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Who crops coca and why?

The case of Colombian farmers[#]

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Abstract

Approximately 1.2% of Colombia's GNP is spent every year on the war on drugs, but very little is known about coca farming decisions at the household level. In order to understand the decision to cultivate coca as well as that of the amount of land to use for its cultivation, we develop an extended version of the portfolio model of crime that considers the effects of behavioral norms and lack of options in the legal economy. The model is tested using data from an original survey with coca and non-coca farmers living in Putumayo, Colombia. We find that farmers react to economic incentives and hence eradication and substitution programs reduce coca cultivation. More interestingly, we find that coca cultivation decisions are explained by moral considerations as well as by the impossibility of making a living from legal forms of agriculture.

Keywords: Coca; Colombia; Portfolio Model of Crime, Norms of Behavior.

JEL classification: D81, G11, K42, Z12, Z13

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1. Introduction

Even though about 1 billion dollars (1.2% of Colombia's GDP in 2005) are spent annually on controlling the production of cocaine in Colombia (ONDCP, 2006; Alvarado and Lahuerta, 2005) the production of cocaine has increased and the prices have remained almost constant (DNE, 2005)[1]. The poor results of the policy against drugs underline the importance of investigating the factors that affect coca cultivation decisions. Some studies (e.g. Carvajal, 2002; Díaz and Sánchez, 2004; Moreno et al., 2003; Moya, 2005; Tabares and Rosales, 2005) investigated the factors affecting coca cultivation at the regional level, finding that marginality, armed conflict and environmental vulnerability were correlated with coca cultivation. However, aggregated historical information, does not allow identifying the motivational factors that affecting coca cultivation. A better comprehension of the monetary and non-monetary factors that determine the decision to cultivate coca at the household level is needed if actual policies against illicit drugs are to be improved and alternative strategies to tackle their production are to be devised.

The objective of this paper is to investigate why farmers cultivate coca and how they decide what amount of their land to allocate to coca production. For many, the answer may seem rather obvious: coca is cultivated because it is good business. Indeed, coca is three to five times more profitable than alternative legal products. However, if it is such good business, why do some farmers choose not to cultivate it and why do farmers do not cultivate all their land with coca? In line with traditional models of crime (e.g. Becker, 1968; Ehrlich, 1973; Eide et al., 1994), differential economic incentives, expected risk of eradication and levels of risk aversion could explain this paradox.

[1] Between 1997 and 2007, the production of cocaine increased from 350 to 430 tons in Colombia. The prices at the farm level have remained around

Moreover, the literature on law compliance, points at that normative factors as morality (e.g. Sutinen and Kuperan, 1999; Eisenhauer, 2004), social norms (e.g. Glaeser et al. 1996; Calvo and Zenou, 2004, Garoupa, 2003) and legitimacy (e.g. Tyler, 1990; Tyran, 2002) also influence the decisions to participate in an illegal activity.

According to Arango and Child (1997) and Santos and Calderon (1990), the boom of illicit drugs in Colombia was partly due to a mentality that valued economic success independently on its origin. On the other hand, Thoumi (2000) argues that low levels of social capital and weak community and governmental institutions are responsible for the expansion of coca cultivation in Colombia. The regions where coca is cultivated have a recent history of colonization and low population density possibly implying weak social networks and hence weak mechanisms of social control. In addition, the presence of illicit armed groups in these areas may generate an attitude of resistance to legal institutions creating an environment that favor illegality. Alternatively, Garcia, (2000) and Ortíz (2000) explain the expansion of coca cultivation as a result of the agricultural crisis. They argue that the low prices and high transport costs of legal products have forced farmers to cultivate coca in order to survive.

Nonetheless, little is known about the factors that affect coca farming decisions at the household level.

In this paper we explore the effects of monetary and non-monetary factors on coca cultivation both theoretically and empirically. We develop an extended version of the economic model of crime that includes both the effects of normative factors and those of lack of alternatives within the legal economy. The predictions of the model are tested using a unique data set of agricultural production for coca and non-coca farmers living in Putumayo, a region producing a sizable proportion of Colombia's coca. To our

knowledge this is the first empirical study of coca cultivation decisions at the individual household level. Our analysis contributes to a better understanding of coca cultivation including key individual socioeconomic characteristics such as morality, social norms, legitimacy and lack of options.

The reminding of the paper is organized as follows. Section two presents an extended version of the economic model of crime. Section three discusses the empirical measures used to capture the effect of monetary and non-monetary factors and section four discusses the results. The last section concludes the paper.

2. A Model of coca cultivation

In our model, we focus on land allocation rather than labor allocation decisions that depend on the production technology. Therefore we consider the case of farmers who have access to land and capital (seeds, fertilizers, etc.). It is also assumed that soil quality is homogenous, which is consistent with the fact that coca plants are highly adaptable. Similarly as the traditional portfolio model of crime (e.g. Becker, 1968; Ehrlich, 1973), a farmer holds L units of agricultural land and decides how much of that land to cultivate with coca, α, so as to maximize the expected utility of income,

$$EU = (1-p)U(Y_g(\alpha)) + pU(Y_b(\alpha)) \tag{1}$$

Without loss of generality, we assume that the remaining land, L-α, is cultivated with a legal product. Since coca farming is an illegal activity that can be penalized by the authorities by eradication, two possible outcomes can arise; either the farmer has bad luck (b) and the coca plants are discovered and destroyed or he has good luck (g) and

the coca crop remains unharmed.[2] The probability of coca plants being destroyed is p and is assumed to be exogenous as one single farmer has a negligible effect on the probability of eradication. A farmer's income in case of good and bad luck is respectively:

$$Y_g = W + (1-\lambda(\alpha))(1-\gamma)\prod_i(\alpha) + \prod_l(L-\alpha) - qt(\bar{a}-\alpha)^2$$
$$Y_b = W + (1-\lambda(\alpha))(1-\gamma)\prod_i(\alpha) + \prod_l(L-\alpha) - qt(\bar{a}-\alpha)^2 - F(\alpha) \quad (2)$$

Where W is the initial wealth, Π_i and Π_l is the profit from coca cultivation and the legal crop, respectively and F is the loss of income in the case of eradication. We assume non-increasing returns to scale on land and a loss of income F proportional to the amount of land cultivated with coca. Other parameters (λ, γ, q, t and $\bar{a}$) refer to non-monetary factors as explained below.

