

**Realizing the Potential of Crop Substitution: An Analysis of the Andean Coca Trade**

(A Thesis submitted to the Department of Economics for Honors)

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## **Abstract**

The United States needs to realize the potential of crop substitution and alternative development schemes in its policy concerning cocaine eradication in the Andes. After analyzing the history and stakeholders involved, it is shown that crop substitution is a more efficient, politically viable, and humane solution than the current United States' policy. Furthermore, general equilibrium analysis shows coca output can be reduced with appropriate United States' policy that influences the world price of agriculture. Specifically, the United States should reconsider its position on agricultural subsidies considering that the current subsidies have a direct impact on increasing drug output. After analyzing the cocaine trade and current United States' policy, the United States should change its policy by eliminating crop eradication programs, reducing military support, informally supporting the eradication of terrorist, revolutionary groups within the Andean region, supporting crop substitution policies, creating a strong export market, allowing coca products to be limited but highly regulated and increasing overall economic development.

## I. Introduction

Illegal drug use is a major epidemic in America. “Americans spent approximately \$64 billion for illegal drugs in 2000—more than 8 times the total federal outlays for research on HIV/AIDS, cancer, and heart disease. Domestic drug users expended more than half that amount (\$35 billion) on cocaine” (Bush 25). Despite a multifaceted approach that requires the cooperation and resources of several governmental organizations ranging from the Drug Enforcement Agency to Housing for Urban Development, the drug problem still persists. The United States’ government’s main attack has been two-pronged in targeting both the demand and supply side of the market. Despite billions of dollars in government revenue being spent each year, major downturns in drug consumption have not occurred.

This paper looks at the United States’ approach to the supply side of the cocaine market, specifically focusing on the Andean region. Thus far, the United States has been somewhat successful in establishing multilateral coalitions to combat cocaine production. “The explosion in Colombia’s potential cocaine production notwithstanding, total Andean Region potential cocaine base production has actually declined by 17 percent in recent years, from 930 metric tons in 1995 to 768 metric tons in 2000” (DEA). Despite this limited success, the United States’ policy should currently be improved in order for the United States to more efficiently achieve its goal of limiting the supply of cocaine in the market. Improvement upon current policy is crucial because not only is the United States using its resources inefficiently, but it is also directly affecting the lives and livelihoods of indigenous populations in the Andean region. Seeking a fairer, more

efficient, and more humane way of eradicating the supply side problem is the focus of this paper.

Ultimately, the evidence shows that crop substitution and alternative development policies have the potential to alleviate the problem. Furthermore, they are more viable and human solutions in limiting cocaine production than the United States' current policy, which while it does include some alternative development agendas, spends an enormous amount of resources on crop eradication programs and military aid.

In order to prove this, the paper attempts to put the debate surrounding coca eradication policies in the context of the countries involved. Section II addresses the history of cocaine production and its cultural roots. Section III addresses the debate surrounding cocaine, since it has only been within the last few decades that a major problem with cocaine consumption has arisen. Section IV addresses whether or not there should be a distinction made between coca and cocaine in international policy. Section V gives an account of the world's source of coca and demonstrates how the Andean region accounts for almost one hundred percent of the cocaine on the world market. Section VI addresses the stakeholders in the cocaine debate, which include the FARC, Sendero Luminoso, the Peruvian government, the Colombian government, the United States, and coca farmers. Section VII addresses the case against crop substitution and gives some possible reasons for why it has failed to take root based on its cultural context and certain past economic variables. It also however, advocates the case for crop substitution and what the United States' approach should be in sponsoring alternative development plans. Most importantly, it establishes a general equilibrium model in order to determine the viability of crop substitution in the region. The model also demonstrates how current

United States' policy of agricultural subsidies undercut the viability of crop substitution in the Andean region. Finally, Section VIII gives recommendations for future United States' policy.

## II. History of Coca in the Andes

For five thousand years, the coca leaf has held special significance for the indigenous populations of Bolivia, Colombia, and Peru, and its use has been widely accepted in the past. Even today, "a coca branch is incorporated into the national emblem of the modern-day Republic of Peru, and the leaf is also displayed on every piece of Peruvian currency" (J. Kennedy 13). Coca became a part of Andean culture even before the establishment of the Incan empire. "Ceramic lime pots and figurines of coca chewers appear associated with the Valdiva culture on the coast of Ecuador and date back to 3000 B.C." (J. Kennedy 15). Only in the past two centuries has the coca leaf been a source of contention in international public policy.

The coca leaf was first used predominantly in the Incan empire, which stretched throughout the Andes. Believing that it had mystical powers and healing properties, the Incans held a great respect for the coca leaf, which led to numerous myths surrounding the leaf and its power. For example, there is a myth

"set in time of great famine. Manco Capac looked down on the world from heaven and wept bitter tears for his suffering children; his tears amounted to a downpour and saturated the ground below. Later, all the tears evaporated, except for the ones that settled on coca plants. Manco then sent a blazing red comet to earth as an omen to his people. It landed in front of the palace of a king named Montana. When the king rushed out and approached the comet, it transformed itself into a flaming cocoa leaf. After the fire subsided, Montana kissed the holy object and tasted the bitterness of Manco's tears. Montana understood that he should give the plant to the Incas to defeat hunger and fatigue. With the famine behind them and the coca leaf giving them power, enthusiasm, and energy, the Incas prospered." (J. Kennedy 21).

These myths elevated the status of the coca leaf in the eyes of the Incan population as it was seen as a tool to combat basic problems such as hunger and altitude sickness.

After seeing the respect for coca among the masses, Incan leaders realized what an important political tool it could become. Therefore, the Incan leaders used their adept management abilities and military power to cultivate and restrict the flow of coca. Because of the restriction on the availability of coca, the leaders increased their power over the people they ruled.

Coca remained a South American good until the conquistadors came to the Americas and transported coca back to Europe. Upon arrival in Europe, the popularity of coca grew and spread. Eventually, scientists became interested in coca because of its medicinal properties. “Herman Boerhaave, a Dutch physician, was the Enlightenment’s gift to coca. Boerhaave gave science its first hint concerning the existence of alkaloids and launched an elaborate search for the working parts of active plants” (J. Kennedy 48). Then, in 1855, “a chemist named Gaedcke published a coca article in *Archives de Pharmacie* in which he described a process that would yield the essence of coca. Gaedcke discovered that the distillation of a dry remnant of dilute coca leaves produced a strange-smelling oily liquor now known to us as hygrine. His refinement of this fluid gave him some small needle-like crystals that he called Erythroxyline, and we now call cocaine” (J. Kennedy 56). Hence, a shift from just chewing coca to using it for the production of cocaine occurred in Europe. Once cocaine use became prevalent, a heated debate ensued about coca and the effects of cocaine.

### III. Coca: A Helpful Medicine or a Degenerative Drug?

As coca and cocaine spread across Europe and the United States, the negative effects of cocaine began to be felt. Hence, a debate started on whether or not coca production should be regulated. On the demand side, both the United States and Europe decided to appeal to the international community to eradicate the production of cocaine in the beginning of the twentieth century. On the supply side, since most of the production of coca came from the Andean region, Peru led the way in trying to determine whether or not it should be banned.

Researchers in Peru began to evaluate the possible negative effects on its citizens. Initial research promoted invidious stereotypes with regards to indigenous populations. “In a sympathetic but misguided attempt to explain and possibly end the Indian’s plight, Dr. Hermilio Valdizan suggested that there was a causal relationship between coca use and racial degeneration. Valdizan’s theory was almost completely ignored until the late 1920s, when a strong anticocaine atmosphere was created” (J. Kennedy 110). As this atmosphere took place, Peruvian researchers began a full-scale analysis of the impacts of cocaine on Peruvian society.

As the international debate brewed, the Peruvian government began to weigh-in on the effects of coca usage. Initially, they sided with the prococa lobby and “refused to undertake any sweeping coca reforms until it could be proven that the leaf was a cause of racial degeneration and that its occasional misuse was not merely a symptom of some other factor such as abject poverty or famine” (J. Kennedy 110). However, after receiving pressure from the international community, the government changed its view quickly.

“All of this suddenly changed in March 1951 when the United Nations sent a mission to Peru to ‘gather information’ on the suppression of the leaf. After

hearing the official government position on prohibition [which was not to act until scientific facts confirmed the negative effects of coca], the mission impatiently advised that it was not really necessary to have all the scientific facts completely answered before beginning a trial prohibition in some communities. For the next three years, the Peruvian government undertook a series of minor steps and pilot programs that were aimed at pleasing the United Nations while not completely giving in to their recommendations for absolute eradication of the leaf.” (J. Kennedy 113).

Therefore, the Peruvian government began their crop eradication efforts.

Initially, the crop eradication efforts focused on crop substitution. “In 1956, no new licenses were given to grow coca and the Institute of Inter-American Affairs began a program of so-called agricultural improvement that was designed to replace coca with other crops such as peanuts” (J. Kennedy 114). However, due to the overwhelming presence of coca in Peruvian culture, other crops were not able to replace coca entirely. Hence, the international community began to form coalitions to eradicate coca from the area by force.

#### IV. A Difference Between Coca and Cocaine?

Recently, the debate concerning cocaine usage has ceased due to scientific evidence demonstrating its deleterious effects. According to the National Institute on Drug Abuse in its Research Report Series, “Cocaine Abuse and Addiction,” the study found that

“the short-term physiological effects of cocaine include constricted blood vessels; dilated pupils; and increased temperature, heart rate, and blood pressure. Large amounts intensify the user’s high, but my also lead to bizarre, erratic, and violent behavior. These users may experience tremors, vertigo, muscle twitches, paranoia, or, with repeated doses, a toxic reaction closely resembling amphetamine poisoning...The long-term effects of cocaine include addiction, irritability and mood disturbances, restlessness, paranoia, and auditory hallucinations” (Leshner 4).

The World Health Organization, which represents the international community has concurred with the opinion that cocaine is harmful and should be outlawed (WHO).

This consensus regarding cocaine has not been established regarding the usage of coca. Scholars continue to disagree about the effects of coca and many now draw a sharp distinction between the use of coca and cocaine. These scholars, for the most part, have claimed that coca has only a mild stimulant effect and is beneficial in combating the symptoms of altitude sickness and hunger. In his work, *The Articulated Peasant*, Enrique Mayer “concur[s] with the general opinion that, unlike cocaine consumption, coca use is about as injurious to the health of its users as the use of coffee or tea, and is certainly less dangerous than cigarettes” (174). He continues to argue that:

“Coca helps one to think through dilemmas in daily life, to mull them over until a way out is found, to ponder options and alternatives. Its effect is the very opposite of the escapism and hedonism sought by the cocaine or crack user. Coca does not stupefy; on the contrary, it generates wisdom and helps find solutions to problems that involve the interaction of unknown factors” (Mayer 195).

This general opinion seems to pervade most of the literature.

Other scholars offer similar opinions. For example, “in its conclusions, presented and debated at a special conference on inter-American traffic in narcotics in Rio de Janeiro in 1986, the Institute [Interamerican Indigenous Institute], with the backing of the United Nations’ Inter-American Consultative Group on Coca Leaf Problems (UNFDAC), recommended that

‘[t]he right to the cultivation and use of the coca leaf in the traditional Andean culture must be effectively recognized in any legislation about drug control in the Andean countries, which must spell out the conditions under which it can be cultivated and legitimately consumed by that sector of the population that shares in this cultural tradition (Cited in Carter 1989: 29)” (Mayer 187).

Other advocates support this notion that coca is harmless when taken in its cultural contexts.

“Coca is profoundly native, the spirit of the Andean culture, and its production and consumption is rooted in the deepest part of indigenous life. Its socio-cultural significance, its nourishing properties like its healing properties and ideological importance within Andean villages, makes coca one of the products most established in the national conscience...Just in the way that coca has resisted centuries of aggression and survived colonizer’s attacks, it will resist and overcome the North American attack” (Translated from Girona 60).<sup>1</sup>

Furthermore, the author makes an important distinction between coca and cocaine:

“When we speak of the defense of coca, it is essential to define it clearly, so that there is no confusion with the protection of cocaine and narcotrafficking” (Translated from Girona 61)<sup>2</sup>. Consequently, South American advocates have pushed for a distinction to be made between coca and cocaine.

Scholars also advocate a cultural relativism approach to coca production. By this, scholars mean that coca should not be judged according to Western standards but rather by the cultural context in which it is used. These advocates have made some progress in pleading their case, “in 1988, the United Nations’ Convention for the Control of Illicit Narcotics and Psychotropic Substances, within the framework of its drastic recommended actions to eradicate these substances at the source, nonetheless stressed that these measures ‘...shall respect fundamental human rights and shall take due account of traditional licit uses, where there is historic evidence such use, as well as the protection of the environment” (Mayer 187).

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<sup>1</sup> Original Text: “La coca es profundamente nativa, es el espíritu de la cultura andina y su producción y consume esta enraizada en lo más hondo de la vida indígena. Su significación socio-cultural, sus propiedades alimenticias así como sus cualidades curativas y la importancia ideológica dentro de los pueblos andinos, hacen de la coca uno de los productos mas arraigados en la conciencia nacional...La coca así como resistió siglos de agresión y sobrevivió a todos los ataques de los colonizadores, resistirán y vencerá el ataque norteamericano” (Girona 60).

<sup>2</sup> Original Text: “Cuando se habla de defensa de la coca es imprescindible deslindar con nitidez, que no se confunda con protección a la cocaína, al narcotráfico” (Girona 61).

In addition to scholars advocating a push for the distinction between coca and cocaine, the Andean population for the most part supports the traditional use of coca. For example, in a public opinion poll of the Bolivian student population, 42% said that they masticate coca. In addition, they felt that chewing coca helped them to combat the cold (22%), to help with sleeplessness (33%), to tranquilize their spirit (7%), to relieve aches and pains (5%), and to mitigate hunger (33%). In addition, 85% of the population felt that coca should be produced for traditional uses, and 77% felt it should be industrialized. Furthermore, only 18% felt that coca was cocaine (Girona 317-318).<sup>3</sup>

As a result of this advocacy, a push to create a market for coca products that are distinct from cocaine such as coca tea has been formed. “The Peruvian coca monopoly known as Empresa Nacional de la Coca (ENACO), recently privatized as part of structural readjustment policies, is under the obligation to buy at below-market prices any coca leaf offered to it, in order to divert the leaf away from cocaine production. As a consequence, ENACO has enormous surpluses of coca leaf that needs to find legitimate and legal market outlets” (Mayer 191). These surpluses are in part created because traditional uses do not use up nearly as much coca leaf as the production of cocaine. In

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<sup>3</sup> Translated from the following:

“Pregunta 1: Mastica Coca?

Si 42%  
No 58%

Pregunta 2: Masticar Coca ayuda a:

Combatir frio	22%
Despejar sueno	33%
Tranquilizar espiritu	7%
Alejar hechizos	5%
Mitigar el hambre	33%

Pregunta 3: Se debe apoyar la produccion de coca para usos tradicionales?

Si 86%  
No 14%

Pregunta 4: Se debe respaldar la industrializacion de la coca?

Si 77%  
No 23%

Pregunta 5: La coca es cocaine?

Si 18%  
No 82%

the production of cocaine, “Bolivian cooks require 386 kilograms of dry leaf to produce 1 kilogram of cocaine base and Peruvian cooks require 400 kilograms of dry leaf.

Scientific fieldwork also confirmed that cocaine HCl [Hydrogen Chloride] cooks in Colombia, Peru, and Bolivia are able to convert 1 kilogram of cocaine base into an equal amount of finished cocaine HCl” (DEA).

Treating coca and cocaine as two distinct entities has become a more popular worldview in that people who are against the legalization of cocaine still favor coca use. However, world opinion has not entirely changed because many individuals still want both substances banned. “Even though the Drug Enforcement Agency (DEA) of the United States and other international organizations now recognize that coca consumption is innocuous, Bolivia’s request to the International Narcotics Convention to strike coca leaf from its list of prohibited substances was once again denied in 1992” (Mayer 194). Furthermore, many groups still target the production of coca due to the fact that once it is processed it becomes a deadly, addictive drug. For example, in the World Health Organization publication, *Guide to Drug Abuse Epidemiology*, cocaine is still “measured as a class or measured separately for powdered cocaine, crack cocaine, coca paste, or coca leaves as relevant” (WHO 191). In other words, the organization makes no distinction between coca and cocaine at least for the purposes of their research. Therefore, while advocacy groups may be making headway, United States’ and United Nations’ policy towards coca eradication does not seem to be changing in the near future.

#### V. The World’s Source of Coca

Due to the history of the Andean Region, the ties of the region to the United States and Europe, and coca advocacy groups coming from the region, the United States

has focused their efforts on the Andes. Due to this international diplomatic pressure and interdiction programs, the specific source of coca within the Andes has been shifting over the past few decades. Originally, Bolivia was the world's greatest source of coca. However, the United States Drug Enforcement Agency applied pressure to Bolivia's main growing area, the Chapare region. After several futile attempts, the Bolivian government and the US Drug Enforcement Agency seem to be having some success. "In December 1997, the Bolivian government stepped up the fight against the coca farmers and launched the US-financed 'dignity plan', to eradicate coca by the end of 2002...According to the Bolivian government, the number of acres used for growing coca has decreased from 127 000 hectares in 1997 to about 5000 hectares today" (Chande 1573). Despite a debate surrounding the accuracy of these numbers, they still show an overwhelmingly decreasing trend.

