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# Rehab or Relocation? Estimating the Demand for Cocaine through an American Port City Analysis

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**Rehab or Relocation?**

**Estimating the Demand for Cocaine through an American Port City Analysis**

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## <u>ABSTRACT</u>

Over the past five decades American drug policy can succinctly be classified by two words: expensive and punitive. American drug policy makers have conducted the "war on drugs" largely through supply side intervention. As the theory goes, by attacking drug producers, drug prices will rise due to the increased risk faced by suppliers, this risk will in turn be passed along to consumers in the form of higher prices. In order to critically asses the merits of such an expensive antidrug policy it is essential to estimate the price elasticity of demand for drugs.

The main finding of this paper is that cocaine users are extremely price inelastic and that a doubling of cocaine prices will result in approximately a five percent drop in cocaine usage. Further, policy analysis reveals that the theory driving supply side intervention is fundamentally flawed. Over the past thirty years, as antidrug spending has increased fivefold, drug prices have declined be nearly eighty percent – bolstering a conclusion that American policy makers need to rethink the "war on drugs".

## Acknowledgements

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**Introduction**

Illicit drugs impose significant costs on society and on individual uses. These costs include increased crime, health problems, and employment. Because of these costs, both the federal government and the state governments have made drug controls an important budget priority. Traditionally, American drug control policy has been focused on supply side intervention. In theory, with interdiction efforts focused on suppliers, the cost (i.e. the risk) of producing drugs will increase, a cost that will then be passed along to the final consumers. This increase in the retail drug prices should then in turn cause usage to drop.

According to the U.S. Office of National Drug Control Policy (ONDCP), in 1995, spending on the "war on drugs" was approximately $30-35 billion between the federal, state, and local government. This figure represents a fivefold increase from the previous decades spending of $6-7 billion (ONDCP 1997). With drug control being such a significant factor of government spending, it becomes crucial for researchers to determine the efficacy of current drug policies and asses the validity of such large government expenses. One possible way of evaluating these policies is to measure the price elasticity of demand for cocaine. This estimate will allow researchers and policy makers to estimate the effects that an increase in drug prices will have on drug consumption.

**A Brief History of Cocaine (- 1970s)**

Cocaine is a powerful drug that is derived from the leaves of the coca shrub. The coca leaf originated in the Andes Mountains and is now grown primarily in the South American countries of Peru, Bolivia, and Colombia. Coca

leaves have been chewed almost universally by some indigenous communities, and in fact, archeologists have found coca leaves in Peruvian grave sites dating from approximately 500 AD (Redda, Walker, and Barnett 1989). Further, the Indians who lived in the mountains of the Andean region chewed the coca leaves for thousands of years as a way to diminish hunger, lessen fatigue, and gain endurance for work – cocaine is both a stimulant of the central nervous system and an anorexigenic (Redda, Walker, and Barnett 1989).

Cocaine was first extracted from coca leaves in Germany in 1855 by the chemist Friedriche Gaedecke (Weiss 1994). For years later, Albert Niemann described a step-by-step purification process and named the new compound "cocaine" – an accomplishment that earned him his PhD from Gottingen University in 1859 (Weiss 1994). However, the discovery remained static, and it wasn't until the mid 1880's when the production of purified cocaine gained momentum. The powder began to be used in the practice of medicine, most notably in ophthalmology as a local anesthetic and pain killer, as well as by various militaries to enhance the endurance of foot soldiers. The drug became somewhat of a fad over the next several years and was integrated into popular consumer products such as tonics and chewing gums and was an active ingredient in (what was a new drink at the time) coca-cola –products that were reported to be enjoyed by such notable figures as Queen Victoria, Winston Churchill, and the fictitious Sherlock Holmes (Streatfeild 2003). Even the popular Austrian neurologist and psychiatrist, Sigmund Freud, extolled the drug and wrote several

enthusiastic papers centered on it. Most notably, in *Über Coca* (On Coca 1884),

Freud wrote,

> *"...exhilaration and lasting euphoria, which in no way differs from the normal euphoria of the healthy person...You perceive an increase of self-control and possess more vitality and capacity for work.... This result is enjoyed without any of the unpleasant after-effects that follow exhilaration brought about by alcohol....Absolutely no craving for the further use of cocaine appears after the first, or even after repeated taking of the drug..."*

By the turn of the century, the addictive and malicious properties of

cocaine began to elucidate themselves as part of the racial backdrop of the time

period. In 1914, Dr. Christopher Koch of the Pennsylvania State Pharmacy Board

asserted that the majority of attacks upon white women in the south were a direct

result of a 'cocaine crazed Negro brain' (Redda, Walker, and Barnett 1989). Dr.

Koch's comments metastasized and even great public hysteria over cocaine and

precipitated a string of newspaper articles focusing on the epidemic of cocaine use

among African Americans in the South. Growing concern by the American public

materialized later that year when the U.S. congress passed, and President

Woodrow Wilson signed, the Harrison Narcotics Tax Act. The acts required all

those handling the drug to be registered with the government, pay special taxes,

and keep records on each sale – measures which effectively made cocaine (as well

as marijuana and heroin) illegal nationwide (Weiss 1994).

In response to the sanctions, cocaine use went underground and was

largely confined to so-called bohemians (such as jazz musicians, actors, and

artists) and affluent members of certain minorities (Platt 2000). Moreover, by the

1930s amphetamines were seen as a cheaper and longer lasting legal substitute for

the now very expensive illegal cocaine. Cocaine was even being curtailed in the medical community thanks to the dawn of newer and longer-lasting anesthetics. By 1950, the United States government was claiming success in the war on recreational drugs, at least with regard to cocaine - yet the celebration was premature (Platt 2000).

The 1960s in United States stands in stark comparison to the previous decade in which the county enjoyed a steady uprising in the economy, education, entertainment, and civil rights. The so-called psychedelic revolution began in the 1960s and ushered in a new class of Americans best remembered for their licentious attitudes and new found interest in drug use, particularly cocaine – Paul Kantner, guitar player for the psychedelic rock band Jefferson Airplane, quipped, "If you can remember anything about the sixties, you weren't really there."

Cocaine was dubbed "the champagne of drugs" for its preference of choice among the rich and famous, and its use was on the rise all across America. In 1972 one in eleven eighteen- to twenty-five-year-old Americans had used cocaine (Mieczkowski 1996). Ten years later that figure was up to one in four, and by 1982 the National Institute on Drug Abuse reported that approximately 22 million Americans had used cocaine at least once - the figure stood at 5 million in 1974 (Mieczkowski 1996).

The following two graphs exhibit the remarkable upward trend in annual and monthly cocaine use carried over from the 1960s into the following decades.

**Figure 1 - Past Year Cocaine Use among Persons Aged 12 or Older, by Age: 1972-2004**
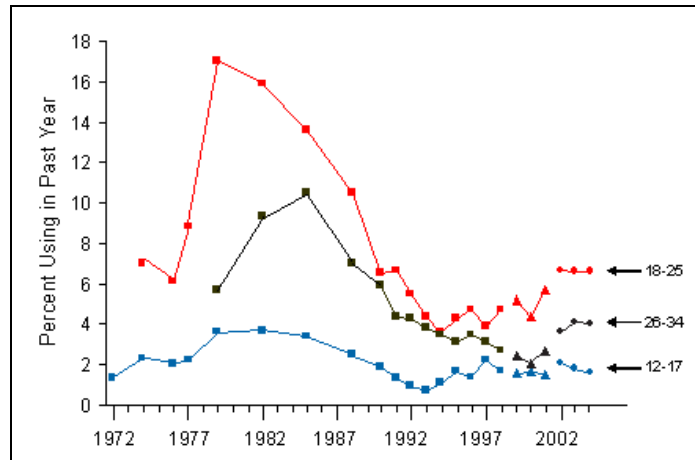


*Source: NSDUH 2005*

**Figure 2 - Past Month Cocaine Use among Persons Aged 18 to 25: 1971-2004**
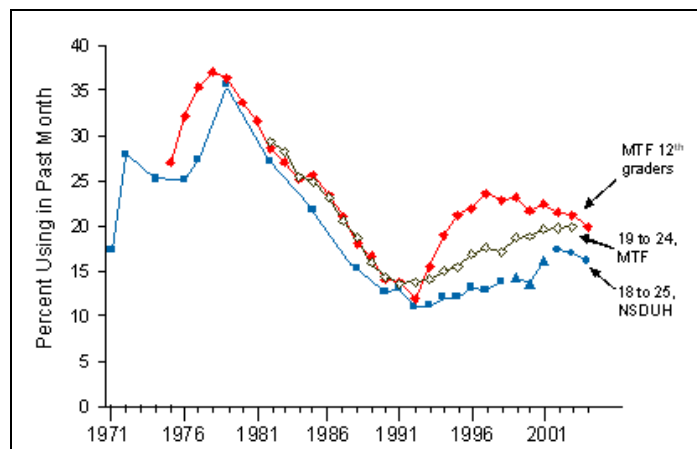


*Source: NSDUH 2005*

**Overview of the American Drug Policy and its Effects (1980s-)**

United States drug policies are readily characterized for their both punitive and extremely expensive nature. In direct monetary costs, according to the Office of National Drug Control Policy, the federal government spends approximately $15 billion annually on drug control in the mid 1990s - state and local governments also spend at least this amount (ONDCP 2004). Thus, drug control was a $30-35 billion government program in the 1990s, a sharp increase from about $6-7 billion in 1985 (ONDCP 2004). According to the ONDCP (2004),

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federal spending on drug control policies has an annual growth rate of over 14 percent for the years 1981 to 1999.

The punitive nature of drug policy in the United States is clearly reflected in budget spending and incarceration trends. About three-quarters of the national drug control budget is spent on apprehending and punishing predominately drug suppliers – leaving treatment options with only one-sixth of the budget (ONDCP 2004). In 1980, there were about 31,000 people serving jail or prison time for selling or using drugs, by 1994 the figure had jumped to near 400,000 (Sevigny and Caulkins 2004). Between 1990 and 2000 drug incarcerations increased by still another 200,000, and have since reached the half-million mark (Sevigny and Caulkins 2004). In summary, it is estimated that supply-oriented enforcement has increased so that the risk of incarceration, given participation in drug selling, has tripled from 1980 to 2000 (i.e. risk of incarceration has increased, not just the number, in absolute term, or drug imprisonments) – while at the same time cocaine prices have dropped by about 80% from 1980 to 2000 (Caulkins and Reuter 1998; ONDCP 2004; MacCoun and Reuter 2001; Caulkins and Chandler 2005).

The vast mast majority of incarcerations stem for the enforcement of people involved in drug distribution, not those who merely use (Sevigny and Caulkins 2004). However, the number of individuals who are imprisoned for drug possession felonies only (non intent to distribute) has significantly increased – in 1992 alone, 50,000 were sentenced to state prison for non-distribution offenses (Sevigny and Caulkins 2004). An infamous example of the penal nature of U.S.

drug policy is that in federal courts the possession of 5 grams of crack cocaine

will generate a five-year mandatory minimum sentence, compared with a national

average time served for homicide of about five years and four months, even

though that $400 worth of crack is just one fifty-millionth of U.S. annual cocaine

consumption, or about two weeks' supply for one regular user (Sevigny and

Caulkins 2004). The following table summarizes some of the characteristics in

incarceration trends through 1994.

**Table 1: Trends in Drug Enforcement, 1980-1994**

| | 1980 | 1985 | 1990 | 1994 |
|---|---|---|---|---|
| **Drug Arrests** | 581,000 | 811,000 | 1,090,000 | 1,350,000 |
| Heroin and cocaine only | 70,000 | 240,000 | 590,000 | 635,000 |
| | (12 %) | (30%) | (54%) | (47%) |
| Distribution only | 104,000 | 192,000 | 345,000 | 370,000 |
| | (18%) | (30%) | (31%) | (27%) |
| **Inmates [Total]** | 31,000 | 68,000 | 291,000 | 392,000 |
| Local Jails | 7,000 | 19,000 | 111,000 | 137,000 |
| State Prisons | 19,000 | 39,000 | 149,000 | 202,000 |
| Federal Prisons | 4,900 | 9,500 | 30,500 | 51,800 |

*Source: Sevigny and Caulkins, 2004*

The justification for aggressive punishment is the claim that high rates of

incarceration will reduce drug use and related problems. The theory is that tough

enforcement and sever convictions will raise the risk of drug selling, reinforce the

message that drugs are disapproved of and harmful, and also make drug dealers

more vigilant and thus make it harder for customers to find them. Some dealers

will then drop out of the business, and the remainder will require higher

compensation for taking on greater risks. Hence, the price of drugs should rise

which in turn will discourage the consumption of illegal drugs, as with licit goods

and services. The following figure shows that this is clearly not the case

(measuring punishment by "Drug Inmates").

