Opium in Afghanistan: Prospects for the Success of Source-Country Drug Control Policies

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Abstract

Recent estimates suggest that in 2004 opiate exports accounted for nearly 40% of Afghanistan's GDP. The magnitude of this activity poses a serious policy concern because of its linkages with both global heroin consumption and roadblocks to reconstruction in Afghanistan itself. In this paper, I estimate the potential effects of different forms of source-country drug control policy by analyzing the supply and demand for raw opium at the farm level. Using price and cultivation data collected by the United Nations, I estimate the district and province level supply elasticities to be approximately 1. I estimate that the elasticity of demand for opium at the farm-gate (which is derived from the demand for opiates in final consumer markets) is between -.16 and -.29. I also construct a model of the factors that influence an individual farmer's allocation of land between opium and alternative crops. I use this model (coupled with the elasticity estimates) to identify policy variables and estimate the potential equilibrium effects of various policy options. I estimate that increasing crop eradication from 21,000 hectares, the number eradicated in 2003, to 60,000 hectares would decrease the equilibrium quantity of opium by 28.4%. I also estimate that raising alternative farm incomes by $450 per hectare would decrease the production of opium by 4.9%, and that sanctioning farmers $500 per hectare of opium (in conjunction with the 2003 crop eradication level) would decrease the quantity of opium by 3.4%.

1. Introduction:

In 2004, Afghan opium cultivation produced an estimated 87% of the world's opium (UNDCP, 2004b). The value of this opium at Afghanistan's borders amounted to around $2.8 billion, an amount equivalent to 40% of Afghanistan's GDP (UNDCP, 2004b). This extraordinary level of opium cultivation poses several policy concerns which span two dimensions.

The first area of concern relates to health problems which result from the use of heroin and other opiates. Worldwide, the United Nations (U.N.) estimates that more than 9 million people abuse heroin, making heroin the most widely used of the hard narcotic substances. The U.N. also estimates that more than 15 million people use opiates in general, a category that includes heroin, morphine, and opium (UNODC, 2004). Heroin consumption can cause much harm. In each year from 2000-2002, for example, heroin use in the United States (U.S.) alone resulted in nearly 100,000 emergency room visits (USDEA, 2005a). These emergency room numbers are slightly higher than those seen for cocaine despite the fact that U.S. cocaine use is estimated to be four times as prevalent as heroin use (UNODC, 2004).

The other reason for concern over Afghan opium cultivation relates to its contribution to insecurity, instability, and corruption within Afghanistan. The production and trafficking of illicit substances has a long history of connection with insurgent, criminal, and terrorist groups. Afghanistan has become an increasingly central part of this history during recent decades. Opium cultivation and heroin processing also pull economic resources out of the licit economy and into the black market. This complicates the emergence of a strong national government in that it both draws out of the national government's tax base and finances the regional warlords and local militia commanders with whom the government competes for control. Lastly, the presence of potentially lucrative black market opportunities creates powerful incentives for corruption in the ranks of the government itself.[1]

These concerns create the impetus for policies designed to combat opium cultivation, but they say nothing about either the potential for such policies to succeed or the extent to which we ought to pursue them. The analysis that follows looks at several of the key parameters that must be estimated and understood in order for source-country drug control policy to proceed in an informed manner. I begin by modeling the decision farmers make when they choose to allocate land between opium and alternative crops. I pay particular attention to the potential impact of policy variables such as the probability of crop eradication and the alternative income opportunities that can be improved through development projects. In agreement with conventional wisdom on the subject, I find that the availability of cheap labor is the primary constraint on the extent to which an individual farmer cultivates opium.

I then use price and cultivation data from the United Nations Drug Control Program's (UNDCP's) annual opium poppy surveys to estimate a district and province level supply elasticity of around 1. I also use data on heroin prices in regional markets around the world to estimate the potential for price changes at the farm level in Afghanistan to influence the price of heroin in retail markets. Applying past estimates of the elasticity of demand for heroin at the retail level, I then estimate the extent to which

1 A fuller discussion of these concerns, as well as a more complete discussion of Afghanistan's institutions and social issues, can be found in Clemens (2005), which is available on request from the author.

price increases in Afghanistan can reduce consumption in retail markets. This combination of Afghan price increases and regional consumption reductions imply an elasticity of the demand for opium within Afghanistan over the short run (during which I assume these regional markets to be supplied exclusively with Afghan opiates). These methods lead me to estimate that the short run farm-gate demand elasticity lies in the neighborhood -.225.

Finally, I bring together the elasticity estimates and land allocation model to estimate the equilibrium effects of manipulating the policy variables. I estimate that increasing crop eradication from 21,000 hectares (the number eradicated in 2003) to 60,000 hectares would decrease the equilibrium quantity of opium by about 28.4%. I also estimate that raising alternative farm incomes by $450 per hectare would decrease the production of opium by about 4.9%, and that sanctioning farmers $500 per hectare of opium (in conjunction with the 2003 crop eradication level) would decrease the quantity of opium by about 3.4%. Lastly, the natural course of development will work in favor of reductions in opium production. In particular, if daily wages increase from $3 to $6, the equilibrium level of opium production should decrease by about 3.0%.

The paper proceeds as follows: Section 2 contains a review of relevant literature and section 3 outlines a basic framework for thinking about drug control policy. Section 4 contains the model of an Afghan farmer's land allocation decision, and Section 5 contains my estimates of the elasticity of supply and demand for opium within Afghanistan. In section 6 I estimate the equilibrium effects of crop eradication, opium cultivation sanctions, and increases in alternative income opportunities. I conclude in section 7 with a brief discussion.

2. Literature Review

Afghanistan's Rise in Global Opium Production

Afghanistan's rise to prominence in global opium production resulted from a variety of internal and external factors. Externally, Iranian, Pakistani, and Turkish crackdowns on opium production during the 1970's left a shortage in both regional and global supply (UNDCP, 2003).[2] Internally, a quarter century of conflict, which began in 1978 with resistance to Soviet occupation, brought on high levels of instability which proved conducive to the rise of the narcotics industry. Several non-geopolitical factors also make Afghanistan suitable for opium cultivation. As a labor intensive crop, opium is suitable for largely agricultural regions in which there are few off-farm income opportunities and a low capital to labor ratio (Misra, 2004)[3]. The absence of off-farm income opportunities is particularly noteworthy for Afghan women, who are generally prevented from working outside the home (UNDCP, 2000b; IRIN, 2005). Afghanistan's soils, climate, and altitude also make Afghan opium cultivation significantly more productive than cultivation in other major opium producing regions. While the major cultivating districts of Afghanistan frequently experience yields as high as 40-60kg per hectare, recent opium surveys in Myanmar and Laos report national yield averages of 13kg and 6.5kg per hectare respectively (UNDCP, 2003c; UNDCP 2004c).

The Determinants of Farm Level Supply

The United Nations and a number of Non Government Organizations have put a

2 See p. 88
3 See p. 82

great deal of work into monitoring the cultivation of drug crops and assessing its causes on a qualitative level. A great deal of fieldwork and data collection have gone into the UNDCP's annual opium poppy surveys and its series of "Strategic Studies" papers on issues relating to Afghan opium. While some aspects of the opium surveys are held for internal use only, much of the UNDCP's price, cultivation, and yield data can be extracted from publicly available versions of the opium surveys.

The analysis performed in the "Strategic Studies" series and in the opium surveys themselves is generally constrained to broad conceptual points. Efforts by the UNDCP to fit its data to economic models of opium cultivation either do not existent or, like the remainder of their data, are held internally. Addressing the absence of such analysis in the area of farm level supply is a primary focus of this study. I seek to identify the most likely explanation for the price fluctuations observed since 2001 with a view towards estimating the potential impact of drug control efforts on the price at which farmers will be willing to cultivate a given amount of opium.

The UNDCP's surveys and studies, as well as the policy recommendations and studies of others, provide valuable pieces of factual and conceptual information. I will cite these in turn as they become relevant to the exposition of the land allocation model.

Retail Heroin Markets and Drug Control Policy

An important aspect of the market for heroin, the elasticity of demand at the retail level, has been estimated in several studies. The relevant papers include Saffer and Chaloupka (1995), Chaloupka, Grossman, and Tauras (1996), Caulkins (1995), and Bretteville-Jensen and Biorn (2003). These studies have yielded higher demand elasticity estimates than were previously assumed, with a median estimate of -.9 coming from the 1995 paper by Saffer and Chaloupka.

Kennedy, Reuter, and Riley (1993) present a simple model of the world cocaine market in one of the most well known analyses of the economics of drug control policy. Their results, which are driven largely by the fact that source-country prices make up a small fraction of the prices observed in U.S. retail markets, are highly pessimistic about the potential efficacy of both source-country and interdiction policies. Rydell and Everingham (1994) extend this analysis by estimating the cost effectiveness of different forms of policy in terms of the expenditure required to reduce cocaine consumption by 1%. Their estimates suggest that, at least on the margin, drug treatment programs are far more cost effective than domestic enforcement, interdiction, and source-country policies. Source-country policies rank as the least cost effective of the four.

Two aspects of the model applied by Kennedy, Reuter, and Riley (1993) make their results much more pessimistic about source-country policies than is warranted. First, they treat the U.S. price as a world price rather than as one of many regional prices in a segmented world market. Since U.S. cocaine prices are significantly higher than prices in countries that either neighbor source countries or have less stringent drug laws (due to higher transportation costs and trafficking risks), this makes source-country prices appear to have a smaller impact on world retail prices than they actually do.

Second, they assume that source-country prices only have an additive impact on retail prices. This implies, for example, that if the price of a kilogram of heroin in Afghanistan rises from \$1000 to \$1100, the price in Europe will only rise from, say, \$100,000 to \$100,100. Hence a 10% increase in the Afghan price results in a mere .1%

increase in the European price. This assumption has been a subject of dispute. A review of related literature by Rhodes et al. (2000) notes that a linear model of the impact of source-country prices on retail prices could also theoretically take on a purely multiplicative form (where a doubling of the source-country price leads to a doubling of the price in retail markets) or, more likely, a mixed form with both an additive and a multiplicative element.

While analyzing the elasticity of demand for Afghan opium I make several estimates of the size of the multiplicative term for heroin prices in Europe. Although data limitations bring a degree of roughness to the methodology, it is nonetheless preferable to proceeding on the basis of assumption alone.

3. The Framework for Economic Analysis

The global market for heroin can best be understood using an equilibrium model of supply and demand with two distinct emphases as the determinants of retail prices: the price paid in a producing country and the costs of transporting the good to retail markets. Kennedy, Reuter, and Riley (1993) use a similar model for cocaine production in South America. The model consists of four equations with four variables. In these equations P_A represents the price of opium in Afghanistan, P_R represents the price of opium in regional (meaning regions of the globe) retail markets, $Q_{(D,R)}$ represents the quantity of opiates demanded in the regional retail markets, and $Q_{(S,A)}$ represents the quantity of opium supplied by Afghanistan. The α_R and β_R are parameters that represent the costs of trafficking opiates from Afghanistan to any given region. The C_R are parameters that summarize all factors other than price that determine demand. ε represents the elasticity of demand to the regional retail prices. The model looks like the following:[4]

$$(1) \sum Q_{(D,R)} = Q_{(S,A)}$$

$$(2) Q_{(S,A)} = f(P_A)$$

$$(3) P_R = \alpha_R + \beta_R P_A$$

$$(4) \sum Q_{(D,R)} = \sum C_R (P_R)^{\varepsilon}.$$

Equation 1 represents the equilibrium condition in which the quantity supplied by Afghanistan is equal to the sum of the quantities demanded in each of the regions that consume Afghan opiates. Equation 2 represents the fact that the quantity supplied in Afghanistan is determined by some function of the price of opium at the Afghan farm-gate. Equation 3 represents the relationship between the price in Afghanistan and the price in each of the regions for which Afghanistan is the supplier. Equation 4 represents the relationship between the quantity demanded and the price charged in each of the consuming regions. Substituting equation three into equation four results in

$$(5) \sum Q_{(D,R)} = \sum C_R (\alpha_R + \beta_R P_A)^{\varepsilon}.$$

Given estimates for $\alpha_R, \beta_R,$ and $\varepsilon,$ it becomes possible to derive an estimate of the price elasticity of demand for Afghan opium by plugging these estimates into equation 5.