With the reduction of coca in Bolivia, production within the last few decades has been shifting to Peru and eventually to Colombia. In Peru, the Upper Huallaga Valley (UHV) has become a main source of coca. "Between 1970 and 1980 coca plantings increased at least six fold in the area around Tingo Maria, to over six thousand hectares. The ease of growing the coca plants in the area and the quality of production sparked the interest of Peruvian and Colombian drug traffickers" (Gonzales 124). The abuse of Peruvian coca farmers by the Colombian drug traffickers eventually acted as a catalyst for the presence of Sendero Luminoso. "By 1987 official figures listed the annual production of the coca leaf as 28,500 metric tons, while agronomists responsible for compiling this data stated in interviews with the author that the actual figures was 80,000 metric tons. The same year, government officials in the UHV maintained that about 95

percent of the local economy was based on illegal activities of drug trafficking and coca production” (Gonzales 124).

In the early 1990s, coca production in Peru increased dramatically under the terrorist activities of Sendero Luminoso. According to the Drug Enforcement Agency, during Sendero Luminoso’s presence, coca levels spiked to 129,100 hectares in 1992. Coca has been on the decline over the last few years just as in Bolivia. In 2000, only 40,200 hectares of coca were produced (Casteel).

While Bolivia and Peru’s coca production has been decreasing, Colombia’s coca production has been increasing since the establishment of Fuerzas Armadas Revolucionarias de Colombia (FARC). According to the State Department’s *International Narcotics Control Strategy Report*, coca production in Colombia went from 41,000 hectares in 1990 to 183,200 hectares in 2000. As a consequence, the United States has increased their interdiction efforts in Colombia. As a result of the FARC and the increase in production, President Clinton pledged \$103.3 billion to PLAN Colombia, which is a multifaceted effort that includes both military and economic aid packages. The plan is just starting to be implemented however (DEA).

Because of its history and climate, the Andes Mountains are extremely conducive to growing coca. Stimulated by an increase in demand in the U.S. and Europe, the supply of coca produced has increased. This increase in production though has shifted to different countries due to U.S. drug policy and international pressures. Colombia now leads the world in the production of coca.

## VI. Stakeholders in the Coca and Cocaine Production

Different stakeholders have become involved in coca production. These include terrorist organizations, such as the FARC and Sendero Luminoso, national governments, such as Colombia, Peru, and the United States, and the local coca growers. It is important to look at these different groups because they influence the incentive processes in the alternative development framework.

#### A. Sendero Luminoso and the FARC: Organized Crime as a Regulatory Agency

The coca industry has established perfect conditions for the FARC in Colombia and Sendero Luminoso in Peru to take root and prosper. Even though, the United States, Fujimori's military regime, and a peasant uprising have largely eliminated Sendero Luminoso from Peru due to aggressive military actions, the Shining Path still had a huge impact on coca production in the 1980s and early 1990s. The FARC, on the other hand, is still very prominent in Colombia after peace talks with then-Colombian President Pastrana failed. Many sources indicate that the FARC's protection of coca farmers is primarily responsible for the increase in coca production. These two organizations have a direct impact on the feasibility of crop substitution plans. The involvement of these two organizations in production of coca varies slightly. Sendero acted primarily as a regulatory agency and fits the profile of organized crime very well. The FARC is in a similar situation; however, there is conflicting evidence on whether or not it is more directly involved in the production of coca.

Sendero Luminoso, which established its roots in the Maoist tradition of Marxism, began in Ayacucho under the leadership of Guzman. However, the indigenous people did not firmly embrace his message. Fortunately for Sendero, conditions were right to thrive due to the burgeoning coca industry. Therefore, Sendero Luminoso

established itself as an organized crime unit with a political message. Sendero's established framework fits closely with the organized crime paradigm. The only addition is that the organization has a political message.

After the initial struggle to recruit members, the group found that coca production was an effective way to supply funding for their organization. Therefore, Sendero Luminoso "began its political work in the Upper Huallaga Valley in 1980" by eliminating Tito Jaime, the mayor of Tingo Maria in order to gain ground with the coca growers in the area (Gonzales 125). "For Sendero, the UHV represents a major component of its political strategy and the principal source of its economic resources. Estimates of the Shining Path's annual revenue range from \$20 million to \$100 million a year. It comes primarily from 'revolutionary taxes' and control of scores of clandestine air strips used to transport coca paste to Colombia for manufacturing cocaine" (Gonzales 139). By using coca business, they were able to model a regulatory agency that is structured like organized crime.

Sendero Luminoso, while still maintaining properties of a political group, was able to transform itself into organized crime as defined by United States law. United States' "federal law defines organized crime as those unlawful activities in which a highly organized, disciplined association supplies illegal goods and services" (Schelling 71). Whether or not Sendero Luminoso was directly involved with planting coca can be disputed, however, there is incontrovertible evidence that shows the organization as facilitators in the process. Forming this organized crime group was fairly easy to do according to Schelling's incentive structure.

In his article, "Economics and Criminal Enterprise," Schelling argues that many economic incentives exist for organized crime, which include economies of scale, prospect of monopoly prices, a larger share of the market, and power in the underworld. These incentives fit for Sendero Luminoso for the most part. By keeping the supply regulated they could demand higher prices, which in turn led to an increased ability to raise tax revenue.

In addition to having the proper incentive structure, Sendero Luminoso also had the opportunity to establish an organized crime unit. In his article, "Organized Crime A Symposium: What is the Business of Organized Crime," Schelling suggests that the following make good criteria: (1) victims should be poor at protecting themselves (2) victims should not be able to hide from organized crime (3) organized crime should be able to monitor their victim's earnings and activities with ease (4) organized crime should have a regular business and a (5) organized crime should be able to operate in a smooth and efficient manner.

Sendero Luminoso was also able to fit all of these criteria. The coca farmers or victims of the Upper Huallaga Valley could not protect themselves from guerilla fighters, Colombian drug traffickers, or from the Peruvian government. Sendero Luminoso was able to seize control over the UHV due to drug interdiction efforts by the Peruvian government under the administration of Alan Garcia and through grievous human rights abuses by Colombia drug traffickers. Because these groups persecuted coca growers, Sendero was able to establish itself as a protective agency. Therefore, Sendero was able to achieve Schelling's first criteria because at the beginning the peasants were unable to

protect themselves for Sendero. Eventually, when the peasants rebelled is when Sendero began to lose ground.

Their victims could not hide from them for the most part because their monitoring system was vast. “By late 1988 Shining Path completely controlled the valley road. Every passing vehicle paid a fee at the Sendero “toll booth,” [which was] a rope put across the highway” (Gonzales 129). Therefore, it was difficult to move without Sendero noticing.

Other criteria include the ability to monitor one’s earnings. By keeping the price of coca high and forming a cartel-like situation, Sendero experienced a collective action problem in that individual coca growers had an incentive to cheat. In order to combat this, Sendero lived with the people whom they were monitoring so it was fairly easy to look for cheaters in the system. In addition, they established extremely stringent enforcement mechanisms. “Murder also reflected one of the constants in the Sendero strategy, opposition to any legal organization that could defy its supremacy. The subsequent systematic assassinations of local authorities in the area and in other parts of the country attest to this”(Gonzales 125). This effective enforcement mechanism changed the payoffs of the system and gave individuals a greater incentive not to cheat.

Having a steady course of business was also not a problem for Sendero. The demand in the European and United States’ cocaine markets has been far from satiated. Therefore, they had constant demand in order to support their business. According to the U.S. Drug Enforcement Agency, “about 10 percent of Americans over the age of 12 have tried cocaine at least once in their lifetime, about 2 percent have tried crack, and nearly one percent is currently using cocaine.” This results in an “estimated six millions users

of cocaine in the United States” (Gonzales 140). Demand is not a problem and establishes a regular course of business for organized crime.

Finally, Sendero Luminoso meets the last criteria because they have to have a smooth and efficient system. The efficient system created this aspect through their discipline. Through their effective enforcement mechanisms, they were able to establish strict discipline in the region. Everyone in Sendero’s jurisdiction had to obey the following rules:

“The three cardinal rules are: (1) Obey orders; (2) Take from the masses neither a single needle nor a piece of string; (3) Turn over everything which is captured. The eight commandments are: (1) Speak courteously; (2) Pay an honest price for everything purchased; (3) Return everything borrowed; (4) give compensation from anything broken or destroyed; (5) do not hit or injure people; (6) Do not take farm produce; (7) Do not abuse women; (8) Do not mistreat prisoners” (Gonzales 128).

These rules and their enforcement abilities allowed for their system to be created.

With their ability to act as an agent for organized crime, it was fairly easy for Sendero Luminoso to gain a stronghold in the Upper Huallaga Valley. Besides having great coordination, the political and economic conditions were right for Sendero to establish a foothold in the coca industry. The actions of CORAH (the Control And Reduction of Coca Crops), the U.S. government, the Colombian drug traffickers, and the Peruvian government all drove poor coca farmers into the hands of Sendero Luminoso.

It should be noted, however, that not all farmers were driven into the hands of Sendero. There was a select group that resisted called the *rondas*. These peasants ultimately helped the Peruvian army take back their land. Duke University cultural anthropologist, Orin Starn, recounts their accomplishment:

“A greater peace represents the most obvious achievement of the *rondas*. . .In general, however, the *rondas* have vastly reduced the Shining Path’s ability to

operate in the Andean countryside... Checkpoints and patrols have pushed the rebels out of the Upper and Lower Tulumayo Valleys in Junin, where peasants, in the words of one leader, began to fight in 1990 with 'clubs, machetes, rocks and slings.' With almost no help from the military, the rondas have also expelled Shining Path from another of the war's bloodiest battlegrounds, the Apurimac Valley. In these and many other war zones, many peasants confirm a greater, if by no means total, sense of security and calm with the rondas" (Starn 243).

Hence, Sendero eventually lost power at the hands of the Peruvian government and the *rondas*.

Sendero Luminoso fits the description of organized crime and played a major part of facilitating the production of coca and keeping the price high. However, whether or not the FARC<sup>4</sup> in Colombia is acting as the same kind of organized crime regulatory agency is another issue. The FARC has allegedly not only taxed the production of coca, but also has been instrumental in not only producing it but also processing it into cocaine. However, there are conflicting reports on what is actually occurring and whether or not they are acting as a regulatory agency or as a cartel. According to most reports, it appears that they started as a regulatory agency but then eventually transformed themselves into a cartel

The FARC claims that they are only a regulatory agency in the production of coca and cocaine. "By the FARC's own admissions, it derives a great deal of its income from taxes it levies upon the production of the coca leaf, coca base and refined cocaine" (Reavis). In addition, "The FARC draws income, its spokesmen say, from a 10 percent tax, a "vacuna" or "vaccination," levied on farmers, cattlemen and business operators in

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<sup>4</sup> According to DEA intelligence reports, "In 1966, members of the Marxist-Leninist-based *Partido Comunista Colombiano* established the FARC as the PCC military wing. Today, the FARC is considered the largest, best-trained and equipped, and most effective insurgent group in Colombia. The FARC is governed by a secretariat, led by Manuel Marulanda-Velez and six others, including senior military commander Jorge Briceno-Suarez. The FARC employs a wide variety of tactics to meet its goals, and has greatly emphasized its military capability."

the areas that it controls. When cattlemen, the elite of Colombia's rural areas, refuse to pay the vacuna, the FARC takes over their holdings, sending the cattle to auction, just as ranch owners would" (Reavis) Therefore, they maintain that they are not in any manner involved in the production of cocaine and solely regulate the industry (LA Times).

Some U.S. government officials however believe that the FARC is more of a cartel than a regulatory agency. According to the a DEA intelligence report, "According to Colombian military authorities, results of the eradication operation included the destruction of 26 FARC camps, 5 cocaine HCl laboratories, 62 cocaine base laboratories, 309 kilograms of cocaine, and 1,391 hectares of coca. The DEA has not independently corroborated these seizure figures." While this does not accuse the FARC directly of being a cartel, it does lend itself to the notion that it does more than just regulate the supply of cocaine. However, it should be noted that according to the DEA's intelligence report, "while individual members of the FARC, such as the 16<sup>th</sup> Front Commander Tomas Molina, are involved in some aspects of the Colombian drug trade, there is no credible information that the FARC as an institution has evolved into a drug trafficking organization."

The contradictory information is significant because of United States' foreign policy. The FARC has an incentive to declare themselves strictly a regulatory agency because U.S. foreign policy is only to give military aid in order to combat drug traffickers. The Colombian government has an incentive to give the U.S. information showing the FARC as a drug cartel because of aid packages tied to this information. Because of these considerations, the case with the FARC seems to be more convoluted than that of Sendero. Regardless of whether they are a cartel or a regulatory agency, they

are making money. “According to Alfredo Rangel, a Colombian military analyst, profits from the drug trade now make up 48 percent of the rebels’ income, amounting to nearly \$180 million annually. Others say the figures run higher” (Houston Chronicle).

“Economists who have studied rebellions tend to think of them not as the ultimate protest movements, but as the ultimate manifestation of organized crime” (Howe 1). The FARC and Sendero Luminoso would definitely fit this description. The FARC and Sendero Luminoso both have a key role in keeping the price of coca high and have manifested themselves into organized crime units. For the most part their crime occurs as they act as regulatory agencies in the production of coca. Therefore, when considering the viability of alternative development schemes such as crop substitution it is important to take these factors into account.

### B. Peruvian Government

The strength of Peru’s economy and political structure has a direct impact on its ability to work with the United States to eradicate cocaine. With varying degrees of success, Peru’s political leaders have been trying to solve the country’s economic woes for quite some time. The poor economy has allowed groups such as Sendero Luminoso to thrive and does not encourage farmers to substitute away from coca by offering few economic alternatives to coca production. Since 1985, three different Presidents have tried to address these issues: Alan Garcia, Alberto Fujimori, and Alejandro Toledo. Each of these Presidents had a different policy that has had a differing effect on coca production.

Alan Garcia’s presidency saw the rise of Sendero Luminoso and produced extremely poor economic policy. During his term,

“Mr. Garcia’s unorthodox economic policies initially generated high GDP growth rates and a sharp increase in purchasing power for the poor. However, economic mismanagement led to hyperinflation, increased poverty and crumbling infrastructure. Violent strikes paralyzed many areas of economic activity. In 1987 a move to nationalize the banking system provoked protest and rallied the opposition. Mr. Garcia’s September 1988 paquetazo (economic shock) was a disaster, and by 1990 the rate of inflation exceeded 7,500%” (EIU 5).

Upon visiting Peru, I was able to speak with individuals who lived in Lima at the time when Garcia was President, they described constant blackouts and bread lines.

Furthermore, Sendero Luminoso was constantly setting off bombs in public places, such as the Kentucky Fried Chicken in Lima. Finally, the inflation was so extreme that no one could take a cab because he would have enough money to pay for the ride at the beginning, but inflation would increase the price so much that the person would not be able to pay at the end. Hence, Garcia’s presidency was filled with turmoil that did not give many economic alternatives to coca producers.

After the chaos of Garcia’s presidency, Fujimori had his focus on reforming the Peruvian economy and eliminating Sendero Luminoso. At first, Mr. Fujimori was somewhat successful by introducing “a radical stabilization programme that brought hyperinflation under control, but led to a deep recession. He [also] adopted a zero-tolerance policy on terrorism, putting large sections of the country under emergency rule and using the army and intelligence services to round up anyone suspected of terrorist activities” (EIU 5). His campaign against Sendero’s terrorist activities was ultimately fairly successful with the help of the *rondas* and saw the disintegration of the group after the imprisonment of Sendero’s leader, Abimael Guzman in 1992.

After two fairly successful terms, Fujimori decided to run for a third term. The election was fairly close and he faced stiff opposition from the Peruvian Congress.

Eventually, however, he achieved a majority in the Peruvian Congress “through a combination of bribery, the granting of favours and the dropping of judicial proceedings” (EIU 6). During the bribery however, Fujimori’s head of the National Intelligence Service, Montesinos, videotaped all of the corrupt acts. After these tapes were exposed to the public, Montesinos fled the country. Meanwhile, Fujimori called for new elections and sought “residency in Japan, from where he resigned as president” (EIU 6).

Amidst this scandal, Alejandro Toledo ran against former President Alan Garcia. The election was close, but Toledo won with 53% of the vote. As a World Bank economist, Toledo showed great promise for the economic future of Peru. He preached a pro-market policy much to the dismay of his political party, *Peru Posible*. He pushed for privatization in Peru; however, was largely unsuccessful in implementing that policy due to protests. For example, “After months of growing public protest at high unemployment, a lack of public funds and continued economic orthodoxy, in June 2002 the government went ahead with the sale of two electricity-generating companies in Arequipa, Peru’s second largest city, which was met with three days of violent protest. The government was forced to back down and reverse the decision to privatize, and shortly afterwards the pro-market champions in [Toledo’s] cabinet were the highest-profile casualties in a cabinet reshuffle” (EIU 8). Since this incident, Toledo’s cabinet has begun to focus on a political agenda instead of an economic agenda. However, it remains to be seen how successful he will be.

The volatile Peruvian economy over the last few decades has weakened chances for crop substitution. In addition, the world economy has also had an adverse effect on the viability of crop substitution. For example, “the fall in the international price of

coffee in recent years—usually a suitable alternative to coca as a cash crop in the Peruvian highlands—is also acting against efforts to reduce the amount of coca cultivated” (EIU 35).

Peru’s government has tried to establish an economy which offers farmers alternatives to crop substitution. However, their success may be eroding.