We consider that the profit generated by coca cultivation can have a lower utility value because of a sense of sinfulness or guilt at breaking one's own principles (e.g. Hausman and Mc Pherson, 1993; Frey 1997; Dawes and Messik, 2000;) or because of a sense of obligation about complying with the authorities (e.g. Easton, 1958; Tyler, 1990 and Tyran and Feld, 2002). Following Eisenhauer (2004) the profit from coca is weighted by $1-\lambda$, where λ is a personal subjective measure of sinfulness. For a moral individual, the sinfulness of engaging in the illegal activity is very high ($\lambda=1$), so he derives little or no utility from the income generated by illegal activity, while an amoral individual will feel no regret for his actions ($\lambda=0$). We consider that individuals feel bad about deviating away from moral precepts ($\lambda>0$), but that the sense of guilt is not high enough to deter them from immoral action ($\lambda<1$): it is therefore tempting to

[2] The law dictates imprisonment and fines for production and transportation of drugs, but in practice this is very seldom used.

engage in coca cultivation. We also assume that the feeling of wrong-doing increases at a constant rate with the amount of land that is cultivated with coca ($\lambda'_\alpha > 0$, $\lambda''_\alpha > 0$). Farmers who cultivate only one quarter of a hectare with coca may rationalize that they do it because they need to have a minimum income to buy food and hence do not feel too bad compared with those who cultivate many hectares of land with coca. Farmers who cultivate many hectares of their land with coca may find it harder to justify their actions.[3]

Similarly, the profit from coca cultivation can be weighted by a factor $1-\gamma$, where γ represents the sense of guilt that disobeying the authorities brings. Legal norms may or may not be in accordance with an individual's own morality; however, the acceptance of authority may be high enough to support compliance (Tyler, 1990). A follower of the law experiences great guilt over breaking the law, $\gamma = 1$, while a protester feels no culpability, $\gamma = 0$. We rule out both the feeling of satisfaction from breaking the law and the feeling of complete dissatisfaction from breaking the law and assume that $0 \leq \gamma \leq 1$. The sense of guilt from breaking the law is assumed to be constant for the amount of land cultivated, though this assumption can easily be relaxed.

Another motivation behind coca cultivation is the effect of social norms (e.g. Elster, 1989, Glaeser et al. 1996; Calvo and Zenou 2004; Garoupa, 1997, 2003). A social norm is an informal external pattern of behavior that is shared by other people and that is sustained by their approval or disapproval (Elster, 1989). The degree to which breaking a social norm has the ability to affect an individual's reputation, depends on the degree to which that individual identifies with the group and with the norm (Akerlof, 1997). Social norms discipline group members by condemning behavior that differs from what

[3] An alternative approximation that includes the effect of behavioral norms and has the same implications as our model is presented in Sutinen and Kuperan (1999); Hatcher et al. (2000) Akpalu (2006).

is socially accepted. In a pro-social environment, social norms protect against anti-social behavior, while in an environment full of anti-social behavior they could have the opposite effect.[4] The reputation cost from behaving differently can be captured by a function that depends on the probability that others observe individual behavior, q, the weight that others have in the utility function, t, and the distance between individual and group behavior. We use a quadratic function to capture the effect of disapproval for having a larger or a smaller amount of land with coca than the average, $\bar{a}$. It is assumed that others have imperfect observation of individual behavior ($0<q<1$) and that farmers are not completely detached ($t>0$).

Finally, the impossibility of making a living from legal agriculture because of the marginality of the region, the lack of infrastructure and high transport costs could be one reason why farmers cultivate coca. If the maximum income that farmers can obtain from cultivating all the agricultural land with coca, $Y_L = W + \Pi_l(L)$, is lower than the minimum subsistence income, Y_s, we consider that the farmer lacks options in legal agriculture to make a living. To capture the effect of lack of options in the decision to cultivate coca, we impose the restriction that the expected income from agricultural activity has to be large enough to generate a minimum subsistence income.

$$W + \prod_i(\alpha) + \prod_l(L-\alpha) - pF(\alpha) = Y \geq Y_{min}.$$

Depending whether coca is cultivated due to lack of options in the legal agriculture and depending whether the minimum income restriction is binding, the model has different predictions.

[4] Social interaction reproduces anti-social behavior by learning effects from criminal peers (Opp, 1989; Calvo and Zenou, 2004; Glaeser, et.al, 1996), crowding-out of the legal system (Schrag and Schotchmer 1997), crowding-out of legal opportunities (Murphy, et Al., 1993: Haung et al., 2004), and social capital depreciation (Sah, 1991, Williams and Sickles, 2002, Mocan et al. 2005).

When farmers do not lack options in the legal agriculture, as it is assumed in the traditional economic models, the first order condition for the maximization problem implies that farmers cultivate coca if:[5]

$$(1-\lambda)(1-\gamma)\pi_i - \pi_l - 2qt(\alpha-\bar{a}) - \lambda'_\alpha(1-\gamma)\prod_i(\alpha) - pf > 0 \qquad (3)$$

So for the farmer to cultivate coca, it has to pay-off both in monetary and non-monetary terms. That is, the marginal profit of coca net of the profit from the alternative production has to be larger than the expected marginal cost. In our model, the expected marginal cost is given by i) the cost of morality, l, ii) the cost of disobedience to authorities, g, iii) the reputation cost, $2qt(\alpha-\bar{a})$[6] and iv) the cost of being more morally aware, $\lambda'_\alpha(1-\gamma)\Pi_i(\alpha)$ and v) the expected cost of having the crops destroyed, *pf*. When both coca and legal crops are cultivated, the optimal amount of land that is cultivated with coca is determined by the equity of the slope between the marginal rate of substitution between income in the lucky and unlucky stages, $\left.\frac{dYg}{dYb}\right|_{dV=0}$ (left hand side of the expression) and the marginal rate of transformation between income in those stages, $\frac{dYg/d\alpha}{dYb/d\alpha}$ (right hand side of the expression)

$$\frac{(1-\lambda)(1-\gamma)\pi_i - \pi_l - 2qt(\alpha-\bar{a}) - \lambda'_\alpha(1-\gamma)\prod_i(\alpha)}{(1-\lambda)(1-\gamma)\pi_i - \pi_l - 2qt(\alpha-\bar{a}) - \lambda'_\alpha(1-\gamma)\prod_i(\alpha) - f} = -\frac{p}{(1-p)}\frac{U'(Y_b)}{U'(Y_g)} \qquad (4)$$

Unless the marginal cost of being caught cultivating coca, *f*, is greater than the marginal incentives to enter into the illegal activity (i.e. the denominator of the left hand side of expression 4 is negative) complete specialization in coca cultivation occurs. To start cultivating, the expected marginal profit from coca cultivation has to be larger, equal or

[5] Evaluating the first order condition at $\alpha=0$ where the marginal utility from cultivating coca is equal to the marginal utility of not cultivating coca, $U'(Y_g)=U'(Y_b)$.

[6] Note that when the social norm is to cultivate coca, $(\alpha-\bar{a})<0$, there is a reputation benefit from coca cultivation.

lower than the marginal profit in the illegal activity for a risk-averse, risk-neutral and risk-loving farmer, respectively.[7] Hence, a risk-loving farmer cultivates more units of land with coca than a risk-neutral farmer and even more than a risk-averse farmer.

As proved in the appendix A, the model predicts that increases in any of the four normative factors that we have considered (λ, γ, q or t), reduce the marginal incentive to start cultivating coca when subsistence can be covered with legal activities. Similarly, increases in the expected cost of eradication (p or f) discourage farmers from starting to cultivate coca irrespective of risk preferences. However, if the authorities offer alternatives to coca cultivation (or wealth or in land holdings increase), the effect on the likelihood to cultivate is ambiguous. The opportunity cost of legal cultivation is increasing, thus farmers are less likely to engage in coca cultivation. However, higher returns on legal activities means that farmers are relatively richer, which is having the opposite effect. The model predicts that increases in normative factors, (λ, γ, q, t), in the expected cost of eradication (p f) decrease the marginal incentive to cultivate coca when subsistence is covered and thus reduce the amount of land that is cultivated. An increase in the opportunity cost of cultivating coca (π_l) has an ambiguous effect on the amount of coca that is cultivated, though.

