglers increases and because the risk of being caught decreases. I showed that this mechanism is a plausible, but sure not complete, explanation of the decreased price of cocaine (and opiates).

However I was unable to provide a comprehensive test of the theory. Cocaine is just one of the imported illegal goods currently available on the black market. It is perhaps a landmark example of a valuable smuggled goods, but certainly not the only one for which the theory should have empirical bite. In fact not only illicit drugs, but also counterfeited goods, like handbags, shoes or apparel, illegal chemical products, exotic animals etc, should be experiencing a similar effect of international trade.

Perhaps one of the most interesting applications of the theory entails illegal immigration. Namely, if it is easier to hide drugs, or other illegal goods, then it must be also easier to hide people. For instance, it must be easier or cheaper to find a truck driver willing to hide an illegal immigrant while crossing the Mexico-US border at Laredo (TX) during peak hours, simply because, especially after the NAFTA agreement, the number of such trucks increased dramatically. But also because a careful inspection of all the trucks, not only will be very costly, but will also significantly slow down the queues and impede trade, going against the motivations that led the countries to sign the trade agreement in the first place (Naim(2005), Glenny (2008)).

A limitation of the analysis is that hiding the drug into a shipment of an imported good is not the only possible way to smuggle the illegal drugs. In fact the drug dealers can also hire individual runners or "Mules", which are simply people that cross the border with the drug hidden in their cars, clothes, luggage, or even swallowed. The problem is that, since they enter the country at different entry ports than the transporters of imported goods, like airports, they face a different inspection protocol. Thus it is the increase in the volume of passengers rather than the increase in the volume of trade that affects the risk they face. Looking empirically at this relationship is another avenue for future research.

Appendix

Full Model Specification

Suppose that the world is composed by J countries, each with a domestic market for cocaine. Suppose also that there is a drug producing country and, within this country, a drug cartel that dominates the entire wholesale World market. The cartel decides the quantity of drug to ship to each country D_j in order to maximize its profit, taking into account that the cocaine wholesale price p_j^w will depend upon the domestic cocaine demand. To bring the drug illegally in the destination countries, the cartel needs the services of drug smugglers, that charge a fee p_j^s on each unit of drug shipped to country j. But, since the drug is illegal, there is a probability π_j that it will be intercepted by the police and that it will not reach the country. I assume that the cartel maintains the possession of the drug even if the smuggler is physically carrying it, so that it bears the risk of inspection directly. The maximization problem of the drug cartel is the following:

$$\max_{\{D_j\}_{j=1}^J} \sum_{j=1}^{J} p_j^w (1-\pi_j)\,\frac{D_j}{\tau_j} - p_j^s\, D_j$$

where τ_j is an iceberg transportation cost that summarizes all the costs that are necessary to physically bring the drug into country j except for the compensation of the smugglers. To keep things simple, I assume that the producer countries have enough production capability to service the entire world cocaine market under every condition or, in other words, that the total cocaine production $D = \sum_j D_j$ is less than what is feasible to produce. I also assume that the quantity of drug sold in the market is a function of income M_j and of the drug retail price p_j:

$$D_j = (M_j)^{\eta_j}(p_j)^{-\varepsilon_j}$$

where η_j and ε_j are the elasticities with respect to income and price. I assume that, once the drug is smuggled in the country, it is sold through retail drug dealers, that simply charge a markup $1+\gamma_j$ on the wholesale price. So that the resulting retail price of cocaine is

$$p_j = (1 + \gamma_j)p_j^w \tag{2}$$

The first order condition of the maximization problem of the cartel implies a simple (monopoly) pricing rule:

$$p_j^w = \frac{\varepsilon_j}{\varepsilon_j - 1}\frac{\tau_j}{1 - \pi_j}p_j^s$$

The compensation of the cocaine smugglers in each country p_j^s is determined as the equilibrium of a competitive market. The supply side of this market is composed by the runners and by the transporters of all the goods imported in country j. If they are not inspected at the border, with probability $1 - \pi_j$, they earn the compensation p_j^s. If they are inspected, I just assume that they are charged with a pecuniary fine f, which can also monetized the disutility of being sentenced to prison. To control for the fact that some individuals have strong moral issues against drugs, I assume that the potential smugglers differ in their perceived disutility attached to the fine according to a parameter θ. I further assume that θ is uniformly distributed in the interval $\left[0, \hat{\theta}\right]$, with $\hat{\theta}$ high enough so that it can encompass honest people that will never accept to carry drugs. An individual will become a smuggler if the expected utility of doing do is positive, or if