“In 2001, the U.S. Government reported the first increase in Peru’s coca cultivation since 1995. Although growth in new coca was limited, it confirms other disturbing trends. Prices for Peruvian coca leaf have rebounded and some Peruvian coca farmers are replanting previously abandoned fields. If these trends are not reversed, the counter drug successes achieved in Peru will be increasingly at risk” (DEA).

Therefore, the Peruvian government must continue to strengthen its economy to offer farmers alternatives to coca production.

### C. Colombian Government

The Colombian government has been plagued with high crime rates and one of the highest murder rates in the world for several decades, especially during La Violencia, which occurred from 1948-1966. These “complex crime and national security issues are, in part, fueled by, the drug trade” (Casteel). In an attempt to increase stability, the Colombian government has been trying to combat cocaine production and the violent actions of revolutionary groups, such as the FARC, and drug traffickers that are associated with it. The duties of drug control policy in Colombia are split between the Justice Department, the Defense Department, the legislative branch, the executive branch, the National Council on Dangerous Drugs (CNE), and The National Directorate on Dangerous Drugs (DNE). With the help of United States’ aid, the Colombian government has been committed to the eradication of coca through interdiction efforts and alternative development plans. However, the Colombian government was not

completely helpful during the Samper and Pastrana administration's in eliminating cocaine. The government allowed citizens to have cocaine for personal use and weakened the judicial punishments against drug traffickers.

Crop eradication can occur in several different ways including aerial crop spraying and manual eradication. Both of which have been exercised in Colombia. The Colombian National Police in conjunction with the U.S. State Department Narcotics Affairs Section oversee the coca aerial eradication programs. However, while "the Colombian military has no direct role in the actual spraying operations," it does clear out areas and provide cover for the eradication aircraft (DEA).

Besides aerial crop eradication efforts and removing coca manually, Colombia has also tried to encourage alternative development programs. "Colombia's *Plan Nacional para Desarrollo Alternativo* (National Plan for Alternative Development of PNDA) is a GOC [Government of Colombia] program seeking to promote cultivation of legitimate crops in areas devoted to illicit cultivation"(Casteel). The United States supports this initiative. "In July 2000, the U.S. Government enacted a comprehensive \$1.3 billion assistance package in support of the Government of Colombia's Plan Colombia" (Casteel).

The government has also formed a coalition in order to stop drug production. In the past all the branches of the Ejercito Nacional (Colombian Army) were spread out in their duties. However, now they are more centralized to support a common goal:

"In March 1997, the GOC created the 5,000-man Southern Joint Task Force (JTF-S) comprised of personnel currently assigned to the Colombian Army, Air Force, Marine, and National Police Anti-Narcotics units. The JTF-S was created after the Colombian Army suffered serious losses at the hands of the FARC" (Casteel).

Hopefully, this coalition will allow more communication among the armed forces.

Despite all the resources and programs towards cocaine eradication, the Colombian government encourages people to be in the cocaine industry by allowing people to possess cocaine for personal use and by giving drug traffickers' rights. Currently, Colombian citizens are allowed to have 1 gram of cocaine for personal use so that they may "freely develop their own personality" (Casteel).

Another major action of the Colombian government that encouraged cocaine production was the restructuring of the constitution.

"Colombia's 1991 Constitution, which replaced the 1886 Constitution, contains several provisions that affect the country's counter drug policies and operations. Article 35, which until December 1997, prohibited the extradition of native-born Colombians, was the most important of these provisions... Other constitutional provisions, such as the *tutela*, [which] refers to the right of a Colombian citizen 'at any time and any place' to petition the courts to protect his or her basic constitutional rights. Judges must give *tutela* appeal priority over all other matters before the court. The right of *tutela* has been used extensively by Colombian drug traffickers to delay prosecution by clogging up the courts with petitions" (Casteel).

Drug traffickers encouraged these changes in the Constitution, which lower the opportunity cost of getting caught. Inspired by the "slogan, boldly proclaimed in the press: 'better a grave in Colombia than prison in the United States,'" as the new constitution was being debated in 1990, the narcotraffickers, used highly paid lawyers, bribery, intimidation, and nationalism to sell the idea that Colombians should be tried and serve their time at home rather than abroad" (Frechette 4). Hence, the government indirectly encouraged cocaine production.

Despite Colombia's efforts, cocaine production has been increasing rapidly over the past few years.

"As recently as 1995, however, Colombia only produced about 25 percent of the world's cocaine base, the intermediate product used to make finished cocaine

HCl. Colombian traffickers were dependent on Peruvian and Bolivian sources for two-thirds of their cocaine base product. Each year, this amounts to hundreds of tons of cocaine base imported by aircraft from Peru and Bolivia. Since 1995, however, the net coca cultivation in Colombia has more than tripled, from 50,000 hectares in 1995 to 169,800 hectares in 2001. Stated differently, the physical land area under coca cultivation in Colombia in 2001 was three times the size of the Peru-Bolivia crop combined” (DEA).

Therefore, Colombia is currently appealing to the United States to give them additional aid.

#### D. The United States

The United States of America has become significantly involved in trying to eradicate coca, especially during the Reagan-Bush administration. The “War on Drugs” seems to be revived again due to the linkage between narco-money and terrorist organizations. Therefore, the United States has renewed their commitment to the war on drugs.

The current strategy is to attack demand on a domestic level by encouraging education in schools through programs such as DARE, establishing prevention and rehabilitation programs, and trying to increase interdiction efforts through increased policing. In order to disrupt the supply side of the market, the administration has increased their border control and worked on disrupting the supply chain domestically. In regards to cocaine, they have also focused their efforts on an international level. Because of the amount of coca grown in the Andean region, the United States has focused particularly on Bolivia, Peru, and Colombia. In order to try to curtail the supply of coca, the United States’ government has two major programs: Plan Colombia and the Andean Counterdrug Initiative. Both of these programs are designed to reduce the amount of cocaine produced dramatically.

The approach of the United States' government can be defined as rational choice theory. The government sees drug suppliers and demanders as rational agents in their consumption of drugs. This approach is best defined in the February 2002 National Drug Control Strategy report. The report claims:

“Few areas of public policy boast linkages as clear as those that exist between the availability and use of illegal drugs. Simply put, the demand for drugs tends to vary with their price and availability. Disrupting this market relationship provides policymakers with a clear lever to reduce use” (Bush 21).

The report also implies that the demand for drugs is fairly elastic in the following claim:

“Whatever compulsion drives them, most addicts are in fact quite conscious of and sensitive to the price and purity of the drugs they consume” (Bush 21). The government contends that there is a high elasticity of drugs because they assume that the consumer of those drugs is rational. They also believe that this rationality can be applied to everyone. In the government's opinion, “even heavy users of drugs are rational consumers, and the market signal conveyed by a drop in availability” (Bush 21). This theory has defined the National Drug Control Strategy, and therefore this thinking has influenced the United States' approach.

In order to complete a multifaceted initiative, several different agencies have become involved in the War on Drugs. According to the National Drug Control Strategy Report, the following institutions receive funding in the War on Drugs: Department of Agriculture, Corporation for National and Community Service, D.C. Court Services and Offender Supervision, Department of Defense, Intelligence Community Management Account, Department of Education, Department of Health and Human Services, Department of Housing and Urban Development, Department of the Interior, Department of Justice, Department of Labor, Office of National Drug Control Policy, Small Business

Administration, Department of State, Department of Transportation, Department of the Treasury, and Department of Veteran Affairs. Hence, United States' funding extends beyond just the Drug Enforcement Agency.

A rational choice theory approach has led the United States to focus on both the demand and supply side of the market. Demand in the United States is still high for illicit drugs, and drug use has led to high economic costs for American society. "The total economic cost to society of illegal drug use in 2000 was an estimated \$160 billion, a 57 percent increase from 1992. The three major components of the total cost are health care costs (\$14.9 billion), productivity losses (\$110.5 billion), and other costs (\$35.2 billion), including the cost of goods and services lost to crime, the criminal justice system, and social welfare" (Bush 25).

Because of these costs to society, the government has tried to eliminate illegal drug use. Despite efforts of focusing on Colombia and Peru, the coca plant has not been able to be eradicated. "Despite two decades of costly crackdowns here and the loss of thousands of lives in the fight against narco-traffickers, drug production continues to expand in Colombia, which supplies 90 percent of cocaine and most of the heroin sold on U.S. streets" (Otis). The international community, particularly the United States and to a certain extent Europe, has put an enormous pressure on the Colombian and Peruvian governments to eradicate the coca crop abroad because of illegal drug abuse within their borders. The United States' government has even sent military aid to both Colombia and Peru to try to capture those individuals involved in the production of coca (PERU). In addition, the Drug Enforcement Agency has sprayed dangerous chemical toxins that have had adverse effects on the health of indigenous coca growers (Gonzales 130) and

residents of Colombia and Ecuador. Hence, an enormous amount of time and resources has been invested in both the supply and demand side of the War on Drugs.

#### E. The Farmers

Individual farmers who produce coca play the most integral part in the supply chain. These farmers are the ones whose lives are directly changed by the advocacy of crop substitution plans. In Peru, the farmers for the most part are of Quechuan or Aymaran descent in Peru and live in the Andes. In Colombia, farmers tend to live in the southern most part of the state along the Ecuador border. The farmers' perceptions of coca production vary from group to group. Some seem more willing than others to give up coca production entirely and produce other goods. Those less likely to switch away from coca production are attached to it for cultural reasons or because they use it as a medium for exchange. Others who have no cultural ties are willing to switch because they do not want to deal with the military during interdiction efforts. For the most part, coca growers seem to follow rational choice theory. Therefore, it may be possible to make crop substitution a reality.

Some farmers are tied to producing coca because it is part of their culture heritage. However, despite the advocacy of traditional production uses, it seems that most local farmers are supplying coca for the production of cocaine. Currently, eleven percent of farmers are producing coca for traditional uses. An overwhelming eighty-nine percent is producing coca as an input for cocaine (Casteel). Because of this, crop substitution may be more viable than initially thought because the opportunity cost of the cultural ties to coca may not be as strong as some analysts initially suggested.

Coca has also been used as a medium for exchange in some Andean villages. With the inflation in the early 1990s in Peru and the resulting instability in the currency, villages began to use coca as currency. Since the leaves are strong and sturdy, light in weight, divisible in nature, and can be saved over time, coca works well as a currency. In fact, this has allowed opportunities for arbitrage among peasant coca growers and has aided currency. For example,

“Roderick Burchard has shown in a study how coca can be bartered with just about all the products that circulate in the peasant economy. Interestingly, the exchange rates between coca and various commodities are different from their monetary terms of exchange, even though in the peasant society of the contemporary Andes all goods can also be exchanged for money. In one example, Burchard shows how it is possible to convert one sack of potatoes into eight, using coca as the medium of exchange. The chain begins in the highlands with three sacks of potatoes. One sack is sold for money to pay the busfare to the lowland tropical region where coca is grown. In the jungle, one sack of potatoes is bartered for twenty pounds of coca. And up in the highlands again, coca can be converted back to potatoes at a rate of three pounds for one sack. Discounting the expenses incurred, one can accumulate up to eight sacks of potatoes in this manner. Such barter is possible with a whole range of products” (Mayer 176-177).

Therefore, coca works as a stabilizing force in the Andean peasant economic system.

With the increased interdiction efforts of the United States and Fujimori’s widespread use of military force, many coca farmers wanted to switch away from coca production. However, they failed to switch because of lack of economic alternatives. For example, as one coca grower expressed,

“We really want to move out of coca production because we know that it is harmful and because of all the problems it causes us. We are harassed and persecuted because we grow coca, and we are victims of corruption and abuse as well. But if we can’t count on help from our own government or from foreign aid, then our only recourse may be to get Sendero’s support” (Gonzales 138).

Therefore, not only did peasants fail to switch crops but they were also driven towards supporting Sendero Luminoso as well. These peasants were willing to submit to

Sendero's regulations in exchange for their right to produce coca. However, after Sendero Luminoso began to lose power and the coca growers no longer viewed it as a protective agency, coca production in Peru began to drop.

In Colombia, however, the cost-benefit structure is different than the Peru's because the FARC is still strong while interdiction efforts have not made a huge impact. Because the Colombian government allowed the FARC its own territory to a certain extent in the southern region of the country in order to induce a cease fire after peace talks during the Pastrana administration had failed, coca growers in that area only have the FARC to fear. "The fact that most of Colombia's new coca cultivation, and much of its cocaine processing, occurs in the eastern lowlands and southern rain forest—areas where the national government exerts limited authority—hinders the Government of Colombia's (GOC) ability to conduct effective counterdrug operations" (DEA). Hence, production in that region has by all accounts has increased as the FARC has planned which has helped stimulate the increase in overall Colombian coca production.

Farmers seem willing to participate in crop substitution. However, their payoffs and incentive structures need to be changed. Inflation needs to be held in check so that coca growers have confidence in their currency. Furthermore, the presence of terrorist groups such as the FARC must be eliminated if the viability of complete crop substitution is to be increased.

## VII. Crop Substitution: Can it be Effective?

Alternative development programs that feature crop substitution are an element of current United States' policy. However, a debate has raged over the effectiveness of this

policy. Ideally, though crop substitution is preferred over more harmful techniques such as aerial eradication programs.

#### A. The Case Against Crop Substitution

Crop substitution has been attacked as a viable option to slowing down coca production in Peru and Colombia and decreasing the amount of cocaine consumption. The arguments are based on both empirical and anecdotal evidence. The United States General Accounting Office identified some flaws in the current policy. In addition, an economic model argues that coca production will not decrease. Finally, advocates of traditional coca use argue anecdotally that it is hard to develop economic alternatives to coca production. While these are legitimate concerns for crop substitution, they do not preclude it from being a viable option entirely. Furthermore, some of the conditions under which the empirical studies were conducted have changed and thus make crop substitution a more viable alternative than previously thought.

The General Accounting Office's *Crop Substitution in the Andes* was published in order to assess the feasibility of the current program of crop substitution in the Andean region. The paper lists several reasons that the program is having difficulty. For example, since coca is a stable crop and other cash crops have higher initial fixed costs and take longer to mature, farmers prefer to produce coca. On the positive side, the per-hectare income is about the same. They also argue that farmers have 'remained in' coca despite interdiction efforts and note that the concept of the 'break-even' point does not apply. They also argue that increases in infrastructure have helped farmers to switch from legal crops to illicit crops because drug traffickers have better access to the area.

Finally, they contend that one of the primary reasons that crop substitution persists is because of political reasons (Clawson).

The GAO report however did not give an entirely bleak picture. They noted that crop substitution could be successful if certain criteria are met. They conclude that the following initiatives would support crop substitution: to identify and introduce alternative crops, to develop markets for new legal crops, to create “industrialization” by adding processing facilities and increasing the value-to-weight ratio for licit agriculture, to develop social infrastructure which includes facilities or services to improve the life for those who grow crops, and to encourage organizational development (Clawson 8-9).

In addition to the GAO report, Michael Kennedy wrote "A Simple Economic Model for Cocaine Production" for the National Defense Research Institute. His work ultimately concludes that

“‘Crop substitution’ programs will have a negligible impact on the world cocaine market. As desirable for other reasons as improving economic conditions in Peru, Bolivia, and Colombia may be, those improvements will not lower cocaine supply. This is because cocaine traffickers can easily match and exceed any increased economic opportunity, resulting from a crop substitution program, that is presented to workers currently in the cocaine industry” (M. Kennedy 39).

His model and analysis are solid based on his assumptions. However, some of his key assertions are no longer true in today's market.

Kennedy bases his conclusion on the following analysis:

“Why would workers not be just as happy to migrate from drug production to legal enterprise if given the opportunity? The answer is that they would, but that the dynamics of the drug market frustrate the purpose of the capital-increasing policy. This is most readily seen by tracing the process by which Peru and Bolivia move from one economic equilibrium to another after the capital stock is increased. An increase in the capital stock means that there are now more factories and farms in Peru and Bolivia which can employ workers. As workers are hired away from the drug sector into these new enterprises, cocaine production will begin to fall. The fall in cocaine production will lead to an

increase in the world price of cocaine (the stated intermediate goal of drug supply strategies), which will increase the profitability of cocaine production at the original wage rate. Given this increased profitability, those who manage cocaine product production and trade (“cocaine traffickers”) will have a pure economic incentive to increase their wage offer for workers to come back to cocaine product production” (M. Kennedy 25).

Furthermore, he uses these ideas to address directly some of his concerns with crop substitution. He argues, “the crucial problem here is that the any crop substitution strategy essentially puts the legal economy in competition with the cocaine traffickers for the services of the labor force” (M. Kennedy 26). Kennedy contends that in the short run, if capital is added to the legal agriculture market, workers will be drawn out of coca production because the wages will increase in the legal sectors due to higher productivity. However, he states that drug traffickers will be able to match these higher wages. Furthermore, because of the relative inelasticity of demand of cocaine in the United States, the traffickers will be able to pass these costs onto consumers (M. Kennedy 26).

Kennedy’s model hinges on two postulations. The first is that there is a “relatively inelastic world demand for cocaine” (M. Kennedy 27). The other is that the drug traffickers have the power to raise the wages of the workers and have large control over the market. I contend that these two assumption may have been correct at the time the study was conducted; however are not as solid today, because the study, while published in 1994, uses 1989 data.