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**Figure 3 - Cocaine Price vs. Drug Inmate Population**
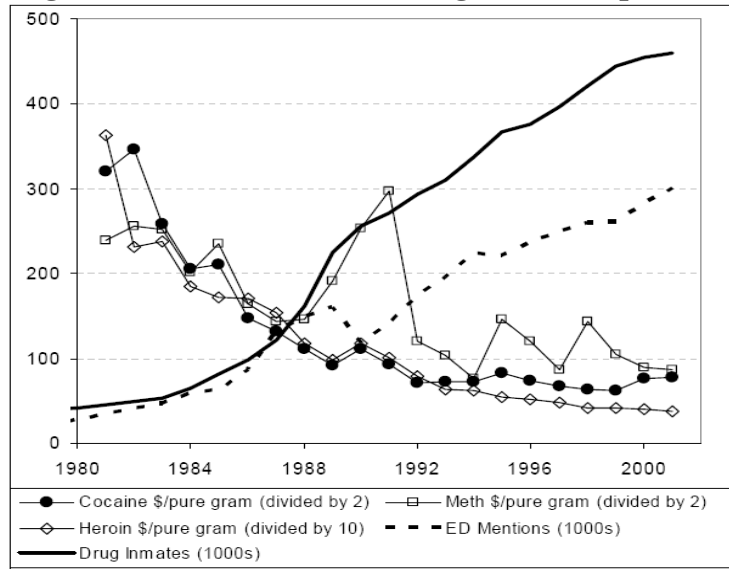


*Source: Caulkins, Reuter, Taylor (2006)*

Yet despite the sharply increased stringency, prices have been in steady decline. During the past 25 years, the general price trends have gone more or less in the opposite direction from what would be expected (see figure above). Incarceration for drug law violations (primarily pertaining to cocaine and heroin) increased 11-fold between 1980 and 2002; yet purity-adjusted powder cocaine prices have declined by roughly 80 percent since 1981 (Caulkins, Reuter, and Taylor 2006). A very sharp (roughly 70 percent) declines during the 1980s through 1989 at all quantity levels, a pronounced (22 to 35 percent) one-year increase from 1989 to 1990, and gradual declines during the 1990s so that prices at the end of the 1990s were 30 to 40 percent below those in 1989 (Caulkins, Reuter, and Taylor 2006). With the additional data for 2000 forward, the series show an apparent price jump between 1999 and 2000 that was sustained until 2001, at least at the lowest quantity level. Prices continued to decline uniformly,

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however, from 2001 to 2003, reaching all-time lows roughly 12 to 21 percent below those in 1999 (Caulkins, Reuter, and Taylor 2006).

Further, it is important to stress that another implication of a punitive drug policy is to lower availability to current and potential users. However, long-term data from an annual survey of high school seniors (Monitoring the Future) suggests that this goal has not been achieved. The fraction of high-school seniors reporting that cocaine is available or readily available has been about 50% for 25 years – it is notable that this average includes a range that started at 30 percent in 1980 and, while somewhat noisy, has continued to drifted upward (Caulkins, Reuter, and Taylor 2006).

**The Cocaine Production Process**

The primary raw material for manufacturing cocaine (cocaine hydrochloride) is the coca leaf, and the two intermediate products are coca paste and coca base. The first step in the process is harvesting coca leaves, which can be done tow to six times per year – the cultivation process, seed to leaf, generally takes 12 to 24 months (Dombey-Moore, Resetar, and Childress 1994). Then the leaves must be dried, which can take about half a day give sufficient sun. These dried leaves can then be stored for extended periods of time without losing much of their alkaloid content (a naturally occurring nitrogen compounds). The next step is to turn the leaves into paste – a process that is not overly complex, and within the supply chain is generally carried out by peasants in small factories. Once the paste is produced, the next step is to refine it into base; this is the more sophisticated process. According to the Defense Science Board, this step requires

1 "chemist" and 50 laborers to produce 500 kilos of base per week (Dombey-Moore, Resetar, and Childress 1994). The final stage is to render the base into cocaine HCL (the normal form of transport and use); a process which is also relatively complicated and requires several chemicals.

**Table 2 - Cocaine Hydrochloride Production**

| Ingredients Required[a] | Amount (per kg of C.HCl required)[a] | Processing Time[b] | Equipment[c] | Product |
|---|---|---|---|---|
| **Coca leaf** | 250–500 kg | 3–5 days | Cement or plastic pit | Paste |
| Potassium carbonate | 30 l | | Filter | |
| Kerosene[d] | 50 l | | | |
| Sulfuric acid | 10 l | | | |
| Sodium carbonate | | | | |
| Water | | | | |
| **Coca paste** | 2.5 kg | 5–10 days | Glassware | Base |
| Sulfuric acid | 500 ml | | Drying tables | |
| Potassium permanganate[e] | 10 kg | | Heat lamps (electrical source) | |
| Ammonium hydroxide | | | | |
| Water | | | Filter | |
| **Cocaine base** | 1–1.1 kg | | | Cocaine hydro-chloride |
| Ethyl ether | 5 l | | | |
| Acetone, methyl ethyl ketone, benzene, or toluene | 5 l | | | |
| Hydrochloric acid | 250 ml | | | |

*Source: Dombey-Moore, Resetar, Childress (1994)*

**Outline of the Factors Contributing to Cocaine Price**

Perhaps the most striking observation about cocaine prices is simply that they are extraordinarily high per unit weight. For example, in the late 1990s, gold sold for around 300 per ounce where as cocaine retailed at $100 per pure gram, and hence can cost upwards of $2834.95 per pure ounce (gold price quoted at www.goldprice.org). This astonishingly high price for cocaine will now be disentangled into its respective percentage costs.

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First, the cost of producing cocaine (raw material costs) is very low. The DEA (1990) lists source prices of cocaine in Columbia at $800 to $1600 per kilogram -- this means that the whole sale price of cocaine in Columbia is only about 1% of U.S. retail prices. This percentage is comparable to many consumer goods. However other than raw material costs, the nature of costs is rather disparate.

For cocaine, like all illicit drugs, no taxes are paid. Conventional shipping costs of cocaine are negligible. For example, FedEX will ship a 1 kilogram package from Bogota, Columbia to New York City (zip code 10001) for $54.81, which is about 0.02% of the kilogram price of cocaine in New York City (price quote obtained from fedex.com, March 15, 2008). The packaging materials account for perhaps 0.25% to 0.5% of the retail price – dealers report paying about $2.50 for 100 glassine bags used for retail costs (Caulkins et al. n.d.). Promotional costs are also negligible because, other than stamping bags with distinctive logos, very little marketing is done (Caulkins and Reuter 1998). Overhead for shelf space is almost nothing, even when drug dealers operate out of buildings, because the buildings are often abandoned and, in any case, the drugs are not bulky. According to Caulkins and Reuter (1998), inventory costs, assuming a 3 month supply (probably only characteristic at the upper levels) and a 25% interest rate (reflecting high risk), would only be on the order of 1% of retail sales. Processing costs are also very low in source countries. In transcripts of interviews with crack sellers, Caulkins et al. (n.d.) note that a "cooker" was paid

$100 to cook up 1.25 ounces of cocaine that sold at retail for $6500, suggesting conversion costs of 1.5% of retail sales.

The costs enumerate above provide little insight into the realized cost for cocaine. Instead, for cocaine, the dominate costs appear to be associated with importing, labor, product and asset seizures, and compensation for the risks of incarceration and physical harm.

Cocaine costs around $15,000 per kilogram at import, with in the U.S. borders – an increase of about $1,500 per kilogram in Colombia (Caulkins and Reuter 1998). However, cocaine sells for about $110 per gram (adjusted for purity), which is equivalent to $110,000 per kilogram. Hence, about 12% ($13,500/$110,000) of the retail value is attributed to import costs (Caulkins and Reuter 1998).

Labor costs are very high, with respect to comparable consumer goods, because illegality forces the distribution system to operate in inefficient ways. For example, cocaine is packaged by hand. Simple machines could do the work at a small fraction of the cost (like they do in the case of sugar or flour); however enforcement makes it very risky to maintain fixed capital equipment. Reuter et al. (1990) estimate that in 1988 a daily cocaine retailer sold a median of $3,600 worth of drugs each month. These same individuals were estimated to have spent 66 hours per month selling; to earn a median of $7 per hour when working in the licit labor market; and thus to have foregone something like 66 hours times $7 per hour = $462 in legitimate earnings per $3,600 sold (Reuter et al. 1990). Hence, one could view about $462/$3,600 = 13% of the retail value of the cocaine market

as compensation for retailers' time. Including costs of labor at higher levels and--to the extent that they are excluded from the Reuter et al. (1996) study--support workers (touters, holders, baggers, look-outs, etc.) would no doubt increase this proportion.

The Federal-wide Drug Seizure System (FDSS) recorded 98 metric tons of cocaine seizures within the Unites States in 1995 (ONDCP 1997). Valued at wholesale prices of $20,000 to $25,000 per kilogram, this represents a loss to traffickers of $1.96 to 2.45 billion, which is 5% to 6% of the $38 billion in retail cocaine sales (Caulkins and Reuter 1998). About $800 million worth of non-drug assets are forfeited to the U.S. Drug Enforcement Agency (USDEA), Organized Drug Enforcement Task Forces, and U.S. Customs each year, which represents about 1.3% of the roughly $60 billion per year market for all illicit drags (Rhodes et al. 1997). Godshaw, Koppel, and Pancoast (1987) estimated that state and local agency seizures were about half as large as federal seizures – suggesting that state and local seizures probably account for at least another 1% to 3.5% of retail sales. Therefore, estimates suggest that seizures at all levels of government represent about 8% to 11% of retail cocaine price.

Finally, risk compensation, for both prison time and physical danger, accounts for a little over 50% of the cost of cocaine. According to Maguire and Pastore (1997), in 1994, drug law violators were sentenced to terms that lead to approximately 325,000 person years of incarceration, with the vast majority being associated with drug trafficking. Further, Kleiman (1992) reports on average, a drug dealer requires an average compensation of $43,500 per expected year on

incarceration. Thus, the risk compensation associate with prison time would represent $14.14 billion ($43,500 x 325,000), or about 23.6% of the $60 billion market for illicit drugs.

Reuter et al. (1990) estimate that per year of retail drug selling in Washington, D.C., compensation for the risk of death ($10,500) and injury ($2,100) together were about 1.4 times greater than that for the risk of incarceration ($9,000). If this same ratio applied nationwide, this suggests that 1.4 times 23.6%, or 33%, of the retail value of drug sales represents compensation for the risk of injury or death (Caulkins and Reuter 1998). It is important to note that this national percentage may be lower because Washington D.C. in 1988 saw a homicide rate that was near the top among U.S. cities and the share attributed to drug trafficking by the local police department was very high – thus it may have been a time period that was unusually violent for drug dealers (Caulkins and Reuter 1998). Further, the late 1980s was also a time period when cocaine markets were still developing, which may have generated very high rates of competitive and transactional violence for dealers (Caulkins and Reuter 1998).

**Table 3 - Estimate of Magnitude of Cost Components for Cocaine Sold at Retail, 1990**

| | |
|---|---|
| Wholesale price in Columbia | 1% |
| Importing of drug | 12% |
| Retail Labor | 13% |
| High-level labor | 1-3% |
| Drug and asset seizures | 8-11% |
| Money laundering fees | 2-4% |
| Packaging, processing, and inventory costs | 1-2% |
| Compensation for risk of prison | 24% |
| Compensation for physical risk | 33% |
| Total | ~100% |

*Source: Caulkins and Reuter (1998)*

**Variation in Cocaine Prices: Market Level Variation**

Despite their high costs, cocaine prices are also exhibit I wide range of variation that sets them distinctly apart from other consumer goods. Cocaine prices vary across market levels, between locations, over time, and from transaction to transaction.

Caulkins and Padman (1993) offer the simple explanation that variation across market levels exists because there is substantial quantity discounts for the drug – this is the simple concept where as the purchaser received a discount, per unit, when he buys in higher volume. Caulkins (1997b) estimates that between the import of a 250 kilogram import of cocaine, and the final street sale of 0.2 grams, there may be five of six separate sales transactions. This high number of steps between the producer and the end user, while highly inefficient, supports a quantity discount. Hence, as one moves down through the distribution hierarchy, transaction sizes get smaller and the price per unit gets larger in a manner that is well described by a power relation.

Specifically, a simple model of the domestic distribution network is that a mid-level dealer buys a quantity of drug, repackages the drugs into $\varphi$ equal size units, and sells them at some multiple, $\delta$, of the original price (Caulkins and Padman 1993). Further, Caulkins and Padman (1993) argue that if the branching factor $\varphi$ (which is understood as the number of children of each node) and the price multiplier $\delta$ are the same at every level of the network, then this implies that the price P as a function of transaction size Q satisfies the following relation:

$$\varphi P(Q/\varphi) = \delta P(Q) \qquad\qquad (1)$$

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This implies that,

$$P(Q) = \alpha Q^{\wedge}(1 - \ln\delta/\ln\varphi) \qquad (2)$$

Therefore, it is apparent that the price per unit is proportional to the transaction size raised to a (negative) power. Caulkins and Padman (1993) test this model empirically and find the log-linear quantity discount model (stated above as the implied form) fits cocaine price data 1981-1994 well.