On the other hand, when the farmer cannot make a living out of legal agriculture, $Y_{\min} > W + \prod_l(L)$, farmers cultivate coca either because they need to cultivated coca to survive or because they have preferences to cultivate coca. Assuming that cultivating coca pays-off in monetary terms, $(\pi_i - \pi_l - pf > 0)$, farmers may cultivate some land with coca even when the moral cost of doing so is high,

$$(1-\lambda)(1-\gamma)\pi_i - 2qt(\alpha - \bar{a}) - \lambda'_\alpha(1-\gamma)\prod_l(\alpha) - pf < 0$$

[7] $(1-\lambda)(1-\gamma)\pi_i - 2qt(\alpha - \bar{a}) - \lambda'_\alpha(1-\gamma)\prod_i(\alpha) - pf \gtreqless \pi_l$ if $U'' \gtreqless \pi_l$

In this case, moral considerations and social pressure (λ, q, t) can deter farmers from starting to cultivate coca provided that there is a social rule against coca cultivation ($\bar{a} < \alpha$) and that cultivating coca does not pay-off in moral terms ($Y_g' - pf < 0$). In all other circumstances, the effect is ambiguous or even positive. Hence, the moral cost from cultivating coca needs to be very high, so as moral considerations deter farmers from start cultivating. Similarly as before, increase in the expected cost of cultivating coca (p, f) deter farmers from cultivating, but, increases in the opportunity cost of the alternative can reduce coca cultivation when cultivating coca pays-off both in monetary and moral terms ($Y_g' - pf > 0$). To generate the minimum subsistence income, a minimum amount of land ($\underline{\alpha}$) should be cultivated with coca, $\underline{\alpha} = \frac{Y_{min} - W}{f^{-1}}$. When farmers have preferences to cultivate coca, the minimum income restriction does not bind, $W + \prod_i(\alpha) + \prod_l(L - \alpha) - pF(\alpha) > Y_{min}$, and farmers cultivate more land with coca than is required to survive, $\alpha > \underline{\alpha}$. In this case, the solution is similar to the case when the individual do not lack alternatives: $EU(\alpha > \underline{\alpha}) > EU(\underline{\alpha}) > EU(\alpha = 0)$. In the other case, although farmers would have preferred not to cultivate coca they are forced to cultivate a minimum fraction $\underline{\alpha}$ to survive.[8] In this case, the marginal utility of income is high and morality cannot be afforded and the amount of land that is cultivated with coca does not depend on moral considerations (λ, γ, q, t). A higher minimum income restriction (Y_{min}) or a lower level of wealth (W) increase the likelihood to cultivate coca and the proportion of land that is cultivated with coca. Contrary to the case where farmers cultivate coca because they prefer to do so, when farmers are

[8] As it is shown in the appendix, a corner solution is obtained where the slope of the indifference curve is larger than the slope of the transformation curve.

obliged to do so to survive, more eradication (p or f) increases the proportion of land that is needed to cultivate with coca to reach the minimum income level. Alternative development projects, on the other hand, could reduce the proportion of land cultivated with coca by increasing the profitability of legal products.

Our model suggests that different policies should be used depending on whether farmers are above subsistence levels or not. When the low profitability of legal activities oblige farmers to cultivate coca, the only mechanism available for authorities to reduce the areas with coca is subsidies to legal production. Once the subsistence level is covered, in addition to economic incentives, authorities can use non-economic instruments to discourage coca cultivation. For example, campaigns to increase awareness of the negative effects of coca cultivation are likely to affect moral resistance to coca cultivation. Similarly, the use of participative mechanisms and institutional transparency may increase the support to the authorities and generate respect for the law.

3. Data

Putumayo in the South East of Colombia was selected as the locality for data collection because of its well-established tradition in coca production. Coca production was established in the region in the 1980's and by 2000 about one third of Colombia's coca-growing areas were located in Putumayo (DNE, 2005). In addition, this was the first region where eradication campaigns (destruction of coca plants through aerial spraying or manual pulling-up of plants) were implemented on a large scale. This was also one of the pioneer regions to benefit from alternative development projects aimed at making non-coca activities more profitable (DNE, 2005). In particular, in 2000 the government

implemented Voluntary Agreements of Substitution (VAS) in which farmers agreed to destroy coca plants in exchange for funding (in kind) for a food security project.[9] Four municipalities were included in our study: Mocoa and Orito, where the number of hectares (ha) of coca per square kilometer of the total municipal area are low (0.08ha coca/Km^2 and 0.17ha coca/Km^2, respectively) and Puerto Asis and Valle del Guamuez where that ratio is higher (0.54ha coca/Km^2 and 1.82ha coca/Km^2, respectively). Three graduate researchers conducted the interviews, assisted by two to four trained enumerators from each municipality. Respondents were farmers who voluntarily participated in a meeting that was called by the local leader to talk to university researchers about coca farming and productive alternatives. To reduce the problem of validity of self-reported data due to the illegality of coca cultivation, participants in the survey were informed that it was an academic study and that we were interested in their opinions alone, therefore no names or addresses were asked. Participants were interviewed during the morning session and participated in what Harrison and List (2004) call a framed field experiment after a break for lunch. The results of the framed field experiment are not presented in this paper. In total 293 households were interviewed for about one hour using a pre-tested questionnaire, but due to time limitations a shorter version of the interview was conducted in 38 cases. Using the Mann-Whitney test, no significant differences were found between the samples with the short and long questionnaires with respect to hectares with coca, education level, age or gender. The questionnaire included questions about i) productive production activities on the individual's farm in 2003 and 2005, ii) coca production in the municipality in

[9] Other programs of voluntary substitution are the Forest Guarding Families Program in which farmers agreed to destroy coca plants in exchange for a three year monetary subsidy, paid monthly. Productive projects (e.g. palm hearts, flowers, vanilla and cattle raising), on the other hand, consist of subsidized credit for the establishment of a legal product plus technological advice and support in commercialization.

2003 and 2005, iii) attitudinal questions on coca production and anti-drug policies, and iv) standard questions on socioeconomic characteristics (See appendix B). The questionnaire also included the Moral Judgment Test developed by Lind et al. (1985) and a risk experiment that followed the design of Binswanger (1980). A hypothetical choice experiment on coca production was used to test for the effect of different levels and combinations of eradication and alternative development, but we do not analyze it in this study.

4. Results

4.1. Descriptive statistics

Table 1 presents the descriptive statistics for self-reported coca and non-coca farmers, as well as for the whole sample. We find that the self-reported proportion of coca farmers and the amount of land cultivated with coca decreased between 2003 and 2005. The reduction in areas cultivated with coca can be explained by the decrease in the economic incentives to cultivate coca observed during this period: The relative profit of coca compared with that of alternatives dropped,[10] the index of credit availability and market facility of coca compared with that of the alternatives decreases, and the number of hectares sprayed out of the total number of hectares cultivated with coca in the municipality increases. Table 1 also reveals that there are significant differences in the socioeconomic characteristics of coca and non-coca farmers.