Studies have shown the elasticity of demand for cocaine is more elastic than was originally expected in previous decades. In addition, recent econometric studies have been conducted to see if the data supports rational choice theory that the National Drug Control Strategy report advocates. In "The Demand for Cocaine by Young Adults: A Rational Addiction Approach," Brown, Grossman, and Chaloupka use Becker's rational

addiction approach to argue that the elasticity of demand for cocaine is higher than expected. They argue, "the conventional wisdom that the demand for addictive substances is not sensitive to price also is contradicted by Becker and Murphy's (1988) theoretical model of addictive behavior which assumes that addicts behave rationally" (Brown 1).

They find evidence to support Becker's theory in that "the positive and significant future consumption effect is consistent with the hypothesis of rational addiction and inconsistent with the hypothesis of myopic addiction. The long-run price elasticity of -1.18 is substantial and approximately 70 percent larger than the short-run price elasticity" (Brown 3). Ultimately, they

"find that cocaine consumption is quite sensitive to its price. A permanent 10 percent reduction in price would cause the number of cocaine users to grow by slightly more than 8 percent in the long run and would increase the frequency of use among users by a little more than 3 percent. Total or unconditional frequency would rise by almost 12 percent in a fixed population in the long run and by almost 7 percent in the short run" (Brown 33).

They also argue that if the war on drugs and price hikes for drugs are perceived by users to be permanent, it will increase the responsiveness to a 10 percent price hike for one year from a reduction in "total cocaine consumption by approximately 4 percent, whereas a permanent 10 percent price hike would lower consumption by 12 percent" (Brown 34). If demand for cocaine is more elastic, drug traffickers will have a slightly harder time passing off the increased costs than Kennedy originally estimated.

The large amount of credit given to intermediaries in being able to raise the wages of the workers was applicable at the time the paper was written due to the fact that it was conducted in 1994. This fact is highly significant because in the early 1990s, Sendero Luminoso was at the height of their power. At the time the study was conducted,

Sendero Luminoso was able to control the Upper Huallaga Valley where most of the coca was produced and was able to apply this pressure as Kennedy suggests.

“In its eagerness to regain the leverage lost in 1989, Sendero began to put pressure on local traffickers to pay better prices for the coca leaf in order to regain standing with the growers (Gonzales 137).”

However, due to their elimination under Fujimori’s regime, this is no longer the case.

Since their elimination from the area, coca production in Peru has fallen dramatically. In 1990, coca production was at 120,000 hectares in Peru. In 2001, the total hectares had decreased to only 40,000 (DEA).

Some advocates of coca production argue that coca production will persist because there are no easily substitutable products. Girona suggests that it is hard to develop an alternative because of the benefits of coca production. He lists the following reasons why coca is different from other agricultural goods:

1. No real economic alternative.
2. You can harvest it 3-4 times a year.
3. The cocaine prices are higher than other agricultural products.
4. Secure Market--The U.S. and Europe supply an everlasting source of demand.
5. High Market Value
6. Long duration of the plant--Crop can grow in the same spot for 30-50 years without affecting the yield.
7. Does not require a lot of labor
8. Resistant to plagues
9. Prolonged conservation does not lose quality over time
10. Easy to transport--High Value to Weight Ratio
11. Market is stable. Price does not fluctuate drastically over time.
12. Innumerable medicinal applications.
13. Adaptable to adverse conditions
14. There are no real substitutes” (Translated from Girona 290-292)<sup>5</sup>

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<sup>5</sup> Original Text: “1)No existe alternativa economica real para la coca. 2)De tres a cuatro cosechas al año. 3)Los precios de la coca superan a todos. 4)Mercado asegurado. 5)Alta Rentabilidad. 6)Larga duracion de la planta. 7)La coca no requiere tanto laboreo. 8)Resistente a las plagas. 9)Prolongada conservacion. 10)Facil transporte. 11)No esta sometida a fluctuaciones bruscas. 12)Innumerables aplicaciones medicinales. 13)Adaptable a dondicones adversas. 14)No pueden ser sustituidos. (Girona 290-292)”

These problems should not be perceived as insurmountable as some of them can be changed with the development of feasible economic alternatives.

Some limitations to crop substitution exist. However, it is still a viable option if the cost-benefit structures are changed. Furthermore, conditions have changed in Peru, such as the elimination of Sendero Luminoso, which makes the market work more efficiently. Therefore, while there are some obstacles to crop substitution, it should not make crop substitution an impossible task.

### B. The Case for Crop Substitution

Alternative development schemes including crop substitution have many admirable attributes in comparison to the current United States' emphasis on crop eradication policies and military aid. Crop substitution policies make those involved better off because they are responding to natural incentives in the market. Hence, the situation becomes more efficient. The farmers are better off because they would not be subjected to aerial fumigation policies, which have deleterious effects on not only coca farmers and crops but also legal agricultural workers and their crops. The government would be better off because it could increase its tax revenue from the increase in legal agricultural products. The United States would be better off because of gains from trade from Andean exports and a reduction in the supply of coca. Hence, crop substitution would improve upon the current status quo by increasing efficiency.

Therefore, it is also important to look at the factors that make crop substitution the most feasible.

Crop substitution should be promoted more than the current system of aerial eradication, which is currently coming under attack for adverse side effects on indigenous

farmers. It should be noted “in Peru and Bolivia, where some coca cultivation is legal and recognized as having significant religious and cultural roles, herbicidal eradication is banned” (Coffin 1). In addition, “at least for now, U.S. plans to use fungal mycoherbicides against drug plants have been discarded on the grounds that their deployment would be generally perceived as biological or biochemical warfare” (Bigwood 1). However, in Colombia a pesticide called RoundupUltra is used. It has also been suspected that “Spike, which according to its worried US manufacturers, Eli Lilly and Co., ‘could cause irreversible damage to the flora and fauna and even affect human beings if it is not applied with painstaking precautions,’” has been used in some areas (Strong 128).

Many different nongovernmental organizations have explored the aerial crop eradication programs. While there has been no conclusive evidence because a lack on information given to the public, the implications for the program do not look promising. The Center for International Policy at the Robert F. Kennedy Memorial Center for Human Rights concludes:

"Although it has been impossible to definitively confirm the chemical mixture that is being sprayed, the information we have indicates that the usage does not comply with EPA regulatory controls. Toxicity studies of the human and ecological impact of the formulated mixture under the exposure conditions experienced in Colombia have not been presented. No baseline data exists in Colombia to evaluate the impact of the fumigation on health or the environment. No epidemiological studies to track the impact over time are underway or planned. The fumigation has been conducted without regard to legal requirements and raises serious constitutional questions. No compensation has been provided to small producers whose legal crops have been destroyed by the fumigation. No mechanism exists to evaluate claims of damage to human health. No link exists between fumigation and the design or implementation of alternative development programs" (Stanton 1).

Therefore, while there are no empirical studies in order to ascertain the effects of aerial crop eradication programs, there is plenty of anecdotal evidence to suggest this is the case.

The news media has given several reports of the dangers of aerial crop eradication programs. An article in the May 18, 2002 edition of the San Francisco Chronicle gives the following account concerning the herbicide, RoundupUltra, which is sprayed and financed by Plan Colombia:

"About 10,000 Ecuadorians have been affected by the aerial spraying, according to the environmental group Ecological Action, based in Quito, Ecuador's capital....All Ecuadorians living within three miles of Colombia and 89 percent residing within six miles of the border have reported symptoms of herbicide poisoning such as respiratory problems, headaches, skin rashes and intestinal bleeding, according to Adolfo Maldonado, a Spanish doctor who helped prepare the study by Ecological Action. Farmers also say the spraying has killed their coffee, yucca and mango crops and polluted local water supplies" (Erlich 2).

Ecological Action is not the only environmental NGO to look into this problem. In an article for americas.org, Luciane Eusani and Alan Grostephan label the crop eradication pesticide as "poison rain." They give the story of farmer, Ismael Cuaran Perenguez:

"Ismael Cuaran Perenguez cries in frustration about the dead peanut plants across his seven acres in southern Colombia. He's among 35,000 farmers in Putumayo Province who agreed to eradicate their illegal crops in exchange for government aid. He replaced coca with black pepper and peanuts. But little of the aid has come, and a U.S.-backed fumigation program doused his land November 24, 2001, killing the food crops. He filed complaints with the Colombia government and the U.S. Embassy, but got no help" (Luciane 1).

Therefore, these are just two of several independent account which link the aerial crop eradication programs with damaging both legal and illegal plants and hurting the health of the farmers.

The United States supply of military aid has also caused numerous problems in the region. For example,

“U.S.-funded proxy forces include the UMOPAR in Bolivia, CORAH in Peru, and the National Police and army antinarcotics in Colombia. Their members are better equipped, paid, and insured than the national armed forces, causing jealousies and discontent among less privileged units. A 1996 Human Rights Watch study documented UMOPAR violations in the Chapare region of Bolivia, including misuse of firearms, arbitrary and unlawful arrests, careless use of tear gas, and slipshod investigations into civilian deaths and injuries, a trend that continues today, according to press reports. By setting minimum standards for coca destruction, the U.S. has pressured the Bolivian government to ignore human rights and due process concerns to achieve eradication goals” (Bigwood 3).

In addition, there are several accounts of the Peruvian and Colombian military abusing their own people.

Given the evidence that crop substitution is a preferable alternative, a look into how it can become a viable option must be proposed. Through a survey of research and literature, certain factors have emerged that seem to encourage crop substitution as an effective alternative. These factors include having risk-averse farmers, establishing a strong, dependable currency, reducing of high initial setup costs, having a weaker cultural connection to coca, increasing hope for a brighter future, replacing the FARC and Sendero Luminoso with sound governmental organizations and regulation, presenting economic alternatives outside of agriculture, expanding monitoring agencies, and creating a strong export market.

Individual farmers in Peru and Colombia seem to be willing to go along with crop substitution in some cases. For example,

“The Upper Huallaga Agrarian Cooperative had been founded in December 1988 by Maria Escudero, an ex-policeman and the son of settlers who had spent two years organizing coca growers; by Justo Silva, the principal of one of the two local schools; and by half a dozen coca growers who filled the cooperative’s other administrative positions. Fed up with police abuse and corruption, the risks of coca cultivation, and Sendero’s political agenda, forty-two of the one-hundred-odd coca-producing communities of the UHV that formed part of the organization

presented the possibilities of crop substitution as the best way out of the coca problem in their valley (Gonzales 133).”

In addition, prices have been able to reach a stage where crop substitution could become a reality.

“DEA-Peruvian police forces approach joined massive efforts by the Colombian government against their own drug lords after the August 1989 assassination of leading presidential candidate Luis Carlos Galan to reduce substantially drug flights from the UHV to Colombia. The result was a large coca production surplus in the valley and a dramatic drop in price, from two dollars to thirty cents per kilo of coca leaf between mid-1989 and mid-1990, a fall to well below the cost of production. For the first time it became realistic to consider crop substitution seriously (Gonzales 136).”

Hence, the ever-changing economic conditions may make crop substitution a reality.

Crop substitution is already part of several alternative development plans.

However, its full potential is not being realized. The United States could do more to eliminate the barriers to crop substitution and promote a more effective alternative development policy.

### C. Using a General Equilibrium Model to Assess the Viability of Crop Substitution in Peru

The United States’ government is currently advocating crop substitution policies through a variety of initiatives such as Bolivia's Dignity Plan, Plan Colombia, and the Andean Counterdrug initiative. Currently, the United States’ government is asking for \$731 million for the Andean Counterdrug Initiative and Plan Colombia. The government spent \$10.9 million in 2002 for Plan Colombia (Bush). Furthermore, they have encouraged a stronger Andean export market upon the passage of the Andean Trade and Preference Act. It has been shown that crop substitution can be beneficial and is a viable option under certain conditions. However, the United States could do more to ensure the

success of crop substitution. For example, the United States' government is undercutting the viability of these programs by promoting U.S. agricultural subsidies. Since agricultural subsidies artificially depress the world price of the subsidized good when the goods are produced in a large open market economy such as the United States, those agricultural substitutes that are produced by less developing countries such as those in the Andean region have their ability to compete in a strong, agricultural world market weakened.

In order to try to determine the exact impact of the United States' agricultural subsidies on the viability of crop substitution, I have constructed a simplified general equilibrium model of the Peruvian economy. The same analysis could also be done for the Colombian economy. However, the focus on Peru is more conducive to general equilibrium analysis because of the elimination of Sendero Luminoso. "Since the threat of guerilla violence is now marginal, Peru has transformed itself from one of the riskiest countries in Latin America in which to do business some ten years ago into one of the safest" (EIU 13). Consequently, market forces will work more easily in the Peruvian economy than the Colombian economy. The model consists of three sectors: manufacturing, agriculture, and coca. The model shows what will happen to the different sectors when different exogenous variables change, e.g. the world price of agriculture is artificially depressed.

To construct the model, I used several different pieces of economic theory, such as the production function, factor price equalization, law of one price, and factor proportions theory. By using this theory, I generated a series of equations that included both exogenous and endogenous variables. The endogenous variables are: manufacturing

output, agricultural output, coca output, labor supply allocated to manufacturing, labor supply allocated to agriculture, labor supply allocated to coca, money supply, wage rate for manufacturing, wage rate for agriculture and coca production, rental rate of capital, rental rate of coca land, rental rate of agricultural land, price of manufacturing, price of agriculture, and price of coca. The exogenous variables are labor supply assuming full employment, capital supply, land for agriculture, land for coca production, a manufacturing tariff, demand for coca in the United States, world price of agriculture, and the world price of coca. Upon transforming the variables of the different equations into percent change form and applying matrix algebra, the computable general equilibrium model that was generated shows the effects on endogenous variables of changing different exogenous variables in the Peruvian economy<sup>6</sup>.

Before the results are illustrated and interpreted, two major assumptions need to be addressed that support this theory: the substitutability of agricultural products between the OECD (Organization for Economic Cooperation and Development) countries and less developing countries such as Peru and Colombia and the precise effect of these subsidies on the world price of the goods.

Economic theory suggests that the assumption that the agricultural goods between OECD countries and less developing countries must be at least somewhat substitutable is fairly important. For crop substitution to take place, Peruvian farmers switch towards producing the crops with the relatively higher prices. If the United States subsidized crops that the Peruvian market did not produce, then the change in the world price would have no effect on the viability of crop substitution in the Andes. On the other hand, the more substitutable the crops are; the greater the effect of United States' subsidies on the

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<sup>6</sup> See Tables D, E, F

viability of crop substitution is. For this model, it appears that Peruvian and United States' agricultural products are somewhat substitutable.

The basis for whether or not the countries have substitutable products comes from what the main agricultural products for the country are. According to the 2002 CIA World Factbook, the United States produces the following agricultural products: “wheat, other grains, corn, fruits, vegetables, cotton; beef, pork, poultry, dairy products; forest products; [and] fish.” It also lists agricultural products as one of the main exports.

For each of the Andean countries that produces coca, overlap exists between what is produced in the United States and what is produced in the Andean range. (For clarity, the overlapping products are italicized.) For the Republic of Bolivia, the following agricultural products are produced: “soybeans, coffee, coca, *cotton*, *corn*, sugarcane, rice potatoes; timber.” Soybeans are a main export. For Colombia, the following agricultural products are listed: “coffee, cut flowers, bananas, rice, tobacco, *corn*, sugarcane, cocoa beans, oilseed, vegetables; *forest products*; shrimp.” Once again, agricultural products are listed as an export. For Peru, the following agricultural products are listed: “coffee, *cotton*, sugarcane, rice, *wheat*, potatoes, *corn*, plantains, coca; *poultry*, *beef*, *dairy products*, wool; *fish*.” Once again, Peru exports commodities such as coffee, sugar, and cotton. Therefore, since the countries produce similar agricultural products, substitutability can occur in the world market. The substitutability could be even greater if fruits and vegetables were defined more specifically by the United States. Therefore, it seems that the assumption that the products are substitutable holds.

The other key assumption is how agricultural subsidies affect the world price of agricultural goods that are substitutes between OECD countries and the Andean

countries. The OECD recently did an analysis of this assumption. In 2001, the OECD conducted a study called *Market Effects of Crop Support Measures: Agriculture and Food*, to calculate how “the effects of support given to producers in one country or region spill over to other countries or regions through trade and world market prices” (OECD 8).

It was found that

“in 1998, market price support accounted for less than half the total PSE [Price Support Expenditure] for crops in the study countries. However, reducing market price support by 10% led to a greater simulated decrease in subsidized crop production and a greater simulated increase in world market prices than the 10% reduction in all other categories of support” (OECD 8).

One of the most interesting findings of the study was that “those support measures causing the greatest distortion to production and trade (per dollar transferred to farmers from consumers and taxpayers) are those least efficient in providing income benefits to farm households and vice versa” (OECD 9).

After analyzing different forms of price support systems in each OECD country, the study shows exactly how each agricultural market would be affected if the rate of support was reduced. Specifically, the OECD simulates the world market price impacts of support reductions. The graph below, which is replicated from the OECD study, illustrates what would occur if there is a ten percent reduction in the rates of all crop support measures:

	<i>Simulated Percent Change in World Market Price of:</i>				
<i>Due to 10% reduction in the rates of</i>	<u>Wheat</u>	<u>Coarse Grains</u>	<u>Oilseeds</u>	<u>Rice</u>	<u>Index</u>
Market price support	1.1%	1.0%	0.3%	1.4%	1.1%
Payments based on output	0.3%	0.4%	0.2%	0.1%	0.2%
Payments based on area planted	0.3%	0.2%	0.1%	0.1%	0.1%
Payments based on historical entitlements	0.2%	0.2%	0.1%	0.1%	0.1%
Payments based on input use	1.1%	0.8%	0.6%	0.3%	0.6%
All categories simultaneously	3.0%	2.5%	1.3%	1.9%	2.2%

(OECD 28)

Since wheat and coarse grains have been established to be substitutable with Andean products, it is shown that market support measures have a direct impact on the price at

which Andean producers trade their goods. Consequently, the assumption that United States' agricultural subsidies affect the world price of certain goods holds.