Quantity discounts are a very familiar concept in the market for consumer goods, however the discounts (or inversely the mark-ups) for illicit drugs is significantly larger (Caulkins and Reuter 1998). Section III discussed how American drug policy is incredibly punitive and predominately targets suppliers, in light of quantity discounts, there are important implications on America's drug war strategy. If most of the drug seizures are occurring at the higher levels (points relatively close to the supplier) than the cost of replacing those drugs is much less than the cost of replacing an equivalent amount at the retail level, because they have not been subjected to the high mark-up costs yet.

Another important question that arises from the variation of cocaine prices across market levels is how enforcement targeted at the higher levels, to raise prices, is transmitted to a change in price at the lower levels. Caulkins and Reuter (1998) present two models for understanding how price changes are realized through the distribution chain. First, the "additive model" suggests that increasing high-level prices by $1 per gram will increase the retail price by approximately $1 per gram. This model assumes that at each level the market is competitive and that additional $1 cost is simply carried through the distribution chain. The "multiplicative model" however suggests that increasing the high level prices by

1% will increase the retail price by 1% (Caulkins and Reuter 1998; Caulkins 1994a).

In regards to market level variations, these two models have significantly different implications for the efficacy of interdiction and enforcement at the high levels. For example, let cocaine have an initial import price of X and a retail price of 10X. Then consider a government program that increased the import price from X to 2X. Under the additive model, the retail price would only rise modestly to 11X. Whereas, under the multiplicative model, because import prices doubles, retail price will double from 10X to 20X. Clearly the multiplicative model is desirable when attempting to raise retail prices in an attempt to curb drug consumption. Caulkins (1990, 1994a) and Boyum (1992), by analyzing historic price data, find some support for the multiplicative model at certain stages in the distribution chain, however because the data is very imprecise they concede that conclusions cannot be accurately drawn.

In summary, it has been observed that the market for cocaine exhibits a substantial degree of discounting for larger quantities (or inversely, substantial mark-ups for smaller quantities). However, because price data is imprecise and missing for many of the steps in the distribution chain, it is not currently possible to imperially test some current theoretical models about the implications of targeting the higher levels of the supply chain in order to drive up retail prices.

**Variation in Cocaine Prices: Spatial Variation**

Unlike the markets for consumer goods, or security prices, illicit drug markets exhibit substantial price variation across location. Caulkins (1995)

observes that a kilogram of cocaine often sells for $6,000 more in Boston than in New York City. This would lead one to expect that an arbitrageur would quickly step in and purchase cocaine in New York City and then sell it for the high price in Boston (pocketing the profit) until the price difference narrowed to only the incurred transportation costs. However, such actions appear not to be occurring as the price difference between Boston and New York City has persisted for many years (Caulkins 1995).

This systematic variation in prices between cities implies that there are poor information flows (implying that arbitrageurs would not be aware of such opportunities), and/or significant transactions cost associated with such lateral market transactions that would evaporate the opportunity for arbitrage.

Reuter et al. (1988) analyze data on 551 wholesale transactions provided by the DEA's Domestic Intelligence Unit, they find that cocaine prices were lowest in southern Florida and lower in New York City than they were anywhere except southern Florida. They hypothesis that such variation is likely the result of Florida being a point of entry for cocaine and that New York City allows for lower prices because of its large market size. Further, Caulkins and Padman (1993) find that prices reported by the Western States Information Network (WSIN) for 1984-1991 are lowest near points of import. Specifically, they find prices were lowest near the principle points on import (Los Angeles and the Mexican Border), are below average near secondary points of import (San Francisco and Seattle/Canadian border), and increase as one moves north. Caulkins and Padman (1993) also test several other illicit drugs and find evidence

for the existence of geographic variation as well in crack, heroin, methamphetamine, and modest geographic effects for cannabis products.

Expanding on these two previous studies, Caulkins (1993) used data from the Middle Atlantic-Great Lakes Organized Crime Law Enforcement Network (MAGLOCLEN) to test the relation of drug prices to population density and locality with respect to "Tier I" cities. Caulkins (1993) finds evidence to support the claim that cocaine prices follow an urban hierarchy where as they are lowest at points of import such as New York City (a tier I city) and increase as you move away from the city. Caulkins (1993) also finds that, all things equal, between two cities with equal distance from a tier 1 city, population size and density are a significant determinate to price.

Grossman, Chalopuka, and Brown (1996) report similar evidence that prices subject to spatial variation based on a system of dispersion. They identify eight import cities for cocaine from the DEA intelligence division: New York, Miami, Los Angeles, Houston, San Diego, New Orleans, Dallas, and Phoenix. Grossman, Chalopuka, and Brown (1996) find, through regression analysis, that prices are lower in the eight port of entry cities than in other cities with differentials ranging from approximately $6 in the case of New Orleans to $38 in the case of Miami.

Continually, Kleiman (1992) provides evidence that there is even systematic variation in prices between neighborhoods within one city; he reports significant heroin prices to be consistently lower in Harlem than in the lower east side (which is only 30 minutes away by subway). This observation is bolstered by

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data from the 1993 domestic monitor program that shows the mean price per pure milligram of heroine in east Harlem was $0.358 vs. a mean price of $0.471 per pure milligram on the lower east side, a difference that that is statistically significant at the 0.05 level (USDEA 1994).

In summary, there is extensive support that cocaine is distributed through an "urban hierarchy", where as large cities tend to be "leaders" with drugs diffusing down through layers of successively smaller surrounding communities. For example, a port of entry such as New York City occupies a top spot on the hierarchy, followed by large cosmopolitan cities such as Philadelphia, and further followed by more regionally oriented cities such as Pittsburgh. This trend is further supported by cocaine dealer interviews in Washington D.C. who report receiving drugs from Los Angeles (Caulkins and Reuter 1998). This phenomenon contradicts the idea that drugs follow the shortest path from place of import to point of retail sale (Caulkins and Reuter 1998).

**Variation in Purity and its Effects on Prices**

Caulkins and Padman (1991, 1993) and DiNardo (1993) studied the effects of quantity on prices and found that price is not determined by quantity alone. Cocaine and illicit drugs in general are frequently sold diluted and/or adulterated. However, because drugs are purchased for their pharmacological effect, and the drugs themselves are vastly more valuable than the adulterants or diluents, it should be expected that two grams of a drug that was 40 percent pure would cost about as much as one gram that was 80 percent pure (Caulkins 1994a). Indeed cutting cocaine is not costless - there are additional fees for labor, packaging, and

to buy the cutting agent. However, Carlson and Siegal (1991) claim that the charge for cutting cocaine powder into crack is only about 2 percent of the value of cocaine. Further, since criminal sanctions are based on the raw, not pure, quantity possessed at the time of arrest, dealers incur a modestly greater risk per pure gram when they sell diluted drugs (United States Sentencing Commission 1998). Thus, these arguments imply that while doubling purity might not exactly double price, the price increase would be almost as great.

Nevertheless, the previously mentioned studies suggest that the market commands only a slight premium for higher purity drugs. Caulkins and Padman (1993), regressed transaction price on transaction size and purity, and found that the coefficient of purity is very small. Essentially, they showed that the market for cocaine values 2 grams at 40 percent purity more than 1 gram at 80 percent purity. These results are very counterintuitive. They suggest that either dealers are not maximizing profits or they are not free to adjust the purity of their product. It would seem that dealers could simply increase their revenues by further diluting their product. This would also increase their risk exposure because now they would need to sell more, and in turn would be more likely to be arrested, however it is more likely that their revenue would increase much faster than their costs (i.e. risk level) (Caulkins and Padman 1993).

Even more perplexing is the concept that purity is not a significant factor that determines the price a user is willing to pay. One interpretation is that drug users simply do not care about the purity of the drug they consume. Again, this can't be true because then it would be difficult to explain why dealers don't dilute

the drugs even more than is customarily done. What is perhaps more likely is that the expected purity, not the actual purity, along with transaction size, governs the price (Caulkins 1994a). This argument seems highly probable given the following notions. First, Caulkins (1994a) demonstrated that cocaine purity varies enormously from purchase to purchase even for a given transaction size in a given city and year. Second, drug users generally have no secure means to verify purity before purchase. Thus, we are lead to believe, a priori, that users are purchasing drugs on what they expect purity to be. Caulkins (1994a) titles this notion the "expected purity hypothesis", and though the application of various regression models, finds evidence for it. The "expected purity hypothesis" is presented bellow.

**Analytical Framework for Developing a Price Series for Cocaine**

In order to estimate a demand curve for cocaine it is essential to develop a price series for cocaine. The STRIDE data set provides observational prices for individual drug purchases, and therefore must be standardized by year and location. Caulkins (1994) demonstrates that a log-linear model, regressing price on quantity, fits the STRIDE data well ($R^2 = 0.797$ for gram and $R^2 = 0.784$ for kilogram) compared with other methods, yet it violates an underlining assumption that purity is a significant determinant of price. Adding pure quantity to the regression produces a magnitude of significance that is very small ($\beta = 0.093$ for gram and $\beta = 0.055$ for kilogram), leading to the conclusion that the purity recorded in the STRIDE data set is disjoint from the purity that determines prices. Caulkins (1994) surmises that such a discrepancy may arise due either to

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measurement error or the asymmetry in information concerning purity between the seller and the buyer – the seller cannot credibly warrant prices and the buyer cannot assay purity until the transaction is completed. Caulkins (1994) tests the latter hypothesis by conducting the Hausman test on the following ordinary least squares (OLS) and two-stage least squares (2SLS) regressions, where X is a vector of explanatory variables and Z is X augmented by the interaction between the dummies for location and time.

$$\text{OLS: } \ln(price) = \beta * X + \beta * \ln(purity) + \varepsilon$$
(3)

$$\text{2SLS: Stage 1: } \ln(purity) = \alpha * Z + \varepsilon$$
(4)

$$\text{Stage 2: } \ln(price) = \beta * X + \beta * \ln(purity) + \varepsilon$$
(5)

Revealing the coefficients on ln(purity) is higher with 2SLS and the differences are significant at the 0.001 level using the Hausman test – if no error, it would be expected that the regressions would produce similar coefficients. Therefore, this study follows the procedure for estimating a price series for cocaine outlined by Caulkins (1994), and replicated by Caulkins and Padman (1991, 1993), DiNardo (1993), Hyatt and Rhodes (1994), Rhodes and Hyatt (1992), Saffer and Chaloupka (1996), Grossman Chaloupka and Brown (1996), etc.

Let r = purity, w = weight, c = city dummies, t = time dummies, and p = price. First, the log of purity was regressed on the log or weight, city dummies, and time dummies.

$$\ln(r) = \beta * \ln(w) + \beta * c + \beta * t + \varepsilon$$
(6)

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This regression will produce an estimated purity variable, ř, for all observations and addresses the problem that purchasers have imperfect information about purity, as discussed above. Next, the log of price was regressed on the intercept of the log of weight and the log of estimated purity, city dummies and time dummies – constraining the coefficients on weight and estimated purity in order to identify the model.

$$\ln(p) = \gamma\ ^* \ln(w) + \gamma\ ^* \ln(\check{r}) + \gamma\ ^* c + \gamma\ ^* t + \varepsilon \qquad (7)$$

Finally, setting weight at 1 and purity at 100 percent (which causes the log of weight and the log of purity to equal zero) the price is given as the antilog of the sum of the intercept, the relevant city coefficient, and the relevant time coefficient.

**The Flow of Cocaine in to the United States**

The major coca leaf producing nations are Peru, Bolivia, and to a lesser extent Ecuador and Columbia. Coca has also been grown in other countries, but the plant is of lesser quality and is unsuitable for cocaine HCL production. In fact, there are over 200 species of coca but only 17 can be used to produce cocaine (Rodgers 2000). Over the past twenty years Columbia has significantly increased their production of coca leaf, which is grown predominately in the remote jungle area of the country that are run by the leftist guerrillas (Rodgers 2000). Columbia is currently the world's leading grower of coca leaf. Peru was the dominate coca leaf producer until around 1995, after which coca production dropped by 66 percent (Rodgers 2000). The reason for the precipitous drop in cultivation is that the land used to grow coca has fallen from 100 thousand hectares to 38 thousand

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hectares, an increase in Peruvian and U.S. eradication and anti-drug policies, and most importantly Peruvian farmers stopped growing the illicit crop after coca prices fell sharply in 1995 (Rodgers 2000). Further, Cocaine production has stagnated from 1990 to 2005 which has been attributed to the opposing forces of a gradual decline in the coca cultivation area during the late 90s and early 2000s while there was an increase in the average yield per hectare (Storti and Grauwe 2007).