This model reflects the assumption that regional markets that are currently supplied by Afghanistan cannot obtain opiates from alternative source countries. This

4 Equations 3 and 4 could, like equation 2, be written to show the left-hand side variable as a generic function of the right-hand side variables. They are written as above to reflect the manner in which each will be treated in the remainder of this paper.

assumption holds reasonably well over the short run, during which traffickers are locked into particular trafficking routes and have not had time to establish relationships with farmers in other countries. Afghanistan's continued dominance in world opium production, despite three consecutive years during which prices in Afghanistan exceeded those in Laos and Myanmar by more than $100/kg (i.e. 2001-2003), suggests that this short run may extend for quite some time. Over a longer time horizon this assumption would break down as traffickers turn to farmers in other source countries and alter their trafficking routes in response to changes in the global market. Hence the demand for opiates in any one source-country will be more elastic in the long run than in the short run.

3. Data Overview

Much of the data that I have compiled for this paper comes from the UNDCP's annual opium poppy surveys for Afghanistan. These surveys have been conducted annually since 1994 with the purpose of charting out the areas under opium cultivation and monitoring its expansions and contractions. The scope of the surveys has varied from year to year, with the published surveys for 2002, 2003, and 2004 being particularly complete following a rise in interest post-September 11, 2001.

The main data of interest for this paper are the number of hectares cultivated, the prices paid, and the total amount of opium produced. For most years this information is readily accessible.

The UNDCP typically provides cultivation data at the district level. It makes these estimates using a combination of satellite imagery and fieldwork. The UNDCP's satellite images register unique light frequencies for various kinds of vegetation. Survey overseers confirm the frequency associated with opium by having survey staff record longitude and latitude coordinates with Global Positioning Systems while standing in or around actual opium poppy fields. The use of on-the-ground survey work to confirm satellite readings is preferred, but satellite readings may stand alone when security concerns prevent fieldwork in high risk areas. Figure 1, below, provides a look at the number of hectares cultivated with opium going back to 1990.

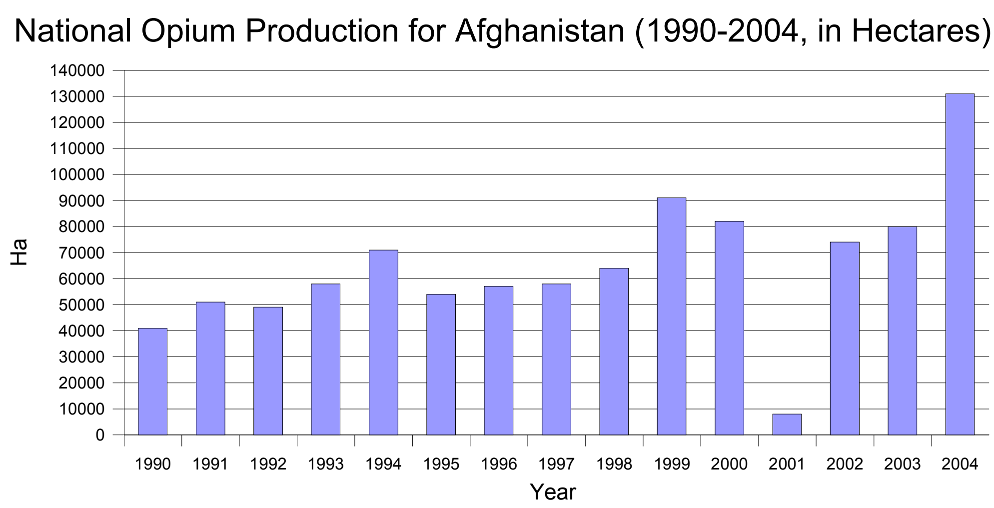

Figure 1Data Source: UNDCP, "Afghanistan: Opium Survey," 2004, p.3.

As can be seen, Afghan opium cultivation rose steadily during the early 1990's. After peaking in 1999, cultivation declined sharply in 2001, but has since recovered. This decline resulted from a cultivation ban put in place by the Taliban in 2000 and rigorously enforced in 2001. However, this anomaly should not be taken to suggest that the Taliban consistently opposed the cultivation of opium, as production had flourished throughout the preceding years during which the Taliban controlled much of Afghanistan. It remains unclear whether or not the Taliban would have maintained its ban in 2002, and whether or not farmers would have heeded it again as they had in the previous year.

Historically, the vast majority of national opium cultivation has taken place in Helmand, Nangarhar, and Badakshan provinces, and to a lesser extent in Uruzgan and Kandahar provinces. Helmand, Uruzgan, and Kandahar neighbor one another in Afghanistan's southern region. Nangarhar has long served as the hub of opium production in the east, while Badakshan has played a similar role in the north. The five major cultivating provinces continue to produce a substantial portion of Afghanistan's opium. In 2004 they cultivated some 77% of the total land devoted to opium throughout the country (UNDCP, 2004b). Nonetheless, opium cultivation has spread more widely across the country in recent years than it did during the mid 1990s. This phenomenon prevailed more than ever in 2004, during which the level of cultivation exceeded the previous high from 1999 by about 40,000 hectares. 2004 also marked the first year in which UNODC survey staff observed opium cultivation in all of Afghanistan's administrative provinces.

The UNDCP has reported price data at the district level in recent surveys, but formerly reported prices at the province level. In some years these data are reported in terms of fresh opium prices, while in others they are in terms of dry opium prices. Fresh opium differs from dry opium in that it retains its original water content. Converting from one price to the other to construct a consistent series of price data is complicated somewhat by the fact that the conversion ratio differs from province to province. I have made such conversions where necessary by looking at the average conversion ratio for individual provinces in the years for which both dry and fresh prices are provided.

Figure 2, below, shows the path of the national average price for fresh opium at the farm-gate from 1994-2004. The spike observed in 2001 (from levels between $20/kg and $40/kg to over $300/kg) is associated with the response of traders and traffickers to the supply shock created by the Taliban's opium ban in that same year. There is a lack of consensus concerning why the price of opium increased further in 2002 and remained as high as it did in 2003. In my analysis I hypothesize that the correct explanation lies primarily with farmer expectations concerning the risk of crop eradication. Under this hypothesis, the cultivation boom and price decline of 2004 suggest that by that year eradication policies were perceived to lack credibility.

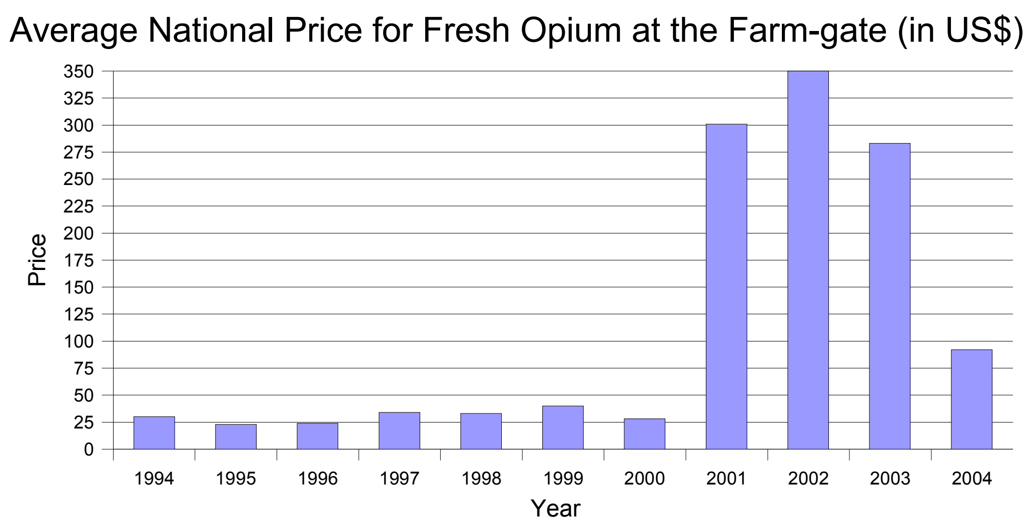

Figure 2Data Source: UNDCP, "Afghanistan: Opium Survey 2004," 2004b, p.5

Most of the price data are collected through surveys that Afghan farmers fill out themselves. The price reported for each province in any given year is the average of the prices reported by individual farmers. The surveys ask farmers for a variety of information including the prices and yields of alternative crops. Province level wheat prices were reported consistently during the early years of the survey, but have not been available since 1997.

The opium surveys also provide estimates of the amount of opium produced in each province in most years. The primary exceptions to this are 1998 and 1999, for which the surveys held back on reporting province level production due to uncertainty on the part of survey staff. Table 1, below, provides estimates of global opium production by country since 1994. These numbers indicate the size of Afghanistan's role in the global market for opiates. This role has expanded substantially as production in Myanmar (which was formerly the world's number one producer and is currently second to Afghanistan) trailed off and production in Afghanistan increased during the late 1990's. Afghanistan's share of world opium production is estimated to have risen from 75.5% in 2003 to 87% in 2004 as Afghan production increased from 3,600mt to 4,200mt.

Table 1: Opium Production Estimates by Country (in metric tonnes)

	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Afghanistan	3416	2335	2248	2804	2693	4565	3276	185	3400	3600
Pakistan	128	112	24	24	26	9	8	5	5	52
Lao PDR	120	128	140	147	124	124	167	134	112	120
Myanmar	1583	1664	1760	1676	1303	895	1087	1097	828	810
Colombia	205	71	67	90	100	88	88	58	50	50
Mexico	60	53	54	46	60	43	21	71	47	84
GRAND TOTAL	5620	4452	4355	4823	4346	5764	4691	1596	4491	4765

Data Source: UNODC, "World Drug Report," 2004, p. 205

In addition to cultivation, price, and production data, the opium surveys provide useful information about a number of issues including the role of family labor in the opium harvest and the average landholding of an Afghan farmer. Other important details relating to opium cultivation are available through a variety of sources, which will be named as they become relevant to the model in the following section.

4. A Model of the Afghan Farmer's Land Allocation Decision

Analyzing the potential for policy to affect a farmer's decision to cultivate opium requires modeling the factors that determine the profitability of cultivating opium relative to other crops. I begin by modeling a farmer's decision as it would likely have been made during the 1990's, when eradication risk was not a significant factor and opium prices were relatively stable. Under normal circumstances (assuming constant crop yields and input costs on any one farmer's plot of land) one would expect farmers to identify their most profitable crop and devote their land to that crop alone. Farmers in Afghanistan, however, do not engage in this practice, which is commonly known as mono-cropping. The early stages of the model will provide an understanding of why this is the case. After completing this comparatively simple model, which focuses on net profit maximization in the absence of risk, I move on to address the uncertainty created by crop eradication and the stigma associated with engaging in illegal and anti-Islamic behavior.

As the data on labor and capital input costs suggest, an important driver of land allocation by Afghan farmers is a substantial discontinuity in the labor costs of opium cultivation. This discontinuity results from the fact that the opium harvest is a highly labor intensive period during which the opportunity cost-free labor of women and children is sufficient for the average family to harvest about .35 hectares. For all opium cultivated beyond this point farmers must hire itinerant laborers at a marginal cost per hectare of around $1360. This amount is highly significant given the size of other input costs and the average total income of an Afghan farmer.

<u>The Basic Model</u>

I view a farmer as allocating a land endowment (T) across i potential crops. I calculate the revenue from any crop by multiplying the number of hectares devoted to the crop by its price and its yield per hectare (1 hectare = 10,000 square meters). I then calculate net profit by subtracting production costs (including the opportunity cost of household labor). Altogether, net profit (π_i) equals the price (P_i) times the yield (Y_i) times the number of hectares (H_i) minus labor costs (L_i) and capital costs (K_i):

$$(6)\,\pi_i = P_i Y_i H_i - L_i - K_i.$$

The farmer's total net profit equals the summation of net profit across the i crops subject to the constraint that the sum of the land devoted to each crop (H_i) equals the land endowment (T):

$$(7)\,\pi = \sum (P_i Y_i H_i - L_i - K_i)\, s.t. \sum (H_i) = T.$$

To maximize profit the farmer would allocate land such that the marginal profitability of any one crop (for which any land is allocated) equals the marginal profitability of every other.