In order to capture the effect of morality on the decision to cultivate coca we used the Moral Judgment Test (Lind et. al., 1985). This test is based on the theory of social development (Kohlberg, 1969). According to this theory, the actions of individuals at

[10] The estimated median annual profit from coca and second best alternative are consistent with the estimated values in other studies (e.g. DNE, 2005; Rocha and Ramírez, (2006); and Uribe, 2005).

the lowest level of moral development, pre-conventionalists, are motivated by individualistic and opportunistic behavior (e.g. avoidance of personal harm or obtaining personal satisfaction). At an intermediate level, the actions of conventionalists are motivated by y social concerns (e.g. what others would think or the desire to preserve social order). At the highest level of moral development, post-conventionalists justify their moral actions by higher objectives such as human rights and principles of conscience. As predicted by the cognitive theory of social psychology, we find that the level of moral development in coca farmers is on average lower than that of non-coca farmers although the difference is not significant at the 10% level using Mann Whitney test.[11]

Another measure of morality is religious belief. Though most of the farmers declared themselves to be Catholic (79%), the percentage of people that declared themselves to be Protestant was significantly higher for non-coca farmers than for coca farmers, and a significantly larger proportion of coca farmers declared themselves as not belonging to any religion than was the case with non-coca farmers. Some evidence of habituation on the coca-cultivation decision is found as the average number of years cultivating coca is significantly larger for coca farmers than for non-coca farmers.

Following the theory of procedural justice (Tyler, 1990), the guilt associated with disobeying the authorities was measured in terms of the degree of acceptance expressed by subjects in response to a series of statements about the authorities and the rule imposed by them. We captured five aspects of the authorities and their rule in our statements. These were: 1) agreement with the need of the prohibition on drugs; 2) agreement with the need to respect to the prohibition; 3) participation in defining

[11] Aguirre (2002) studies criminal participation and moral development in Bogota, Colombia using Lind et al.'s (1985) Moral Judgment Test.

policies to control coca cultivation; 4) effectiveness of the policies against coca cultivation and 5) fairness in the implementation of the policies against coca cultivation. The level of obligation to comply is significantly higher in non-coca farmers than in coca farmers.

To capture the effect of social norms, we asked participants what proportion of the municipality's farmers they believed to have farmed coca in previous years. It is remarkable how close the average perceived proportion of coca farmers is to the sample's self reported percentage of coca farmers in both years. This is a good indicatation of the consistency of the self-reported information. However, since coca farmers may declare a higher proportion of coca farmers in order to justify their own behavior, this measure may be subject to endogeneity.

The effect of social norms is captured using the density of coca in the municipality in previous years (number of hectares with coca over total number of hectares in the municipality). To measure the probability that others observe individual behavior and the importance of the opinion of others in maintaining a sense of well-being we used participation in community organizations and the stated degree of trust. We find that the average degree of trust of non-coca farmers is not significantly different from that of coca farmers, but that on average, non-coca farmers participate more in community organizations. Using the Mann-Whitney test, we reject the null hypothesis of equal average participation of coca and non-coca farmers at 1% significance level.

Other significant differences between coca and non-coca farmers are observed in the characteristics of the head of the household. Coca farmers are significantly older, less educated and more risk-averse than non coca farmers. Although the difference is not significant, coca farmers also have less land than non-coca farmers.

Risk preferences were measured using Binswanger's (1980) risk experiment design whereby farmers compare five sets of lotteries in which the payment for lottery A was held constant at 1 million pesos with no risk while lottery B offered equal chances of receiving a payment above and below 1 million. The expected payment of lottery B increased in each choice set but so did the variance.[12] By finding the point at which farmers switch from option B to option A, it is possible to estimate the average coefficient or partial risk aversion. More than half of the sample had high or extremely high levels of risk aversion.

When the maximum income attainable from cultivating all the available land with the most profitable legal product is lower than 93,000 pesos per person per month (the official poverty line) we say that an individual lacks options in the legal economy in order to survive. Using this definition, 45% of the farmers were classified as lacking options.

4.2. Econometric model

The coca-cultivation decision can be analyzed using an extended version of the Generalized Tobit Model. In the first step, farmers decide whether to cultivate coca or not, and then decide what amount of their land to cultivate with coca. A farmer cultivates coca (z=1) if the utility of cultivating it is larger than the utility of not cultivating it, ($V^* > 0$).

$$z = \begin{cases} 1 & V^* = \beta_1 X_1 + \alpha D + \varepsilon_1 \geq 0 \\ 0 & otherwise \end{cases} \qquad (5)$$

[12] 1 USD = 2,200 Colombia pesos in June, 2006

$(\varepsilon_1, \varepsilon_2) \sim N(0,0,\sigma^2,1,\rho)$ and X_1 is a vector of the economic and non-economic factors previously discussed, D is a binary variable that represents participation in programs of voluntary substitution (D=1). Participation in voluntary substitution programs depends on individual socioeconomic characteristics X_2.

$$D = \begin{cases} 1 & \text{If } D^* = \beta_2 X_2 + \varepsilon_2 > 0 \\ 0 & \textit{otherwise} \end{cases} \quad (6)$$

However, since participation in programs of substitution is voluntary, unobserved characteristics that affect the decision to participate in the substitution program (ε_2) can be correlated with the unobserved characteristics that affect the decision to cultivate coca (ε_1), so the model will be subject to self-selection bias. We control for self-selection bias on coca-cultivation decisions by estimating a bivariate probit model that considers the effect of participation in a substitution program on the decision to cultivate coca (Equations 5 and 6). Conditional on cultivating coca, the amount of land cultivated with coca (α) is

$$\alpha = \begin{cases} \beta_3 X_3 + \varepsilon_3 & \text{If } z = 1 \\ 0 & \textit{otherwise} \end{cases} \quad (7)$$

We estimate a linear regression model on the amount of land cultivated with coca conditional on a non-zero investment (Equation 7). Coca farming decisions for 2003 and 2005 were treated as independent of one another, so a pooled data set was used. To avoid scale effects, monetary related variables such as profits from coca and the best legal alternative as well as the number of hectares per household, were normalized using natural logarithms.

4.3. Econometric Results

Table 2 presents the predicted signs and estimated coefficients for the seemingly unrelated bivariate probit model for the coca-cultivation decision, and participation in agreements of voluntary substitution. The econometric results support the hypothesis of correlation between unobserved characteristics that affect the decision to cultivate coca, and that of participating in agreements of voluntary substitution at the 5% significance level. It is reasonable to think that all farmers face the same market incentives to enter into coca cultivation and that they are all aware of the high levels of profitability in coca cultivation compared with legal forms of production. Therefore, if farmers take different production decisions it must be because they face different opportunities, risks and needs. Econometric results confirm this hypothesis. Those farmers who had more opportunities and participated in VAS were less likely to cultivate coca while farmers that faced higher risks of having coca plants destroyed are significantly less likely to cultivate coca at 5% significance level and farmers with less land have fewer options to make a living from legal forms of production which significantly increases their likelihood of cultivating coca. This suggests that both strategies used by authorities in Colombia to control coca cultivation, i.e. both eradication and alternative development programs, have an effect on coca cultivation.