**Figure 4 – Andean Coca Cultivation, 1998-2005**
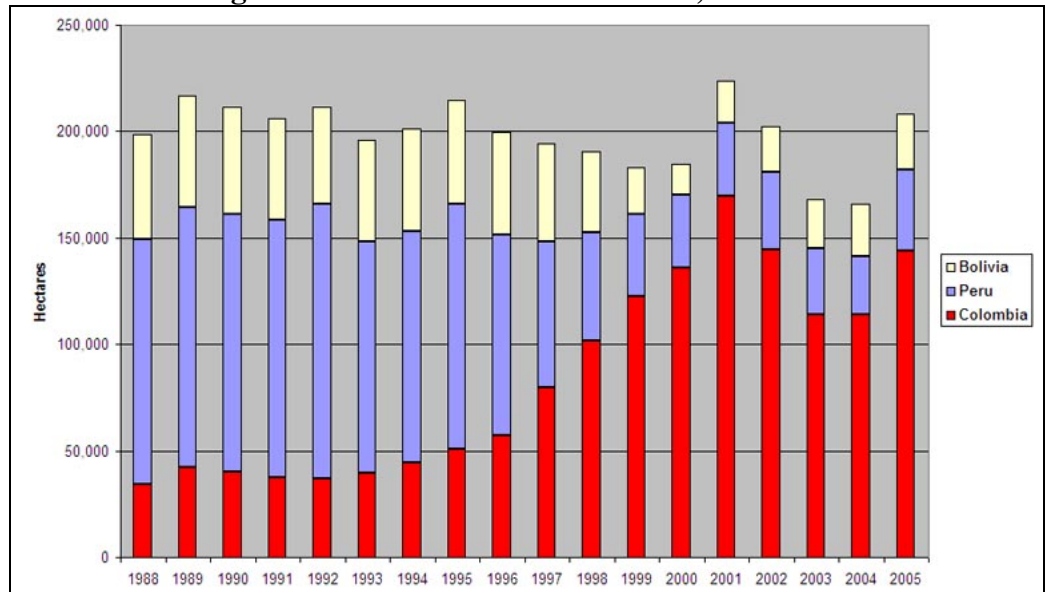


*Source: Isacson 2002*

**Figure 5 – Farm-gate Prices for Sun-Dried Coca Leafs ($ per kilo), 1990-2005**
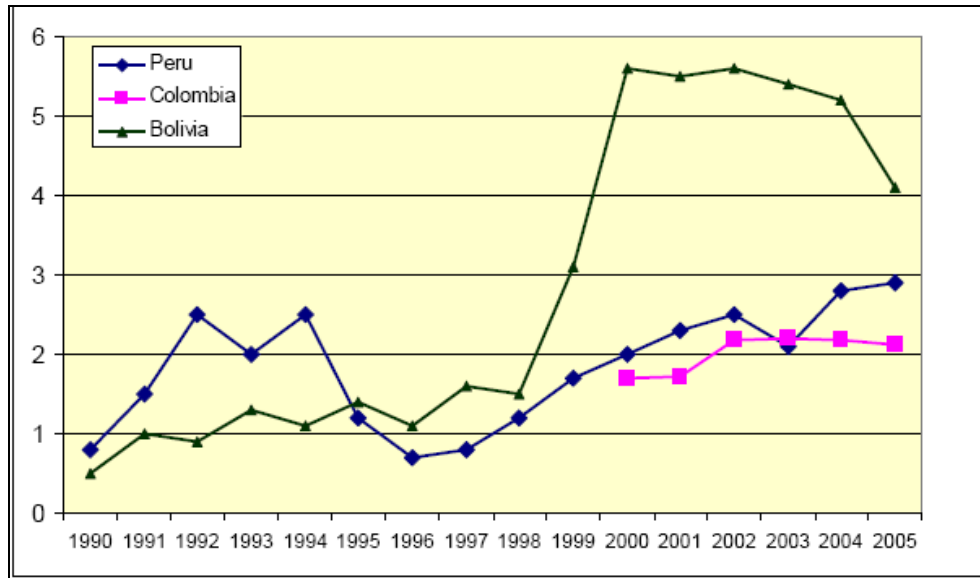
Source: Storti and Grauwe 2007

After the coca leaf is cultivated it is than transformed into cocaine HCL (powdered cocaine). Because Columbia has the financial resources, it has developed into the major cocaine processing center (Dombey-Moore, Resetar, and Childress 1994). The three countries – Bolivia, Colombia, and Peru – produce most of the world's cocaine. Once the cocaine is produced, five other countries – Argentina, Brazil, Ecuador, Mexico, and Paraguay – largely serve a transport role, moving the drug from production location to distribution centers in the market countries (Dombey-Moore, Resetar, and Childress 1994).

Once the cocaine is processed, approximately 90 percent of the documented cocaine flow events destined for the United States transited the Mexico-Central America corridor (which is composed of the Eastern Pacific, Central America, and Western Caribbean transportation vectors) (NDIC 2006). This percentage may be somewhat inflated because of underreporting in other areas, where there are fewer U.S. counterdrug assets or actionable intelligence –

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the USDOJ estimates the cocaine flows as a function of seizures of shipments –
nevertheless, the Mexico-Central America corridor is the predominant transit
route for cocaine destined for the United States.

**Figure 6 – Cocaine Import Vectors into the United States**
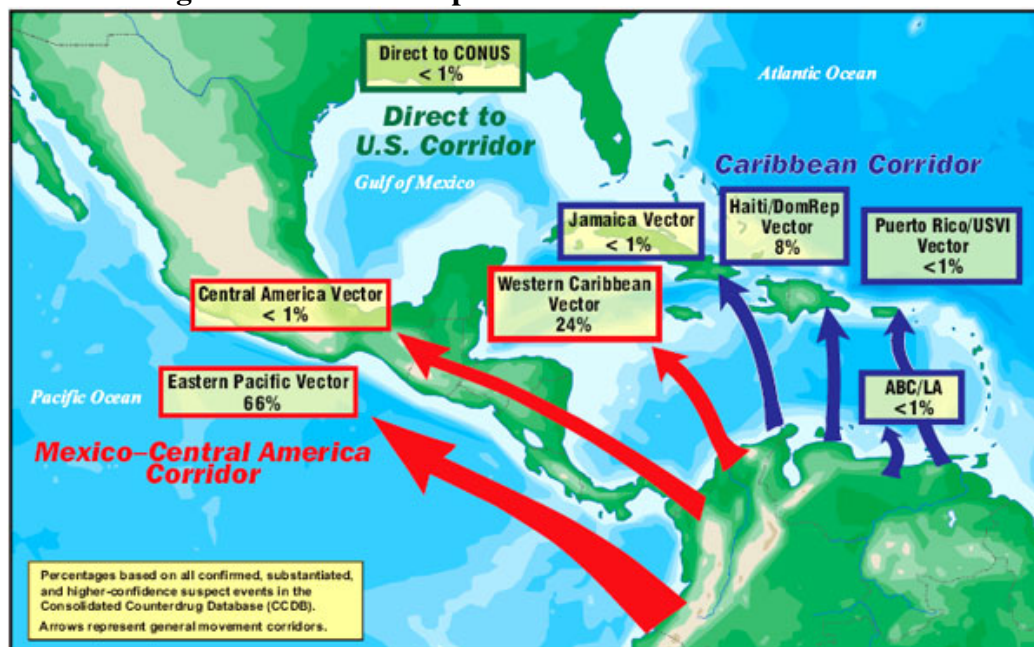


*Source: NDIC 2005*

Moreover, the primary modes of conveyance of cocaine from Columbia to
the Mexico-Central America corridor are go-fast boats and fishing vessels, a
method that has not changed significantly since the 1990s despite changes in
interdictions (NDIC 2006) -- have not changed even as interdictions, arrests of
smugglers, and vessel seizures continue to climb. Most cocaine available in the

United States is transported from South America to Mexico by maritime and, to a lesser extent, air conveyances and then smuggled across the Southwest Border. According to the U.S. Department of Justice's Interagency Assessment of Cocaine Movement (IACM), thirty seven percent of the cocaine bound for the United States from South America initially is transported to Mexico via the eastern Pacific (NDIC 2005). Similarly, thirty seven percent of the cocaine available in the United States initially is transported from South America to Mexico via the western Caribbean (NDIC 2005). An additional 3 percent of the cocaine bound for the United States initially is transported from South America to Mexico, although the route to Mexico--eastern Pacific or western Caribbean--is unknown (NDIC 2005).

Once in Mexico, cocaine is transported to the Southwest Border by Mexican drug trafficking organizations (DTOs) and criminal groups and subsequently smuggled into the United States through or between Southwest Border ports of entry (POEs), particularly Texas POEs (NDIC 2005).

Approximately 22 percent of the cocaine available in the United States is transported from South America through the Caribbean to maritime POEs in the United States, particularly in southeastern states (NDIC 2006). According to the IACM, of the cocaine shipments that were detected departing South America moving toward the United States via the Caribbean, most departed South America on vectors that indicated transit via either Jamaica (7% of the 22%) or Haiti/Dominican Republic (7% of the 22%) (NDIC 2005). Cocaine shipments also were detected moving toward the United States on vectors that indicated transit

via Puerto Rico/U.S. Virgin Islands (4% of the 22%) and Aruba/Lesser Antilles (3% of the 22%) (NDIC 2005). An additional one percent of cocaine shipments were detected moving toward the United States via the Caribbean, although the areas through which the cocaine transited were undetermined (NDIC 2005). Most of the cocaine that is transported to the United States via the Caribbean corridor is smuggled into the country through maritime POEs in southeastern states, particularly maritime POEs in Florida (NDIC 2005). The principal POEs for cocaine transported to the continental United States via the Caribbean corridor include Miami, Fort Lauderdale and, to a lesser extent, New Orleans, although cocaine is smuggled into several other maritime POEs as well (NDIC 2005).

Relatively little cocaine is smuggled from South America directly to maritime and air POEs in the continental United States. According to the IACM, only one percent of the cocaine detected departing South America toward the United States is transported directly to the continental United States via commercial vessels, mail services, or passengers on commercial flights (NDIC 2005).

The three central distribution areas for cocaine smuggled into the United States are the South-West with 35 percent of the cocaine inflow, the South-East with roughly 25 percent of the cocaine inflow, and finally the North- East with approximately 17.5 percent of the cocaine inflow (Dombey-Moore, Resetar, and Childress 1994). Powder cocaine is transported within the United States primarily in private and commercial vehicles but also via mail services and by couriers on commercial flights, buses, and trains (NDIC 2005). Crack typically is not

transported over long distances because of harsher legal penalties associated with

crack possession; however, law enforcement agencies occasionally seize crack

from private and commercial vehicles as well as from mail facilities and couriers

at domestic airports, bus terminals, and train stations (NDIC 2005). African

American and Hispanic gangs control most retail powder cocaine distribution

throughout the country.

Atlanta, Chicago, Los Angeles, Houston, Miami, and New York are the

cocaine Primary Market Areas because these cities have demonstrated very high

levels of cocaine abuse and are among the largest regional- or national-level

cocaine distribution centers (NDIC 2005). Dallas and Phoenix are national-level

cocaine distribution centers, but cocaine abuse in these cities is significantly lower

than in many metropolitan areas (NDIC 2005). Cocaine consumption is very high

in Baltimore, Detroit, and Philadelphia; however, drug seizure data show

relatively little cocaine distribution from these cities to other significant drug

markets (NDIC 2005).

**Previous Research on Cocaine Price Elasticity**

Using cross-sectional data from the National Household Survey of Drug

Abuse (NHSDA), for the years 1988, 1990, and 1999, Saffer and Chaloupka

(1995) estimate the use price elasticity for cocaine at approximately -1.10 to -0.66.

They also support that income has a mostly insignificant effect of cocaine

consumption and that the price of cocaine is negative and significant. Grossman,

Chaloupka, and Brown (1996) use data from the Monitoring the Future panel. The

surveys were conducted on 2,400 high school seniors in 1976, and then the sample

was split into two groups of 1,200, with one group being resurveyed on odd calendar years and the other on even calendar years. They report a long-run unconditional price elasticity of -1.18, and a short-run price elasticity of -0.71, and a temporary current price elasticity of -0.42. Further, they report negative cross price effects that are inconsistent with non addictive behavior, and that their results were inconsistent with the hypothesis that cocaine consumers are myopic. Van Ours (1995) examines the demand for opium in Indonesia for the time period 1923 through 1938. He uses data collected from a state monopoly that was established by the Dutch to reduce the criminality associated with drug trafficking, improve user health by guaranteeing opium with consistent quality, and finally to reduce opium use. He estimates a short-term price elasticity of opium use at -0.7 and a long run price elasticity of -1.0. Liu, Liu, and Chow (1999) examine the demand for opium in Taiwan from 1914 through 1942. They estimate a long-run elasticity of 1.22 and a short-run elasticity of approximately -.40. Bretteville-Jensen and Sutton (1996) studied the price responsiveness of 500 Norwegian heroin users. The price and consumption data are self-reported. They estimate a price elasticity of heroin demand of -1.23.

**Research Method Overview**

One potential source of bias in previous research arises from omitted variables and the endogeneity of drug price. Further, previous studies have failed to identify exogenous events that independently impact prices, thus allowing for the possibility of biased elasticity estimates. However, this study will correct for

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these problems by implementing an instrumental variable solution. This study instruments for drug prices through two approaches.

The first instrument for drug prices is a geographic approach in which textual research has revealed a persisting disparity in prices between cities. These disparities are subject to the nature of drug flows into the United States, and contingent on where a city falls within the cocaine distribution network. The geographic analysis attempts to match these port of entry cities (where drug prices are observed to be consistently lower) with similar non-port of entry cities, in order to measure the effect that disparate prices have on usage.