Several simplifying assumptions make it easier to examine the farmer's decision in concrete terms. In the first place, I assume that individual farmers are price takers, and thus take the P_i as constants in any given year within any given district. (Note, however, that prices can vary significantly across provinces, and even districts, for reasons such as opium quality and access to trafficking routes.)

Second, given that wheat is far more intensively cultivated in Afghanistan than any other crop, it is sensible for ease of analysis to think of the farmer's decision as being between opium and wheat rather than between opium and a universe of potential crops.[5] This simplification is necessary for the purpose of data analysis because the required data is simply not available for other crops.

Additionally, although it is certainly possible for there to be variation in the yields on any given plot of land, such variation at the level of the individual farmer (who owns only 2.1 hectares of land on average) is likely to be minimal. Thus although it is possible for there to be variability in the relative profitability of opium and wheat on a single plot of land, it should be kept in mind that for most farmers the labor constraint to which I alluded above will be the primary driver of the land allocation decision.

In general, then, a farmer choosing to allocate land between opium and wheat would attempt to maximize net profit as a function of revenues, labor costs, and capital costs. This function looks like the following:

$$(8)\ \pi = P_O Y_O H_O + P_W Y_W H_W - w(L_O H_O + L_W H_W) - r(K_O H_O + K_W H_W),$$

$$s.t.\ H_O + H_W = T\ ,$$

where $L_O, L_W, K_O,$ and K_W represent the amounts of labor and capital needed to farm a hectare of opium or wheat. The labor variables should be thought of as the required number of days of labor, for which laborers are compensated with a daily wage of w. The capital variables should be thought of as the dollar value of the capital inputs, with r representing the capital's "rental rate." r here is not an interest rate as generally construed. It represents exorbitant borrowing costs that are only faced by farmers if they purchase capital inputs beyond those which they can

5 The UNODC (2003) notes that Afghan farmers devoted 2,534,000 hectares of land to cereal grains in 1999, of which 2,027,000 went to wheat. After the cereal grains, the next most intensively cultivated category of crops is "oil-crops," which consists largely of soybeans. Afghan farmers cultivated oil-crops on approximately 146,800 hectares of land, which amounts to little more than 7% of the land devoted to wheat.

purchase using their cash on hand.[6]

The Labor Constraint

Peculiarities relating to Afghanistan's labor market result in a substantial discontinuity in the labor cost function. The labor intensity of the opium harvest has enough of an effect on labor demand that there are distinct harvest and non-harvest wages in opium producing areas. As Mansfield (2004) observes, wage increases are noticeable during the harvest, with wages fluctuating between the equivalent of $3 and $9 per day in areas of Badakshan province. Although these wage increases directly affect the cost of itinerant labor, and raise the opportunity cost of male household labor, this opportunity cost does not apply to the labor of household children and females.

For religious reasons the women in most areas of Afghanistan do not have access to labor opportunities off of their family farms. The U.N.'s Strategic Study #6, "The Role of Women in Opium Poppy Cultivation in Afghanistan," finds that women play a prominent role in the opium harvest in Afghanistan's Northern and Eastern provinces (notably Badakshan and Nangarhar). Restrictions on women's labor seem to be relaxing in some areas of Badakshan, where women have recently been observed to receive wages for labor during the harvest (Aga Kahn Foundation, 2004). This kind of movement towards gender equality has not been seen in the south, however, where local control remains in the hands of relatively conservative Islamic leaders. The south appears to operate with relatively more reliance on its long established system of itinerant labor (UNODC, 1999c).

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6 This issue is given fuller treatment in Clemens (2005), which is available on request from the author. Its impact on the analysis in this paper is not significant enough to merit its inclusion.

As estimated in many of the U.N.'s surveys and reports, opium farming requires approximately 350 person days per hectare over the course of the year relative to 41 days for wheat (UNODC, 2003).[7] 200 of these days fall during the two to three week harvest period (UNODC, 2003).[8] This implies a need for between 10 and 14 individuals working full time on any one hectare of opium in order to complete the harvest during the appropriate time. With families averaging 6-7 members (including those both too young and too old to work), there is thus a need for itinerant labor if the typical family intends to cultivate more than about .35 hectares of opium (UNDCP, 2003b).[9]

This state of affairs has the following implications for the labor costs for farming opium and wheat: Both crops contain a component that involves an opportunity cost in terms of the non-harvest wage, $(L_O H_O + L_W H_W) w_{nh}$. In addition, opium farming involves labor at an opportunity cost equal to the opium harvest wage, w_h. The amount of this labor equals the number of laborers needed per hectare times the number of hectares of opium minus the number of family (i.e. women and children) labor days available, or $L_{OH} H_O - L_{F.}$ All together, this results in

$$(9)\, Labor\ Costs = (L_O H_O + L_W H_W) w_{nh} + (L_{OH} H_O - L_F) w_h,\ s.t.\ L_F \leq L_{OH} H_O,$$

where I restrict L_F to being less than the amount of labor required for the opium harvest because, as noted, it is not possible for such labor to be hired out at the harvest wage when it is available in excess.

<u>The Complete Net Profit Model</u>

7 See p. 109
8 See p. 105
9 See p. 51

With labor costs defined as above, net profit is maximized with respect to hectares of opium when the following condition holds

$$(10)\, P_O Y_O - w_{nh} L_O - w_h L_{oh} - K_O = P_W Y_W - w_{nh} L_W - K_{W.}$$

This result makes sense intuitively, as it implies that net profit is maximized when opium and wheat are cultivated such that the marginal net profit from either crop is equal. This condition must be interpreted with caution, however, because net profit is discontinuous with respect to H_O. In particular, $w_h = 0$ when $H_O L_{oh} \leq L_F$, and $w_h = \$6.8$ when $H_O L_{oh} \geq L_{F.}$

Table 2, on the next page, contains the parameter estimates and sources I use to calibrate the net profit function. The prices and yields are estimated as the means of distributions of a relatively large numbers of observations. These price data will come into play again when I estimate the price elasticity of Afghan opium supply in the next section. Capital costs, wages, labor requirements, and the availability of family labor are estimated on the basis of single observations from case studies. In Table 3, also on the next page, I bring these parameter estimates together to produce estimates of the total labor and capital costs for cultivating wheat and opium with and without the labor constraint.[10]

10 I assume that the household males are performing all labor necessary for cultivating wheat, and all non-harvest labor necessary for cultivating opium. U.N. reporting on the roll of women during the harvest suggests that although women typically have a full slate of household responsibilities, they are worked particularly hard during the opium harvest (UNODC, 2000b). It is easiest to think of the effort they exert during the opium harvest as being an effort that could not be sustained year round. Thus the women are not available for farm work during the remainder of the year (hence the opportunity cost of the standard daily wage), but they are nonetheless available as opportunity cost-free labor during the opium harvest. Also, I assume that the farmer himself is involved in the opium harvest along with his women in children. Thus the farmer's own labor during the harvest is included in the labor costs for opium cultivation. This cost amounts to the harvest wage times the estimated 17 harvest days for a total of $115.60.

Table 2: Net Profit Model Parameter Estimates and Sources

Parameter	Estimate	Sources
Land Endowment	2.1 hectares	UNDCP, 2004a
Opium Price	$36.69	UNDCP Surveys (1994-2000)
Wheat Price	$0.18	UNDCP Surveys (1994-1997)
Opium Yield kg/hectare	38.8	UNDCP Surveys (1994-2000)
Wheat Yield kg/hectare	3815	UNDCP Surveys (1994-1997)
Labor/Ha (Opium; non-harvest)	150	UNODC, 2003
Labor/Ha (Opium; harvest)	200	UNODC, 2003
Labor/Ha (Wheat)	41	UNODC, 2003
Capital/Ha (Opium)	$127.82	Asad and Harris, 2003; Mansfield, 2001
Capital/Ha (Wheat)	$186.70	Asad and Harris, 2003; FEWS NET, 2003
Interest Rate	1.38	UNDCP, 1999b
Non-Harvest Wage	$1-$2	UNDCP, 2004a
Harvest Wage	$6.80	UNDCP, 2004a
Family Harvest Labor Days	68	UNDCP, 2004a

Table 3: Net Profit Model Production Costs Estimates (1994-2000 costs estimated per hectare)

Aspect of Production Costs/Ha	Estimate
Opium Labor Costs (without constraint)	$340.60
Opium Labor Costs (with constraint)	$1,585.00
Wheat Labor Costs	$61.50
Opium Capital Costs	$127.82
Wheat Capital Costs	$186.70

Note again that the labor constraint works uniquely against opium cultivation because the opium harvest is the only time period during which constraints on labor are experienced. Assuming that yield variability on any given plot of land is minimal, the data lead to the following predictions for the land allocation of the average farmer from 1994-2000: An average farmer would have required an opium price of at least $23.38 in order to cultivate opium to the point of the labor constraint and a price of $55.45 in order to devote all of his land to opium.

The key insight made apparent by these figures is the substantial impact that the labor constraint plays on land allocation decisions. Since the average price of opium from 1994-2000 was $36.69, the model suggests that the labor constraint would, in fact, have determined the opium cultivation level for any farmer without yields substantially higher than the average.

The average opium cultivating farmer has been observed to devote approximately .34 hectares of his 2.1 hectare land endowment to opium. This observation coincides neatly with the fact that the available opportunity cost-free labor in the average family would be sufficient to harvest about .35 hectares of opium.

With the net profit model anchored by these concrete values, I now turn to two more complicated issues. The first involves extending the profit model into a utility maximization model which incorporates the uncertainty imposed by crop eradication. The second involves accounting for the significant residual between observed opium prices and the prices predicted by the model of utility maximization under uncertainty for the years 2001-2003. I do this by considering three ways in which farmers might be affected by the social stigma (or moral costs) associated with engaging in activity that is both illegal and widely perceived to be anti-Islamic. These factors must be incorporated in order to make the model applicable to the current opium cultivating environment.

Eradication Risk

The issue of crop eradication poses two difficulties for model calibration. The first results from the fact that the opium surveys only contain crop eradication data for the 2003 harvest. This leaves it unclear how extensive eradication operations were in 2002 and 2004. The second involves the fact that the relevant parameter is technically the expectation of the probability of crop eradication rather than the level of crop eradication that is actually observed. I hypothesize that this distinction plays an important role in explaining the price shifts observed since 2001. It is likely that in 2002 and 2003, Afghan farmers and drug traffickers anticipated that the United States would engage in relatively large-scale opium eradication operations. This would explain the high price levels observed in 2001 ($301/kg) and 2002 ($350/kg), which brought cultivation levels back to 72,000 hectares in 2002 and 80,000 hectares in 2003. When the actual levels of crop eradication fell below these expectations in 2002 and 2003, however, farmers would have reevaluated their risk assessments. This would explain why the 2003 price level of $280/kg was sufficient to induce the cultivation of a record high 130,000 hectares in 2004.

To incorporate the probability of crop eradication, I employ a constant relative risk aversion (CRRA) utility function of the form:

$$(11)\, EU = p_b \frac{W_b^{(1-\gamma)}}{(1-\gamma)} + p_g \frac{W_g^{(1-\gamma)}}{(1-\gamma)}$$

This function assumes that after the outcome of an event, an individual will find him or herself in either of two states of the world. The probabilities that the individual will be in the "good" and "bad" states of the world are p_g and p_b respectively. W_g and W_b represent the individual's level of wealth in the good and bad states. For all $\gamma > 0$, utility increases with wealth at a decreasing rate. High levels of γ indicate relatively high levels of risk aversion.

For an opium farmer in Afghanistan, the bad state of the world represents the state in which the authorities eradicate his opium crop, which occurs with probability (p_e).

The good state of the world, which occurs with probability $1-p_e$, is the state in which the opium crop is not eradicated and provides the farmer with revenue in the amount of $P_o Y_o$ per hectare.