After establishing that the key assumptions hold, the following equations and variables were used to generate a computable general equilibrium model:

Endogenous Variables		Exogenous Variables	
<u>Symbol</u>	<u>Variable</u>	<u>Symbol</u>	<u>Variable</u>
$\hat{M}$	Manufacturing Output	$\hat{K}$	Capital Supply
$\hat{A}$	Agricultural Output	$\hat{L}$	Labor Supply
$\hat{D}$	Coca Output	$\hat{N}_A$	Land for Agriculture
$\hat{L}_A$	Labor Supply for Agriculture	$\hat{N}_D$	Land for Coca Cultivation
$\hat{L}_M$	Labor Supply for Manufacturing	$\hat{P}_A$	World Price of Agriculture
$\hat{L}_D$	Labor Supply for Coca Cultivation	$\hat{P}_M$	World Price of Manufacturing
$\hat{w}_M$	Wage for Manufacturing workers	$\hat{Q}$	Demand for Coca
$\hat{w}_{AD}$	Wage for Agricultural and Coca workers	$\hat{t}$	Tariff on Manufacturing
$\hat{P}_M$	Price of Manufacturing		
$\hat{P}_A$	Price of Agriculture		
$\hat{P}_D$	Price of Coca		
$\hat{r}$	Rental Rate of Capital		
$\hat{n}_D$	Rental Rate of Coca Land		
$\hat{n}_A$	Rental Rate of Agricultural Land		
$\hat{H}$	Money Supply		

\*\*\*The carat on top of the variable symbolizes that the variable is in percentage change form. For example, M represents manufacturing output while  $\hat{M}$  represents the percentage change in manufacturing output.

The following equations were used to build the model:

	Equation
1	$\hat{M} = \theta_{KM} \hat{K} + \theta_{LM} \hat{L}_M$
2	$\hat{A} = \theta_{NA} \hat{N}_A + \theta_{LA} \hat{L}_A$
3	$\hat{D} = \theta_{ND} \hat{N}_D + \theta_{LD} \hat{L}_D$
4	$\hat{L} = \lambda_A \hat{L}_A + \lambda_M \hat{L}_M + \lambda_D \hat{L}_D$
5	$\hat{P}_M = \theta_{LM} \hat{w}_M + \theta_{KM} \hat{r}$
6	$\hat{P}_A = \theta_{LA} \hat{w}_{AD} + \theta_{NA} \hat{N}_A$
7	$\hat{P}_D = \theta_{LD} \hat{w}_{AD} + \theta_{ND} \hat{N}_D$
8	$\hat{P}_M = \hat{P}_M^* + \hat{t}$
9	$\hat{P}_A = \hat{P}_A^*$
10	$\hat{P}_D = -\delta \hat{Q}$
11	$\hat{w}_{AD} + \hat{L}_A = \hat{n}_A + \hat{N}_A$
12	$\hat{w}_{AD} + \hat{L}_D = \hat{n}_D + \hat{N}_D$
13	$\hat{w}_M + \hat{L}_M = \hat{r} + \hat{K}$
14	$\hat{L}_M = s[\hat{w}_M - \hat{w}_A]$
15	$\hat{H} = \phi_A \hat{A} + \phi_M \hat{M} + \phi_D \hat{D} + \phi_A \hat{P}_A + \phi_M \hat{P}_M + \phi_D \hat{P}_D$

Equations 1-3 represent production functions. Equation 4 represents the labor supply at full employment. Equations 5-7 represent the long run, zero economic profit condition. Equations 8-10 represent the law of one price. Equations 11-13 represent the factor proportion equations assuming a Cobb-Douglas production function and a constant elasticity of substitution between the two factors of production of 1. Equation 14 represents imperfect labor mobility between the manufacturing sector and all other sectors. Finally, the last equation represents the money supply. All of the mathematical and theoretical derivations of the formulas are in the appendix.

In order to establish the equilibrium model, certain additional assumptions were made. For example, for simplicity, I assumed that there were only three sectors in the

economy and that there was full employment. While the service and mining sectors are excluded, having three sectors is adequate because the relationship of interest is between coca production and agriculture. While service and mining are important sectors in the Peruvian economy, mining functions similarly to manufacturing in that it uses the same labor supply and is more capital intensive than agriculture and coca production. The service sector also requires a different skills set than agriculture or coca production because of the necessary Spanish knowledge. Furthermore, I made the assumption that there could not be overlap between the land used for drugs and the land used for agricultural purposes. This assumption was made in order to obtain an upward sloping demand curve.

For labor, restrictions to mobility were made in the model. Mobility of labor between the agricultural sector and the coca-producing sector was allowed. However, for mobility between the manufacturing sector and the other two sectors was not. The reason for these assumptions is that the agricultural and coca production sectors require many of the same skills sets while manufacturing requires a different skills set. Furthermore, a rich history of coca and agricultural production among indigenous farmers exists. Some of these farmers even produce both coca in addition to agricultural products for subsistence living. Therefore, there is some mobility between the agricultural and coca producing sectors in Peru. However, this mobility is limited in the movement between the rural sector and urban sector of manufacturing. In Peru, “technical education is woefully lacking” (EIU 17). Thus, many individuals are unable to move from sector to sector. Another reason is that manufacturing may require the use of Spanish as well. Some but not all agricultural

workers speak only the indigenous languages of Quechua or Aymara. Therefore, transferring to the manufacturing sector if Spanish is required may not be achievable.

After applying matrix algebra to the system of equations, the results were compiled into the following table. On the top row of the table is the list of exogenous variables used in the model. The column to the left indicates the list of endogenous variables.

	$\hat{L}$	$\hat{K}$	$\hat{N}_A$	$\hat{N}_D$	$\hat{P}_M$	$\hat{P}_A$	$\hat{Q}$	$\hat{t}$
$\hat{M}$	0.14869	0.41966	-0.0432	-0.04316539	0.25899236	-0.12949618	0.0001295	0.25899236
$\hat{A}$	1.04085	-0.0624	0.69784	-0.30215775	-0.1870535	1.09352675	0.00090647	-0.1870535
$\hat{D}$	1.04085	-0.0624	-0.3022	0.69784225	-0.1870535	-0.90647325	-0.00109353	-0.1870535
$\hat{L}_A$	1.56127	-0.0935	0.54676	-0.45323662	-0.28058026	1.64029013	0.00135971	-0.28058026
$\hat{L}_M$	0.22304	0.1295	-0.0647	-0.06474809	0.38848853	-0.19424427	0.00019424	0.38848853
$\hat{L}_D$	1.56127	-0.0935	-0.4532	0.54676338	-0.28058026	-1.35970987	-0.00164029	-0.28058026
$\hat{w}_M$	-0.0743	0.29017	0.02158	0.0215827	0.87050382	0.06474809	-6.4748E-05	0.87050382
$\hat{w}_{AD}$	-0.5204	0.03118	0.15108	0.15107887	0.09352675	0.45323662	-0.00045324	0.09352675
$\hat{n}_A$	1.04085	-0.0624	-0.3022	-0.30215775	-0.1870535	2.09352675	0.00090647	-0.1870535
$\hat{n}_D$	1.04085	-0.0624	-0.3022	-0.30215775	-0.1870535	-0.90647325	-0.00209353	-0.1870535
$\hat{r}$	0.14869	-0.5803	-0.0432	-0.04316539	1.25899236	-0.12949618	0.0001295	1.25899236
$\hat{P}_M$	0	0	0	0	0	0	-0.001	0
$\hat{P}_A$	0	0	0	0	0	1	0	1
$\hat{P}_D$	0	0	0	0	0	0	1	0
$\hat{H}$	0.52786	0.21481	-0.0282	0.14676286	0.64442287	-0.08471143	-0.00044029	0.64442287

These results indicate how changes in exogenous variables affect endogenous variables. The table can be read as follows: a one percent change in the exogenous variable leads to specified change in the endogenous variable, where the specified percent change is given by the value in the matrix. In order to obtain these numbers, I also had to

make certain assumptions about the Peruvian economy. Because the model was simplified and the service sector was excluded, I had to estimate some of the numbers. I based my estimates on figures used by the World Development Report. For the labor supply, I assumed that 29.03% work in both agriculture and coca cultivation while 41.933% work in manufacturing. I also assumed for the production functions that one-third of the resources dedicated to a sector are consumed by the fixed factor while the remaining two-thirds are dedicated to the more mobile factor. For example, in manufacturing, I assumed that one-third of resources dedicated to manufacturing come from capital while two-thirds go to labor. This once again is a simplifying assumption. I also used these numbers to calculate the coefficients for the money supply equation as follows:  $\Phi-A = 1/8$ ,  $\Phi-M = 23/40$ , and  $\Phi-D = 2/7$ . The reciprocal of the coefficient of the demand equation was assumed to be really small at  $-.001$ , which comes from the fact that the elasticity for Peruvian coca is extremely large because Colombian coca is such an attainable substitute. Finally, I assumed a mobility coefficient between sectors of  $.5$ .

While these coefficients are simplified, they are still useful because they give us an estimate of what the change in certain endogenous variables will be. Furthermore, even if the numbers changed slightly, the signs would not change. Hence, the model gives an overall picture of where different variables are headed. If perfect information concerning the number of people working in the drug sector was obtained and information concerning the proportion of fixed factors and mobile factors to different sectors of the market, then the numbers would work out more concretely. However, even with simplifying assumptions there is still a lot to be gleaned from the model.

The particular endogenous variables of interest are coca and agricultural output. Another variable to look at is how wages in this industry fluctuate. The goal for crop substitution is for coca output to decrease, while agricultural output increases. Changes in land dedicated to agriculture, the price of agriculture, and demand for drugs, all lead to this price changing mechanism. Furthermore, if the wage in agriculture increases relative to all other wages, individuals will move into agricultural sector.

The model shows that agricultural output is influenced by a number of exogenous variables. One way of encouraging crop substitution is by increasing the price of agriculture. When the world price of agriculture increases by one percent, agricultural output goes up by 1.09% while coca production decreases by .906%. These numbers are extremely significant in context. As the OECD simulation above suggests, if agricultural supports are reduced by 10%, the world price of wheat will rise 3.0%. Since wheat is one of Peru's main exports, this would cause wheat production in Peru to rise by 3.27% while coca production falls by 2.718%. Meanwhile, Drug Enforcement Agency reports suggest that total coca production in 2000 was 40,200 metric tons<sup>7</sup>. Hence, if one were to reduce this number by 2.718%, 1092.636 metric tons of coca would be eliminated. For the entire Andean region, 245,653 metric tons of coca was produced. Thus, if the model were generalized to the entire region, an elimination of 6676.84854 metric tons of coca would result.

Another scenario may be to adjust the manufacturing tariff by one percent. When the price of manufacturing or the tariff on manufacturing increases by one percent, coca and agricultural output both go down by .187%. Another factor that could be adjusted in the policy is the amount of land dedicated to agricultural production. If this land goes up

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<sup>7</sup> See Appendix for the amount of coca leaves cultivated and the amount seized

by one percent, then the amount of agricultural output goes up by .697842% while coca output decreases by .30216%. Furthermore, if this occurs, the wage rate for both the agricultural and drug sector increases by .151079%. If enforcement was strengthened so that the opportunity cost of producing drugs increases, then the wage would not be exactly equal. Hence, more individuals will want to switch into the agricultural sector.

This model shows that crop substitution is a viable alternative. It also demonstrates, however, that the United States is undercutting its crop substitution efforts by subsidizing products that are substitutes with those agricultural exports of the Andean countries. Hence, one way to encourage crop substitution in the Andes may be to cut agricultural subsidies in OECD countries.

#### VIII. Recommendations and Conclusion

Despite a multifaceted approach and billions of dollars spent, cocaine use in the United States is still extremely high. “For the United States the impact of illegal drugs is devastating, not only in terms of human misery and lives lost, but also the billions it costs to combat this illegal trade; house the prison population of drug offenders; to provide health care to drug users; and sustain the loss of productivity in the economy. One estimate puts the dollar cost at \$100 billion a year. This is a staggering amount, even in an \$8 trillion economy” (Frechette 1). Consequently, the status quo must be improved upon when considering supply side issues in the Andean region.

The United States must realize the potential of crop substitution in its efforts in the War on Drugs. It cannot spray the livelihoods of licit and illicit farmers and offer them no solution except military action. The policy can be improved by the following recommendations of eliminating crop eradication programs, eliminating the FARC and

resurgence of Sendero Luminoso, supporting crop substitution policies, creating a strong export market, allowing coca products to be highly regulated while increasing monitoring and enforcement, and encouraging overall economic development. These following recommendations are made after taking into consideration the history of the coca industry and the stakeholders involved in this process. Furthermore, it utilizes the general equilibrium analysis, which shows that crop substitution is in fact a workable solution. By implementing these solutions, the United States' government will be able to reach a more efficient outcome in regards to the supply side for all parties involved, with the exception of the terrorist organizations, provided that there is support from the major stakeholders involved.

“A United States diplomat is quoted in a 1975 *New York Times* article as saying, ‘These countries don’t have a drug problem themselves. There’s no mutual interest to work with us’ “ (Bakalar 54). The United States is fortunate that that attitude is no longer the case. The United States is employing many of the same techniques in its War on Drugs since the Nixon era when the war was started. Hence, it is essential to refresh United States’ policy from the supply side in fighting cocaine production. This is why the aforementioned recommendations need to come into place.

A revised U.S. policy needs to be formed. The past policy focused too much on military aid and not enough on economic development. In regard to military aid the following has been given:

“Under what was the first substantial US military aid package to Peru since the late 1960s, when the Velasco regime swung the country’s political axis towards the Soviet Union, the Peruvian security forces were to receive training, arms and ammunition, uniforms and medical supplies to the tune of 20.5 million [British pounds]. The agreement stated, ‘In order to effectively support the attack on the narcotics threat and defend the sovereignty of Peru, the capabilities of the

Peruvian Armed Forces must be enhanced and training intensified. The Peruvian Armed Forces must be able to assure and reinforce civilian government control over the most important coca growing and trans-shipment areas, provide protection to police forces on counter-narcotics operations from guerrilla insurgents, and develop the capability to strike at drug trafficking organizations” (Strong 132).

On the other hand, the following has been given in economic aid:

“Economic aid work about 35.5 million [British pounds] was aimed at stimulating crop substitution and development by assisting the liberalization of the economy and repairing of roads...Although in the mid 1991 there were signs that the coca growers were beginning to organize themselves better and even to trust the government’s promises, anger and disillusionment set in as the aid failed to materialized” (Strong 132).

While more economic aid was promised than military aid, numerous accounts exist that this aid did not actually coming. Hence, the United States must follow through with its commitment to economic aid. In addition, by eliminating military aid, the United States would have more money to spend on economic aid.

In regards to Colombia, the United States has supported Plan Colombia, which is an extensive program to combat drug exportation from Colombia and to help stabilize Colombia within its borders. “The strategic theory behind Plan Colombia is very simple: economic development, security, and peace are directly linked...Contrary to the opinion of many nongovernmental organizations and the media, Plan Colombia is not a military strategy. The military component is one of 10 elements of a grand strategy designed to remake the nation into a secure democracy free from violence and corruption” (Marcella 2). While the military component is only one element, it should to be de-emphasized while economic development is showcased in its place.

In order to reduce the coca supply in the Andean region successfully, crop eradication programs must be eliminated because they destroy legal crops, cause illness,

and cause an unnecessarily large amount of military action. This is especially true in Colombia where aerial eradication is allowed. As a result of these crop eradication policies, “hundreds of thousands of farmers in Andean countries march against eradication every year and demand economic alternatives. They also complain that herbicides are damaging food crops and causing medical problems” (Coffin 2).

Major problems can also arise with eradication programs, such as the excessive use of force against farmers when eradicating areas. In addition, they have been fairly unsuccessful in making a firm sustainable impact on the coca supply. Here is an example of some of the problems that may arise:

“But they [UMOPAR] failed to cut the air traffic: just two aircraft were captured despite Peru’s estimated 1600 drug flights a year. In 1991, despite the assistance of US radar AWACS planes and the intervention of Peruvian air force aircraft, efforts to throttle the drug flights proved little more effective. Meanwhile, the local population complained bitterly of abuses allegedly committed by both UMOPAR and the Americans helping them.

‘The DEA agents harass the peasantry,’ said the mayor of Uchiza, Demetrio Diaz, who was installed after the army restored civil government there under Arciniega. ‘They burn peasants’ coca as it dries, or hover above in helicopters to blow away the leaves, dropping tear-gas. Dynamite is dropped on people’s homes under the pretext that they are really cocaine laboratories’” (Strong 130)...[Furthermore], Guillermo Lopez, an alderman and reporter in Tingo Maria with strongly suspected sympathies for Shining Path, said, also in January 1989...“I have been told the DEA want to make me disappear because I defend the peasants against the corrupt CORAH workers.’ The previous year, his home had been dynamited. In April, he was tortured and shot dead in front of his family by either soldiers or police. His claims regarding the DEA can probably be dismissed. However, such claims---made at a time when the Americans had a conspicuous presence in Tingo Maria where they were still living what by local standards is the luxury hotel—materialize into potent local myths which Shining Path takes full advantage of: especially when events such as the death of Lopez might appear to bear them out. The DEA is hated with a vengeance” (Strong 133).