$$(1 - \pi_j) p_j^s - \pi_j \theta f \geq 0$$

The above expression implies that all the individuals with disutility θ below a cut-off value will become smugglers and all the others will not. Suppose that the total number of transporters in country j is proportional to the aggregate domestic demand for imports I_j and that the potential runners are in fixed supply λ_j. Then, multiplying the fraction of individuals that become smugglers by the total number of transporters and runners, I obtain an expression for the total number of smugglers:

$$\frac{1}{\hat{\theta}\, f} \frac{1 - \pi_j}{\pi_j} p_j^s \left(I_j^k + \lambda_j\right)$$

where k is the elasticity of the number of transporters with respect to the demand for imports. The demand side of the smuggling market is simply proportional to the domestic demand for drug D_j according to the elasticity parameter α. Equating the supply and demand of smugglers, I can solve for the equilibrium price of the smuggling services (omitting the subscripts at the exponents):

$$p_j^s = \frac{\pi_j}{1 - \pi_j} \frac{(M_j)^{\alpha\eta}}{(p_j)^{\alpha\varepsilon}} \frac{1}{\left(I_j^k + \lambda_j\right)} \hat{\theta} f \tag{3}$$

I also assume that the probability of inspection at the border is simply the ratio between the number of inspection and the total volume of imported goods. But the number of inspections is itself an increasing function of the enforcing effort of the anti-drug authorities e and, in particular, a concave function. In fact the number of inspections cannot grow beyond a certain treshold value without significantly impeding trade. The probability is

$$\pi_j = \frac{e_j^{\xi}}{I_j} \tag{4}$$

with $\xi < 1$. Plugging (4) into (3), combining the resulting expression with the pricing rule (2) and solving for the final price of cocaine p_j, I obtain a simple log linear expression[15] that can be brought to the data:

$$\log(p_j) = \beta_0 + \beta_1 \log(I_j) + \beta_2 \log(\gamma_j) + \beta_3 \log(e_j) + \beta_4 \log(\tau_j) + \beta_5 \log(M_j) \tag{5}$$

where the β's are all function of the structural model parameters.

The interesting feature of the model is that it delivers an inspection probability which is a decreasing function of imports even if the effort is optimally chosen by the anti-drug authorities. Suppose that the authorities want to minimize the quantity of drug that flows into the country, but that the necessary effort is costly. Suppose also that they have the following linear loss function:

$$\min_{e_j} \delta_j [(1-\pi_j)\, D_j] + (1-\delta_j) e_j$$

where π_j is given by (4) and where δ_j is the weight assigned to the drug flow. Taking the first order condition, solving for the optimal effort and plugging the resulting expression in (4), results in the following probability:

$$\pi_j = \left(\frac{1-\delta_j}{\delta_j} \frac{1}{D_j} \frac{1}{\xi} \right)^{\frac{\xi}{\xi-1}} I_j^{\frac{1}{\xi-1}}$$

Even if the optimal effort is an increasing function of the level of imports, the inspection probability at the border is still a decreasing function of imports.

[15]Note that, if λ is small relative to I^k, then: $log(I^k + \lambda) = log(\lambda(\frac{I^k}{\lambda} + 1)) = log(\lambda) + log((\frac{I^k}{\lambda} + 1)) \approx log(\lambda) + log(\frac{I^k}{\lambda}) = log(\lambda \frac{I^k}{\lambda}) = log(I^k)$

Cocaine Production Stages

The following techincal information is a summary of a DEA strategic intelligence report published in September 1993.

Coca processing can be broken down into three stages. The first is the conversion of the coca leaf into coca paste, which is almost always done very close to the coca fields to cut down on the transport cost of the coca leaves. The second is the conversion of the coca paste into cocaine base. The final stage is conversion of cocaine base into cocaine HCI (Hydrocloride).

The conversion of coca leaf into coca paste is accomplished in a coca paste pit (*pozo*), which is usually a hole in the ground, lined with thick, heavy plastic. After putting the coca leaves in the pit, an alkaline material (sodium carbonate) and water are added to the leaves to extract the cocaine alkaloid present in the leaf. Kerosene is then added to water, solution, and leaves and the mixture agitated, usually by having several people stomp on the leaves. Cocaine alkaloids and kerosene separate from water and leaves. The water and leaves are then drained off. Cocaine alkaloids are extracted from the kerosene into a dilute acid solution. Sodium carbonate is added to the remaining solution, which causes a precipitate to form. The acid and the water are drained off and the precipitate is filtered and dried to produce coca paste. The process usually takes a few days.