Interestingly, other non-economic factors can explain the decision about whether to cultivate coca or not, at least to some extent. First, Protestants are less likely to cultivate coca than Catholics. One interpretation is that this might be the result of a change in attitude towards coca cultivation that has been introduced to the region by the Protestant Churches. This result suggests that authorities can change people's attitudes toward coca cultivation by providing them with information about the negative effect

that coca has on the environment, the community, the family and other individuals. Publicity campaigns and educational programs seem to offer some options. Second, we find that farmers living in a municipality with more coca are more likely to cultivate. This result points at the importance on creating social resistance towards coca cultivation and suggest that authorities should use both local and national campaigns. Third, farmers who have a higher level of perceived obligation to comply with the law and the authorities are less likely to cultivate coca. This result indicates that institutional policies can alternative development and eradication programs. For example, the creation of participative spaces where farmers and authorities negotiate reducing coca cultivation is an option. Forest Guarding Families (see footnote 7) seem to be a promising option in this respect. However, the authorities will have to bargain over realistic offers if they are to ensure that the agreement will be lasting. The process of eliminating the cultivation of illicit crops has to be gradual in order to allow both farmers and authorities to adjust. Farmers will need to agree to lower levels of income and probably to returning to subsistence agriculture because it is simply not possible for the alternatives to compete in terms of profitability with coca cultivation. The authorities, on the other hand, should work on creating productive options that allow farmers to make a living. The creation of price premiums on labels such as "COCA FREE" could be an alternative. The gradual elimination of illicit crops could also make it possible to generate the social cohesion needed for the negotiation of community agreements on areas free of coca and to implement social control mechanisms. The authorities can gain the trust of the communities by increasing the coverage of the alternative development programs and the efficiency of their implementation.

Other socioeconomic characteristics of the head of a household such as age, gender, level of education, degree of risk aversion and distance from the market are not significant in explaining the decision to cultivate coca. Although not significant, the likelihood of cultivating coca does decrease with age and level of education, while it increases for female respondents, distance from the market and level of risk aversion. Although coca is more risky in terms of having the crops destroyed, legal production faces lower levels of credit availability, harder market conditions and more price variability than coca all of which could explain the positive sign on risk aversion.

On the other hand, participation in agreements of voluntary substitution –VAS- is explained by the degree of trust in others and participation in community organizations reflecting the strategy that the program used to reach the beneficiaries. Similarly, there is a positive effect of age and education on participation in this program. The negative and significant effect of risk aversion on participation in VAS may reflect a perception among farmers that the substitution program was risky. Finally, farmers living in Orito and Valle are significantly less likely to participate in VAS compared with farmers from Mocoa, which indicates that substitution programs were directed to areas with better accessibility.

Our theoretical model predicts that the effect of economic and non-economic factors will differ according to whether farmers lack options in the legal economy or not. To test the predictions of the model, we run independent regressions for farmers in both groups. Table 3 presents the predicted signs from the theoretical model and the estimated coefficients of a linear regression model on hectares cultivated with coca for both groups. We find that irrespective of whether farmers lack options in the legal economy or not, those who have larger farms cultivated more hectares with coca. This

could indicate that the high cost of production restricts smaller farmers from engaging in coca cultivation. We find some evidence for the effect of social norms on the decision to cultivate. Farmers who do not lack alternatives in the legal economy cultivate a larger amount of coca if they live in a municipality with higher levels of coca cultivation. For farmers who lack options in the legal economy, we find that participation in community organizations increases the amount of land that is cultivated with coca. These two effects may indicate a degree of social acceptance of coca cultivation in the area. It is also interesting to note that in the case of farmers who lack alternatives in the legal economy, the perception that there is a higher profit to be made from coca reduces the amount of coca that is cultivated. This could indicate that the coca-cultivation decisions depend on subsistence needs. As coca is more profitable, they can survive with only a few hectares given over to coca cultivation. More evidence for the positive correlation between lack of options and coca cultivation is provided by the positive correlation between the cost of traveling to market and coca cultivation. Other socioeconomic characteristics that are significant in explaining the amount of land cultivated with coca are age and the dummy for female respondents.

From a policy perspective, our results suggest that eradication and alternative development are effective in reducing the incentive to start cultivating coca but have a smaller role in affecting the amount of coca that is cultivated.

5. Conclusions

In this paper we explain the decision to cultivate coca and the amount of land that is cultivated both from a theoretical and empirical perspective. We develop a behavioral version of the economic model of crime to explain coca farming decisions.

Our model also considers situations in which farmers cannot make a living from legal activity. Coca is cultivated because it is more profitable than the legal alternatives, but also because this relative profit is tempting enough to compensate for the personal and social disapproval that coca cultivation generates. Therefore, higher moral standards or higher levels of social pressure reduce the likelihood of cultivating coca. This suggests that in addition to policies of eradication and alternative development, authorities can increase the population's awareness of the negative effects of coca cultivation in order to discourage the activity. Authorities can gain better support if policies are regarded as necessary and if the public recognize the efficiency, fairness and transparency in the policies. Increasing coverage of the existing programs and negotiating gradual reductions in areas can be some of the mechanism that authorities can use to gain public's trust. We find evidence that marginality and the impossibility of making a living out of legal activities is a strong factor behind coca cultivation. In this case, the emphasis of the policy should be towards increasing the profitability of legal agriculture by, for example, investing in infrastructure or offering minimum prices for legal products. Our model suggests that farmers reduce coca cultivation in response to both eradication and VAS.

Using self-reported information on an illicit activity such as coca cultivation may underestimate the dimensions of the problem of coca cultivation. However, our intention has been to unveil some of the factors that affect coca cultivation that cannot be studied with aggregated information. We consider that this study is a first step towards understanding the effect of motivational factors on coca cultivation and is meant to be indicative for alternative strategies that could be used by the authorities.

6. References

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Appendix A. Model

The Lagrangean for individual maximization problem can be written as:

$$L = (1-p)\,U(Y_g) + p\,U(Y_b) + \mu(Y - Y_{\min}) = (A + B + C) = 0$$

Kuhn Tucker conditions for maximization imply:

$$i)\ \frac{\partial \mathrm{L}}{\partial \alpha_i} = (1-p)U'(Y_g)Y_g' + pU'(Y_b)Y_b' + \mu Y' = 0 \qquad (1)$$

$$\frac{Y_g'}{Y_b'} + \frac{\mu Y'}{(1-p)U'(Y_g)Y_b'} = -\frac{p}{(1-p)}\frac{U'(Y_b)}{U'(Y_g)}$$

$$ii)\ \mu \geq 0; \quad \mu(Y - \mathrm{Y}_{\min}) = 0 \qquad (2)$$

Where,

$$\frac{\partial U(Y_z)}{\partial \alpha} = U'(Y_z)\ for\ z = g, b$$

$$\frac{\partial Y_g}{\partial \alpha} = Y_g' = (1-\lambda)(1-\gamma)\pi_i - \pi_l + 2qt(\bar{a} - \alpha) - \lambda'(1-\gamma)\Pi_i > 0$$

$$\frac{\partial Y_b}{\partial \alpha} = Y_b' = (1-\lambda)(1-\gamma)\pi_i - \pi_l + 2qt(\bar{a} - \alpha) - \lambda'(1-\gamma)\Pi_i - f < 0$$

$$\frac{\partial Y}{\partial \alpha} = Y' = \pi_i - \pi_l - pf > 0$$

$$\frac{\partial \prod_k}{\partial \alpha} = \pi_k \quad for\ k = i,l; \quad \frac{\partial \lambda}{\partial \alpha} = \lambda' > 0; \quad and\ \frac{\partial F}{\partial \alpha} = f$$