Hence, crop eradication programs make indigenous farmers suspicious of United States' involvement. Because of these suspicions and a lack of economic alternatives, peasants to run into the hands of the FARC and other such revolutionary groups for protection.

Crop eradication programs also increase the price of the coca plants that are not eradicated because of the scarcity of supply. These higher prices are counterproductive to United States' efforts to encourage crop substitution.

“Eradication programs are driven by the theory that decreasing coca production will make cocaine scarcer and more expensive and thereby decrease use. However, experience has proven this theory to be fallacious. First, when eradication programs succeed in reducing coca cultivation in one area, other farmers whose plantations survive eradication earn more for their coca, which in turn entices even more farmers to move into or expand coca cultivation” (Bigwood 1).

Because crop eradication programs contradict the effects of crop substitution and cause a large deal of anguish for the indigenous population, crop eradication programs need to be eliminated in favor of more humane and effective alternatives.

The next step to attacking the supply side successfully is to eliminate the FARC and other terrorist organizations in Colombia and keep Sendero Luminoso at bay. Newly elected President Uribe of Colombia is committed to eliminating the FARC and other terrorist groups. “His statements make clear that he considers guerrillas and paramilitaries alike as outlaws and, while remaining open to contacts, he insists that the Colombian state must maintain the upper hand in any talks with dissidents” (McLean 2). Furthermore, “Uribe confounded observers by, on the contrary, fully endorsing and backing the U.S.-financed antinarcotics campaign...Counter narcotics operations are now able to go forward at full speed with full Colombian government support” (McLean 3). Finally, Uribe ran on a good government campaign vowing to clean up corruption. In

addition, these foci have given him extremely high approval ratings. “The president’s popularity rankings have fallen but still hold at an impressive 66 percent after reaching a sky high 75 percent late year” (McLean 4). Because the FARC is identified as a terrorist organization by the United States’ State department and has committed numerous grievous human rights violations, the FARC must be brought to justice. However, due to the promising actions and policy of President Uribe, the United States should allow Colombia to take the lead.

Many Peruvian drug analysts predict that there is going to be a resurgence of Sendero Luminoso in the near future. Sendero Luminoso must not be allowed to reorganize itself because of the atrocious human rights violations that the group committed.

“Latin American human rights movements have emerged almost exclusively as responses to abuses by the state... The eruption of the Shining Path in 1980 and its conduct over the succeeding years broke the schemes that had previously shaped the human rights theme in Latin America. For the first time in the region, an insurgent force on the Left developed a systematic practice of violence against the civilian population that matched, and perhaps surpassed, state-sponsored violence. Shining Path’s profound disregard for human life, its contempt—in both theory and practice—for the discourse for human life, its contempt—in both theory and practice—for the discourse of human rights, and its refusal to ascribe to the norms and principles of International Humanitarian Law rendered it unique on the continent” (Iglesias 426).

In order to keep reorganization from occurring, economic alternatives must be presented.

Currently, the movement is gaining strength again, despite the fact that its leader,

Guzman, is still incarcerated.

“Given the lack of markets and transportation for the legal alternative crops, drug enforcement agents report that farmers are instead planting new coca plots elsewhere. In Peru, manual eradication has been increasingly hindered by the demonstrations of organized coca farmers in the Huallaga Valley, the lack of a viable replacement crop, the sheer vastness of the area where coca is grown, and the endemic corruption associated with the illicit drug trade and drug prohibition.

Thus, a renewed and less violent Shining Path rebel movement is slowly growing again in Peru, and the Chapare region of Bolivia may at any time erupt into insurgency” (Bigwood 3).

Therefore, Sendero Luminoso must be stopped in order for market mechanism to have full effect in Peru.

It is crucial to eliminate the FARC and Sendero Luminoso because it changes the incentive structure for coca farmers. It is no coincidence that the major increases in supply of cocaine in Colombia came at the time when the FARC had expanded its authority. Furthermore, the evidence shows that between the years of 1985 and 1993, cocaine production in Peru was at a high. This was precisely when Sendero Luminoso was in power. The reason for this is that these groups change the market incentive structure. Farmers have to face a choice of growing coca to comply with these terrorist organizations or facing sanctions by the government. Since these organizations result to deadly means that are carried out within their own towns and farmers witness them, farmers often chose to side with these organizations. If these organizations were eliminated, the incentives change. The farmer must either grow legal crops or face stiff penalties from the state. Now the penalties from the state become the less attractive option.

The United States must also realize the potential of crop substitution. While aid to encourage crop substitution has been pledged, there is evidence to suggest that the United States did not follow up on its promises to local farmers concerning aid. Furthermore, the general equilibrium model that was constructed in this paper shows how changes in exogenous variables, such as the world price of agriculture, can lead to crop

substitution, which lowers drug output and increases legal agricultural output. Crop substitution is also encouraged by increasing land for growing legal agriculture.

Analysts who have looked into crop substitution have provided caveats about its effectiveness that should be taken into consideration for current U.S. policy. For example, the GAO report and Kennedy's study for the RAND corporation both concluded that increases in capital will only lead to diversification and not complete crop substitution. Hence, the government must find ways only to increase the inputs of legal crops. This could be done by providing seeds or even developing fertilizers that promote growth in legal crops but would have an adverse effect on coca plants. Admittedly, this strategy would be hard to implement which is why monitoring is key. Once aid is given out, monitoring must be put into place to make sure that aid would be used in an efficient manner. After cutting crop eradication programs and exorbitant amounts of money for military aid, resources will be available to support economic development and monitoring agencies.

Creating a strong export market for Andean goods is also a key to success in the war on cocaine from the supply side. Legislation such as the Andean Trade Preference Act is a step in the right direction.

“President Bush recognized that U.S. counternarcotics efforts in Colombia had to increase and that the Colombian judicial system had to be strengthened. He signed the Andean Trade Preference Act (ATPA) to give duty free entry to the United States for a vast array of goods from Andean countries that were fighting narcotrafficking. This strengthened Colombia's economy and its ability to fight drugs. President Bush also provided 26 million dollars in assistance to reform the judicial system” (Frechette 2).

While the United States is pledging funding to strengthening Peru's judicial system and lowering tariffs, it must also take into account the effect of United States' agricultural

subsidies on products that are substitutable with Andean products. The United States will benefit from the gains of trade and increase overall welfare for American society. In addition, however, the United States cannot ignore the American farmers who are getting their subsidies cut.

A debate was discussed considering the merits of coca versus cocaine. Some farmers are going to produce coca regardless of what the United States' government does because of the strong cultural heritage connected to coca growth in the Andes. By following the above recommendations, the United States' government can hope to contain coca production, but not stop it entirely. Hence, a highly regulated market must be made for coca products such as coca tea. "Since trade in coca leaf and low-potency coca-based products poses no apparent threat to public health and safety, the U.S. should recognize legitimate coca production in Andean countries and permit limited international trade in low-potency coca-based products such as coca leaf tea and chewing gums" (Bigwood 4).

Coca can be legally grown in Peru and Bolivian, and 11 percent of farmers grown coca for traditional use. This is already part of current policy. Today, "coca leaves are grown for licit domestic and tiny international markets, including pharmaceutical cocaine and flavor extracts used in Coca-Cola and a handful of other products" (Bigwood 3). As shown in the debate discussion, USAID and United Nations' organizations respect Andean cultural heritage. Therefore, the current limited production policy should be continued but be highly regulated by the state.

State regulation for illicit crops has had precedent. For example, Turkey had prohibited opium growth due to United States' insistence. However, eventually, this

prohibition led to an increase in organized crime. Therefore, the Turkish government successfully switched back into making opium a highly regulated industry.

“By the late 1960s, for instance, Turkey had successfully reduced the number of regions allowed to legally grow opium poppy from 27 to four centralized provinces that were more accessible to authorities. Then, at President Nixon’s urging, opium cultivation was banned outright in 1972. Turkish authorities complained that they were losing tax revenue from legal opium sales and that they could not enforce the ban or effectively implement crop substitution plans. Farmers reported economic troubles, and illicit opium cultivation spread to other provinces and other countries. Turkey later rescinded the ban in favor of a system requiring farmers to be licensed and to produce poppies for the state.

One factor in the eventual success of the Turkish poppy scheme was the peer pressure imposed on individual growers to eschew growing illicit opium in order to preserve the legal market upon which the community relied” (Bigwood 4).

Hence, it may be possible to monitor coca successfully.

There would be assorted benefits to concentrating coca production into certain sectors. First, currently, in areas of Peru where coca is grown legally, “farmers often remain on one plot of land for decades” (Bigwood 3). This would allow monitoring to take place more easily. Furthermore, by allowing limited legal production, it would keep Sendero Luminoso from regaining a stronghold in the area. There have been well-documented links between prohibition and organized crime. Hence, allowing some production may tamper with Sendero’s efforts to act as an efficient organized crime unit.

The adoption of coca products must be done, however, simultaneously with increases in monitoring and enforcement. This is critical to changing the incentive structure for cocaine. In Peru, during the time of Sendero Luminoso, coca farmers had two choices. They could either comply with Sendero Luminoso and produce their quota of coca risking government sanctions or be killed. Hence, many people continued to grow coca. However, if the FARC and Sendero Luminoso were eliminated and farmers

had good economic alternatives through crop substitution, the incentive structure changes. Instead of facing death by the hands of the FARC or the Shining Path, the farmer now faces getting caught by the government and being imprisoned or farming legal agricultural products. Now, the incentive structure advocates producing legal goods.

Finally, overall economic development would help the Andean region and encourage crop substitution to take place. Both Peru and Colombia have had massive problems with corruption that need to be stopped. In addition, inflation needs to be stabilized and foreign investment needs to be encouraged. Peru has made some steps in this direction especially during the Fujimori administration. If Toledo can regain some of his power, pro-market policies could dominate his administration as well. In Colombia, Uribe needs to continue his get-tough approach to crime to decrease the risk level of investors and stabilize the currency. Strong economic development plans promises to have a promising effect in offering economic alternatives to coca production.

Dramatically reducing the supply of coca will not eliminate the U.S. drug problem entirely. However, it certainly will help. Many different analysts of supply side drug issues recognize the role of demand: “it is not enough to reduce the drug supply or to interdict it in transit. The United States also must reduce consumption further” (Frechette 3). Therefore, the United States must continue to press hard not only on the supply side of the market but also on its demand side. Hopefully, with a combination of these efforts, the cocaine consumed in the United States can steadily decrease.

## Works Cited

- Anonymous. "Peru." Overhaul and Maintenance. Washington, 2002.
- Bakalar, James and Lester Grinspoon. Cocaine: A Drug and Its Social Evolution. New York: Basic Books, 1976.
- Bigwood, Jeremy and Phillip Coffin. "Coca Eradication." Foreign Policy In Focus. 6.7 (2001). CIAO. Duke University Libraries, Durham. 3 April 2003.  
<http://www.ciaonet.org>
- Brown, Charles, Frank Chaloupka, and Michael Grossman. "The Demand for Cocaine by Young Adults: A Rational Addiction Approach." NBER Working Paper Series. Working Paper 5713. August 1996.
- Bush, George W. National Drug Control Strategy 2002. (2002).  
[http://www.whitehousedrugpolicy.gov/publications/policy/03ndcs/pages1\\_30.pdf](http://www.whitehousedrugpolicy.gov/publications/policy/03ndcs/pages1_30.pdf)
- Casteel, Steve. "The Drug Trade in Colombia: A Threat Assessment." Drug Enforcement Agency Intelligence Division. (2002)  
<http://www.dea.gov/pubs/intel/020006/index.html>
- Central Intelligence Agency. The World Factbook 2002. (2002)  
<http://www.cia.gov/cia/publications/factbook/>
- Chande, Minal. "Bolivia and USA wage war on the coca leaf farmers." The Lancet. 16 November 2002. ProQuest. Duke University Libraries. 1 December 2002.
- Clawson, Patrick and Rensselear Lee. Crop Substitution in the Andes. Washington D.C.: Government Printing Office, 1995.
- Coffin, Phillip. "Foreign Policy In Focus: Coca Eradication." Foreign Policy in Focus. 3.29 (1998). CIAO. Duke University Libraries, Durham. 3 April 2003.

<http://www.ciaonet.org>

Drug Enforcement Agency. "Drug Intelligence Brief: Changing Dynamics of Cocaine Production in the Andean Region." (2002).

<http://www.usdoj.gov/dea/pubs/intel/02033/02033.html>

Economist Intelligence Unit. Peru: Country Profile 2002. London: The Economist Intelligence Unit Limited, 2002.

Erich, Reese. "Ecuador Border Tainted by U.S.-Made Coca Killer." San Francisco Chronicle, 18 May 2002. San Francisco Chronicle Archives.

<<http://sfgate.com/cgi-bin/article.cgi?file=/chronicle/archive/2002/05/18/MN244080.DTL>>

Eusani, Luciane and Alan Grostephan. "Colombia: Poison Rain." November 2002.

Resource Center of the Americas.org. <http://americas.org>

Frechette, Myles. "Colombia Alert: U.S. Counternarcotics Policy toward Colombia."

Hemisphere 2000. 8.2 (2000). CIAO. Duke University Libraries, Durham. 3

April 2003. [http://www.ciaonet.org/pbei/csis/hem01/hem20008\\_2.html](http://www.ciaonet.org/pbei/csis/hem01/hem20008_2.html)

Gironda, Eusebio. Coca Inmortal. La Paz: Plural Editores, 2001.

Gonzales, Jose. "Guerrillas and Coca in the Upper Huallaga Valley." The Shining Path of Peru. Ed. David Scott Palmer. New York, NY: St. Martin's Press, 1994. 123-143.

Howe, Benjamin. "Global Newsstand: Revolutionaries or Crooks." Foreign Policy.

(2001). CIAO. Duke University Libraries, Durham 3 April 2003.

<http://www.ciao.net.org>

Iglesias, Carlos Basombrio. "Sendero Luminoso and Human Rights: A Perverse Logic

- that Captured the Country.” Shining Path and Other Paths: War and Society in Peru, 1980-1995. Ed. Steve J. Stern. Durham: Duke University Press, 1998. 425-446.
- Kennedy, Joseph. Coca Exotica: The Illustrated Story of Cocaine. Madison: Fairleigh Dickinson University Press, 1985.
- Kennedy, Michael. A Simple Economic Model of Cocaine Production. Santa Monica: RAND, 1994.
- Leshner, Alan. “Cocaine: Abuse and Addiction.” National Institute on Drug Abuse Research Report Series. NIH Publication Number 99-4342. (2001)  
<http://www.nida.nih.gov/PDF/RRCocain.pdf>
- Marcella, Gabriel. “Colombia Alert: Plan Colombia: An Interim Assessment.” Hemisphere Focus. (2002). CIAO. Duke University Libraries, Durham. 3 April 2003. <http://www.ciaonet.org>
- Mayer, Enrique. The Articulated Peasant: Household Economies in the Andes. Cambridge: Westview Press, 2002.
- McLean, Phillip. “Colombia Alert: Colombia has changed: Uribe at Six Months.” Hemisphere Focus. (2003). CIAO. Duke University Libraries, Durham. 3 April 2003. <http://www.ciaonet.org>
- Organisation for Economic Co-Operation and Development. Market Effects of Crop Support Measures. Paris: OECD Publications, 2001.
- Otis, John. “Colombia calls for drug war summit, Leader says U.S. is partly to blame.” Houston Chronicle.
- Reavis. “FARC Rebels Without a Clear Cause.” The San Antonio Express-News.

- ProQuest. Duke University Libraries. 1 December 2002.
- Schelling, Thomas. "Organized Crime A Symposium: What is the Business of Organized Crime?" Journal of Public Law 20 (1971): 71-84.
- Schelling, Thomas. "Economics and Criminal Enterprise." The Economics of Corruption and Illegal Markets. Eds. Fiorentini, Gianluca, Zamagni, and Stefano. Cheltenham, U.K: Elgar Reference Collection, 1967. 61-78.
- Stanton, Kimberly. "Compliance with Fumigation Conditions in the Andean Counterdrug Initiative." April 2002 Robert F. Kennedy Memorial Center for Human Rights. <http://www.ciponline.org/colombia/02041004.htm>
- Starn, Orin. "Villagers at Arms: War and Counterrevolution in the Central-South Andes." Shining Path and Other Paths: War and Society in Peru, 1980-1995. Ed. Steve J. Stern. Durham: Duke University Press, 1998. 224-257.
- Strong, Simon. Shining Path: The World's Deadliest Revolutionary Force. Hammersmith: Harper Collins Publishers, 1992.
- United States Department of State. Foreign Terrorist Organizations. August 9, 2002. <http://www.state.gov/s/ct/rls/fs/2002/12389.htm>
- United States Department of State. International Narcotics Control Strategy Report. March 2003. <<http://www.state.gov/g/inl/rls/nrcrpt/2002/pdf/>>
- United States. House of Representatives. Andean Trade Preference Act. 107<sup>th</sup> Congress, 2<sup>nd</sup> session. 2002 H.R. 3009; 107 H.R. 3009. Washington: GPO, 2002.
- World Bank. World Development Report. Hong Kong: World Bank, 2000.
- World Health Organization. 2003. World Health Organization. <http://www.who.int/en/>
- World Health Organization. "Guide to Drug Abuse Epidemiology." World Health

Organization, 2000.