The processing of coca paste into cocaine base is more complicated than paste production, requiring more sophisticated equipment and skills. The coca paste is added to sulfuric acid or hydrochloric acid and water. The paste is dissolved into the acid solution. Potassium permanganate is combined with water. This mixture is added to the coca paste and acid solution. Potassium permanganate is used in this step to extract other alkaloids and material that is undesired in the final product. This mixture is then allowed to stand for about six hours. The solution is filtered and the precipitate is discarded. Ammonia water is added to the filtered solution and another precipitate is formed. The liquid is drained from the solution and the remaining precipitate is usually dried with heating lamps. The resulting powder is cocaine base.

The final stage of cocaine processing requires even more skill and equipment, and is much more dangerous than the previously mentioned steps. Unlike paste and base processing, cocaine HCI processing needs expensive chemicals that are hard to find and often not manufactured in the processing country. Acetone or ether is added to dissolve the cocaine base and the solution is filtered to remove undesired material. Hydrochloric acid diluted in acetone or ether is added to the cocaine solution. The addition of the hydrochloric acid causes the cocaine to crystallize out of the solution as cocaine hydrochloride. The remaining acetone/ether solvent can be discarded or reused. Cocaine HCI is dried under heat lamps, laid out to dry with the aid of fans, or dried in microwave ovens. It is common in Colombia to skip the base stage of cocaine processing and go right from coca paste to cocaine HCI, which is usually accomplished by avoiding adding potassium permanganate solution.

References

Baier, Scott J. and Jeffrey H. Bergstrand. 2001. "The Growth of World Trade: Tariffs, Transport Costs and Income Similarity." *Journal of International Economics*, 53(1): 1-27.

Basov, Suren, Mireille Jacobson and Jeffrey A. Miron. 2001. "Prohibition and the Market for Illegal Drugs." *World Economics*, 2(4): 1-25.

DiNardo, John. 1993. "Law Enforcement, the price of cocaine, and cocaine use.", *Mathematics and Computer Modelling*, 17: 53-64.

European Monitoring Center for Drugs and Drug Addiction. 2009. "Annual Report 2009: The State of the Drug Problem in Europe."

Feenstra, Robert C. 2004. *Advanced International Trade.* Princeton, NJ: Princeton University Press.

Glenny, Misha. 2008. *McMafia*. New York: Knopf.

Grossman, Michael and Frank J. Chaloupka. 1998. "The Demand of Cocaine by Young Adults: a Rational Addiction Approach." *Journal of Health Economics*, 17(2): 427-474.

Helpman, Elhanan. 1987. "Imperfect Competition and International Trade: Evidence from Fourteen Industrial Countries." *Journal of the Japanese and International Economics*, 1(1): 62-81.

Hummels, David and James Levinsohn. 1995. "Monopolistic Competition and International Trade: Reconsidering the Evidence." *Quarterly Journal of Economics*, 110(3): 799-836.

Krugman, Paul. 1995. "Growing World Trade: Causes and Consequences." *Brookings Papers on Economic Activity*, (1): 327-362.

Levitt, Steven D. and Sudhir Venkatesh. 2000. "An Economic Analysis of a Drug-Selling Gang's Finances." *Quarterly Journal of Economics*, 115(3): 755-789.

Miron, Jeffrey A. 2003. "The Effect of Drug Prohibition on Drug Prices: Evidence from the Markets for Cocaine and Heroin." *Review of Economics and Statistics*, 85(3): 522-530.

Naim, Moises. 2005. *Illicit.* New York: Anchor Books.

Reuter, Peter, Robert MacCoun and Patrick Murphy. 1990. *Money from Crime.* Santa Monica: Rand Corporation.

United Nations Office on Drug and Crime. 2008. "World Drug Report."