Second order condition implies:

$$\frac{\partial^2 L}{\partial \alpha^2} = (1-p)\left(U''(Y_g)(Y_g')^2 + U'(Y_g)Y_g''\right) + p\left(U''(Y_b)(Y_b')^2 + U'(Y_b)Y_b''\right) + \mu Y'' = \Delta < 0 \qquad (3)$$

Where,

$$\frac{\partial^2 Y_g}{\partial \alpha^2} = Y_g'' = (1-\lambda)(1-\gamma)\pi_i' - \pi_l' - 2qt - \lambda''(1-\gamma)\Pi_i - \lambda'(1-\gamma)\pi_i$$

$$\frac{\partial^2 Y_b}{\partial \alpha^2} = Y_b'' = (1-\lambda)(1-\gamma)\pi_i' - \pi_l' - 2qt - \lambda''(1-\gamma)\Pi_i - \lambda'(1-\gamma)\pi_i - f'$$

$$\frac{\partial^2 Y}{\partial \alpha^2} = Y'' = \pi_i' - \pi_l' - pf'$$

$$\frac{\partial \Pi_i}{\partial \alpha^2} = \pi_i' \le 0;\ \frac{\partial \Pi_l}{\partial \alpha^2} = \pi_l' \le 0;\ \frac{\partial \lambda_i}{\partial \alpha^2} = \lambda'' > 0;\ \frac{\partial F}{\partial \alpha^2} = f' > 0$$

When minimum income restriction does not bind (μ=0), there are no lack of options in legal agriculture, coca is cultivated if the expected utility from cultivating is larger than the utility from not cultivating, $\mathrm{Y} = (1-p)U(Y_g) + pU(Y_b) - U(W + \prod_l(L)) > 0$. Which implies the following effects on the decision whether to cultivate coca or not.

$$\frac{\partial Y}{\partial \lambda} = ((1-p)U'(Y_g) + pU'(Y_b))(-(1-\gamma)\prod_{\mathrm{i}}) < 0 \quad (1.1)$$

$$\frac{\partial Y}{\partial \gamma} = ((1-p)U'(Y_g) + pU'(Y_b))(-(1-\lambda)\prod_{\mathrm{i}}) < 0 \quad (1.2)$$

$$\frac{\partial Y}{\partial q} = ((1-p)U'(Y_g) + pU'(Y_b))(-t(\bar{a}-\alpha)^2) < 0 \quad (1.3)$$

$$\frac{\partial Y}{\partial t} = ((1-p)U'(Y_g) + pU'(Y_b))(-q(\bar{a}-\alpha)^2) < 0 \quad (1.4)$$

$$\frac{\partial Y}{\partial p} = -U(Y_g) + U(Y_b) < 0 \quad (1.5)$$

$$\frac{\partial Y}{\partial f} = pU'(Y_b)F_f < 0 \text{ if } \mathrm{F_f} < 0 \quad (1.6)$$

$$\frac{\partial Y}{\partial \pi_i} = ((1-p)U'(Y_g) + pU'(Y_b))\prod_{i\pi i} > 0 \quad (1.7)$$

$$\frac{\partial Y}{\partial \pi_l} = ((1-p)U'(Y_g) + pU'(Y_b) - U'(Y_L))\prod_{l\pi l} = ? \quad (1.8)$$

$$\frac{\partial Y}{\partial W} = (1-p)U'(Y_g) + pU'(Y_b) - U'(Y_L) = ? \quad (1.9)$$

Defining, the coefficient of absolute risk aversion, $R(Y_z) = -\frac{U''(Y_z)}{U'(Y_z)}$ and assuming that farmers have decreasing absolute risk aversion – DARA–, $R(Y_b) > R(Y_g) > 0$. When the minimum income restriction does not bind, (μ=0), The first order condition for an interior solution implies:

$$\frac{\partial \alpha}{\partial \lambda} = \frac{1}{\Delta}\left[(1-\gamma)\prod_i (R(Y_g) - R(Y_b))B + ((1-\gamma)\pi_i + \lambda'_\lambda (1-\gamma)\prod_i)((1-p)U'(Y_g) + pU'(Y_b))\right]$$

$$\frac{\partial \alpha}{\partial \lambda} < 0 \tag{2.1}$$

$$\frac{\partial \alpha}{\partial \gamma} = \frac{1}{\Delta}\left[(1-\lambda)\prod_i (R(Y_g) - R(Y_b))B + ((1-\lambda)\pi_i + \lambda'\prod_i)((1-p)U'(Y_g) + pU'(Y_b))\right]$$

$$\frac{\partial \alpha}{\partial \gamma} =< 0 \tag{2.2}$$

$$\frac{\partial \alpha}{\partial q} = \frac{-1}{\Delta}\left[(R(Y_g) - R(Y_b))B(-t(\overline{\alpha} - \alpha)^2) + ((1-p)U'(Y_g) + pU'(Y_b))2t(\overline{a} - \alpha)\right]$$

$$\frac{\partial \alpha}{\partial q} \; is \begin{cases} < 0 & if \quad \overline{a} < \alpha \\ ? & if \quad \alpha < \overline{a} \end{cases} \tag{2.3}$$

$$\frac{\partial \alpha}{\partial t} = \frac{-1}{\Delta}\left[(R(Y_g) - R(Y_b))B(-q(\overline{\alpha} - \alpha)^2) + ((1-p)U'(Y_g) + pU'(Y_b))2q(\overline{a} - \alpha)\right]$$

$$\frac{\partial \alpha}{\partial t} \; is \begin{cases} < 0 & if \quad \overline{a} < \alpha \\ ? & if \quad \alpha < \overline{a} \end{cases} \tag{2.4}$$

$$\frac{\partial \alpha}{\partial p} = \frac{-1}{\Delta}\left[-U'(Y_g)Y'_g + U'(Y_b)Y'_b\right] < 0 \tag{2.5}$$

$$\frac{\partial \alpha}{\partial f} = \frac{1}{\Delta}\left[pU''(Y_b)Y'_b F_f + pU'(Y_b)\right] < 0 \;\; if \; F_f > 0 \tag{2.6}$$

$$\frac{\partial \alpha}{\partial \pi_l} = \frac{-1}{\Delta}\left[(R(Y_g) - R(Y_b))B\prod_{\pi l} - ((1-p)U'(Y_g) + pU'(Y_b))\right]$$

$$\frac{\partial \alpha}{\partial \pi_l} = ? \; if \; \prod_{\pi l} > 0 \tag{2.7}$$

$$\frac{\partial \alpha}{\partial \pi_i} = \frac{-1}{\Delta}\Big[(R(Y_g) - R(Y_b))B(1-\lambda)(1-\gamma)\prod_{i\pi l} +$$
$$((1-p)U'(Y_g) + pU'(Y_b))((1-\lambda)(1-\gamma) - \lambda'(1-\gamma)\prod_{i\pi l}\Big]$$

$$\frac{\partial \alpha}{\partial \pi_i} = ? \text{ if } \prod_{i\pi l} > 0 \tag{2.8}$$

$$\frac{\partial \alpha}{\partial W} = \frac{-1}{\Delta}\Big[(R(Y_g) - R(Y_b)B\Big] > 0 \tag{2.9}$$

If the minimum income restriction binds (μ>0), coca is cultivated if $X = U'(Y_g)((1-\lambda)(1-\gamma)\pi_i - \pi_l + 2qt(\bar{a}-\alpha) - \lambda'(1-\gamma)\pi_i - pf) + \mu(\pi_i - \pi_l - pf) \geq 0$