The second instrument for drug prices is a time series approach in which two exogenous events have been identified to explain distinct time series shocks in cocaine prices. These blips in the cocaine prices are used to measure the effects of exogenous price shifts on cocaine consumption. This approach measures how cocaine users shift their consumption when faced with an independent increase in short term cocaine prices.

**Data**

National Longitudinal Survey of Youth 1979 (NLSY79) and Geocode File

Beginning in 1979, the United States Bureau of Labor Statistics has conducted nationally representative surveys on a sample of 12,686 young men and woman. Surveys were collected annually for the years 1979 through 1994 and thereafter, beginning with 1996, were collected biannually.  The restricted NLSY79 Geocode file have been used to link respondents to their state, county, and metropolitan statistical area of residence. Drug related questions were asked

during the years 1984, 1988, 1992, 1994, and 1998. Initially, soldiers and civilian Hispanics, black and economically disadvantaged whites were oversampled in the NLSY. Since 1985, the military oversampling disappeared and 1643 individuals of the oversampled civilian population were dropped in 1991.

The NLSY79 is an optimal data set because it provides a cross sectional time series of a large nationally representative sample of individuals that can be linked to geographic location. This is important because cocaine use, while persistent, still occurs at moderately low levels.

System to Retrieve Information from Drug Evidence (STRIDE)

Cocaine price data come from the United States Department of Justice's Drug Enforcement Agency's (DEA) STRIDE data set. The data set includes acquisitions of various drugs (including cocaine) by undercover agents and informants of the DEA and the Metropolitan Police of the District of Columbia (MPDC). The data includes the type of drug acquired (e.g. cocaine base, cocaine hydrochloride, heroin), the amount acquired, the purity, the date of acquisition, and the city in which the drug transaction occurred. If the acquisition was a purchase (as opposed to a seizure,) then the data includes the price paid.

Because of its detail, geographical coverage, and relatively long time period, the STRIDE data set is widely used by policy analysts to study factors that affect or are affected by the prices of illegal drugs. Further, the prices are conjectured to be fairly accurate because officers use the data to makes bids during negotiations with dealers – any significant aberrations in prices would lead to suspicion and put agents at risk.

STRIDE data have been used in many policy studies. Caulkins (1994) and Rhodes *et al*. (1994) used the STRIDE data set to develop a price-index series for illegal drugs. Saffer and Chaloupka (1995), Chaloupka *et al*. (1998), and Grossman *et al*. (1996) used the STRIDE data set to estimate demand functions for illegal drugs. DeSimone (1998) used the STRIDE data set in a study of whether marijuana is a gateway drug for the use of cocaine. Yuan and Caulkins (1998), DiNardo (1993), and Crane *et al*. (1997) used the STRIDE data set to investigate the effects of enforcement actions on the prices of illegal drugs. Boyum *et al*. (1994) used the STRIDE data set to predict future trends in heroin availability and use. Caulkins (1997) used the STRIDE data set to investigate the relative prices of crack and powder cocaine. Bach *et al*. (1999) used the STRIDE data set to investigate the relation between heroin prices and changes in the use of heroin by users seeking methadone treatment. Agencies of the federal government use the STRIDE data set to estimate quantities of illegal drugs consumed in America. Consumption is not measured directly, but estimates of expenditures on illegal drugs are available from surveys. Consumption is estimated by dividing expenditures by a price estimate obtained from STRIDE (National Research Council 1999).

However, despite being fairly ubiquitous with drug research, the STRIDE data set does present serious empirical limitations. Horowitz (2001) argues that the STRIDE data set is solely a record of drug acquisitions made to support criminal investigations and prosecutions. The decision to buy drugs is based on criteria that aim at serving this objective; this criterion is not necessarily the ones

that would be used if the objective were to develop price indexes or to support

other economics analysis of markets for illegal drugs (Horowitz 2001). Thus, the

behavior of prices in the STRIDE data set may be artifacts of the data acquisition

procedure and not indicators of price variations in actual markets. Horowitz

(2001) states the nature in which data is collected does not produce a random

sample of one or more known populations, nor are they realizations of an

identifiable stochastic process that can be modeled. Further, ethnographer Richard

Curtis, who studies drug markets, reports that prices often vary systematically

among dealers, buyers, and dealer-buyer pairs – for example, a dealer may set a

higher price for an unfamiliar customer than for a customer he know. This

observation means that records of purchase prices are not necessarily statistically

independent of each other. Finally, Horowitz (2001) argues that the STRIDE data

set for cocaine is not representative of market prices; specifically because there

are large differences among price estimates from different subsets of STRIDE.

A serious current limitation to this research is that the STRIDE data set is

currently still in clearance with the DEA. Thus, for this paper, only rough

estimates of prices can be presently determined at the national level.

<u>The Crack Index</u>

Fryer, Heaton, Levitt, and Murphy (2005) construct an index of crack

cocaine prevalence based on a wide range of indirect proxies such as cocaine

arrests (FBI's Uniform Crime Reports), cocaine-related emergency room visits

(from Drug Abuse Warning Network (DAWN)), cocaine induced drug deaths per

capita (from Mortality Detail File produced by National center for Health Stats),

crack mentions in the newspaper (based on LexisNexis searches), and DEA drug

busts (from the STRIDE data set). They analyze data separately at the city level

and at the state level; the city level analysis consists of 144 cities with population

greater than 100,000 in 1980. Using factor analysis the authors construct a single

measure for prevalence. They claim that the single factor is desirable because of

its relative simplicity; a single factor substantially increases the signal-to-noise

ratio (because each individual proxy is quite volatile), and each proxy will have an

identical impact of a dependent variable (this avoids the problem of potentially

overstating the role of cocaine on fluctuations in social outcomes). This data set is

used to measure the prevalence of cocaine and cocaine usage.

State Court Processing Statistics data (1990 – 2000)

The State Court Processing Statistics (SCPS) data set is administered by

the U.S. Department of Justice's Bureau of Justice Statistics (BJS). Originally

known as the National Pretrial Reporting Program, the State Court Processing

Statistics (SCPS) program tracks felony cases filed in May of even-numbered

years until their final disposition or until one year has elapsed from the date of

filing. This SCPS data set presents records on felony cases filed in approximately

40 of the Nation's 75 most populous counties. These 75 counties account for more

than a third of the U.S. population and approximately half of all reported crimes.

The cases from these 40 jurisdictions are weighted to represent all felony filings

during the month of May in the 75 most populous counties. Data are collected on

arrest charges, demographic characteristics, criminal history, pretrial release and

detention, adjudication, and sentencing.

The dependent variables used in this study are dichotomous measures of cocaine usage from the NLSY79. The NLSY79 asked respondents the following two questions: "Have you ever used cocaine?" and "Have you used cocaine in the past 30 days?" The variables will equal one if the individual reports yes, and zero otherwise. These questions were not asked every year; data is available only for the years 1984, 1988, 1992, 1994, and 1998. The following two graphs present a summary of the number of users, from a total of 12,686, who answered yes to either of the questions.

**Figure 7 – Total Number of Times Ever Used Cocaine, by Year**
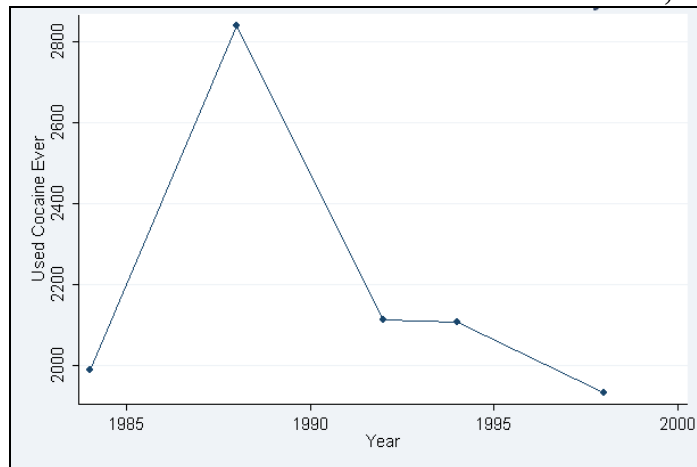


*Source: NLSY79*

**Figure 8 – Total Number of Times Used Cocaine in Past 30 Days, by Year**

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Used Cocaine Past 30 Days
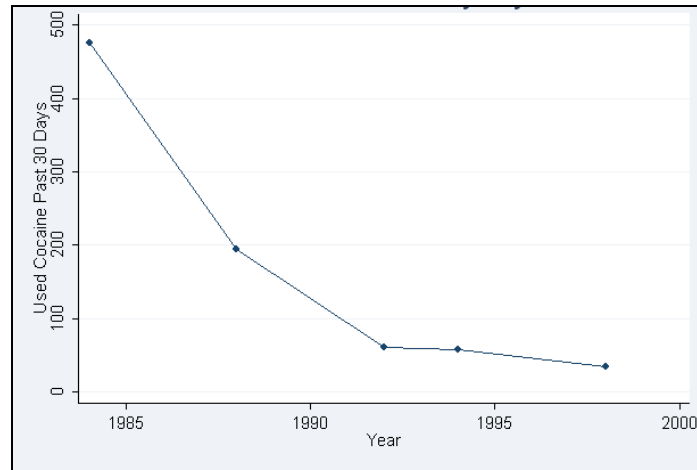
Year

*Source: NLSY79*

NLSY79 & Geocode: Independent Variables

- Age: the age variable records the participant's age for each year the survey is conducted. The age variable ranges from 14 in 1979 to 45 in 2002

- Income: the income variable is the sum of income received for both military income and nonmilitary income by year – note that there is no double counting between the two specifications. For military income, the NLSY asks, "During [year x], how much total income did you receive from the military before taxes and other deductions? Please include money received from special pays, allowances, and bonuses." For nonmilitary income, the NLSY asks "During [year x], how much did you receive from wages, salary, commissions, or tips from all jobs, before deductions for taxes or anything else."

- Race: the race variable is sampled at 1979 and assumed constant across years (i.e. assuming there were no mistakes at original sampling that were corrected in later years). There are two race variables: first a dichotomous variable that equals one if the participant self reports to be black, and zero otherwise. The other dichotomous race variable equals one if the participant self reports to be Hispanic, and zero otherwise. It is important to note that there is a significant sample of people who identified themselves as both white and Hispanic.

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- Male: the male variable is a dichotomous variable taking the number one if male and zero if female. The variable is recorded in 1979, the first survey year.

- SMSA: the Standard Metropolitan Statistical Areas (SMSAs) are a measure of geographical location provided by the NLSY79 geocode data set. Each SMSA represents a group of counties and/or cities. The SMSA codes used in the NLSY79 are taken from the October 1981 issue of the *Statistical Reporter* (NLSY79 1981).

- Urban: the urban variable is a dichotomous variable taking the value one if the respondent lives in an urban area and zero if the respondent lives in a rural area.

**Table 4 - Summary Statistics for NLSY19 Independent Variables**

| Variable | Mean | Std Dev. |
|---|---|---|
| Age | 29.51962 | 5.690726 |
| Income | 14645.48 | 111797.8 |
| Urban | 0.759256 | 0.42754 |
| Hispanic | 0.182925 | 0.386611 |
| Black | 0.249879 | 0.432947 |
| Age 19-25 | 0.281878 | 0.449919 |
| Age 26+ | 0.718122 | 0.449919 |

*Source: NLSY79*

Weights

- Because of the oversampling previously discussed in the NLSY79, for each year a set of sampling weights were constructed. These weights provide the researcher with an estimate of how many individuals in the United States each respondent's answers represent. The weights were used in every analysis involving the NLSY79 data set.

Other Regressors of Interest

- South-Census: the south-census variable is a dichotomous variable taking the value one if the state is within the set of states classified as south by the census bureau. All SMSAs which lie in a south-census state were assigned the value one, and zero for all other SMSAs.

- South-Border: the south-border variable is a dichotomous variable taking the value one if the state is Texas, Louisiana, Mississippi, Alabama, or Florida. All of these states lie along Mexico or the Gulf of Mexico – the two central vectors for drug transportation into the United States. All SMSAs which lie in a south-border state were assigned the value one, and zero for all other SMSAs.
- Port: the port variable is a dichotomous variable taking the values one if the SMSA code represents Atlanta, Chicago, Los Angeles, Houston, Miami, or New York and zero otherwise
- Several city specific dichotomous variables were constructed for specific cities; including: New York, San Diego, Miami, Houston, Los Angeles, Atlanta, Phoenix, Dallas, Baltimore, Detroit, and Philadelphia.
- dummy1995: takes the value one if the year equals 1995, and zero otherwise.
- dummy1990: takes the value one if the year equals 1990, and zero otherwise.

**Instrument for Prices: Geographic Analysis**

The key distribution and port of entry cities for cocaine are Atlanta, Chicago, Los Angeles, Houston, Miami, New York, Dallas, and Phoenix. First, each of these cities faces a relatively lower cocaine price because of their high position within the drug distribution network. In particular, due to the cost of shipping cocaine to other cities and the increased probability of interception and arrest incurred during longer transportation times it is easily understood why port of entry cities have higher prices. Further, preliminary regression analyses by Grossman, Chaloupka, and Brown (1996) have empirically identified these port of

entry cities as having lower drug prices. These regression results are based on the STRIDE data set. However, for this paper, because the STRIDE data is still in clearance with the DEA, it is not possible to provide exact estimates for how much cheaper drug prices are in these port of entry cities.