Table 1: **Explaining the Retail Price of Cocaine**

	Retail Price						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
imp/gdp	-1.028*	-1.037*		-0.651**	-0.633**	-0.979*	-0.658*
	(0.423)	(0.447)		(0.155)	(0.135)	(0.449)	(0.228)
imp			-1.023*				
			(0.444)				
seizures		-0.008					
		(0.033)					
gdp			1.061**				
			(0.385)				
markup					0.169**		
					(0.039)		
transp							0.508**
							(0.119)
R^2	0.395	0.411	0.364	0.464	0.543	0.426	0.343
obs	255	255	255	233	233	180	180

Notes: Dependent variable is the retail price of cocaine adjusted for inflation from the UNODC. markup is a proxy for the markup applied by drug retailers, computed as the difference between wholesale and retail prices over wholesale prices. imports/gdp is the ratio of imports to GDP from the OECD statistical database. transp is the transportation cost measured as a ratio between the difference between the c.i.f. and f.ob. valued imports over the f.o.b valued imports from Feenstra, Romalis and Schott database. seizures is the effort of anti-drug enforcing authorities, proxied by the total amount of cocaine seized, as reported by the UNODC. All variables are in logs. The panel Includes observations for US, Spain, UK, Italy, France, Germany, Portugal, Ireland, Switzerland, Greece, Netherlands, Belgium, Austria, Denmark and Norway from 1990 to 2006 (2001 if the transportation cost is included). If markups are used, the data are purged from all the observations for Ireland, the first 4 observations for Norway and the first observation of France, as a consequence of reporting errors in the wholesale price series. Estimation is performed with a panel ols estimator with fixed country effects and a time trend. Standard errors clustered at the country level are in brackets. **=significant at 1% level *=significant at 5% level.

Table 2: **Explaining the Wholesale Price and the Seizures of Cocaine**

	Wholesale Price					Seizures	
	(1)	(2)	(3)	(4)	(5)	tot	rel
imp/gdp	-0.575**	-0.488**		-0.100	-0.103		
	(0.143)	(0.142)		(0.194)	(0.197)		
imp			-0.476**			-3.187**	-3.205**
			(0.189)			(0.884)	(0.890)
seizures		0.063°					
		(0.032)					
gdp			1.203**			10.122**	10.163**
			(0.488)			(1.259)	(1.263)
transp					0.064		
					(0.217)		
R^2	0.219	0.111	0.010	0.335	0.348	0.188	0.020
obs	233	233	233	163	163	204	204

Notes: Dependent variable in columns 1-5 the wholesale price of cocaine adjusted for inflation from the UNODC. In column 6 (tot) the total amount of cocaine seized in the country from the UNODC. In column 7 (rel), the total quantity of cocaine seized over the fraction of the total world production that can be associated to the domestic market. imports/gdp is the ratio of imports to GDP from the OECD statistical database. transp is the transportation cost measured as a ratio between the difference between the c.i.f. and f.ob. valued imports over the f.o.b valued imports from Feenstra, Romalis and Schott database. seizures is the effort of anti-drug enforcing authorities, proxied by the total amount of cocaine seized, as reported by the UNODC. All variables are in logs. The panel Includes observations for US, Spain, UK, Italy, France, Germany, Portugal, Switzerland, Greece, Netherlands, Belgium, Austria, Denmark and Norway from 1990 to 2006 (2001 if the transportation cost is included). In column 1-5, the data exclude the the first 4 observations for Norway and the first observation of France, as a consequence of reporting errors in the wholesale price series. Austria and Greece are excluded from the regressions in column 8 and 9. Estimation is performed with a panel ols estimator with fixed country effects and a time trend. Standard errors clustered at the country level are in brackets. **=significant at 1% level *=significant at 5% level ○=significant at the 10% level..

Table 3: **Gravity Equations, Bilateral Trade Flows**

	1990	1995	2000	2005	1990	1995	2000	2005
distance	-0.909**	-0.872**	-0.953**	-0.871**	-0.892**	-0.865**	-0.943**	-0.842**
	(0.038)	(0.032)	(0.031)	(0.035)	(0.045)	(0.038)	(0.041)	(0.043)
gdp imp	0.925**	0.917**	0.945**	0.976**	0.924**	0.917**	0.945**	0.975**
	(0.029)	(0.026)	(0.025)	(0.026)	(0.029)	(0.026)	(0.025)	(0.026)
gdp exp	0.921**	0.974**	1.016**	1.015**	0.919**	0.979**	1.015**	1.014**
	(0.033)	(0.034)	(0.033)	(0.034)	(0.034)	(0.034)	(0.033)	(0.033)
border					0.158	0.072	0.088	0.243
					(0.163)	(0.158)	(0.157)	(0.155)
language	0.610**	0.625**	0.543**	0.499**	0.575**	0.609**	0.524**	0.445**
	(0.141)	(0.120)	(0.122)	(0.141)	(0.139)	(0.118)	(0.121)	(0.146)
R^2	0.842	0.864	0.876	0.858	0.842	0.864	0.877	0.858
obs	580	643	660	651	580	643	660	651