Assuming that cultivating coca pays off in monetary terms, $\pi_i - \pi_l - pf \geq 0$, coca would be cultivated if the marginal utility of income is high (μ), even when it does not pay-off morally, $((1-\lambda)(1-\gamma)\pi_i - \pi_l + 2qt(\bar{a}-\alpha) - \lambda'(1-\gamma)\pi_i - pf) < 0$

The partial derivative of this expression implies the following effects on the decision whether to cultivate coca or not.

$$\frac{\partial X}{\partial \lambda} = -U''(Y_g)(Y_g' - pf)(1-\gamma)\Pi_i - U'(Y_b)(1-\gamma)\pi_i - \lambda_\lambda'(1-\gamma)\prod_i$$

$$\frac{\partial X}{\partial \lambda} = \begin{cases} < 0 & if \;\; Y_g' - pf \leq 0 \\ ? & f \;\; Y_g' - pf > 0 \end{cases} \tag{3.1}$$

$$\frac{\partial X}{\partial \gamma} = -U''(Y_g)(Y_g' - pf)(1-\lambda)\Pi_i - U'(Y_b)(1-\lambda)\pi_i + \lambda'\prod_i = ? \tag{3.2}$$

$$\frac{\partial X}{\partial q} = -U''(Y_g)(Y_g' - pf)t(\bar{a}-\alpha)^2 + U'(Y_b)2t(\bar{a}-\alpha) = \begin{cases} \leq 0 & if \;\; Y_g' - pf \leq 0; \bar{a} \leq \alpha \\ > 0 & if \;\; Y_g' - pf > 0; \alpha < \bar{a} \end{cases} \tag{3.3}$$

$$\frac{\partial X}{\partial t} = -U''(Y_g)(Y_g' - pf)q(\bar{a}-\alpha)^2 + U'(Y_b)2q(\bar{a}-\alpha) = \begin{cases} \leq 0 & if \;\; Y_g' - pf \leq 0; \bar{a} \leq \alpha \\ > 0 & if \;\; Y_g' - pf > 0; \alpha < \bar{a} \end{cases} \tag{3.4}$$

$$\frac{\partial X}{\partial p} = -U'(Y_g)f - \mu f < 0 \tag{3.5}$$

$$\frac{\partial X}{\partial f} = -U'(Y_g)\,p - \mu p < 0 \tag{3.6}$$

$$\frac{\partial X}{\partial \pi_i} = U''(Y_g)(Y_g' - pf)(1-\lambda)(1-\gamma)\Pi'_{i\pi_i} + U'(Y_b)(1-\lambda)(1-\gamma) + \mu$$

$$\frac{\partial X}{\partial \pi_i} = \begin{cases} > 0 & if\ Y_g' - pf \le 0 \\ ? & if\ Y_g' - pf > 0 \end{cases} \tag{3.7}$$

$$\frac{\partial X}{\partial \pi_l} = U''(Y_g)(Y_g' - pf)\Pi'_{l\pi_l} - U'(Y_b) - \mu = \begin{cases} < 0 & if\ Y_g' - pf \ge 0 \\ ? & if\ Y_g' - pf < 0 \end{cases} \tag{3.8}$$

$$\frac{\partial X}{\partial W} = U''(Y_g)(Y_g' - pf) = \begin{cases} < 0 & if\ Y_g' - pf \ge 0 \\ ? & if\ Y_g' - pf < 0 \end{cases} \tag{3.9}$$

In this case, the minimum income restriction binds, $\mu>0$, so the amount of coca that is cultivated is given by $Y = W + \prod_i(\alpha) + \prod_l(L-\alpha) - pF(\alpha) = Y_{min}$. Taking the total derivative of this expression, and solving for α, we find the following effects on the proportion of land that is cultivated with coca

$$\frac{\partial \alpha}{\partial \lambda} = \frac{\partial \alpha}{\partial \gamma} = \frac{\partial \alpha}{\partial q} = \frac{\partial \alpha}{\partial t} = 0 \tag{4.1}$$

$$\frac{\partial \alpha}{\partial Y\min} = \frac{1}{\pi_i - \pi_l - pF_\alpha} > 0 \tag{4.2}$$

$$\left.\frac{\partial \alpha}{\partial p}\right|_{dYm=0} = \frac{F(\alpha_i)}{\pi_i - \pi_l - pf} > 0 \tag{4.3}$$

$$\left.\frac{\partial \alpha}{\partial F}\right|_{dYm=0} = \frac{p}{\pi_i - \pi_l - pf} > 0 \tag{4.4}$$

$$\left.\frac{\partial \alpha}{\partial \prod_i}\right|_{dYm=0} = \frac{-1}{\pi_i - \pi_l - pf} < 0 \tag{4.5}$$

$$\left.\frac{\partial \alpha}{\partial \prod_L}\right|_{dYm=0} = \left.\frac{\partial \alpha}{\partial W}\right|_{dYm=0} = \frac{-1}{\pi_i - \pi_l - pf} < 0 \tag{4.6}$$

Appendix B. Survey

Table 1. Descriptive Statistics

Variable	Non-Coca farmers		Coca Farmers		Test Ho: Non-Coca=Coca	All Farmers	
	Mean	Std. Dev.	Mean	Std. Dev.		Mean	Std. Dev.
Socioeconomic Characteristics							
Age	44.02	13.99	37.85	14.32	***	41.40	14.33
Dummy Female	0.34	0.48	0.36	0.48		0.35	0.48
Education Grade	1.47	0.86	1.75	0.90	**	1.59	0.88
0 = Percentage with no education	10.43		5.69			8.22	
1 = Percentage with basic education	46.01		39.02			43.15	
2 = Percentage with complete primary education	29.45		30.08			30.14	
3 = Percentage with more than primary education	14.11		25.20		**	18.46	
Risk aversion	3.77	3.58	3.14	3.67	*	3.44	3.62
0 = Percentage missing response for risk preference	15.95		23.58			20.48	
1 = Percentage risk-neutral to risk-loving	15.34		17.89			16.04	
2 = Percentage with slight to neutral risk preference	6.13		6.50			6.14	
3 = Percentage with moderate risk preference	7.98		10.57			9.22	
4 = Percentage with intermediate risk preference	7.98		4.07			6.14	
5 = Percentage with severe [strong?] risk preference	10.43		3.25		**	7.17	
6 = Percentage with extremely strong risk preference	36.20		34.15			34.81	
Transport cost (Thousand COL 2005)	2.56	2.20	2.99	2.53		2.74	2.34
Hectares per capita	1.05	1.24	0.78	1.12		0.92	1.20
Coca Cultivation							
Dummy coca 2005	-	-	1	-		0.43	0.50
Dummy coca 2003	-	-	1	-		0.71	0.45
Hectares with coca 2005	-	-	1.41	1.29		0.61	1.10
Hectares with coca 2003	-	-	1.85	1.85		1.31	1.77
Proportion of farm land with coca 2005	-	-	0.29	0.30		0.12	0.24
Proportion of farm land with coca 2003	-	-	0.31	0.30		0.22	0.29
Perceived proportion of coca farmers in 2005	0.37	0.23	0.61	0.25	***	0.47	0.27
Perceived proportion of coca farmers in 2003	0.70	0.24	0.82	0.19	**	0.79	0.21
Hectares with coca per square Km 2002-2003	0.42	0.34	0.92	0.39	***	0.63	0.44
Hectares with coca per square Km 2000-2001	3.11	3.54	6.49	4.94	**	5.50	4.82
Number of years cultivating coca	5.15	5.77	7.52	5.50	***	6.15	5.75