At this point I will simplify the equation by simply using N_o and N_w to represent net income per hectare of opium and wheat respectively. With this in mind, I incorporate crop eradication risk as follows:

$$(12)\, EU = p_e \frac{(W + H_W N_W - H_O C_{(O,nh)} - H_O S)^{(1-\gamma)}}{(1-\gamma)}$$

$$+ (1-p_e) \frac{(W + H_W N_W + H_O N_O)^{(1-\gamma)}}{(1-\gamma)}.$$

The W in both terms represents the farmer's initial wealth level at the beginning of the planting season. $C_{(O,nh)}$ represents the costs incurred when the farmer plants a hectare of opium that gets eradicated before the harvest. S represents a hypothetical sanction that might be imposed on farmers on a per-hectare basis for cultivating opium.

For my primary estimates, I use $W=\$3000$. De Soto (2000) uses a value of \$3973/Ha in his estimations of the value of the rural landholdings of farmers in developing countries. I scale this value down to account for Afghanistan's relatively low land productivity and low accessibility to markets for farm commodities. The model is not sensitive to moderate variations in this assumption.

The wealth parameter differs from the income and cost parameters in that it represents a stock of wealth rather than a yearly income flow. It is necessary to incorporate this reserve of wealth to allow for the possibility of negative yearly income in the case of crop eradication. In the absence of a wealth term, negative yearly income makes utility infinitely low. This would make sense under the assumption that negative income results in starvation, but landholding farmers retain the possibility of selling their land or entering a share cropping agreement.[11]

In my primary estimates I assume that $\gamma=4$. Efforts to directly estimate risk aversion (outside of controlled experiments) are relatively rare in the economic literature. Chetty (2004) notes that γ is generally assumed to be some value less than 2 on the basis of introspection about hypothetical gambles. Chetty (2004) goes on to estimate that $\gamma=4.75$ for recipients of unemployment insurance in the United States. Hausman (1985) estimates γ values ranging from 1 to 4 for U.S. disability insurance applicants. I use $\gamma=4$ because it seems likely that the nearly subsistence level living standards of Afghan farmers will put them towards the high end of the risk aversion spectrum.

As will be seen momentarily, $\gamma=4$ leaves a substantial residual between predicted and observed opium prices. Adjusting γ within a moderate range of values does little to account for this discrepancy. From 2001 to the present (the time during which crop eradication has been a factor), it would be possible to make recourse to very high levels of γ, which, although seemingly extraordinary, are implied by the extension of economic experiments involving aversion to small scale losses. However, as Rabin and Thaler (2001) contend, "the correct conclusion for economists to draw, both from thought experiments and from actual data, is that people do not display a consistent coefficient of relative risk aversion." Thus rather than resorting to the high levels of risk

11 Evaluating utility in terms of the effects of yearly income on end-of-year wealth is also consistent with the notion of decision isolation, which implies that individuals assess the potential effects of risks one at a time rather than in the context of a lifetime of risky choices. Rabin and Thaler (2001) argue that decision isolation (also known as narrow framing and myopic loss aversion) "must [be a key component] of a good descriptive theory of risk attitudes."

aversion implied by aversion to small scale risks, I keep to the estimates made by Chetty (2004) and Hausman (1985), which apply to individuals making decisions that will have a significant impact on lifetime wealth. I find it more plausible to address this residual in terms of the social stigma, or moral costs, associated with engaging in anti-Islamic and illegal behavior.

Stigma (The Moral Costs Associated with Engaging in Illegal and Anti-Islamic Behavior)

The issue of stigma poses a significant hurdle for the task of model calibration because it has no obvious functional form. Stigma clearly plays an important role in farmers' decisions, however, as evidenced by survey results included in both the 1995 opium survey (UNODC) and the 2003 Survey of Farmer's Intentions (UNODC, 2004). In 1995, legal bans on opium poppy cultivation were sparsely imposed in only a few of Afghanistan's districts. At this time, U.N. survey teams asked non-opium cultivating farmers in opium cultivating areas to give their primary reason for not cultivating opium. More than half of these farmers claimed that religious opposition or superstition were their primary reasons, while fewer than a quarter cited cited either legal bans or farm specific factors such as soil quality. In this same survey, around two-thirds of the farmers also expressed a desire for their communities to either reduce cultivation levels or eradicate opium poppy altogether (UNDCP, 1995).

By the time of the 2003 Survey of Farmer Intentions, opium cultivation had been banned throughout Afghanistan. At this time, among non-opium cultivating farmers, 47.1% cited either religious opposition or the fact that the ban was in place as their primary reason for not cultivating opium. 33.4% cited fear of actual enforcement of the ban, and 11% cited soil quality.

Following is a description of my strategy for estimating the size of the moral cost parameter (I subsequently address its form): I use my other parameter estimates to identify the extent to which input costs, opportunity costs, and eradication risks cannot explain observed prices. Recall that there is a substantial discontinuity in the cost of cultivating opium beyond the labor constraint (typically at .35 hectares), and that this constraint determines the amount of opium cultivated by the typical farmer. Because of this discontinuity at the primary point of interest, analysis of the utility function cannot involve taking its derivate around this point. Instead, I begin by calculating the farmer's expected utility if he were to devote all of his land to wheat. I then calculate the threshold opium price at which the utility from cultivating .35 hectares of opium (and the rest of the land with wheat) is marginally higher than that from devoting all of the land to wheat.

The calculations in Tables 4 and 5, on pages 26 and 27, indicate how necessary it is to include a moral cost term to fit this model. As can be seen in column 2 of Table 4 (which refers back to calculations for the pre-eradication period from 1994-2000), in the absence of a moral cost it would only have been necessary for traffickers to pay a price of $24 for the utility from cultivating .35 hectares of opium to exceed the utility from mono-cropping wheat.[12] In column 3 of Table 4 I estimate that the moral cost term would have to amount to 53% of the net income from opium cultivation in order to bring the threshold price up to $36.69.

12 This higher price cannot be explained by the idea that the marginal opium farmer (whose conditions determine the market price) has yields that are low enough to require a price of $36. This explanation is insufficient because there is a great deal of land throughout Afghanistan on which opium yields of 40kg/Ha or even 50kg/Ha could be attained, but which are farmed exclusively with wheat or other alternative crops.

Table 4: Expected Utility Calculations for 1994-2000

	(1)	(2)	(3)
	Utility with no opium cultivation	**Calculation of the threshold opium price with no moral cost term**	**Calculation of the moral cost term necessary to make the threshold opium price equal the actual opium price**
Land Endowment	2.1	2.1	2.1
Opium Hectares	**0**	**0.35**	**0.35**
Net Income (wheat)	438.57	438.57	438.57
Opium Costs (no harvest)	352.82	352.82	352.82
Opium Cost	468.42	468.42	468.42
Opium Yield	38.8	38.8	38.8
Wealth	3000	3000	3000
Sanction	0	0	0
Eradication Probability	0	0	0
Moral Cost	0	0	**0.53**
Opium Price	**36.38**	**24**	**36.38**
1 – Gamma	-3	-3	-3
EU * 10^10	-0.05530	-0.05494	-0.05523

Note: Utility is always negative in this model, with values closer to zero designating higher levels of utility then values farther from zero. I have multiplied all utility levels by 10^10 to avoid having to display a long string of zeros after each decimal.

In Table 5 I calibrate the expected utility model for the amount of opium cultivation observed in 2004, which reflects farmers' expectations for prices and eradication levels in that year. I assume these expectations to be the levels observed in 2003. A price of $283 and eradication probability of .21 in 2003 induced farmers to cultivate 130,000 hectares of opium in 2004. The subsequent decline in prices after the 2004 harvest (from $283 to $92) suggests that this increase in cultivation from the 2003 level of 80,000 hectares was not an increase for which opium traffickers had intended to signal. Using a supply elasticity estimate of 1 (which I derive in Section 5), I estimate that 80,000 hectares (the number around which cultivation has fluctuated in recent years) would have been cultivated at a price of about $170. Consequently, I fit the moral cost term to the point at which the probability of eradication is .21 and the price is $170.

Table 5: 2004 Model Calibration (Eradication Probability = .21, Opium Price = $170)

	(1)	(2)	(3)
	Baseline with no moral cost	**Calculation of the threshold opium price with no moral cost**	**Calculation of the moral cost term necessary to make the threshold opium price equal the actual opium price**
Land Endowment	2.1	2.1	2.1
Opium Hectares	**0**	**0.35**	**0.35**
Net Income (wheat)	378.57	378.57	378.57
Opium Costs (no harvest)	577.82	577.82	577.82
Opium Cost	693.42	693.42	693.42
Opium Yield	38.8	38.8	38.8
Wealth	3000	3000	3000
Sanction	0	0	0
Eradication Probability	**0.21**	**0.21**	**0.21**
Moral Cost	0	0	**0.88**
Opium Price	**24**	**36**	**170**
1 – Gamma	-3	-3	-3
EU * 10^10	-0.06099	-0.06099	-0.06093

Note: The input costs used here reflect the fact that daily wages increased from around $1.50 (1994-2000) to around $3 in 2004. The analysis in this table is similar to that in Table 1E. Column 2 shows that in the absence of a moral/psychic cost term, the observed level of eradication risk in 2001 (i.e. .21) would have driven the threshold price at which the farmer would be willing to cultivate opium up to his labor constraint to about $36/kg. Column 3 shows that the moral/psychic cost term would essentially have to wipe out 88% of the net income from opium cultivation in order for the threshold price to have been at its observed level of $170/kg.

As can be seen in Table 5, the model estimates that in the absence of a moral cost term, the price would only have to reach $36 to induce the average farmer to cultivate .35 hectares of opium with an eradication probability of .21. This number is not particularly sensitive to adjustments of the risk aversion parameter. Increasing γ from 4 to 6, for example, only increases the opium price from $36 to $38. I calculate that a moral cost equivalent to 88% of the net income from opium cultivation is required to bring the threshold price to $170.

Keeping to simple and intuitive functional forms, I consider three ways in which one might expect the stigma of engaging in anti-Islamic and illegal behavior to impact an opium farmer's utility. The first form, $M_{(O,1)}$, is as a negative constant that appears both when the crop is and is not eradicated. This form suggests a cost which impacts the farmer at planting time, as it is independent of whether or not the farmer earns income from harvesting the crop. The second form, $M_{(O,2)}$, is a negative constant that only appears when the crop is not eradicated. This form suggests a constant cost associated with earning income from engaging in morally questionable activity. The third form, $M_{(O,3)}$, is a proportion of the net income earned from opium cultivation. This form suggests a cost that rises with the amount earned from illicit activity. The inclusion of these terms results in the following final form of the expected utility function:

$$(13)\, EU = p_e \frac{(W + H_W N_W - H_O C_{(O,nh)} - H_O S - M_{(O,1)})^{(1-\gamma)}}{(1-\gamma)}$$

$$+(1-p_e)\frac{(W + H_W N_W + H_O N_O - M_{(O,1)} - M_{(O,2)} - N_O M_{(O,3)})^{(1-\gamma)}}{(1-\gamma)}$$

Intuition offers little when it comes to assigning weights for the importance of the moral cost terms. To address this problem I experiment with the functional forms in which one of the three moral cost terms is, by itself, assumed to account for the entire residual factor. I calibrate the model in each case to fit the point at which the probability of eradication equals .21 and the price of opium equals \$170. I then determine the importance of each term based on the plausibility of its implications for the prices observed in 2001 and 2002.

For example, when I assume that $M_{(O,2)}=0$ and $M_{(O,3)}=0$, then the entire residual must be explained by $M_{(O,1)}$ (i.e. the moral cost that applies whether or not the authorities eradicate the opium crop). Fitting this form for the point at which $p_e=.21$

and $P_O = 170$ requires that $M_{(O,1)} = 2377$. The presence of this large, negative parameter in the term that represents utility in the case of crop eradication makes the "gamble" of opium cultivation appear to be far more risky than it would in the absence of this moral cost. Consequently, this functional form has seemingly implausible implications for the effects of increasing the level of eradication risk. To increase the price of opium to the $350 level observed in 2002, this form implies that the expected probability of crop eradication need only have been .3. It implies further that the probability of eradication need only increase to .34 in order to make it so that no price will induce the farmer to cultivate .35 hectares of opium. It seems unlikely to me that this result could accurately reflect the preferences of Afghan farmers.