[http://www.who.int/substance\\_abuse/PDFfiles/EPI\\_GUIDE\\_A.pdf](http://www.who.int/substance_abuse/PDFfiles/EPI_GUIDE_A.pdf)

## Appendix

**Table A. Map of Coca Production Areas**



\*Shaded areas of the country represent coca cultivation zones.

Source: Drug Enforcement Agency, 2002

**Table B. Symbol Translation Key**

<b>Endogenous Variables</b>		<b>Exogenous Variables</b>	
<u>Symbol</u>	<u>Variable</u>	<u>Symbol</u>	<u>Variable</u>
$\hat{M}$	Manufacturing Output	$\hat{K}$	Capital Supply
$\hat{A}$	Agricultural Output	$\hat{L}$	Labor Supply
$\hat{D}$	Coca Output	$\hat{N}_A$	Land for Agriculture
$\hat{L}_A$	Labor Supply for Agriculture	$\hat{N}_D$	Land for Coca Cultivation
$\hat{L}_M$	Labor Supply for Manufacturing	$\hat{P}_A$	World Price of Agriculture
$\hat{L}_D$	Labor Supply for Coca Cultivation	$\hat{P}_M$	World Price of Manufacturing
$\hat{w}_M$	Wage for Manufacturing workers	$\hat{Q}$	Demand for Coca
$\hat{w}_{AD}$	Wage for Agricultural and Coca workers	$\hat{t}$	Tariff on Manufacturing
$\hat{P}_M$	Price of Manufacturing		
$\hat{P}_A$	Price of Agriculture		
$\hat{P}_D$	Price of Coca		
$\hat{r}$	Rental Rate of Capital		
$\hat{n}_D$	Rental Rate of Coca Land		
$\hat{n}_A$	Rental Rate of Agricultural Land		
$\hat{H}$	Money Supply		

\*\*\*The carat on top of the variable symbolizes that the variable is in percentage change form. For example, M represents manufacturing output while  $\hat{M}$  represents the percentage change in manufacturing output.

**Table C. Symbols for Coefficients in the Equations**

<b>Symbol</b>	<b>Name</b>
$\Theta_{KM}$	Share of Capital Resources dedicated to Manufacturing
$\Theta_{LM}$	Share of Labor Resources dedicated to Manufacturing
$\Theta_{NA}$	Share of Land Resources dedicated to Agriculture
$\Theta_{LA}$	Share of Labor Resources dedicated to Agriculture
$\Theta_{ND}$	Share of Land Resources dedicated to coca cultivation
$\Theta_{LD}$	Share of Labor Resources dedicated to coca cultivation
$\Phi_A$	Percentage of Agriculture in the Money Supply
$\Phi_M$	Percentage of Manufacturing in the Money Supply
$\Phi_D$	Percentage of Coca in the Money Supply
$\delta$	The reciprocal of the elasticity of the demand for coca that is fulfilled by Peruvian Suppliers
$\lambda_A$	Share of Labor dedicated to Agriculture
$\lambda_M$	Share of Labor dedicated to Manufacturing
$\lambda_D$	Share of Labor dedicated to Coca Production

**Table D. General Equilibrium Model Equations and Their Derivations**

**1. Production Functions**

**Economic Reasoning:** These equations come from using a standard economic production function where total output is contingent upon the factor inputs and the marginal products of those factor inputs.

**a. Production Function for Manufacturing**

$$M = MPP_K K_M + MPP_L L_M$$

$$dM = MPP_K dK_M + MPP_L dL_M$$

$$\left(\frac{M}{M}\right)\left(\frac{dM}{M}\right) = \left(\frac{r_{KM}}{P_{MM}}\right)\left(\frac{dK_M}{K_M}\right) + \left(\frac{w_{LM}}{P_{MM}}\right)\left(\frac{dL_M}{L_M}\right)$$

$$\hat{M} = \left(\frac{r_{KM}}{P_{MM}}\right)\hat{K}_M + \left(\frac{w_{LM}}{P_{MM}}\right)\hat{L}_M$$

$$\hat{\quad} = \quad \hat{\quad} + \quad \hat{\quad}$$

M=Manufacturing Output  
MPP<sub>K</sub>=Marginal Physical Product of Capital  
MPP<sub>L</sub>=Marginal Physical Product of Labor

**b. Production Function for Agriculture**

$$A = MPP_{NA} N_A + MPP_L L_A$$

$$dA = MPP_{NA} dN_A + MPP_L dL_A$$

$$\left(\frac{A}{A}\right)\left(\frac{dA}{A}\right) = \left(\frac{n_{NA}}{P_{AA}}\right)\left(\frac{dN_A}{N_A}\right) + \left(\frac{w_{LA}}{P_{AA}}\right)\left(\frac{dL_A}{L_A}\right)$$

$$\hat{A} = \left(\frac{n_{NA}}{P_{AA}}\right)\hat{N}_A + \left(\frac{w_{LA}}{P_{AA}}\right)\hat{L}_A$$

$$\hat{\quad} = \quad \hat{\quad} + \quad \hat{\quad}$$

**c. Production Function for Coca**

$$D = MPP_{ND} N_D + MPP_L L_D$$

$$dD = MPP_{ND} dN_D + MPP_L dL_D$$

$$\left(\frac{D}{D}\right)\left(\frac{dD}{D}\right) = \left(\frac{n_{ND}}{P_{DD}}\right)\left(\frac{dN_D}{N_D}\right) + \left(\frac{w_{LD}}{P_{DD}}\right)\left(\frac{dL_D}{L_D}\right)$$

$$\hat{D} = \left(\frac{n_{ND}}{P_{DD}}\right)\hat{N}_D + \left(\frac{w_{LD}}{P_{DD}}\right)\hat{L}_D$$

$$\hat{\quad} = \quad \hat{\quad} + \quad \hat{\quad}$$

**2. Labor Supply**

**Economic Reasoning:** This equation comes from the assumption that there is full employment in the Peruvian economy. Hence, each sector of the Peruvian economy will have a certain amount of labor apportioned to that sector when labor supply is represented in percent change form.

$$\begin{aligned}
L &= L_M + L_A + L_D \\
dL &= dL_M + dL_A + dL_D \\
L\left(\frac{dL}{L}\right) &= L_M\left(\frac{dL_M}{L_M}\right) + L_A\left(\frac{dL_A}{L_A}\right) + L_D\left(\frac{dL_D}{L_D}\right) \\
\frac{L}{L}\left(\frac{dL}{L}\right) &= \frac{L_M}{L}\left(\frac{dL_M}{L_M}\right) + \frac{L_A}{L}\left(\frac{dL_A}{L_A}\right) + \frac{L_D}{L}\left(\frac{dL_D}{L_D}\right) \\
\hat{\phantom{L}} &= \hat{\phantom{L}_M} + \hat{\phantom{L}_A} + \hat{\phantom{L}_D}
\end{aligned}$$

### 3. Long-Run Zero Economic Profit Condition in Equilibrium

**Economic Reasoning:** In the long run, economic profit is equal to zero in a competitive industry. Hence, total revenue equals total cost, where total revenue equals price times quantity and total cost equals the summation of factors of production times their relative prices. Hence, the following equations result when total revenue is equal to total price in each of the sectors.

#### a. Long-Run Zero Economic Profit Condition for Manufacturing

$$\begin{aligned}
P_M M &= w_M L_M + rK_M \\
M(dP_M) + P_M(dM) &= (dw_M)L_M + w_M(dL_M) + (dr)K_M + r(dK_M) \\
P_M M\left(\frac{dP_M}{P_M}\right) + P_M M\left(\frac{dM}{M}\right) &= \left(\frac{dw_M}{w_M}\right)L_M w_M + w_M L_M \left(d\frac{L_M}{L_M}\right) + \left(d\frac{r}{r}\right)K_M r + rK_M \left(\frac{dK_M}{K_M}\right) \\
P_M M(\hat{P}_M) + P_M M(\hat{M}) &= (\hat{w}_M)L_M w_M + w_M L_M (\hat{L}_M) + (\hat{r})K_M r + rK_M (\hat{K}_M) \\
P_M M(\hat{P}_M + \hat{M}) &= w_M L_M (\hat{w}_M + \hat{L}_M) + rK_M (\hat{r} + \hat{K}_M) \\
\left(\frac{P_M M}{P_M M}\right)(\hat{P}_M + \hat{M}) &= \left(\frac{w_M L_M}{P_M M}\right)(\hat{w}_M + \hat{L}_M) + \left(\frac{rK_M}{P_M M}\right)(\hat{r} + \hat{K}_M) \\
\hat{P}_M + \hat{M} &= \theta_{LM}(\hat{w}_M + \hat{L}_M) + \theta_{KM}(\hat{r} + \hat{K}_M) \\
\hat{P}_M + (\theta_{LM}\hat{L}_M + \theta_{KM}\hat{K}_M) &= \theta_{LM}(\hat{w}_M + \hat{L}_M) + \theta_{KM}(\hat{r} + \hat{K}_M) \\
\hat{\phantom{P}} &= \hat{\phantom{P}_M} + \hat{\phantom{P}_M}
\end{aligned}$$

### b. Long-Run Zero Economic Profit Condition for Agriculture

$$P_A A = w_{AD} L_A + n_A N_A$$

$$A(dP_A) + P_A(dA) = (dw_{AD})L_A + w_{AD}(dL_A) + (dn_A)N_A + n_A(dN_A)$$

$$P_A A \left( \frac{dP_A}{P_A} \right) + P_A A \left( \frac{dA}{A} \right) = \left( \frac{dw_{AD}}{w_{AD}} \right) L_A w_{AD} + w_{AD} L_A \left( d \frac{L_A}{L_A} \right) + \left( d \frac{n_A}{n_A} \right) n_A N_A + n_A N_A \left( \frac{dN_A}{N_A} \right)$$

$$P_A A(\hat{P}_A) + P_A A(\hat{A}) = (\hat{w}_{AD})L_A w_{AD} + w_{AD}L_A(\hat{L}_A) + (\hat{n}_A)N_A n_A + n_A N_A(\hat{N}_A)$$

$$P_A A(\hat{P}_M + \hat{A}) = w_{AD}L_A(\hat{w}_{AD} + \hat{L}_A) + n_A N_A(\hat{n}_A + \hat{N}_A)$$

$$\left( \frac{P_A A}{P_A A} \right) (\hat{P}_M + \hat{A}) = \left( \frac{w_{AD}L_A}{P_A A} \right) (\hat{w}_{AD} + \hat{L}_A) + \left( \frac{n_A N_A}{P_A A} \right) (\hat{n}_A + \hat{N}_A)$$

$$\hat{P}_A + \hat{A} = \theta_{LA}(\hat{w}_{AD} + \hat{L}_A) + \theta_{NA}(\hat{n}_A + \hat{N}_A)$$

$$\hat{P}_A + (\theta_{LA}\hat{L}_A + \theta_{NA}\hat{N}_A) = \theta_{LA}(\hat{w}_{AD} + \hat{L}_A) + \theta_{NA}(\hat{n}_A + \hat{N}_A)$$

$$\hat{P}_A = \hat{w}_{AD} + \hat{L}_A + \hat{N}_A$$

### c. Long-Run Zero Economic Profit Condition for Coca

$$P_D D = w_{AD} L_D + n_D N_D$$

$$D(dP_D) + P_D(dD) = (dw_{AD})L_D + w_{AD}(dL_D) + (dn_D)N_D + n_D(dN_D)$$

$$P_D D \left( \frac{dP_D}{P_D} \right) + P_D D \left( \frac{dD}{D} \right) = \left( \frac{dw_{AD}}{w_{AD}} \right) L_D w_{AD} + w_{AD} L_D \left( d \frac{L_D}{L_D} \right) + \left( d \frac{n_D}{n_D} \right) n_D N_D + n_D N_D \left( \frac{dN_D}{N_D} \right)$$

$$P_D D(\hat{P}_D) + P_D D(\hat{D}) = (\hat{w}_{AD})L_D w_{AD} + w_{AD}L_D(\hat{L}_D) + (\hat{n}_D)N_D n_D + n_D N_D(\hat{N}_D)$$

$$P_D D(\hat{P}_D + \hat{D}) = w_{AD}L_D(\hat{w}_{AD} + \hat{L}_D) + n_D N_D(\hat{n}_D + \hat{N}_D)$$

$$\left( \frac{P_D D}{P_D D} \right) (\hat{P}_D + \hat{D}) = \left( \frac{w_{AD}L_D}{P_D D} \right) (\hat{w}_{AD} + \hat{L}_D) + \left( \frac{n_D N_D}{P_D D} \right) (\hat{n}_D + \hat{N}_D)$$

$$\hat{P}_D + \hat{D} = \theta_{LD}(\hat{w}_{AD} + \hat{L}_D) + \theta_{ND}(\hat{n}_D + \hat{N}_D)$$

$$\hat{P}_D + (\theta_{LD}\hat{L}_D + \theta_{ND}\hat{N}_D) = \theta_{LD}(\hat{w}_{AD} + \hat{L}_D) + \theta_{ND}(\hat{n}_D + \hat{N}_D)$$

$$\hat{P}_D = \hat{w}_{AD} + \hat{L}_D + \hat{N}_D$$

#### 4. Factor Proportion Equation for Each Sector

**Economic Reasoning:** These equations are based on a Cobb-Douglas production function with constant returns to scale. By having constant returns to scale, one can assume a function where the elasticity of substitution between the two factor inputs equals one. Therefore, the basic factor proportion equation in a generic form is as follows:

$$\left(\frac{\text{Factor Input A}}{\text{Factor Input B}}\right) = (E_{Sub}) \left(\frac{\text{Rental Price B}}{\text{Rental Price A}}\right)$$

##### a. Factor Proportion Equation for Manufacturing

$$\frac{\theta_{LM}}{\theta_{KM}} = \frac{\frac{w_M L_M}{MP_M}}{\frac{r K_M}{MP_M}} = \left(\frac{w_M L_M}{MP_M}\right) \left(\frac{MP_M}{r K_M}\right) = \frac{w_M L_M}{r K_M}$$

$$\ln\left(\frac{\theta_{LM}}{\theta_{KM}}\right) = \ln\left(\frac{w_M L_M}{r K_M}\right)$$

$$\ln\left(\frac{\theta_{LM}}{\theta_{KM}}\right) = \ln(L_M w_M) - \ln(K_M r)$$

$$\ln\left(\frac{\theta_{LM}}{\theta_{KM}}\right) = \ln(L_M) + \ln(w_M) - \ln(K_M) - \ln(r)$$

$$0 = \left(\frac{dL_M}{L_M}\right) + \left(\frac{dw_M}{w_M}\right) - \left(\frac{dK_M}{K_M}\right) - \left(\frac{dr}{r}\right)$$

$$0 = \hat{L}_M + \hat{w}_M - \hat{K}_M - \hat{r}$$

$$\hat{\quad} + \hat{\quad} = \hat{\quad} + \hat{\quad}$$

### b. Factor Proportion Equation for Agriculture

$$\frac{\theta_{LA}}{\theta_{NA}} = \frac{\frac{w_{AD}L_A}{AP_A}}{\frac{n_A N_A}{AP_A}} = \left(\frac{w_{AD}L_A}{AP_A}\right)\left(\frac{AP_A}{n_A N_A}\right) = \frac{w_{AD}L_A}{n_A N_A}$$

$$\ln\left(\frac{\theta_{LA}}{\theta_{NA}}\right) = \ln\left(\frac{w_{AD}L_A}{n_A N_A}\right)$$

$$\ln\left(\frac{\theta_{LA}}{\theta_{NA}}\right) = \ln(L_A w_{AD}) - \ln(N_A n_A)$$

$$\ln\left(\frac{\theta_{LA}}{\theta_{NA}}\right) = \ln(L_A) + \ln(w_{AD}) - \ln(N_A) - \ln(n_A)$$

$$0 = \left(\frac{dL_A}{L_A}\right) + \left(\frac{dw_{AD}}{w_{AD}}\right) - \left(\frac{dN_A}{N_A}\right) - \left(\frac{dn_A}{n_A}\right)$$

$$0 = \hat{L}_A + \hat{w}_{AD} - \hat{N}_A - \hat{n}_A$$

$$\hat{\quad} + \hat{\quad} = \hat{\quad} + \hat{\quad}$$

### c. Factor Proportion Equation for Coca

$$\frac{\theta_{LD}}{\theta_{ND}} = \frac{\frac{w_{AD}L_D}{DP_D}}{\frac{n_D N_D}{DP_D}} = \left(\frac{w_{AD}L_D}{DP_D}\right)\left(\frac{DP_D}{n_D N_D}\right) = \frac{w_{AD}L_D}{n_D N_D}$$

$$\ln\left(\frac{\theta_{LD}}{\theta_{ND}}\right) = \ln\left(\frac{w_{AD}L_D}{n_D N_D}\right)$$

$$\ln\left(\frac{\theta_{LD}}{\theta_{ND}}\right) = \ln(L_D w_{AD}) - \ln(N_D n_D)$$

$$\ln\left(\frac{\theta_{LD}}{\theta_{ND}}\right) = \ln(L_D) + \ln(w_{AD}) - \ln(N_D) - \ln(n_D)$$

$$0 = \left(\frac{dL_D}{L_D}\right) + \left(\frac{dw_{AD}}{w_{AD}}\right) - \left(\frac{dN_D}{N_D}\right) - \left(\frac{dn_D}{n_D}\right)$$

$$0 = \hat{L}_D + \hat{w}_{AD} - \hat{N}_D - \hat{n}_D$$

$$\hat{\quad} + \hat{\quad} = \hat{\quad} + \hat{\quad}$$

## 5. Law of One Price for Manufacturing

**Economic Reasoning:** In a competitive industry, the price of the good being produced domestically will be equal to the world price provided the country is sufficiently small. For manufacturing, however, the Peruvian economy protects domestic producers with a tariff. Therefore, the Peruvian manufacturing price factors in a tariff in addition to the world price.