Continue…

Variable	Non-Coca farmers		Coca Farmers		Test	All Farmers	
	Mean	Std. Dev.	Mean	Std. Dev.	Ho: Non-Coca=Coca	Mean	Std. Dev.
Economic Benefit							
Net annual income coca 2005 (Thousand COL 2005)	3818	3485	3212	3167	*	3507	3336
Net annual income coca 2003 (Thousand COL 2005)	5678	3545	5460	3767		5514	3707
Net annual income alternative 2005 (Thousand COL 2005)	1098	1267	842	1000	*	978	1157
Net annual income alternative 2003 (Thousand COL 2005)	839	1069	1006	1398		962	1319
Index of market conditions coca vs. alternative 2005	-0.69	1.34	-0.61	1.15		-0.65	1.25
Index of market conditions coca vs. alternative 2003	0.34	1.15	0.30	1.42		0.31	1.35
Eradication and Alternative Development							
Sprayed hectares over total hectares with coca 2002-2003	8.97	7.55	6.33	5.08		7.94	6.74
Sprayed hectares over hectares with coca 2000-2001	0.69	0.80	1.23	0.74	***	1.07	0.79
Dummy Voluntary Agreements of Coca Substitution	0.45	0.50	0.24	0.43	***	0.35	0.48
Morality, Social Norms and Legality							
Level of moral development	1.34	0.72	1.10	0.76	***	1.23	0.75
0 = Missing response for moral development	6.75		20.33		***	12.9	
1 = Pre-Conventionalist	60.7		53.66			57.6	
2 = Conventionalist	24.5		21.95			23.2	
3 = Post-Conventionalist	7.98		4.07			6.14	
Religion	1.10	0.48	0.97	0.40	**	1.04	0.45
0 = Percentage who do not belong to any Religion	6.79		9.76			8.25	
1 = Percentage Catholics	75.9		83.74			79.3	
2 = Percentage Protestants	17.28		6.50		***	12.37	
Index of obligation to comply (Completely disagree=1. Completely agree=5)	3.69	0.69	3.19	0.82	***	3.48	0.79
Degree of trust (not at all=1 a lot=5)	3.09	1.29	2.89	1.20	***	3.01	1.25
Dummy participation in community organizations	0.63	0.48	0.50	0.50	***	0.57	0.50

The test of equal distribution is based on the Wilcoxon rank-sum test for continuous variables and the proportion test for fractions

*, ** and *** denote rejection of the null hypothesis with statistical significance at 10% 5% and 1% level respectively.

Table 2. Seemingly unrelated bivariate probit

Dependent Variables	Coca cultivation Decision			Participation in Agreements of Substitution		
	n = 329			n = 329		
Independent Variables	**Predicted Signs**	**Coef.**	**Std. Err.**	**Coef.**		**Std. Err.**
Log profit coca.	-	-0.162	0.107			
Log profit alternative.	?	-0.025	0.084			
Index of credit availability and commercialization facility	-	0.078	0.075			
Sprayed ha/Total ha with coca in municipality	-	-0.037 **	0.017			
Dummy Atheists		-0.178	0.374	-0.005		0.329
Dummy Protestant		-0.950 ***	0.326	-0.183		0.306
Years cultivating coca	+	0.025	0.017	-0.001		0.017
Moral development. Missing response=0; Pre-Conv=1; Conv=2; Post-Conv=3	-	-0.171	0.159	0.124		0.156
Obligation to comply. Completely disagree=1, completely agree=5	-	-0.482 ***	0.155	-0.005		0.146
Degree of trust. Not at all=1, a lot=5	-	0.016	0.080	0.193	***	0.074
Dummy participation in community organizations.	-	-0.251	0.204	0.393	**	0.190
Ha with coca/Municipal area.	+	0.345 ***	0.063			
Cost of transport (Thousand COL)	+	0.001	0.034	0.019		0.033
Log land per capita	?	-0.322 ***	0.095	0.023		0.095
Age		-0.021	0.042	0.065		0.040
Squared age		0.000	0.000	0.000		0.000
Female		-0.157	0.207	0.268		0.183
Education (None=0,Basic=1, Primary=2, More=3	-	-0.150	0.414	1.171	***	0.393
Squared education grade		0.089	0.117	-0.233	**	0.109
Coefficient of risk aversion (missing response=0,lover=0.84 to extreme=8	-	0.015	0.028	-0.076	***	0.025
Dummy missing response level of moral development		1.385 **	0.614	0.700	*	0.402
Dummy missing response for risk aversion		-1.071	1.188			
Constant		4.263 ***	1.436	-3.763	***	1.173
Dummy Orito				-1.105	***	0.251
Dummy Puerto Asis				-0.249		0.303
Dummy Valle del Guamuez				-1.295	***	0.351
Rho		-0.340	0.123			
Likelihood-ratio test of rho=0 chi2(1)		6.750	0.009			

*, ** and *** denote statistical significance at 10% 5% and 1% level respectively.

Table 3. Linear regression Model

Dependent variable hectares with coca	Do not lack options in the legal economy			Lack options in the legal economy			
	n=106			n=108			
Variables	**Predicted signs**	**Coef.**	**Std. Err.**	**Predicted signs**	**Coef.**		**Std. Err.**
Log profit coca	+	-0.107	0.209	?	-0.222	*	0.116
Log profit Alternative	-	0.135	0.198	?	0.070		0.111
Index of Credit Availability and Commercialization Facility		-0.100	0.130		0.133		0.084
Sprayed ha/Total ha with coca in municipality	-	0.032	0.045	+	-0.031		0.027
Dummy Atheists	+	-0.549	0.697	?	-0.565		0.390
Dummy Protestant	-	-0.505	0.911	?	0.004		0.572
Years cultivating coca	+	0.019	0.028	?	0.025		0.022
Moral development (Missing response=0; Pre-Conv=1; Conv=2; Post-Conv=3)	-	-0.218	0.295	?	-0.205		0.215
Obligation to comply (Completely disagree=1, Completely agree=5)	-	-0.015	0.234	?	0.093		0.136
Degree of trust (not at all=1, a lot=5)	-	0.222	0.134	?	0.089		0.096
Dummy participation in community organizations	-	-0.173	0.341	?	0.417	**	0.199
Ha with coca/Municipal area	+	0.091 **	0.044	?	0.017		0.024
Cost of transport (Thousand COL)	+	0.015	0.091		0.064	*	0.035
Log land per capita	+	0.557 **	0.228	?	0.326	**	0.149
Age		-0.030 *	0.017		-0.015	*	0.008
Female		-1.015 **	0.422		-0.183		0.199
Education (None=0,Basic=1, Primary=2, More=3		0.215	0.212		-0.113		0.140
Coefficient of risk aversion	-	0.010	0.046		0.018		0.028
Dummy missing response for moral development		-0.330	0.695		-0.170		0.419
Dummy missing response for risk aversion		dropped			0.446		0.825
Constant		1.909	2.699		3.000	**	1.153

*, ** and *** denote statistical significance at 10% 5% and 1% level respectively.