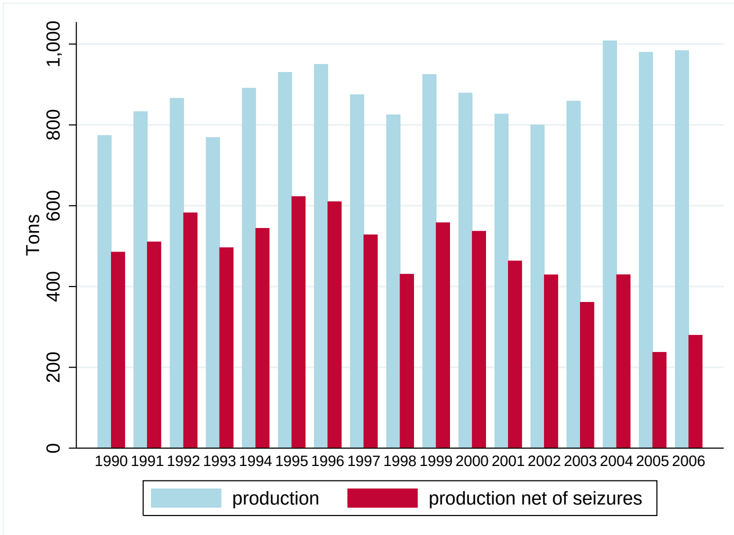
Notes: Dependent variable is the bilateral trade flows among France, Germany, Italy, Spain, Ireland, the Netherlands, Belgium, Portugal, Greece, Norway, Switzerland the US and the U.K. and between these countries and Bolivia, Colombia, Peru, Mexico, Brazil, Argentina, Paraguay, Panama, Venezuela, Chile, Costa Rica, Belize, Dominican Republic, Ecuador, Guatemala and Nigeria. All the trade data are from the OECD. gdp imp is the GDP of the importer country while gdp exp the one of the exporter, from the World Bank. The Distance between trading partners dist is from the CIA World Factbook. Border is a dummy variable that equals one if the trading partners share a border. Language is equal to 1 if the same language is spoken in the trading countries. All variables are in logs. Standard Errors robust to eteroskedasticity are reported in brackets. **=significant at the 1% level.

Table 4: **Explaining the Retail Price of Opiates and Cocaine**

	Opiates Price			Cocaine Price	
	(1)	(2)	(3)	(4)	(5)
imp/gdp	-0.509*				
	(0.229)				
imp/gdp (no cocaine instr)		-0.596*	0.192		
		(0.227)	(0.335)		
imp/gdp (no opiates instr)				-1.179*	-0.909**
				(0.457)	(0.207)
cocaine price			0.675**		
			(0.214)		
opiates price					0.441**
					(0.177)
R^2	0.339	0.317	0.483	0.391	0.537
obs	252	244	244	244	244