When accounting for the entire residual with $M_{(O,2)}$ (i.e. the constant moral cost that applies only when the authorities do not eradicate the opium crop), fitting the model requires that $M_{(O,2)} = 5199$. Like the previous functional form, the implications of this form for past perceptions of p_e lack plausibility. This form implies that the expected probability of eradication must have been .71 in order to generate the observed price of $350 in 2002. It also implies that if the expected probability of eradication were to rise slightly higher, to .76, there would be no opium price at which the average farmer would be willing to take the gamble associated with cultivating .35 hectares of opium. In other words, in order to account for 2002 price levels the eradication probability would have to be high enough that the model is approaching an asymptote, and is thus unreliable in terms of its implications for farmer preferences.

When accounting for the entire residual with $M_{(O,3)}$ (i.e. the moral cost that increases as a proportion of the income earned from opium cultivation in the absence of crop eradication), fitting the model requires that $M_{(O,3)}=.88$. Of the three cases addressed, this form provides the most plausible explanation for the price levels observed in 2002 and 2003. The model implies that farmers must have expected an eradication probability of about .45 to have required an opium price of $350 to cultivate .35 hectares. In this case the model behaves normally around the point at which it is fitted.

In accordance with these results, my final estimates use $M_{(O,3)}$ to account for most of the residual factor. In the estimates reported below, I use $M_{(O,3)}=.66$, $M_{(O,1)}=283$, and $M_{(O,2)}=849$. [13] Table 6, on the next page, contains the implications of this model for estimates of the effects of different levels of crop eradication policy. I estimate that raising the probability of crop eradication to .35 would increase the price of opium to $253 and that increasing the probability to .5 would increase the price to $525.

Table 7, on page 32, contains the implications of this model for the effectiveness of two forms of alternative development. The first form involves efforts to increase alternative farm incomes by, for example, introducing new agricultural techniques to improve wheat yields. The UNDCP (2003) suggests that targeted programs of this sort increased wheat income per hectare by slightly less than $450 in three districts

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13 This form uses $M_{(O,3)}$ to account for approximately 75% of the residual and splits divides the remaining 25% between $M_{(O,1)}$ and $M_{(O,2)}$.

Table 6: 2004 Expected Utility Calculations: Opium Prices For Eradication Levels

	(1)	(2)	(3)
	Baseline with Moral Cost and 2003 Eradication Probability of .21	**Eradication probability of .35**	**Eradication probability of .5**
Land Endowment	2.1	2.1	2.1
Opium Hectares	0.35	0.35	0.35
Net Income (wheat)	378.57	378.57	378.57
Opium Costs (no harvest)	577.82	577.82	577.82
Opium Cost	693.42	693.42	693.42
Opium Yield	38.8	38.8	38.8
Wealth	3000	3000	3000
Sanction	0	0	0
Eradication Probability	**0.21**	**0.35**	**0.5**
Moral Cost (1)	283	283	283
Moral Cost (2)	849	849	849
Moral Cost (3)	0.66	0.66	0.66
Opium Price	**170**	**253**	**525**
1 – Gamma	-3	-3	-3
EU * 10^10	-0.06093	-0.06092	-0.06093

Kandahar province. I estimate that if the net income for a hectare of wheat increased by $450, the threshold price of opium would increase from $170 to $220.

The second form of alternative development involves an improvement in off-farm earning opportunities in the form of general wage increases. Such increases are not necessarily brought about by any particular policy, but rather come naturally through the broader process of economic development. The World Bank (2004) estimates that the daily wage of casual unskilled labor in Afghanistan increased by 86.1% in 2001/02, by 9.0% in 2002/03, and by 70.0% in 2003/04.[14] Similarly, the UNODC (2004b) estimates that between 2002 and 2003, the daily wage for labor in Afghanistan's opium cultivating districts increased from $1-$2 to about $2.70.[15] In Table 7 I estimate that if wages were to increase by an additional $3 across the board the opium price would have to increase from

14 See Table 3.3
15 See p. 40

$170 to $199. Increases in wages have this effect on the price of opium because of opium's relative labor intensity.

Table 7: 2004 Expected Utility Levels: Opium Prices Associated With Alternative Development (Alternative Farm Income Growth and Wage Growth)

	(1)	(2)	(3)	(4)
	Baseline with wheat income increased by $450	**Threshold opium price calculation with wheat income increased by $450**	**Baseline with all wages increased by $3/day**	**Threshold opium price calculation with wages increased by $3/day**
Land Endowment	2.1	2.1	2.1	2.1
Opium Hectares	0	0.35	0	0.35
Net Income (wheat)	**838.57**	**838.57**	**255.57**	**255.57**
Opium Costs (no harvest)	**577.82**	**577.82**	**1027.82**	**1027.82**
Opium Cost	**693.42**	**693.42**	**1194.42**	**1194.42**
Opium Yield	38.8	38.8	38.8	38.8
Wealth	3000	3000	3000	3000
Sanction	0	0	0	0
Eradication Probability	0.21	0.21	0.21	0.21
Moral Cost (1)	283	283	283	283
Moral Cost (2)	849	849	849	849
Moral Cost (3)	0.66	0.66	0.66	0.66
Opium Price	**170**	**220**	**170**	**199**
1 – Gamma	-3	-3	-3	-3
EU * 10^10	-0.03089	-0.03088	-0.07535	-0.07535

Table 8, on the next page, contains the model's implications for the effects of adding a per/hectare sanction which would be imposed on farmers along with crop eradication. I estimate that a sanction of $500/hectare coupled with the 2003 eradication probability of .21 would force the price of opium from $170 to $203. A similarly imposed sanction of $1000 would force the price of opium to $252. The effects of such sanctions increase with the probability of eradication.

Table 8: 2004 Expected Utility Levels: Opium Prices Associated With Sanctions

	(1)	(2)	(3)
	Baseline with Moral Cost and 2003 Eradication Probability of .21	**Sanction of $500/Ha**	**Sanction of $1000/Ha**
Land Endowment	2.1	2.1	2.1
Opium Hectares	0.35	0.35	0.35
Net Income (wheat)	378.57	378.57	378.57
Opium Costs (no harvest)	577.82	577.82	577.82
Opium Cost	693.42	693.42	693.42
Opium Yield	38.8	38.8	38.8
Wealth	3000	3000	3000
Sanction	**0**	**500**	**1000**
Eradication Probability	0.21	0.21	0.21
Moral Cost (1)	283	283	283
Moral Cost (2)	849	849	849
Moral Cost (3)	0.66	0.66	0.66
Opium Price	**170**	**203**	**252**
1 – Gamma	-3	-3	-3
EU * 10^10	-0.06093	-0.06089	-0.06090

The model also has two important distributional implications on which I will comment briefly. If a farmer is poor, then the income from the harvest in any particular year will represent a relatively large proportion of his potential wealth at the end of the year. Consequently, poor farmers will be more sensitive to the risks associated with crop eradication. All else equal, poor farmers will require a larger increase in the price of opium to compensate them for crop eradication risks than will rich farmers. Additionally, as is the case in any law enforcement setting, those who are relatively less inclined to obey the law will naturally be inclined to do so for relatively low levels of compensation. Thus the Afghan farmers who are relatively less inclined to respect either Islamic or secular law (i.e. those with relatively low moral cost parameters) will emerge as low cost producers on the opium supply curve.

These estimates of the capacity for policy to increase the price of opium represent my estimates of the capacity for policy to shift the supply curve. I now turn to estimating the elasticities of farm-gate supply and demand in order to derive the equilibrium effects of these supply curve shifts.

5. Supply and Demand Elasticity Estimation

The Elasticity of Supply

To estimate the elasticity of opium supply at the farm-gate level I use a lagged price model in which the number of hectares cultivated with opium in a particular district or province is determined by the opium price in the previous year. Such models are uniquely suited for agricultural settings for two reasons. First, the number of hectares cultivated and the market price are not subject to instantaneous adjustment, but are rather determined at discrete moments in time each year (namely the planting season and the harvest season). This makes it easy to identify a clearly defined time 1, time 2, etc. Second, since the determination of quantity and the determination of price take place at different times during the year (again the planting and harvest seasons), and since Afghan farmers receive little, if any, information about price adjustments between one year's harvest and the next year's planting season, it is relatively easy to identify the price to which farmers are reacting. A farmer's best expectation of the price that he will receive at the harvest in year t will be the price he received when he brought his produce to market in year t-1.

The supply determinants described in the previous section must also be dealt with before proceeding with elasticity estimates. Unfortunately, with the exception of wheat prices, data restrictions preclude the possibility of controlling for other factors. However, this does not create as dire a situation for present purposes as one might imagine.

I avoid the complications of crop eradication by basing my estimates on data for the pre-eradication time period of 1994-2000. Fluctuations in the prices of labor and capital inputs, to the extent that such fluctuations prevailed, would introduce a negative bias to my estimates. Given the conditions which prevailed in Afghanistan during the time period in question, however, it does not seem likely that such fluctuations would have been significant. 1994-2000 constituted the 15^{th}-21^{st} consecutive years of conflict in Afghanistan, and by most accounts the country's basic infrastructure, banking system, labor market, and markets for inputs like fertilizers were in essentially the same, ill-functioning state throughout these years.

My basic strategy, then, is to estimate the number of hectares cultivated with opium as a function of either the previous year's price of opium alone, or as a function of both the previous year's price of opium and price of wheat:

$$(14)\ln(H_{(O,t)})=\beta_0+\beta_1\ln(P_{(O,t-1)})+\varepsilon_1$$

$$(15)\ln(H_{(O,t)})=\beta_0+\beta_1\ln(P_{(O,t-1)})+\beta_2\ln(P_{(w,t-1)})+\varepsilon_2.$$

I take natural logs in all cases so that I can interpret coefficient estimates as elasticities.

From 1994-2000, the UNODC collected opium cultivation data at the district level, which I also aggregate to construct province level observations. During this time period the UNODC reported price data for both opium and wheat at the province level. For opium, I associate prices from 1994-1999 with cultivation levels from 1995-2000. Since the UNODC only reported wheat prices in the opium surveys from 1994-1997, specifications that include the price of wheat only make use of opium cultivation data from 1995-1998. In different specifications I have matched the province level price data with either the province level cultivation data, or with the more detailed district level cultivation data (with the province level price applied to each district in the province). Summary statistics for opium and wheat prices can be found in Table 9 on page 37.

I report my results in Tables 10 and 11 on pages 37 and 38. Specifications 1 and 2 on each table make use of all available observations for the time period in question. Specifications 3 and 4 restrict the sample to districts with cultivation levels of at least 50 hectares (in Table 10) and provinces with cultivation levels of at least 250 hectares (in Table 11). I do this because cultivation sometimes begins in a district on a small scale, as farmers experiment with opium as a new crop, and then increases dramatically in the next year as the crop is phased in. Cultivation increases of this sort would, in effect, result from shifts of the district or province level supply curve rather than because of movements in price. In both tables, I include wheat prices in specifications 1 and 3.

The estimates consistently suggest that district and province opium cultivation levels are quite responsive to prices. The district level estimates for the opium price elasticity range from .74 to 1.64. The province level estimates range from .45 to 1.43. Although one can always hope for more, the precision, consistency, and plausibility of the estimates is reassuring given the potential for measurement error in data on the cultivation of an illicit commodity. Given that the point estimates cluster around 1, I estimate for the purpose of my equilibrium analysis that the level of opium cultivation in Afghanistan is unit elastic with respect to price.[16] These district and province level elasticities are most likely driven by variations in crop yields and moral cost parameters across farmers.

The small, negative coefficients on wheat prices in the district level estimates are plausible, but highly imprecise estimates for a cross-price elasticity. The larger, positive coefficients on wheat prices in the province level estimates, on the other hand, are theoretically implausible. In both cases, the wheat price coefficients are imprecisely measured, as can be seen from the size of their standard errors. These estimates will not play a role in subsequent analysis.

Table 9: Summary Statistics for Opium and Wheat Prices (1994-2000)

	Mean	**Std. Dev.**	**Min.**	**Max.**
Opium Price	$36.69	$16.61	$17.64	$92.57
Wheat Price	$0.18	$0.09	$0.09	$0.50

Data Source: UNDCP, "Afghanistan Opium Surveys," 1994-2000.