From this list of port of entry cities, a subset consisting of Phoenix, Dallas, Houston, Atlanta, and Miami were chosen to be matching with five other cities on the basis of population, population density, land area, and median income across several years. Only these cities were selected because the remaining port of entry cities are believed to be incomparable to other cities based on relative size and city uniqueness. The theory behind such matching is that if you can pair two roughly identical cities, except one faces higher drug prices, an estimate of how usage shifts between high and low drug price areas can be achieved. The following pairs were chosen completely at the discretion of the author based on the four characteristic: Phoenix and San Antonio, Dallas and San Diego, Houston and Columbus (OH), Atlanta and Albuquerque, Miami and Minneapolis. The tables bellow presents a summary of the characteristics used for matching and descriptive statistics comparing the selected port of entry cities with their respective matches.

**Table 5 – Summary of City Matching Variables**

| City | Land Area | Pop '80 | Pop '90 | Pop den'80 | Pop den90 | Inc '85 | Inc '90 |
|------|-----------|---------|---------|------------|-----------|---------|---------|
| Phoenix | 419.9 | 789704 | 983403 | 2437 | 2342 | 14582 | 17919 |
| San Antonio | 333 | 785880 | 935933 | 2992 | 2811 | 12474 | 15586 |
| Dallas | 342.4 | 904078 | 1006877 | 2715 | 2914 | 16510 | 19870 |
| San Diego | 324 | 875538 | 1110549 | 2736 | 3428 | 15095 | 19729 |
| Houston | 539.9 | 1595138 | 1630553 | 2867 | 3020 | 15706 | 19456 |
| Columbus | 190.9 | 573822 | 632910 | 3123 | 3315 | 13755 | 18264 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Atlanta** | 131.8 | 425022 | 394017 | 3244 | 2990 | 15464 | 20446 |
| **Albuquerque** | 132.2 | 331767 | 384736 | 3481 | 2910 | N.A. | N.A. |
| **Miami** | 35.6 | 346865 | 358548 | 10113 | 10072 | 15180 | 19464 |
| **Minneapolis** | 57.9 | 370951 | 368383 | 6732 | 6710 | 16398 | 21418 |

*Source: U.S. Census Bureau*

**Table 6 - Descriptive Statistics for Treatment and Control City Sets**

| | Treatment Cities | | Control Cities | | Entire Sample | |
|---|---|---|---|---|---|---|
| Variables | Mean | Std. Error | Mean | Std. Error | Mean | Std. Error |
| Dependent | | | | | | |
| Ever | 0.279734 | 0.007875 | 0.279476 | 0.01142 | 0.227991 | 0.002132 |
| Thirty Days | 0.024591 | 0.002922 | 0.015932 | 0.003423 | 0.019067 | 0.000685 |
| Controls | | | | | | |
| Black | 0.241604 | 0.007413 | 0.079438 | 0.006775 | 0.249879 | 0.001945 |
| Hispanic | 0.093168 | 0.005691 | 0.064429 | 0.00683 | 0.182925 | 0.0022 |
| Male | 0.51805 | 0.008654 | 0.559034 | 0.01244 | 0.503836 | 0.002247 |
| Age | 29.65646 | 0.097508 | 29.63022 | 0.13977 | 29.51962 | 0.02557 |
| Income | 29989.27 | 3634.11 | 25487.72 | 3545.925 | 14645.48 | 502.3314 |

*Source: NLSY79*

This method presents a serious limitation to the study because of the discretionary method in which control cities were matched with treatment cities. The above table presents means for each dichotomous variable broken down by the treatment cities (port or distribution cities) and the control cities (matching cities). Two particularity troubling insights from the above table are that average income is higher in the treatment cities as well as the proportion of blacks and Hispanics.

According to data from the 2003 National Survey of Drug Use and Health (NSDUH; formerly the National Household Survey on Drug Abuse) and 2003 data from Monitoring the Future (MTF) males are more likely to use cocaine than females (NDIC 2005). Further, prevalence data from both the 2003 NSDUH and 2003 MTF do not indicate significant differences in the rates of use among

different ethnic groups (NDIC 2005). According to 2003 NSDUH data, the rates

of use for cocaine (both powder and crack) were much higher among persons aged

18 to 25 (6.6%) than among those aged 12 to 17 (1.8%) or 26 or older (1.9%).

2003 MTF data also reveal higher rates of use for cocaine among young adults

aged 19 to 28 (6.6%) than for other user groups including eighth (2.2%), tenth

(3.3%), and twelfth graders (4.8%) as well as college students aged 19 to 22

(5.4%). 2003 NSDUH data also shows that rates of use for cocaine (both powder

and crack) among persons aged 12 or older is much higher among those in large

metropolitan areas (2.7%) than among those in completely rural areas (0.9%).

2003 MTF data shows that past use of cocaine (both powder and crack) among

adults aged 19 to 30 is much higher among those in a very large city (7.7%) than

in farm or country areas (4.4%). (SAMHSA 2007). Finally, income has previously

been studied as a determinate of drug use and found to be insignificant (Saffer and

Chaloupka 1995).

　　　These trends bolster a rationale for matching based on population,

population density, land area, and median income. Further, it assuages some of the

concern associated with lopsided racial populations between treatment and control

cities. However, it can be argued that there may be individual characteristics that

cause a person to choose a treatment city over a control city that may also

determine their likelihood to use cocaine. Future research will fix this problem by

using propensity scoring to create matches. An analysis of individuals who moved

in and out of port of entry cities was also conducted, however the NLSY79

revealed that relatively few people moved (small sample size) and at later ages

when drug use was not significant.

Despite differences in race and income, table 5 reveals that treatment cities

are using drugs at a slightly higher rate (2.5%) than control cities (1.5%) over the

past thirty days; whereas being in a treatment city has no effect on using drugs

ever. Further, income and race are controlled for through regression analysis and

reveal a very similar result. Regressions were run separately for the age group 19-

25 and 26 plus because of the use rate disparities between the two groups. The

independent variables were the two dichotomous measures of drug use (ever and

thirty days), the regressor of interest was a dummy variable for "are you a

treatment city?" and all regressions were run with and without controls.

$$\text{Cocaine Use} = \alpha + \beta \quad *(\text{Treatment City}) + \beta \quad *\text{Controls} + \varepsilon$$

(6)

Regression analysis reveals that treatment cities are using drugs in the past

thirty days at a rate of 1-3% higher than control cities – the following table

highlights some of the results.

**Table 7 - Geographic Regression Results**

| Variables | Ever Age 19-25 (Model 1) | | Ever Age 19-25 (Model 2) | | 30Days Age 19-25 (Model 3) | | 30Days Age 19-25 (Model 4) | |
|---|---|---|---|---|---|---|---|---|
| | Coeff. Std. Er. | T-stat | Coeff. Std. Er. | T-stat | Coeff. Std. Er. | T-stat | Coeff. Std. Er. | T-stat |
| Dependent | | | | | | | | |
| Treatment City | .033 .053 | 0.62 | 079 .058 | 1.36 | .012 .015 | 0.77 | .031 .0188 | 1.66 |
| Controls | | | | | | | | |
| Black | | | -.19 .035 | -5.4 | | | -.051 .019 | -2.61 |
| Hispanic | | | -.076 .079 | -0.95 | | | -.017 .023 | -0.76 |

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| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Male | | | .021 .032 | 0.65 | | | -.005 .014 | -0.34 |
| Age | | | .011 .007 | 1.43 | | | -.002 .006 | -0.34 |
| Income | | | 3.76e-08 2.02e-06 | 0.02 | | | -1.42e-06 4.94e-07 | -2.87 |
| Constant | .197 .044 | 4.41 | -.046 .193 | -0.24 | .033 .014 | 2.46 | .104 .153 | 0.68 |

**Instrument for Prices: Time Series Analysis**

Cocaine prices have varied substantially over time. In fact, the inflation-adjusted gram price of cocaine fell by 75% between 1981 and 1988 (ONDCP 1997b). Further, cocaine prices have fallen by about 80% from 1980 to 2000 (Caulkins, Reuter, and Taylor 2006).

Beginning in 1989 there was a sharp increase in prices that lasted only about 18-months (Caulkins 1994a). On August 18, 1989 the Medellin Cartel assassinated the leading Columbian presidential candidate, Luis Carlos Galán, and declared "total and absolute war", seeking to stop the potential extradition of its members to the United States; a policy which began in 1985 (Noblet 1989). In response, Columbian President Virgilio Barco Vargas declared war against the drug dealers and stated, "We cannot rest until we destroy the organizations dedicated to narcotics trafficking." (Brooke 1989) The state of Columbia was living through a severely tense time as car bombs and assassinations continued over the next several months.

Further, in 1989, President George H.W. Bush appointed William Bennett to be the first Director of the Office of National Drug Control policy (aka Drug

Czar) and declares an intensified anti-drug campaign (Treaster 1990). President Bush and President Barco worked together on the Columbian war on drug trafficking, and President Bush helps provide necessary supplies (US Department of State Bulletin). In December of 1989, President Bush invaded Panama which had a reputation as a drug transshipment point between South America and the United States and as a center for money laundering (The Columbia Encyclopedia 2007).

This combination of U.S. efforts and the "war" between the Columbian government and the Medellin-based traffickers in 1989 led to the pronounced but short lived increase in cocaine prices (Caulkins and Reuter 1998). There was a small but identifiable increase in cocaine prices in 1995. In early 1995, the government of Peru implemented a shoot-down policy against trafficker aircraft. Since April 1995, the governments of Peru and Colombia, assisted by tracking data from many U.S. agencies, have successfully shot down or otherwise destroyed dozens of trafficker aircraft flying the so-called "air bridge" from the growing regions of Peru to the processing centers in Colombia (Crane et al. 1997). This interdiction effort lead to another short but pronounced increase in cocaine prices in 1995 (Crane et al. 1997; Caulkins and Reuter 1998).

**Figure 9 – U.S. Wholesale and Retail Prices of Cocaine**

Source: Prepared for ONDCP by the RAND Corporation

* 2003 figures are based on data for January-June only
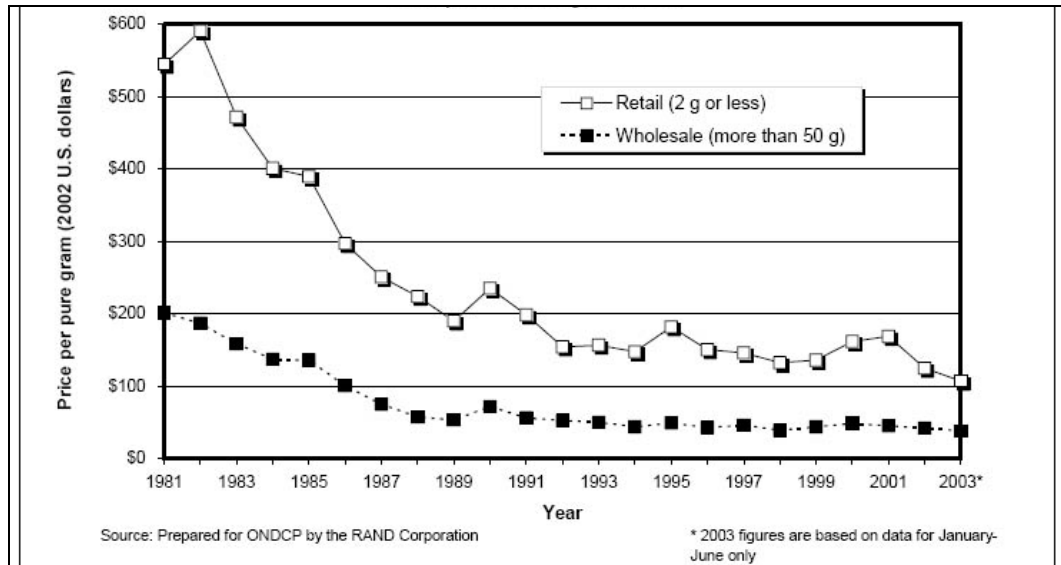
These two events that resulted in the blips in the cocaine prices in 1990 and 1995 present an opportunity to study the effects of how usage changes in response to price. However, the events in 1995 present a better natural experiment because these events are almost entirely independent of the United States. The events in 1990 are not entirely exogenous because the United States played a significant role in the events within Columbia and also may have influenced drug prices through their institutional changes of drug policy – thus causing bias in the estimates. Further, the 1989 and 1990 events fall at the tail end of a pronounced downward shift in drug prices, whereas the 1995 events occur during a time period or relatively flat price movement. For these reasons, only the 1995 events will be considered in this paper. The 1990 events were tested and found to be particularly noisy and insignificant.