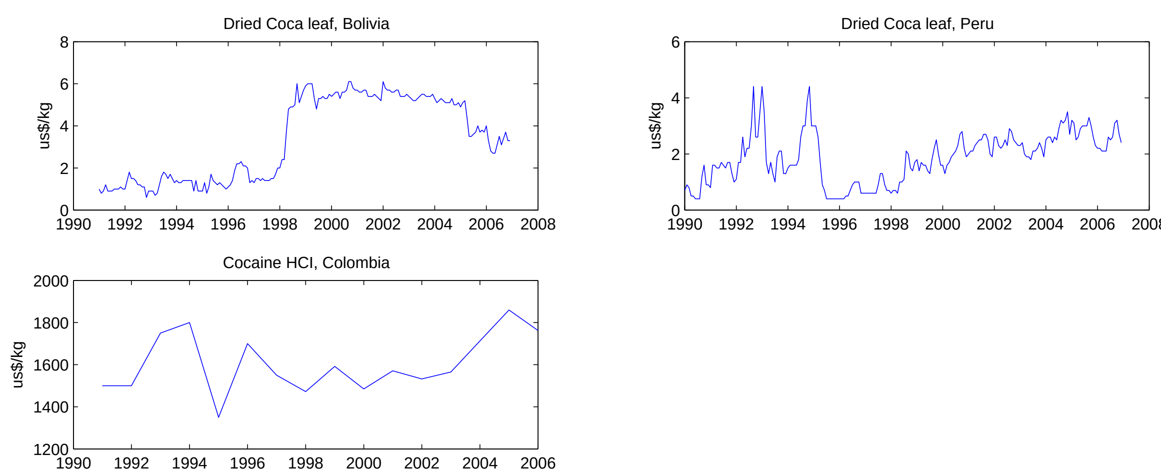
Notes: Dependent variable in columns 1-3 is the retail price of opiates drug (heroin and morphine) adjusted for inflation (opiates price) and in columns 4 and 5 the retail price of cocaine adjusted for inflation (cocaine price), both from the UNODC. The same variables are also used as regressors in columns 3 and 5. The cocaine price in column 3 is instrumented with the ratio of imports of fruit and coffee to GDP from the OECD statistical database. The opiates price in column 5 is instrumented with the ratio of imports of carpets, wool, cotton and fur skins to GDP from the OECD statistical database. imp/gdp is the ratio of imports to GDP from the OECD statistical database. imp/gdp (no coc instr) is the ratio of total imports minus the imports used as instruments for the cocaine price over GDP. imp/gdp (no opium instr) is the ratio of total imports minus the imports used as instruments for the opiates price over GDP. All variables are in logs. The panel Includes observations for US, Spain, UK, Italy, France, Germany, Portugal, Ireland, Switzerland, Greece, Netherlands, Belgium, Austria and Denmark from 1990 to 2006 and for Norway from 1993 to 2006. No disaggregated imports data are available for Austria prior to 1995 and for Belgium prior to 1993, Estimation is performed with a panel IV estimator with fixed country effects and a time trend. Standard errors are in brackets. **=significant at 1% level *=significant at 5% level.

Figure 1: **Production of Cocaine**



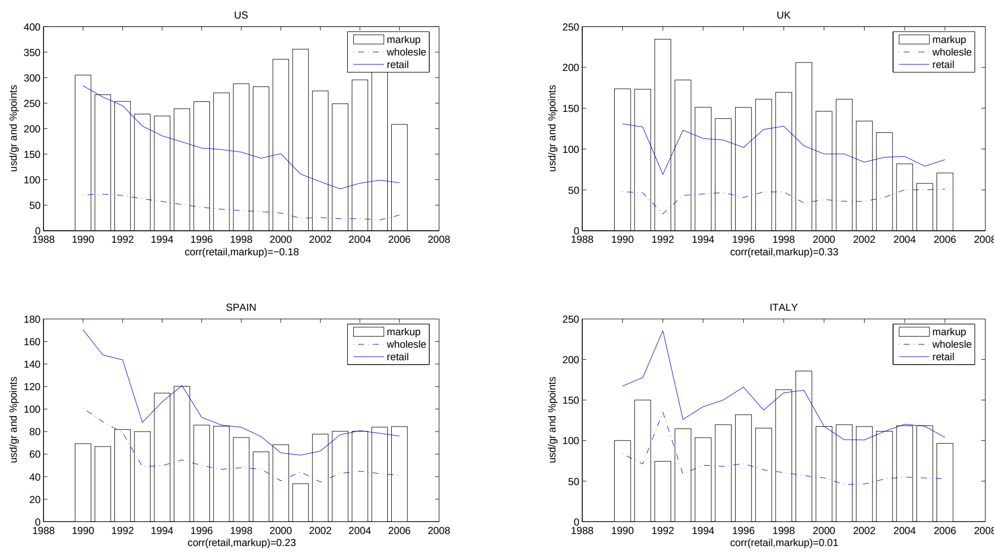
Notes: Production of cocaine powder (HCI) measured in tons. Production is the estimated production from the United Nations Office on Drug and Crime(UNODC). Production net of seizures is the difference between total production and total World seizures from the UNODC.

Figure 2: **Price of Dried Coca Leaf and Cocaine HCI**



Notes: Upper left panel: monthly price (91-06) of dried coca leaf in the Chapare region of Bolivia in US dollars per kilo. Upper right panel: monthly price (90-06) of dried coca leaf in Peru' in US dollars per kilo. Lower left panel: yearly price (91-06) of Cocaine HCI in Colombian US dollars per kilo. All the data are from the Andean Reports and the World Drug Reports from the UNODC.

Figure 3: **Wholesale and Retail Price of Cocaine**



Notes: Wholesale and Retail price, in US dollars, of a gram of cocaine powder from the United Nations Office on Drug and Crime (UNODC). Markup is the percentage difference between retail and wholesale price.