Table 10: Estimates of the Price Elasticity of Hectares Cultivated (Using District Level Cultivation Data)

	(1)	(2)	(3)	(4)
ln (opium price)	1.07	1.64	0.74	0.80
	(0.50)	(0.78)	(0.30)	(0.53)
ln (wheat price)		-0.05		-0.14
		(0.53)		(0.30)
District fixed effects?	Yes	Yes	Yes	Yes
Year fixed effects?	Yes	Yes	Yes	Yes
r^2	0.89	0.90	0.89	0.90
Observations	323	221	280	187

Note: Standard errors are reported in parentheses beneath each point estimate. All standard errors are robust and clustered at the district observation level.

16 Aggregation from a district and province level elasticity to a national elasticity comes with the caveat that national production can also expand through the spreading of opium cultivation to new areas. This source of expansion has certainly played a major role over the past decade, but will now be diminished given that in 2004 opium cultivation was observed in all of Afghanistan's administrative provinces.

Table 11: Estimates of the Price Elasticity of Hectares Cultivated (Using Province Level Cultivation Data)

	(1)	(2)	(3)	(4)
ln (opium price)	0.45	1.43	0.61	0.80
	(0.65)	(1.09)	(0.38)	(0.74)
ln (wheat price)		1.02		0.38
		(0.93)		(0.75)
District fixed effects?	Yes	Yes	Yes	Yes
Year fixed effects?	Yes	Yes	Yes	Yes
r^2	0.93	0.96	0.98	0.98
N	38	26	36	22

Note: Standard errors are reported in parentheses beneath each point estimate. All standard errors are robust and clustered at the province observation level.

The Elasticity of Demand

The final key parameter of the market for opium in Afghanistan is the elasticity of demand. As noted in the literature review in section 3, the demand for opium at the Afghan farm-gate is derived from the demand for opiates in final consuming markets. Since almost all of the opium cultivated in Afghanistan is intended for export, demand is essentially a national (or at least regional) phenomenon rather than a localized phenomenon like supply.

The national nature of opium demand makes it difficult to directly estimate the demand curve using UNODC cultivation data because it reduces the number of observations to one per year. Direct estimation is further complicated by the difficulty of controlling for factors such as shifts in the demand in consuming countries and changes in the ability of drug traffickers to evade interdiction efforts. Consequently, my attempt to directly estimate the farm-gate demand elasticity using UNODC data produced results that were imprecise and theoretically implausible.[17]

As an alternative to direct estimation of the elasticity of demand, I turn to equations 3 and 4 from the model of the global market for heroin:

$$(3) P_R = \alpha_R + \beta_R P_A$$

$$(4) \sum Q_{(D,R)} = \sum C_R (P_R)^{\varepsilon}.$$

I construct a range of estimates of β_R in order to bound the ability of changes in the price in Afghanistan to affect prices in consuming countries. Coupling these bounds with past estimates of the elasticity of demand for heroin in consuming countries (ε), I arrive at a range of estimates of the elasticity demand for opium at the farm-gate by substituting equation 3 into equation 4 to produce equation 5 (again from section 4):

$$(5) \sum Q_{(D,R)} = \sum C_R (\alpha_R + \beta_R P_A)^{\varepsilon}.$$

Central to this strategy is the process of estimating the parameters of equation 3, where α_R should be thought of as a fixed, additive markup, and β_R should be thought of as a multiplicative markup which determines the potential effect of changes in the source-country price on the price faced by the consumer.

Both theory and experience suggest that demand for the crops used in illicit narcotics (i.e. raw opium gum and coca leaf) is quite inelastic. The contribution of theory relates to the fact that opium gum and coca leaf are essential inputs for heroin and

17 This attempt involved using of a combination of rainfall data for the growing seasons from 1994-2003 and proxies for eradication efforts in 2001-2003 as instruments for changes in the price of opium that result purely from shocks to the supply curve. Unfortunately rainfall proved to be very weakly correlated with opium production levels. It also proved difficult to quantify the levels of eradication during these years because eradication by the Taliban was qualitatively different than that attempted by the international community in 2002 and 2003. This is because a) there is no estimate of the number of hectares actually eradicated by the Taliban, and b) it is unclear how one might quantify the effect of Taliban-style sanctions.

cocaine, and that they represent a relatively small fraction of the total cost of getting heroin and cocaine to consumer markets (although, importantly, the total impact of the source country price depends on the level of β_R). The contribution of experience relates to the fact that in spite of significant resource expenditure in the war on drugs, both heroin prices in Europe and cocaine prices in the United States declined substantially during the past two decades. It does not seem likely that these declines resulted from reductions in demand, as the years during which prices declined most dramatically were years in which global opium and coca leaf production were increasing. Tables 12 and 13, below, provide a look at the price data in question for European heroin and American cocaine respectively. As can be seen, the inflation adjusted, consumption weighted, aggregate price level for heroin in Europe dropped from as high as $244 thousand/kg in 1990 to a low of $61 thousand/kg in 2001.

Table 12: European Retail Prices for Heroin (1990-2003, in 1000's of US$/kg)

Year	**'90**	**'91**	**'92**	**'93**	**'94**	**'95**	**'96**	**'97**	**'98**	**'99**	**'00**	**'01**	**'02**	**'03**
European Price	244	202	192	136	147	144	138	107	106	96	68	61	64	69

Data Source: UNODC World Drug Report, 2004, p. 363.

Table 13: Cocaine Retail Prices in the United States (1990-2002, in 1000's of US$/kg)

Year	**'90**	**'91**	**'92**	**'93**	**'94**	**'95**	**'96**	**'97**	**'98**	**'99**	**'00**	**'01**	**'02**
U.S. Price	260	239	223	188	169	159	148	145	140	130	138	73	92

Data Source: UNODC, World Drug Report, 2004, p. 369

My estimation of β_R uses the inflation adjusted, consumption weighted, aggregate price level of heroin in Europe. The source of identification is the increase in European prices from 2001 to 2003 which reversed the previous downward trend and followed the shock to prices that occurred in Afghanistan in 2001. I begin by running a series of regressions of the following form:

$$(16)\, P_{(E,t)} = \delta + \beta_E P_{(A,t-1)} + \gamma t + \varepsilon,$$

where the index E indicates that I am dealing specifically with Europe, and where I include the year variable to pick up the downward trend in European heroin prices over time. I treat this downward trend as a supply phenomenon because contemporaneous increases in heroin consumption levels rule out downward shifts in demand (UNODC, 1997; UNODC, 2000; UNODC, 2004). I link $P_{(A,t-1)}$ with $P_{(E,t)}$ to account for the time that it takes for an opium crop to be collected, refined into heroin, trafficked to Europe, and sold on the streets. I take $P_{(A,t-1)}$ to be the average fresh price of opium in Afghanistan for year $t-1$ times the 10kg of opium needed to produce 1kg of pure heroin. For any given year, $\delta + \gamma t$ provides an estimate of the additive markup α_E. ε is an error term.

I first run this regression using the European prices for $t=1995$ through $t=2003$ because 1995 is the first year for which I have Afghan prices in year $t-1$. [18] I then re-run the regression for $t=1996$ through $t=2003$, for $t=1997$ through $t=2003$, and so on until I run out of degrees of freedom.

Using these results, I then make two estimates for β_E in 2003. The first estimate involves predicting β_E for 2003 based on the values of the β_E coefficient

18 I have thrown out the observation for t = 2002, t-1 = 2001 since the supply of opium in Afghanistan in 2001 was almost entirely eliminated by the Taliban's opium ban. The literature on Afghan opium generally assumes that at this time the heroin on the streets of Europe came from stock-piles collected by traffickers during previous years when the supply of opium was plentiful. It is impossible for us to know just how much opium had truly been stockpiled and what impact these stockpiles were having on opium and heroin prices.

obtained in the series of regressions described above. This method suggests that in 2003 β_E would have equaled about 6. For the second estimate, I simply take the value of β_E obtained in the last of the regressions described above (i.e. from the regression that uses only the most recent data). In this case, β_E is about 4.49. My third estimate of β_E is a pessimistic baseline for the effect of the 2001 Afghan price increase on prices in Europe. It relies on the assumption that the downward trend in prices would not have continued in 2003, and that the effect of the change in the Afghan price is simply the observed change in the European price from \$61,000 in 2001 to \$69,000 in 2003.[19] In this case β_E is about 2.48.

These estimates suffer from a source of upward bias, namely that the 2001 increase in the Afghan price resulted from a shock to the quantity produced in addition to a shift of the Afghan supply curve. The near elimination of the 2001 crop would be expected to have led to an increase in European prices independent of any changes to the Afghan price itself. Two factors mitigate this source of bias. First, it is widely believed that opium stockpiles within Afghanistan and along the trafficking chain were sufficient to prevent significant shortages in the European market. Second, Afghan opium production was back to historically levels in 2002. This opium, which was harvested in the spring of 2002, would have been flowing into European markets by 2003. The fact that heroin prices increased by more between 2001 and 2003 than between 2001 and 2002 (when shortages, had they existed, would have been in effect) suggests that the one year shock to production did not have a particularly significant effect on European prices.

19 Refer back to the "Aggregated Price" row in Table 11

With these estimates in hand I then collect a consistent set of heroin prices for regions of the world that consume Afghan opium.[20] I report these estimates in Table 14, below. When the price estimate comes from 2002, I assume that the heroin was made from opium produced in 2001 (i.e. opium that would have cost $301/kg). When the price estimate comes from 2001, I assume that the heroin was made from opium produced in 2000 (i.e. opium that would have cost $28/kg).

Table 14: Baseline Regional Price Data For Use In Demand Elasticity Estimat

Region	Known 2001 Heroin Prices	Known 2002 Heroin Prices	Opium Year	Opium Price
Western Europe	77000		2000	$28.00
Eastern Europe	50000		2000	$28.00
S. and SE. Asia	35000		2000	$28.00
C. Asia		15000	2001	$301.00
Africa	12375		2000	$28.00
Iran		8400	2001	$301.00
Pakistan		5000	2001	$301.00

Data Sources: UNODC, "The Opium Economy in Afghanistan," 2003, Annex 7, and UNODC, World Drug Report, 2004, pp.366-368

I then work through a series of calculations that are summarized in Tables 15-17 on the following pages, where Table 15 uses the assumption that $\beta_E=6$, Table 16 that $\beta_E=4.49$, and Table 17 that $\beta_E=2.48$. Given the known heroin prices from Table 16, I either work forward to estimate a 2002 price based on the known 2001 price, or backward to a 2001 price based on the known 2002 price. In all cases the difference between the 2001 and 2002 prices equals $\beta_E(3010-280)$ because $3010 was the cost

20 These prices were obtained from two sources: Annex 8 of UNODC, 2003, and pp. 366-368 of the 2004 World Drug Report (UNODC, 2004). These sources were chosen because the price observations coincide with an estimate of heroin purity whenever purity information is available. I have restricted the data used to form my estimates to the observations for which there are purity estimates, and I have scaled all price estimates to coincide with a purity level of about 27.5%. Unfortunately these rough estimates were necessary because of the current absence of data on drug prices in many countries. Nonetheless, the estimates at which I arrived are consistent with the idea of increasing prices as one moves farther and farther along the trafficking chain.

of 10kg of opium in Afghanistan in 2001, and $280 was the cost of 10kg of opium in Afghanistan in 2000.