First Stage

National price data was obtained from the above graph. Then a dummy variable for year 1995 and two control variables, year and year squared, were regressed on this national level cocaine price series. This analysis represents a first stage regression of determining the effect of the instrument for price, year 1995, on the endogenous regresser, cocaine prices.

$$\ln(\text{real price}) = \alpha + \beta_1 * \text{dummy95} + \beta_2 * \text{Controls} + \varepsilon$$

(7)

Regressions were run with two different specifications: restricting the years to 1990 or greater and using Prais-Winsten regression analysis. Year is restricted to 1990 and greater because over the 1990s price is relatively flat, whereas during the 1980s the price drops significantly – thus avoiding the possibility of serial correlation. Prais-Winsten regression analysis accomplishes a similar goal by correcting for first order autocorrelation (AR1). All regressions are computed with robust variance estimators. The following tables present the first stage regression results.

**Table 8 - First Stage - dependent variable: ln(real price); year>=1990**

| | Model 1 (N=9) | | Model 2 (N=9) | | Model 3 (N=9) | |
|---|---|---|---|---|---|---|
| Variables | Coeff. Std. Error | T-stat | Coeff. Std. Error | T-stat | Coeff. Std. Error | T-stat |
| dummy95 | .202241 .057649 | 3.51 | .1511088 .044881 | 3.37 | 1805608 .047927 | 3.77 |
| Controls | | | | | | |

| | Coeff. Std. Error | T-stat | Coeff. Std. Error | T-stat | Coeff. Std. Error | T-stat |
|---|---|---|---|---|---|---|
| year | | | -.0316533 .0120366 | -2.63 | -7.74852 12.04174 | -0.64 |
| year^2 | | | | | 0019326 .0030166 | 0.64 |
| constant | 5.018115 .057649 | 87.05 | 68.21758 24.02506 | 2.84 | 7771.353 12017.08 | .65 |

**Table 9 - First Stage - dependent variable: ln(real price); Prais-Winsten regressions**

| Variables | Model 1 (N=15) Coeff. Std. Error | T-stat | Model 2 (N=15) Coeff. Std. Error | T-stat | Model 3 (N=15) Coeff. Std. Error | T-stat |
|---|---|---|---|---|---|---|
| dummy95 | .2253093 .0262769 | 8.57 | .221926 .0221149 | 10.04 | .2219235 .0221263 | 10.03 |
| Controls | | | | | | |
| year | | | -.0720798 .0129385 | -5.57 | dropped | dropped |
| year^2 | | | | | -.0000181 3.26e-06 | -5.54 |
| constant | 5.416668 .5517557 | 9.82 | 148.9616 25.7384 | 5.79 | 77.14933 12.91084 | 5.98 |
| Durbin Watson | 1.181138 | | 1.614381 | | 1.613540 | |

Regression results reveal fairly robustly that across several specifications and models, the effect of year 1995 on real price is about 0.2 – or the year 1995 was associated with a 20% increase in prices. This result is further bolstered by the graph of national level prices where we see prices rising roughly from 148 to 185 in the years 1994 to 1995.

Reduced Form

The Fryer, Heaton, Levitt, and Murphy (2005) crack index is used as a single factor for the prevalence of cocaine use. The crack index amalgamates some of the best measures of cocaine usage and thus makes it a believable

measure of cocaine usage. The following graph depicts the amount of cocaine usage at a national level across time.

**Figure 10 – Crack Index, National Level**
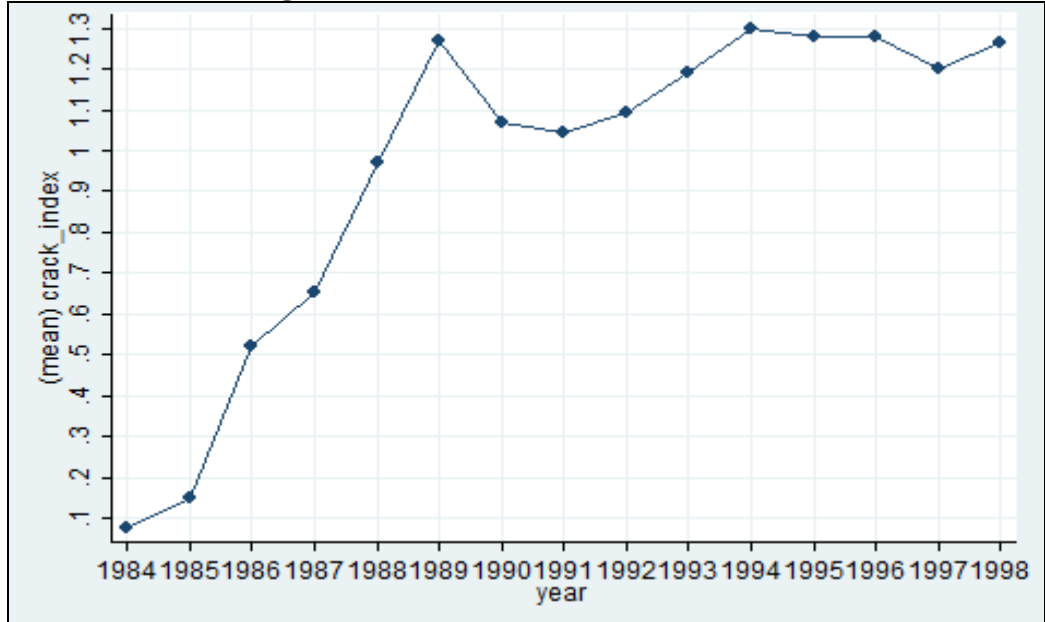
Because the crack index is a measure of usage, we expect a priori that a spike in cocaine prices will lead to a corresponding decrease in usage to some degree. We see above that the 1990 and 1995 spikes are associated with a drop in usage – the 1990 drop is very pronounced while the 1995 drop is very small.

The reduced form regression measures the effect of the instrument for prices, year 1995, on the dependent variable, cocaine usage as measured by the crack index. Thus, a dummy variable for year 1995 and two control variables, year and year squared, were regressed on the crack index.

$$\ln(\text{crack index}) = \alpha + \beta \ *\text{Dummy95} + \beta \ *\text{Controls} + \varepsilon \qquad (8)$$

Regressions were again run with two different specifications: restricting the years to 1990 or greater and using Prais-Winsten regressions. All regressions

are computed with robust variance estimators. The following tables present the

reduced form regression results.

**Table 10 - Reduced Form - dependent variable: ln(crack index); year>=1990**

| | Model 1 (N=9) | | Model 2 (N=9) | | Model 3 (N=9) | |
|---|---|---|---|---|---|---|
| Variables | Coeff. Std. Error | T-stat | Coeff. Std. Error | T-stat | Coeff. Std. Error | T-stat |
| dummy95 | .0821242 .0323005 | 2.54 | .0553083 .0225899 | 2.45 | .0227558 .0296692 | 0.77 |
| Controls | | | | | | |
| year | | | .0238363 .005533 | 4.31 | 20.00638 12.07669 | 1.66 |
| year^2 | | | | | -.0050105 .0030275 | -1.66 |
| constant | .1620339 .0323005 | 5.02 | -47.36466 11.02898 | -4.29 | -19970.46 12041.82 | -1.66 |

**Table 11 - Reduced Form - dependent variable: ln(crack index); Prais-Winsten regressions**

| | Model 1 (N=15) | | Model 2 (N=15) | | Model 3 (N=15) | |
|---|---|---|---|---|---|---|
| Variables | Coeff. Std. Error | T-stat | Coeff. Std. Error | T-stat | Coeff. Std. Error | T-stat |
| dummy95 | .0330051 .1761754 | 0.19 | -.0081132 .1351578 | -0.06 | -.0080449 .1350207 | -0.06 |
| Controls | | | | | | |
| year | | | .1901295 .0457999 | 4.15 | dropped | dropped |
| year^2 | | | | | .0000477 .0000115 | 4.13 |
| constant | -.4698228 .6846574 | -0.69 | -379.2508 91.19233 | -4.16 | -189.6652 45.71323 | -4.15 |
| Durbin Watson | 0.995507 | | 1.134625 | | 1.134166 | |

The reduced form regression results are very noisy and mainly

insignificant. However, for each regression model and specification the coefficient

on dummy95 is very small. This result reaffirms conclusions from the graphical

analysis of the crack index, that is, year 1995 did not have a very large effect on

cocaine usage.

Two-Stage Least Squares

The two-stage least squares (2SLS) estimation regresses drug prices on usage (crack index) and uses a dummy for year 1995 as an instrument for drug price.

$$\ln(\text{crack index}) = \alpha + \beta \ *\ln(\text{real price}) + \beta \ *\text{Controls} + \varepsilon \qquad (9)$$

This regression shows the effect of drug prices on cocaine usage. The lagged crack index was used as a control variable in one of the models because last year's usage (i.e. crack index) may be correlated with this year's price, and so including it as a regressor will control for such correlation.

**Table 12 - 2SLS - dependent variable: ln(crack index)**

| | Model 1 (N=14) | | Model 2 (N=14) | | Model 3 (N=14) | |
|---|---|---|---|---|---|---|
| Variables | Coeff. Std. Error | T-stat | Coeff. Std. Error | T-stat | Coeff. Std. Error | T-stat |
| Instrumented Variable | | | | | | |
| ln(real price) | -5.60248 3.999201 | -1.40 | -.6666123 .3915568 | -1.70 | -.0709902 .1181074 | -0.60 |
| Controls | | | | | | |
| year | | | 93.92305 20.79674 | 4.52 | 3.562182 16.48946 | 0.22 |
| year squared | | | -.0235634 .0052217 | -4.51 | -.0008954 .0041342 | -0.22 |
| lagged ln(crack index) | | | | | .623738 .2514815 | 2.48 |
| constant | 29.4911 20.87725 | 1.41 | -93589.74 20705.85 | -4.52 | -3542.332 16439.71 | -0.22 |

**Price Elasticity of Demand for Cocaine**

Price elasticity of demand is simply a measure of the effect that a change in price has on usage. Elasticity is calculated as the percentage change in quantity

divided by the percentage change in price. The elasticity ratio will generate a negative number (because price and demand are inversely related), then taking the absolute value: if the ratio is greater than one demand is price elastic, if the ratio equals one demand is unit elastic, and if the ratio is less than one demand is price inelastic. In general, the higher the price elasticity the more sensitive a consumer is to changes in price. As before, we consider only the price blip in 1995 when calculating the price elasticity.

Linear Interpolation

Price elasticity of demand can be first calculated graphically through linear interpolation. First, the counterfactual is computed for crack index (cocaine usage). The counterfactual is the linear average between the years 1994 and 1996 – i.e. it's the value for the crack index that would have been realized had the index been linear (no blip occurred) over the time period. Then the difference between the counterfactual and the observed 1995 value is computed. This process is repeated for the graph of cocaine prices as well. Then taking the ratio of the difference for the crack index and the difference for the prices we obtain an elasticity estimate.

Linear interpolation produces an estimate of approximately -0.05. This can be interpreted as: a 100% increase in prices (prices double) will cause usage to drop by 5%. Linear interpolation analysis reveals that cocaine users are very price inelastic. The mathematical steps for linear interpolation are summarized in the following table.

**Table 13 - Linear Interpolation Elasticity Calculations (1994-1996)**

| Crack Index | |
|---|---|

| | |
|---|---|
| Estimated Counterfactual | 1.28853585 |
| Observed 1995 value | 1.276546053 |
| Cocaine Price | |
| Estimated Counterfactual | 4.9938225 |
| Observed 1995 value | 5.220356 |
| Reduced-form (RF) effect on crack index | -0.011989797 |
| First-stage effect on prices | 0.2265335 |
| Ratio of RF/first-stage (elasticity) | -0.05292726 |

<u>Two-Stage Least Squares Interpretation</u>

The coefficients on ln(real price) in the two-stage least squares regression can be interpreted as elasticity estimates. Further, the results from linear interpolation were verified by running two-staged least squares estimates on a restricted sample for the years 1994 to 1996.

**Several Theories on Reconciling the Effects of Policy on Prices**

Perhaps the most paradoxical characteristic of cocaine prices over time is their consistent decline over the past twenty years, despite increasing stringency in the "war on drugs". In fact, over the time period of the 1980s to the mid 1990s, Reuter (1997) shows that the annual cell years for cocaine offenses quintupled. However, to make sense of these trends we need to remember that policy is not the only determinate to price. We will now attempt to understand this still open-ended question by exploring some theories already given.

Table 3, from section V, suggests that factors other than enforcement are directly responsible for nearly half of the price of cocaine. Hence, it is possible for the overall price to decline, even as enforcement stringency increases, if the

declines in the other cost-components more than offset the increase in enforcement components.

Reuter and Kleiman (1986), Rydell and Everingham (1994), Caulkins et al. (1997a), and Yuan and Caulkins (n.d.) all show empirically the lack of correlation between increases in federal enforcement and increases in heroin prices on a month-to-month basis. Further, this relationship between enforcement and prices can be understood non-empirically by considering the fact that crack and powder cocaine consistently sells for the same price per pure unit even though federal sanctions for crack are more stringent than for possession of a comparable amount of powder cocaine (Caulkins 1997c).

Cave and Reuter (1988) suggest that import costs might decline as smuggles acquire experience; hence they suggest cocaine price may drop as a result of "learning by doing". Therefore, smugglers may become more efficient over time and this drive down the import cost.