$$P_M = P_M^* (1 + t)$$

$$\ln P_M = \ln(P_M^* (1 + t))$$

$$\ln P_M = \ln P_M^* + \ln(1 + t)$$

$$\left(\frac{dP_M}{P_M}\right) = \left(\frac{dP_M^*}{P_M^*}\right) + \left(\frac{dt}{1+t}\right)$$

$$\hat{P}_M = \hat{P}_M^* + \hat{t}$$

## 6. Law of One Price for Agriculture

**Economic Reasoning:** In a competitive industry, the domestic and world prices equilibrate in a small, open economy. Peru is essentially a price taker in the world agriculture market. Therefore, the law of one price applies.

$$P_A = P_A^*$$

$$\ln P_A = \ln P_A^*$$

$$\left(\frac{dP_A}{P_A}\right) = \left(\frac{dP_A^*}{P_A^*}\right)$$

$$\hat{P}_A = \hat{P}_A^*$$

## 7. Price for Coca

**Economic Reasoning:** The price of coca is determined by the demand for coca times an elasticity coefficient. Consumers in the United States and Europe exogenously determine the demand for coca. The coefficient of demand represents the reciprocal of the elasticity of demand for Peruvian coca.

$$\hat{P}_C = -\hat{E}_C$$

## 8. Wage Differentials in Different Sectors

**Economic Reasoning:** Economic theory suggests that if there is perfect mobility between sectors in an economy, the wage will equilibrate over those sectors. However,

in the Peruvian economy, there is restricted mobility between the manufacturing sectors and the other two sectors. There is perfect mobility between the drug and agricultural sector, however. Therefore, the wage in the agricultural and drug sector will be the same. This wage has been labeled throughout the equations as  $w_{AD}$ . However, the wage in the manufacturing sector is different. Therefore, this equation represents the difference between the wages in the two sectors. The difference between the wages is multiplied by a factor,  $s$ , which represents the amount of mobility between the industries.

$$\hat{\quad} = \hat{\quad} - \hat{\quad}$$

## 15. Money Supply

**Economic Reasoning:** Peru has a free floating exchange rate. However, if there is a large amount of volatility in the market, then the Central Bank will stabilize the exchange rate. Therefore, the Peruvian exchange rate works similarly to a fixed exchange rate. Hence the money supply is endogenously determined. The money supply is then represented by the money supply being equal to price times output.

$$H = P_A A + P_M M + P_D D$$

$$dH = P_A dA + P_M dM + P_D dD + dP_A A + dP_M M + dP_D D$$

$$\frac{dH}{H} = \frac{P_A dA + P_M dM + P_D dD + dP_A A + dP_M M + dP_D D}{P_A A + P_M M + P_D D}$$

$$\frac{dH}{H} = \frac{P_A dA}{P_A A + P_M M + P_D D} \left(\frac{A}{A}\right) + \frac{P_M dM}{P_A A + P_M M + P_D D} \left(\frac{M}{M}\right) + \frac{P_D dD}{P_A A + P_M M + P_D D} \left(\frac{D}{D}\right)$$

$$+ \frac{dP_A A}{P_A A + P_M M + P_D D} \left(\frac{P_A}{P_A}\right) + \frac{dP_M M}{P_A A + P_M M + P_D D} \left(\frac{P_M}{P_M}\right) + \frac{dP_D D}{P_A A + P_M M + P_D D} \left(\frac{P_D}{P_D}\right)$$

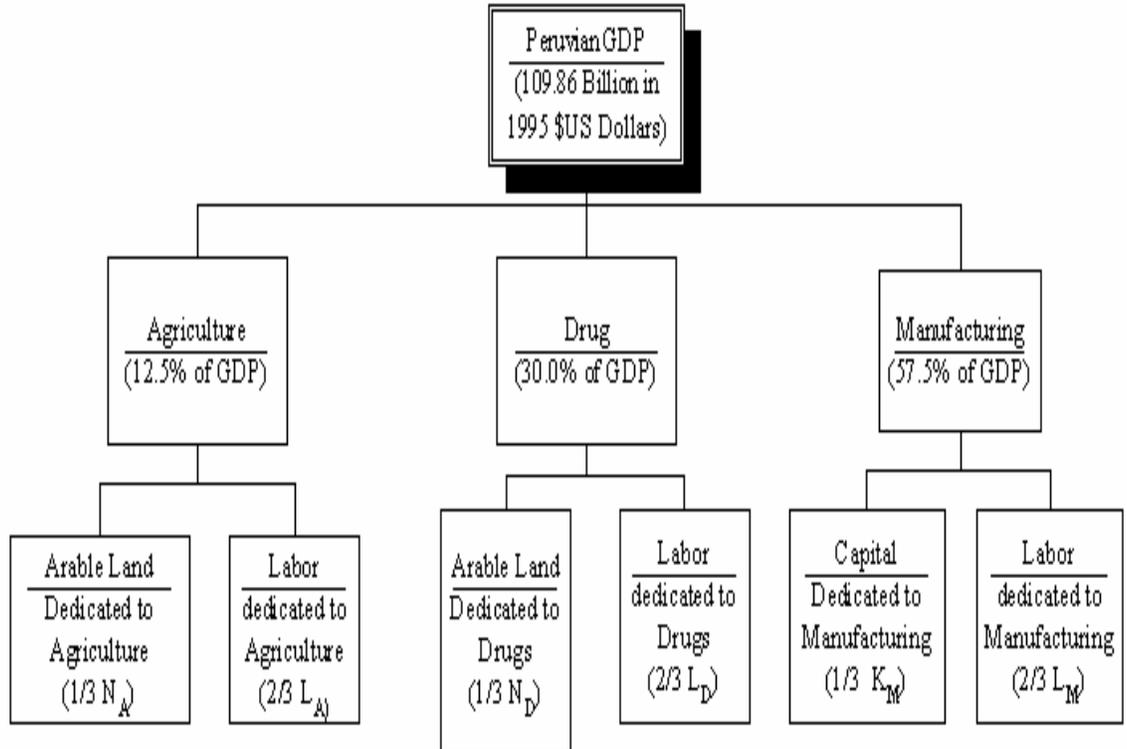
$$\hat{H} = \frac{P_A A \hat{A}}{P_A A + P_M M + P_D D} + \frac{P_M M \hat{M}}{P_A A + P_M M + P_D D} + \frac{P_D D \hat{D}}{P_A A + P_M M + P_D D}$$

$$+ \frac{P_A A \hat{P}_A}{P_A A + P_M M + P_D D} + \frac{P_M M \hat{P}_M}{P_A A + P_M M + P_D D} + \frac{P_D D \hat{P}_D}{P_A A + P_M M + P_D D}$$

$$\hat{H} = \phi_A \hat{A} + \phi_M \hat{M} + \phi_D \hat{D} + \phi_A \hat{P}_A + \phi_M \hat{P}_M + \phi_D \hat{P}_D$$

**Table E. Flow of Funds Diagram**

FLOW OF FUNDS CHART



### Table F---Matrix for General Equilibrium Model

In order to create a General Equilibrium Model, I used matrices and matrix inversion techniques.

For my analysis, I used four matrices. The matrices are defined as follows: (1) N is a matrix representing the endogenous variables of the model, (2) A is a matrix representing the coefficients of the endogenous variables, (3) B is a matrix representing the coefficients of the exogenous variables, and (4) X is a matrix representing the exogenous variables.

(1) Matrix N and Matrix A

	$\hat{M}$	$\hat{A}$	$\hat{D}$	$\hat{L}_A$	$\hat{L}_M$	$\hat{L}_D$	$\hat{w}_M$	$\hat{w}_{AD}$	$\hat{n}_A$	$\hat{n}_D$	$\hat{r}$	$\hat{P}_D$	$\hat{P}_M$	$\hat{P}_A$	$\hat{H}$
A	0	0	0	$\lambda_A$	$\lambda_M$	$\lambda_D$	0	0	0	0	0	0	0	0	0
B	1	0	0	0	$-\theta_{LM}$	0	0	0	0	0	0	0	0	0	0
C	0	1	0	$-\theta_{LA}$	0	0	0	0	0	0	0	0	0	0	0
D	0	0	1	0	0	$-\theta_{LD}$	0	0	0	0	0	0	0	0	0
E	0	0	0	0	0	0	$\theta_{LM}$	0	0	0	$\theta_{KM}$	0	-1	0	0
F	0	0	0	0	0	0	0	$\theta_{LA}$	$\theta_{NA}$	0	0	0	0	-1	0
G	0	0	0	0	0	0	0	$\theta_{LD}$	0	$\theta_{ND}$	0	-1	0	0	0
H	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
I	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
J	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
K	$\phi_M$	$\phi_A$	$\phi_D$	0	0	0	0	0	0	0	0	0	$\phi_D$	$\phi_M$	$\phi_A - 1$
L	0	0	0	1	0	0	0	0	1	-1	0	0	0	0	0
M	0	0	0	0	1	0	1	0	0	0	-1	0	0	0	0
N	0	0	0	0	0	1	0	1	0	-1	0	0	0	0	0
O	0	0	0	0	-1	0	$s$	$-s$	0	0	0	0	0	0	0

- A=Labor Supply Equation
- B=Manufacturing Production Function
- C=Agricultural Production Function
- D=Coca Production Function
- E=Zero Profit Condition for Manufacturing
- F=Zero Profit Condition for Agriculture
- G=Zero Profit Condition for Coca Production

H=Law of One Price for Manufacturing  
 I=Law of One Price for Agriculture  
 J=Law of One Price for Coca  
 K=Money Supply  
 L=Factor Proportion for Agriculture  
 M=Factor Proportion for Manufacturing  
 N= Factor Proportion for Coca Production  
 O=Labor Immobility Equation

(2) Matrix B and Matrix X

$$\begin{bmatrix}
 \hat{L} & \hat{K} & \hat{N}_A & \hat{N}_D & \hat{P}_M^* & \hat{P}_A^* & \hat{Q} & \hat{t} \\
 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
 0 & \theta_{KM} & 0 & 0 & 0 & 0 & 0 & 0 \\
 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 \\
 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 \\
 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
 0 & 0 & 0 & 0 & 1 & 0 & 0 & 1 \\
 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 \\
 0 & 0 & 0 & 0 & 0 & 0 & -\delta & 0 \\
 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 \\
 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 \\
 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 \\
 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0
 \end{bmatrix}$$

\*\*\* The same equation lines correspond to the equations in the previous matrix.

After approximating values for the equation coefficients from the World Development Report, I conducted an analysis as follows in order to get the final matrix. First, I took the inverse of Matrix A. Next, I multiplied A inverse matrix times the B matrix. I relabeled this resulting matrix as matrix C. Then I multiplied the C matrix times the X matrix and set it equal to the N matrix.

**Matrix A and Matrix N**

$\hat{M}$	$\hat{A}$	$\hat{D}$	$\hat{L}_A$	$\hat{L}_M$	$\hat{L}_D$	$\hat{w}_M$	$\hat{w}_{AD}$	$\hat{n}_A$	$\hat{n}_D$	$\hat{r}$	$\hat{P}_M$	$\hat{P}_A$	$\hat{P}_D$	$\hat{H}$
-----------	-----------	-----------	-------------	-------------	-------------	-------------	----------------	-------------	-------------	-----------	-------------	-------------	-------------	-----------

0	0	0	0.2903	0.41933	0.2903	0	0	0	0	0	0	0	0	0
1	0	0	0	-0.6667	0	0	0	0	0	0	0	0	0	0
0	1	0	-0.6667	0	0	0	0	0	0	0	0	0	0	0
0	0	1	0	0	-0.6667	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	-2/3	0	0	0	-1/3	0	1	0	0
0	0	0	0	0	0	0	-0.6667	-1/3	0	0	0	0	1	0
0	0	0	0	0	0	0	-0.6667	0	-1/3	0	1	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
4/7	1/8	2/7	0	0	0	0	0	0	0	0	2/7	4/7	1/8	-1
0	0	0	1	0	0	0	1	-1	0	0	0	0	0	0
0	0	0	0	1	0	1	0	0	0	-1	0	0	0	0
0	0	0	0	0	1	0	1	0	-1	0	0	0	0	0
0	0	0	0	-1	0	0.5	-0.5	0	0	0	0	0	0	0

**Matrix B and Matrix X**

Equation	$\hat{L}$	$\hat{K}$	$\hat{N}_A$	$\hat{N}_D$	$\hat{P}_M$	$\hat{P}_A$	$\hat{Q}$	$\hat{t}$
Labor Equation	1	0	0	0	0	0		0
Prod.Func. for M	0	1/3	0	0	0	0		0
Prod.Func. for A	0	0	1/3	0	0	0		0
Prod.Func. for D	0	0	0	1/3	0	0		0
Zero Profit for M	0	0	0	0	0	0		0
Zero Profit for A	0	0	0	0	0	0		0
Zero Profit for D	0	0	0	0	0	0		0
Law of One price (M)	0	0	0	0	1	0		1

Law of One price (A)	0	0	0	0	0	1	0	0
Law of One Price (D)	0	0	0	0	0	0	-0.001	0
Money Supply	0	0	0	0	0	0	0	0
Factor Proportion (A)	0	0	1	0	0	0	0	0
Factor Proportion (M)	0	1	0	0	0	0	0	0
Factor Proportion (D)	0	0	0	1	0	0	0	0
Lm Immobility	0	0	0	0	0	0	0	0

After completing this process, the final product was the general equilibrium model from below:

### Matrix C, N, and X

	$\hat{L}$	$\hat{K}$	$\hat{N}_A$	$\hat{N}_D$	$\hat{P}_M$	$\hat{P}_A$	$\hat{Q}$	$\hat{t}$
$\hat{M}$	0.14869	0.41966	-0.0432	-0.04316539	0.25899236	-0.12949618	0.0001295	0.25899236
$\hat{A}$	1.04085	-0.0624	0.69784	-0.30215775	-0.1870535	1.09352675	0.00090647	-0.1870535
$\hat{D}$	1.04085	-0.0624	-0.3022	0.69784225	-0.1870535	-0.90647325	-0.00109353	-0.1870535
$\hat{L}_A$	1.56127	-0.0935	0.54676	-0.45323662	-0.28058026	1.64029013	0.00135971	-0.28058026
$\hat{L}_M$	0.22304	0.1295	-0.0647	-0.06474809	0.38848853	-0.19424427	0.00019424	0.38848853
$\hat{L}_D$	1.56127	-0.0935	-0.4532	0.54676338	-0.28058026	-1.35970987	-0.00164029	-0.28058026
$\hat{w}_M$	-0.0743	0.29017	0.02158	0.0215827	0.87050382	0.06474809	-6.4748E-05	0.87050382
$\hat{w}_{AD}$	-0.5204	0.03118	0.15108	0.15107887	0.09352675	0.45323662	-0.00045324	0.09352675
$\hat{n}_A$	1.04085	-0.0624	-0.3022	-0.30215775	-0.1870535	2.09352675	0.00090647	-0.1870535
$\hat{n}_D$	1.04085	-0.0624	-0.3022	-0.30215775	-0.1870535	-0.90647325	-0.00209353	-0.1870535
$\hat{r}$	0.14869	-0.5803	-0.0432	-0.04316539	1.25899236	-0.12949618	0.0001295	1.25899236
$\hat{P}_M$	0	0	0	0	0	0	-0.001	0
$\hat{P}_A$	0	0	0	0	0	1	0	1

$\hat{P}_D$	0	0	0	0	0	1	0	0
$\hat{H}$	0.52786	0.21481	-0.0282	0.14676286	0.64442287	-0.08471143	-0.00044029	0.64442287

**Table G. Coca Cultivated Each Year**

**Amount of Coca Leaf Cultivated and Eradicated, Calendar Years 1987–2000 (Hectares)**

Year	Cultivated			Eradicated		
	Bolivia	Colombia	Peru	Bolivia	Colombia	Peru
1987	41,400	22,960	109,155	1,040	460	355
1988	50,400	34,230	115,530	1,475	230	5,130
1989	55,400	43,400	121,685	2,500	640	1,285
1990	58,400	41,000	121,300	8,100	900	—
1991	53,386	38,472	120,800	5,486	972	—
1992	48,652	38,059	129,100	3,152	959	—
1993	49,597	40,493	108,800	2,397	793	—
1994	49,158	49,610	108,600	1,058	4,910	—
1995	54,093	59,650	115,300	5,493	8,750	—
1996	55,612	72,800	95,659	7,512	5,600	1,259
1997	52,826	98,500	72,262	7,026	19,000	3,462
1998	49,621	—	58,825	11,621	—	7,825
1999	38,779	—	52,500	16,999	43,246	13,800
2000	22,253	183,200	40,200	7,653	47,000	6,200

— Data not available.

Source: U.S. Department of State, Bureau of International Narcotics and Law Enforcement Affairs, *International Narcotics Control Strategy Report* (1988–2001). Data for 1992–2000 are from the March 2001 report.