Table 15: Demand Elasticity Estimation Assuming $\beta_E = 6$

	(1)	(2)	(3)	(4)	(5)
Region	**Price Estimate for 2001**	**Price Estimate for 2002**	**ln change in price**	**Predicted ln change in consumption**	**Regional Elasticity to Afghan Price**
Western Europe	77000	93380	0.19	-0.17	-0.07
Eastern Europe	50000	66380	0.28	-0.26	-0.11
S. and SE. Asia	35000	51380	0.38	-0.35	-0.15
C. Asia	1395	15000	2.38	-2.14	-0.9
Africa	12375	28755	0.84	-0.76	-0.32
Iran	781	8400	2.38	-2.14	-0.9
Pakistan	465	5000	2.38	-2.14	-0.9
Region	**Regional Weights (by opium)**	**Regional Weights (by heroin)**			
Western Europe	0.14	0.22			
Eastern Europe	0.24	0.22			
S. and SE. Asia	0.36	0.28			
C. Asia	0.03	0.04			
Africa	0.07	0.12			
Iran	0.11	0.05			
Pakistan	0.06	0.07			
Estimated Farm-gate Demand Elasticity in Afghanistan	-0.29	-0.27			

The calculations in the remaining columns proceed as follows. In column 3 I compute the log change in price between 2001 and 2002. In column 4 I multiply the log change in price by Saffer and Chaloupka's estimate that the retail elasticity of demand for heroin is -.90 (1995). This produces my estimate of the log change in the quantity demanded in each region. To estimate the elasticity of demand in each region to the price

Table 16: Demand Elasticity Estimation Assuming $\beta_E = 4.49$

	(1)	(2)	(3)	(4)	(5)
Region	**Price Estimate for 2001**	**Price Estimate for 2002**	**ln change in price**	**Predicted ln change in consumption**	**Regional Elasticity to Afghan Price**
Western Europe	77000	89257.7	0.15	-0.13	-0.06
Eastern Europe	50000	62257.7	0.22	-0.2	-0.08
S. and SE. Asia	35000	47257.7	0.3	-0.27	-0.11
C. Asia	2742.3	15000	1.7	-1.53	-0.64
Africa	12375	24632.7	0.69	-0.62	-0.26
Iran	781	8400	2.38	-2.14	-0.9
Pakistan	465	5000	2.38	-2.14	-0.9

Region	**Regional Weights (by opium)**	**Regional Weights (by heroin)**
Western Europe	0.14	0.22
Eastern Europe	0.24	0.22
S. and SE. Asia	0.36	0.28
C. Asia	0.03	0.04
Africa	0.07	0.12
Iran	0.11	0.05
Pakistan	0.06	0.07
Estimated Farm-gate Demand Elasticity in Afghanistan	-0.26	-0.23

Table 17: Demand Elasticity Estimation Assuming $\beta_E = 2.48$

	(1)	(2)	(3)	(4)	(5)
Region	**Price Estimate for 2001**	**Price Estimate for 2002**	**ln change in price**	**Predicted ln change in consumption**	**Regional Elasticity to Afghan Price**
Western Europe	77000	83770.4	0.08	-0.08	-0.03
Eastern Europe	50000	56770.4	0.13	-0.11	-0.05
S. and SE. Asia	35000	41770.4	0.18	-0.16	-0.07
C. Asia	8229.6	15000	0.6	-0.54	-0.23
Africa	12375	19145.4	0.44	-0.39	-0.17
Iran	1629.6	8400	1.64	-1.48	-0.62
Pakistan	465	5000	2.38	-2.14	-0.9

Region	**Regional Weights (by opium)**	**Regional Weights (by heroin)**
Western Europe	0.14	0.22
Eastern Europe	0.24	0.22
S. and SE. Asia	0.36	0.28
C. Asia	0.03	0.04
Africa	0.07	0.12
Iran	0.11	0.05
Pakistan	0.06	0.07
Estimated Farm-gate Demand Elasticity in Afghanistan	-0.18	-0.16

in Afghanistan, I then divide the log change in quantity by the log change in the price in Afghanistan between 2001 and 2002 in column 5.[21]

A drawback of these regional estimates is the unavailability of the time series data necessary for estimating a β_R particular to each region. The assumption that β_E applies to all regions will likely bias the elasticity results upward. It seems likely that if β_R varies, it will be relatively small in regions close to Afghanistan for the same reason that the additive markup is relatively small in these regions (namely that trafficking to these regions involves less risk).

The final step towards a cumulative demand elasticity estimate involves establishing weights for the percentage of Afghan opium that is consumed in each region. I develop two sets of weights, both of which refer to data from the 2004 World Drug Report (UNDCP, 2004). One set of weights uses data on the distribution of the number of opiate users around the world, while the other set focuses strictly on the number of heroin users. I take estimates for the number of users in Iran, Pakistan, and Central Asia from UNODC, 2003. I assume that Afghanistan supplies the opium used by all addicts in its neighboring regions, Africa, and Europe. I add 200,000 North American addicts to the number of users in Western Europe to account for Afghan opium that is consumed in the United States and Canada. I then add as many South and East Asian users as necessary to bring the total number of users supplied by Afghanistan to 75% of the world total. Use of the heroin numbers results in smaller elasticity estimates than use of the opiate numbers because heroin use is more highly concentrated in regions like Western Europe, where the Afghan price represents a relatively small percentage of the full retail price.

21 $\ln(3010/280)=2.37$

The farm-gate demand elasticity estimates range from -.16 to -.29. As noted, it is likely that the high end estimate of -.29 is biased upward by the use of β_E for each of the β_R. The low-end estimate of -.16 is likely to be excessively low, as it was calculated under the assumption that the downward price trend from 1990-2001 would have ceased altogether in 2003, even in the absence of the rise in Afghan prices. I thus use a central estimate of -.225 for the estimated equilibrium effects in section 6.

As a final note, I make these estimates under the assumption that following an increase in the price in Afghanistan, consumers who were originally supplied with Afghan opiates will continue to be supplied with Afghan opiates. This assumption should hold reasonably well in the short run and less well over long time horizons. This is because the short run supply of illicit narcotics depends on existing relationships between farmers and traffickers, and on preexisting trafficking routes. Over time, however, if prices in Afghanistan remain significantly higher than the prices observed in other opium cultivating countries (e.g. Myanmar, Laos, and Columbia) traffickers will adjust their routes and work to build new relationships with farmers in relatively low cost areas. This difference between the short and long run drives the following result: In the long run it is far easier to drive narcotics production out of any one country than it is to hold down the level of global narcotics production.

6. Potential Effects of Policy on Market Equilibrium

The analysis conducted in the previous sections provides the material necessary for estimating the equilibrium effects of crop eradication, sanctions, and alternative development. In my estimates I use a supply elasticity of 1 and a demand elasticity of -.225. Estimating the effects of different policies requires substituting values into the following system of equations:

$$(17)\, Q_D = Q_S$$

$$(18_a)\, Q_S = C_1 (P_A)^{\theta}$$

$$(19)\, Q_D = C_2 (P_A)^{\varepsilon},$$

where θ is the price elasticity of supply, ε is the price elasticity of demand, and C_1 and C_2 are constants. I estimate C_1 and C_2 by plugging in my elasticity estimates and my estimate that in 2004 the market would have been in equilibrium at $P_A = \$170$ and $Q_S = Q_D = 80{,}000\, \textit{hectares}.$ [22]

At this point, calculating the equilibrium effects of sanctions and alternative development becomes relatively straightforward. In section 4 I described these policies as shifting the price at which the typical opium cultivating farmer would continue to cultivate opium to the point of his labor constraint. Aggregating across Afghanistan, I treat these policies as shifting the price at which Afghan farmers (taken together) would continue to cultivate 80,000 hectares of opium. Consequently, I enter these shifts into equation 19 as follows:

$$(18_b)\, Q_S = C_1 (P_A - \Delta P_A)^{\theta},$$

where ΔP_A is simply the difference between the new threshold price and the old price of \$170.

22 Please refer to section 4.

The situation becomes slightly more complicated when estimating the effects of crop eradication. For example, in 2003 the UNODC estimated that 80,000 hectares of opium were harvested, and that 21,000 hectares were eradicated. Thus the price of $170 was sufficient to induce farmers to plant 101,000 hectares, of which 80,000 hectares were actually harvested. My estimates in section 5 suggest that if the probability of eradication increases from .21 to .35, farmers will require a price of $253 in order to plant 101,000 hectares with opium. However, a larger portion of these 101,000 hectares would now be eradicated. In order for 80,000 hectares to be harvested, it would be necessary to plant about 123,000 hectares of opium. Calculating the price necessary for this level of cultivation requires returning to the supply elasticity, which suggests that prices would have to rise by an additional 21% to about $312.

With these factors taken into account, I make the following estimates under the assumption that all else in both the wholesale and retail opiate markets is held constant:

1) Increasing the level of crop eradication from 21,000 hectares to 40,000 hectares would reduce the equilibrium level of opium production (net of eradication) by about 11.4%, and increasing the level to 60,000 hectares would reduce opium production by about 28.4%.

2) A sanction of $500 per hectare of opium enforced hand-in-hand with crop eradication at the 21,000 hectare level would decrease the level of opium production by about 3.4%, and a similar sanction of $1000 would decrease production by about 7.7%.

3) Increasing alternative farm incomes by $450 per hectare through development projects across the country would decrease the equilibrium level of opium production by about 4.9%.

4) The natural course of development will work in favor of reductions in opium production. In particular, if daily wages increase from \$3 to \$6, I estimate that the equilibrium level of opium production would fall by about 3.0%.

7. Discussion and Conclusion

My estimates suggest that substantial levels of crop eradication have the potential to bring about appreciable reductions in Afghan opium production over the short run. Alternative development on the other hand, while desirable from the standpoint of Afghanistan's reconstruction, is not likely to induce significant numbers of opium cultivating farmers to cease the activity. As noted earlier, my estimates are specific to the short run during which I treat the supply of heroin from other parts of the world as being fixed. Over a longer time horizon, a successful effort to hold opium prices above \$500 or \$600 per kilogram will likely be sufficient to push opium production out of Afghanistan. Although prices in this range are not likely to reduce the demand for opium in Afghanistan by more than about 25% in the short run, traffickers will seek to shift their production base to lower cost source-countries. Such flexibility on the part of traffickers bodes well for Afghanistan's long term future, but bodes ill for the ability of source-country drug control policy to reduce global consumption in the long term.

My results in general, and particularly for the effects of crop eradication, are significantly more optimistic than the results produced by Rydell and Everingham (1994) and by Kennedy, Reuter, and Riley (1993). 4 aspects of my model drive this difference. The first relates to the impact of source-country prices on retail prices. The aforementioned studies assume the multiplicative markup to be equal to 1. My effort to estimate this markup allows for the source-country price to have a more significant impact on retail prices. Second, I break the demand for opiates down by region rather than focus exclusively on the quantity of opiates demanded in U.S. and European markets. This also contributes to a higher demand elasticity estimate because the price in Afghanistan composes a much smaller portion of the European retail price than the retail prices in other regions. The third and fourth aspects relate to my supply elasticity estimate and model of expected utility maximization. My analysis of both of these factors suggests that in response to eradication programs, prices will have to rise to achieve the opium production levels desired by traffickers. It is not sufficient for traffickers to simply pay the same price to more farmers as is implicitly assumed by Kennedy, Reuter, and Riley (1993) when they model cocaine as being produced by workers at a constant wage rate.[23]

The U.S. State Department recently requested $780 million from Congress for combating opium through a variety of activities (Efrom, 2005). In addition to crop eradication and alternative development, these include strengthening Afghanistan's judicial system, targeting drug kingpins and their heroin laboratories, and a campaign to increase the perception that opium cultivation is morally wrong. It will be interesting to see how far these dollars go in terms of raising the level of crop eradication and increasing alternative incomes. Further work on the cost-effectiveness of these programs will help to sharpen the policy implications of analysis like that contained in this paper.

23 Kennedy, Reuter, and Riley (1993) only allow for this to the extent that the shift of labor to the drug producing sector will result in a higher competitive wage rate.

References

Aga Kahn Foundation, "Badakhshan Province: Suggestions for an Area Development based Counter-narcotics strategy," *Aga Kahn Development Network* April 2004.

Asad, Amir Zada, and Harris, Robert, The Politics and Economics of Drug Production on the Pakistan-Afghanistan Border, *Burlington: Ashgate Publishing Company*, 2003.

Bennett, A., de Schaetzen, B., van Rooden, R., Dicks-Mireaux, L., Fischer, F., and Kalfon, T., "Islamic State of Afghanistan: Rebuilding a Macroeconomic Framework for Reconstruction and Growth," *IMF Country Report* No. 03/299, September 2003.

Berry, LaVerle, Curtis, Glenn E., Hudson, Rex A., and Kollars, Nina A., "A Global Overview of Narcotics-Funded Terrorist and Other Extremist Groups," *Federal Research Division, Library of Congress*, May, 2002.