Caulkins and Reuter (1998) suggest that labor costs might decline if the industry shifted to less skilled labor (e.g. from pilots to small boat crew members) or if there was a decline in the prevailing wage for current dealers (e.g. aging dealer/users whose legitimate labor force opportunities weaken as their drug-using careers lengthen).

Caulkins and Reuter (1998) suggest that risk compensation for the physical risk of selling drugs could decline if the markets stabilize and the risk of being killed declined.

Stares (1996), Naim (2005), and Storti and Grauwe (2007) argue that globalization has worked in two ways to drive down prices. First, there is a substantial "efficiency effect" of globalization. Transportation costs have been reduced and the use of new information technology (IT) has allowed for dramatic improvements in the efficiency of drug distribution and made it possible to cut on the number of intermediaries. This new IT has also made the communication between demand and supply safer and quicker, leading to better stock management, and has much improved communication among dealers. In addition, the explosion in the size of international trade flows has made it possible to better conceal the transport and the distribution of drugs.

According to Storti and Grauwe (2007), the second mechanism by which globalization has lowered the costs of drugs is the "risk premium effect". Globalization has opened the borders of many countries with a surplus of poor and low skilled workers. As a result, millions of "have-nots" who have little to lose may have been attracted by the fantastic intermediation margins (the difference between retail and producer prices) provided by the drug market. This massive entry into the business of transporting and distributing drugs by people who are willing to take risks may help to explain the decline in the risk premium, and hence the drop in prices. The authors' points are bolstered by the historic convergence in the wholesale and retail price (shown in the following two figures).

**Figure 11 – Cocaine Prices in New York, 1977-1991**
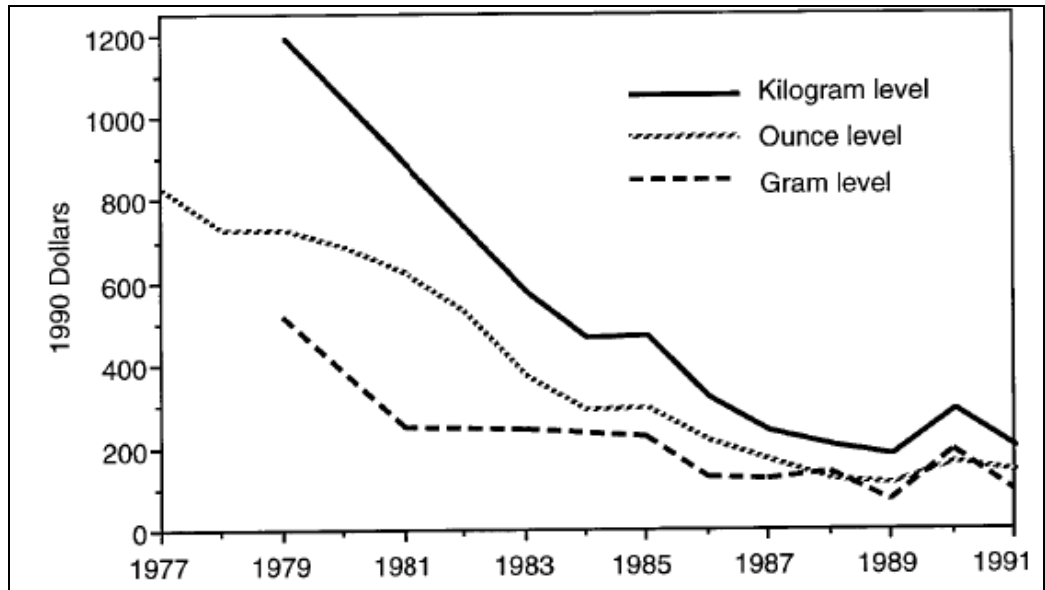
*Source: Caulkins (1994) – Developing a Price Series for Cocaine*

**Figure 12 – Margins Between Retail and Wholesale Price of Cocaine**
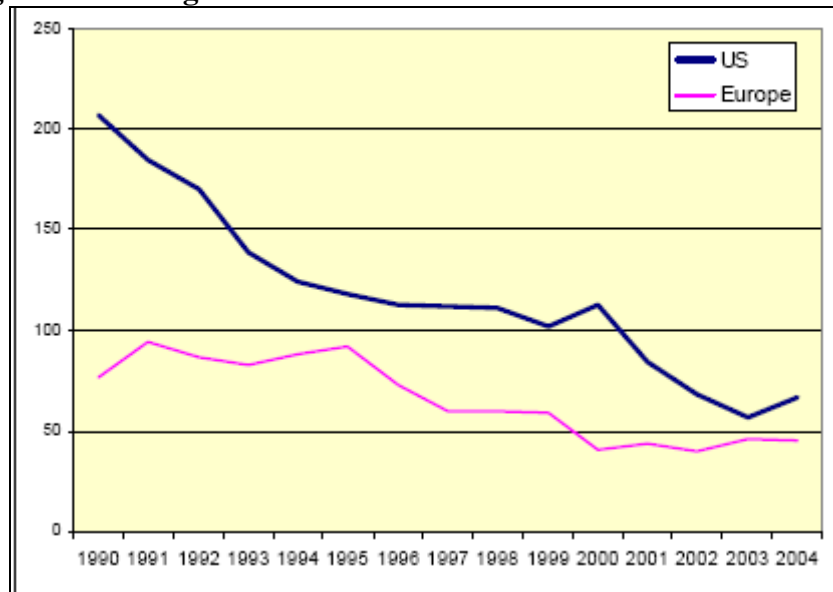


*Source: Storti and Grauwe (2007) - Globalization and the Price Decline of Illicit Drugs*

Caulkins, Reuter, and Taylor (2006) hypothesize that because U.S. drug policy is targeted towards incarcerating people involved in the distribution process, a policy of arresting and incarcerating violent dealers may have the effect of reducing the equilibrium price of the drug. The authors explain that this

counterintuitive outcome occurs because the arrest of violent dealers reduced external costs borne by other dealer, with the net effect being a possible reduction in costs for the marginal dealer.

Reuter (1988) argues that suppliers react to market disruptions by modifying their tactics and operations and thus preventing enforcement interventions from driving up prices. For example, cocaine smugglers shifted routes to Mexico as a transshipment point in response to increased interdiction in Florida, and shifted to maritime cocaine smuggling in response to aggressive air interdiction.

**Conclusion**

American drug policy over the past five decades has not only been punitive and expensive, but extremely inefficient. The government's supply-side intervention tactics are aimed at increasing the retail price of cocaine by attacking cocaine supplier – yet the price of cocaine has dropped by nearly 80 percent in the face excessive government spending and increased drug incarcerations.

This study provides support that cocaine is a highly inelastic product - which means that cocaine price increases will result in negligible affects on retail usage. Further, with such a low price elasticity, increases in the cocaine price may only cause dealers to become wealthier, because consumption will remain stable while prices rise. These long criticisms bolster an argument that he government needs to rethink the "war on drugs" by exploring other avenues in more detail, such as drug education, treatment, and decriminalization.

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**Table 14 - Timeline of Significant Events in American Drug Policy**

| June 1971 | President Richard Nixon officially declares a "war on drugs," identifying drug abuse as "public enemy No. 1." |
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| July 1973 | President Nixon created the Drug Enforcement Agency (DEA) to coordinate the efforts of all other agencies. |
| 1981 | The Medellin cartel rises to power. The alliance includes the Ochoa family, Pablo Escobar, Carlos Lehder and Jose Gonzalo |

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| | Rodrigues Gacha. The drug kingpins work together to manufacture, transport and market cocaine. The United States and Colombia ratify a bilateral extradition treaty. |
| 1982 | Panamanian leader Gen. Manuel Noriega allows Pablo Escobar to ship cocaine through Panama. In the United States, Vice-President Georgia H.W. Bush forms the South Florida Drug Task Force, Miami being the main entry point at the time. |
| 1984 | Nancy Regan launches her "Just Say No" anti-drug campaign |
| 1985 | Colombia extradites drug traffickers to the United States for the first time. |
| Mid-1980s | Because of the South Florida Drug Force's work, cocaine trafficking slowly changes transport routes. The Mexican border becomes the major point of entry for cocaine headed into the United States. Crack, a cheap, addictive potent form of cocaine, is first developed in the early 1980s; it becomes popular in the New York Region, devastating inner-city neighborhoods. |
| October 1986 | Reagan signs the first Anti-Drug Abuse Act of 1986, which appropriates $1.7 billion to fight the drug war. The bill also creates mandatory minimum penalties for drug offenses, which are increasingly criticized for promoting significant racial disparities in the prison population. |
| February 1987 | Carlos Lehder is captured by the Colombian National Police and extradited to the United States, where he's convicted of drug smuggling and sentenced to life in prison without parole, plus an additional 135 years. |
| May 1987 | After receiving personal threats from drug traffickers, the justice on the Colombian Supreme Court rules by a vote of 13-12 to annul the extradition treaty with the United States. |
| 1989 | President George H.W. Bush creates the Office of National Drug Control Policy (ONDCP) and appoints William Bennett as his first "drug czar." Bennett aims to make drug abuse socially unacceptable. |
| December 1989 | The United States invades Panama. Gen. Manuel Noriega surrenders to the DEA on Jan. 3, 1990, in Panama and is sent to Miami the next day. In 1992, Noriega is convicted on eight counts of drug trafficking, money laundering and racketeering, and sentenced to 40 years in prison. |
| 1991 | The Colombian assembly votes to ban extradition in its new constitution. Pablo Escobar surrenders to the Colombian police the same day. He is confined in a private luxury prison, though reports suggest that he travels in and out as he pleases. When Colombian authorities try to move Escobar to another prison in July 1992, he escapes. |
| 1992 | Mexican President Carlos Salinas de Gortari issues regulations for DEA officers in his country. The new rules limit the number |

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| | of agents in Mexico, deny them diplomatic immunity, prohibit them from carrying weapons, and designate certain cities in which they can live. |
| November 1993 | President Clinton signs the North American Free Trade Agreement (NAFTA), which increases the amount of trade and traffic across the U.S.-Mexican border. This makes it more difficult for U.S. Customs to find narcotics moving across the border. |
| December 1993 | Pablo Escobar, in hiding since mid-1992, is found by Colombian police using American technology that can recognize his voice on a cell phone call and estimate his location. He tries to flee but is killed. |
| August 2000 | President Bill Clinton gives $1.3 billion in aid to Plan Colombia, an effort to decrease the amount of cocaine produced in that nation. The aid supports the aerial spraying of coca crops with toxic herbicides, and also pays for combat helicopters and training for the Colombian military. |

*Source: NPR, the Forgotten War on Drugs*

**Written Summary of Capstone project**

Illicit drugs impose significant costs on society and on individual uses.

These costs include increased crime, health problems, and employment. Because

of these costs, both the federal government and the state governments have made drug controls an important budget priority. Traditionally, American drug control policy has been focused on supply side intervention. In theory, with interdiction efforts focused on suppliers, the cost (i.e. the risk) of producing drugs will increase, a cost that will then be passed along to the final consumers. This increase in the retail drug prices should then in turn cause usage to drop.

According to the U.S. Office of National Drug Control Policy (ONDCP), in 1995, spending on the "war on drugs" was approximately $30-35 billion between the federal, state, and local government. This figure represents a fivefold increase from the previous decades spending of $6-7 billion (ONDCP 1997). With drug control being such a significant factor of government spending, it becomes crucial for researchers to determine the efficacy of current drug policies and asses the validity of such large government expenses. One possible way of evaluating these policies is to measure the price elasticity of demand for cocaine. This estimate will allow researchers and policy makers to estimate the effects that an increase in drug prices will have on drug consumption.

This research estimates the price elasticity for cocaine through two approaches. The first approach is a geographic analysis. Textual research has revealed a persisting disparity in prices between cities. These disparities are subject to the nature of drug flows into the United States, and contingent on where a city falls within the cocaine distribution network. The geographic analysis attempts to match these port of entry cities (where drug prices are observed to be

consistently lower) with similar non-port of entry cities, in order to measure the effect that disparate prices have on usage.

The second approach is a time series analysis. Two exogenous events have been identified (however only one event is used) to explain distinct time series shocks in cocaine prices. These blips in the cocaine prices are used to measure the effects of exogenous price shifts on cocaine consumption. This approach measures how cocaine users shift their consumption when faced with an independent increase in short term cocaine prices.

The geographic analysis reveals that on average, people in the port of entry cities are using drugs, in the past thirty days, at a rate of 1-3% higher than people in non-port of entry cities. The time series analysis reveals that the identified exogenous event worked to elevate prices by 20% for that year, however there was almost negligible effects on cocaine usage.

This study estimates a short term price elasticity of 5% for cocaine. This means that is the price of cocaine is doubled, cocaine consumption will decrease by only 5%. This result raises serious policy concerns – why is the government so focused on driving up prices, when a price increase results in an almost negligible usage decrease? Further, these results bolsters an argument that the United States needs to reassess its strategy for fighting the "war on drugs". By attacking suppliers and driving the price up, there is going to be scant effect on drug usage, given its significant inelasticity. Rather, public policy may be better served by concentrating on drug education, treatment, and decriminalization efforts.