Blanchard, Christopher M., "Afghanistan: Narcotics and U.S. Policy," *Congressional Research Service*, December 7, 2004.

Bretteville-Jensen, A., and Biorn, E., "Heroin Consumption, Prices and Addiction: Evidence from Self-reported Panel Data," *Scandinavian Journal of Economics*, Volume 105, No. 4, December 2003, pp. 661-679 (19).

Caulkins, Jonathan P., "Drug Prices and Emergency Department Mentions for Cocaine and Heroin," *American Journal of Public Health*, Volume 91(9) September 2001, pp.1446-1448.

Caulkins, J. "Estimating Elasticities of Demand for Cocaine and Heroin with DUF Data," working paper, *Carnegie Mellon University*, August 1995.

Caulkins, Jonathan P., and Renter, Peter, "What Price Data Tells Us About Drug Markets," *Journal of Drug Issues*, Summer 98, Volume 28 Issue 3, pp.593-612.

Chaloupka, F, Grossman, M., and Tauras, J. "The Demand for Cocaine and Marijuana by Youth," *NBER* working paper, No. 6411, 1998, February.

Chetty, Raj, "Optimal Unemployment Insurance When Income Effects Are Large," *National Bureau of Economic Research*, Working Paper #10500, May 2004.

Chouvy, Pierre-Arnaud "Opiate smuggling routes from Afghanistan to Europe and Asia," *Jane's Intelligence Review*, Volume 15, No. 03, March 2003, p. 32-35.

Christoplos, Ian, “Agricultural Rehabilitation in Afghanistan: Linking Relief, Development, and Support to Rural Livelihoods,” *Overseas Development Institute*, October 2004.

Clemens, Jeffrey “Opium in Afghanistan: Prospects for the Success of Source-Country Drug Control Policy,” undergraduate research thesis, Harvard College, 2005.

Clifford, Mary Louise, The Land and People of Afghanistan, New York: Harper Collins, 1989.

Council on Foreign Relations, “Afghanistan: Are We Losing the Peace?” June, 2003.

Crane, B.D., Rivolo, A.R., and Comfort, G.C., “An Empirical Examination of Counterdrug Interdiction Program Effectiveness,” prepared for the I*nstitute of Defense Analysis*, Washington, DC, 1997

Curtis, Glenn E., “Involvement of Russian Organized Crime Syndicates, Criminal Elements in the Russian Military, and Regional Terrorist Groups in Narcotics Trafficking in Central Asia, the Caucasus, and Chechnya,” *Federal Research Division, Library of Congress*, October, 2002.

Curtis, Glenn E., and Karacan, Tara, “The Nexus among Terrorists, Narcotics Traffickers, Weapons Proliferators, and Organized Crime Networks in Western Europe,” *Federal Research Division, Library of Congress*, December, 2002.

Duffield, Mark, Gossman, Patricia, and Leader, Nicholas, “Review of the Strategic Framework for Afghanistan,” *Afghanistan Research and Evaluation Unit*, 2001.

Efron, Sonni, “The World: U.S. Backs Away From Aerial Spraying,” *Los Angeles Times*, January 22, 2005.

Evans, Anne, Manning, Nick, Osmani, Yasin, Tully, Anne, and Wilder, Andrew, “A Guide to Government in Afghanistan,” *World Bank*, 2004.

FEWS NET, “Afghanistan: Monthly Food Security Bulletin,” October 2003.

German Technical Corporation (GTZ), "Drugs and Conflict,” *Drugs and Development Programme*, September, 2003.

Goodhand, Jonathan, “From Holy War to Opium War: a Case Study of the Opium Economy in North Eastern Afghanistan”, *Peace building and Complex Emergencies, Working Paper Series*, Paper No. 5, IDPM, University of Manchester, 1999.

Greenfield, Victoria, Personal Correspondence, December 17, 2004.

Hausman, Jerry, "The Econometrics of Nonlinear Budget Sets," *Econometrica* Vol. 53 (1985), pp. 1255-1282.

Integrated Regional Information Networks (IRIN), "Bitter-Sweet Harvest: Afghanistan's New War," an IRIN Web Special on the threat of opium to Afghanistan and the region, <http://www.plusnews.org/webspecials/opium/popafg.asp> Copyright 2004.

Johnston, Patrick, Rhodes, William, and Carrigan, Kyla, "Estimation of Heroin Availability 1995-1998," prepared by *Abt Associates, Inc.*, for the Office of National drug Control Policy, 2000, December.

Katzman, Kenneth, "Afghanistan: Current Issues and U.S. Policy," *Congressional Research Service, Library of Congress*, August 2003.

Kennedy, Michael, Reuter, Peter, and Riley, Kevin Jack, "A Simple Economic Model of Cocaine Production," *RAND, National Defense Research Institute*, 1993.

Kenefick, Frank and Morgan, Larry, "Opium in Afghanistan: people and poppies, the good evil," Afghanistan RAMP, Rebuilding Markets in Afghanistan, by *Chemonics International Inc. for US Agency For International Development* / Kabul, February 5, 2004.

Kleiman, Mark A.R., "Illicit Drugs and the Terrorist Threat: Causal Links and Implications for Domestic Drug Control Policy," *Congressional Research Service, Domestic Social Policy Division*, 2004, April.

Johnston, P., Rhodes, W., Carrigan, K., and Moe, E. "The Price of Illicit Drugs: 1981 through the Second Quarter of 1998," *Abt Associates. Inc.*, report submitted to the Office of National Drug Control Policy, February 1999.

Mansfield, David, "Alternative Development in Afghanistan: The Failure of Quid Pro Quo", paper prepared for the *International Conference on the Role of Alternative Development in Drug Control and Development Cooperation*, Feldafing/Munic, Germany, January, 2002.

Mansfield, David, "Alternative Development: The Modern Thrust of Supply-Side Policy," Occasional Papers, *Bulletin of Narcotics*, Vol. 6, Nos 1&2, 1999.

Mansfield, David, "Coping Strategies, Accumulated Wealth and Shifting Markets: The Story of Opium Poppy Cultivation in Badakhshan 2000-2003," A Report for the *Agha Khan Development Network*, January 2004.

Mansfield, David, "The Economic Superiority of Illicit Drug Production: Myth and Reality Opium Poppy Cultivation in Afghanistan," Paper prepared for the *International Conference on The Role of Alternative Development in Drug Control and Development Cooperation,* Feldafing/Munich, Germany, January 2002.

Manski, Charles F., Pepper, John V., and Thomas, Yonette F., "Assessment of Two Cost-Effectiveness Studies on Cocaine Control Policy," *Committee on Data and Research for Policy on Illegal Drugs*, National Academy Press, Washington, D.C., 1999.

Pain, Adam, "The Impact of the Opium Poppy Economy on Household Livelihoods: Evidence from the Wakhan Corridor and Khustak Valley in Badakhshan," a study for the *Aga Kahn Development Network, Badakhshan Programme funded by GTZ*, January, 2004.

Pain, Adam, and Lautze, Sue, "Addressing Livelihoods in Afghanistan," *Afghanistan Research and Evaluation Unit,* issues paper series, September 2002.

Rabin, Matthew, and Thaler, Richard H., "Anomalies: Risk Aversion," *The Journal of Economic Perspectives*, Vol. 15, No. 1 (Winter 2001) pp. 219-232.

Reuter, Peter, and Greenfield, Victoria, "Measuring Global Drug Markets: How good are the numbers and why should we care about them," *World Economics*, Volume. 2, No. 4, October-December, 2001, pp.159-173.

Rhodes, William, et al.,"Illicit Drugs: Price Elasticity of Demand and Supply (Final Report)," prepared by Abt. Associates Inc., for the *National Institute of Justice*, 2000, February.

Riley, Kevin Jack, Snow Job? The War Against International Cocaine Trafficking, *RAND*, 1996.

Rubin, Barnett R., "Road To Ruin: Afghanistan's Booming Opium Industry," *Center on International Cooperation*, October 7, 2004.

Rydell, Peter C., and Everingham, Susan S., "Controlling Cocaine: Supply Versus Demand Programs," *RAND, Drug Policy Research Center*, 1994.

Saffer, H. and Chaloupka, F., "The Demand for Illicit Drugs," *NBER* working paper, No. 5238, 1995, August.

Transnational Institute, "Merging Wars: Afghanistan, Drugs and Terrorism" , *TNI Briefing Series 2001/2*, Drugs and Conflict Debate Paper no. 3, November 2001.

United Nations International Drug Control Program (UNDCP), “Afghanistan: Annual Opium Poppy Survey,” 1998a.

UNDCP, “Afghanistan: Annual Opium Poppy Survey 1999,” 1999a

UNDCP, “Afghanistan: Annual Poppy Survey,” 2001a.

UNDCP, “Afghanistan: Farmer's Intentions Survey,” 2004a.

UNDCP, “Afghanistan: Opium Poppy Survey 1994,” October, 1994.

UNDCP, “Afghanistan: Opium Poppy Survey 1995,” October, 1995.

UNDCP, “Afghanistan: Opium Poppy Survey 1996,” September, 1996.

UNDCP, “Afghanistan: Opium Poppy Survey 1997,” 1997.

UNDCP, “Afghanistan: Opium Poppy Survey 2000” 2000a.

UNDCP, “Afghanistan: Opium Rapid Assessment Survey,” 2003a.

UNDCP, “Afghanistan: Opium Survey 2002” October, 2002a.

UNDCP, “Afghanistan: Opium Survey 2003,” 2003b.

UNDCP, “Afghanistan: Opium Survey 2004,” 2004b.

UNDCP, “Afghanistan Strategic Studies #1: An Analysis of the Process of Expansion of Opium Poppy Cultivation to new Districts in Afghanistan,” June, 1998b.

UNDCP, “Afghanistan Strategic Studies #2: The Dynamics of the Farmgate Opium Trade and the Coping Strategies of Opium Traders,” October, 1998c.

UNDCP, “Afghanistan Strategic Studies #3: The role of Opium as a Source of Informal Credit,” January, 1999b.

UNDCP, “Afghanistan Strategic Studies #4: Access to Labor: The role of Opium in the Livelihood Strategies of itinerant Harvesters working in Helmand Provinces,” June, 1999c.

UNDCP, “Afghanistan, Strategic Study #5: An Analysis of the Process of Expansion of Opium Poppy to New Districts in Afghanistan, Second Report,” November, 1999d.

UNDCP, “Afghanistan, Strategic Study #6: The Role of Women in Opium Poppy Cultivation in Afghanistan,” June, 2000b.

UNDCP, “Afghanistan, Strategic Study #7: An analysis of the Process of Expansion of Opium to New Districts in Afghanistan, Final Report,” November 2000c.

UNDCP, “Global Illicit Drug Trends,” 2001b and 2002b.

UNDCP, “Laos: Opium Survey 2004,” July, 2004c

UNDCP, “Myanmar: Opium Survey 2003,” June, 2003c.

United Nations Office on Drugs and Crime (UNODC), “The Opium Economy in Afghanistan: An International Problem,” 2003.

UNODC, “World Drug Report,” 1997, 2000, 2004.

U.S. Dept. of Health and Human Services (USDHHS), “National Survey on Drug Use and Health,” 2002.

USDHHS, “National Survey of Drug Use and Health,” 2003.

USDEA, “Heroin Signature Program: 2002,” Drug Intelligence Brief, DEA website, <http://www.usdoj.gov/dea/pubs/intel/04005/04005.html> accessed on January 8, 2005, written in 2004.

USDEA, “Heroin,” USDEA website <http://www.usdoj.gov/dea/concern/heroin_factsheet.html> accessed January 8, 2005b.

USDEA, “Opium Poppy Cultivation and Heroin Processing in South East Asia,” USDEA website, <http://www.usdoj.gov/dea/pubs/intel/20026/20026.html> accessed January 8, 2005, written March 2001.

Ward, Adam, and Hackett, James, “Afghanistan and the drugs trade: Preventing the emergence of a narco-state,” *IISS Strategic Comments*, Volume 10, Issue 7, September 2004, pp.1-2.

World Bank, “Afghanistan: State Building, Sustaining Growth, and Reducing Poverty: A Country Economic Report,” Report No. 29551-AF, 2004.