The Potential Role of Price Insurance to Improve Welfare of Honduran Coffee Producers

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ABSTRACT

Coffee is the major export crop in Honduras, but the export price is relatively low. This paper investigates the potential role for a coffee price insurance product - based on the use of the coffee future market - to increasing producer welfare by reducing coffee price risk faced by individual farmers. By constructing a typology of six different types of coffee farmers and developing a forecasting model, the authors show that more risk-averse farmers would prefer to buy the insurance contract than those with lower risk aversion. The subjective assessments analysis also show that Honduran coffee producers have optimistic expectations for coffee prices and appear to underestimate the variability of coffee prices.

Key Word: commodity insurance, risk analysis, coffee price, Honduras

1. Introduction

Of the 6.5 million inhabitants in Honduras, nearly 80% live in poverty. The average Honduran family, lives on less than $1,000 US per year (HTH 2003). Poverty in rural areas is worse still, and absolute numbers and proportion of households living in poverty in the rural areas has been increasing in recent years. Many observers believe that one of the key causes of worsening rural poverty in Honduras – and indeed in Latin America more generally – has been the precipitous decline in coffee prices realized by producers. Even today, coffee is the second most important export crop in Honduras in value terms, and is thus a major source of international revenue, representing almost a quarter of the country's gross domestic product (Partners 2003). Hondurans produces mainly Arabica coffee. Total production has increased steadily since 1981, reaching 3,3913,460 quintals (1 quintal = 100 pounds), with an average yield of 15 quintal/ha on an average farm size of 2.9 ha (Varangis et al. 2003).

Much of the coffee in Honduras is grown by small-scale producers in the more isolated, high altitude locations; with 92% of the coffee producers' annual production less than 100 quintals per farm (Ibid. 2003). Yet, although Honduras has considerable acreage and labor force dedicated to coffee cultivation, its international market share and export price are both relatively low compared to other Central American countries (Partners 2003). Farmers also sell the majority of their production to intermediaries. Quality is also of concern; Honduras coffee suffered penalties anywhere between 5 and 15 cents per pound on the world market in the past two years (Hearne et al. 2002; Partners 2003).

Combined with internal factors associated with low relative prices, during 2000 and 2001, worldwide supply caused coffee prices to drop to their lowest levels in 30 years, or, to a 100 year low, if adjusted for inflation (Varangis et al. 2003). Since the middle of 2001, the nominal Arabicas coffee price ("other mild" category, which Honduras coffee belong to, though at a discount) in international market has declined to below 60 US cents per pound (ICO). Yet, world coffee prices have been declining – in both nominal and real terms since at least the mid-1970's; real coffee prices have markedly declined in recent years in Honduras due to high inflation rates of the past few years, but even nominal prices have been declining. Oddly enough, domestic production has been expanding over the past twenty or so years – precisely when prices have been falling. Since Honduras is really too small to affect world coffee prices, it remains a mystery as to why production has expanded so much – increasing by more than 2.5 times over the period 1981 – 2001. Certain explanations have been given for fall in the world price of coffee, e.g. the collapse of the International Coffee Agreement (ICA) in 1989 or the continued expansion of world supplies, particularly by new entrants such as Vietnam, in the 1990's. But, these explanations fall short of explaining the rather dramatic fall of real coffee prices during 1975-1989, before the collapse of the ICA or, more importantly for this study, the dramatic rise in domestic production in still relatively low-production countries like Honduras.

In order to baseline the simulation model developed below, certain questions on farmers' perceptions of yield and price risk for coffee and maize were included on a large survey of farm households in Honduras. Under the project titled "Rural Development Policies and Sustainable Land Use in the Hillsides of Honduras", the International Food Research Institute (IFPRI), in association with Wageningen University and Research Center (WUR) and the National Program for Sustainable Rural Development

(PRONADERS) of the Secretariat of Agriculture and Livestock (SAG) in Honduras, undertook a farm survey in 9 provinces and 19 counties of Honduras. Their collaborator EAS collected data between November 2001 and May 2002 for 376 farm households in these hillsides regions of Honduras, where 91% of the population has incomes of less than $1.00 per capita per day. There are total 68 coffee farmers in the survey, their average coffee yield is 7.74 quintal/ha, which is almost half of the national standard mentioned previously – and Honduran national yields are lower than the Central American averages to begin with (Varangis et al. 2003). The annual overall average income is US$ 728 per household (exchange rate based on 1 US$ = 15.8 Lempira).

In Jansen et al., the authors cluster households based on the asset portfolios, resulting in six types of rural households: smallest basic grains farms, small basic grains farms, medium basic grains farms, coffee farms, medium livestock farms, and large livestock farms. The 48 coffee farm households have the second highest average total income due to coffee production and relatively high off-farm earnings. The average farm size for this cluster is 7 hectares. Annual total income is US$ 969 and per capital income is US$ 179. Medium livestock farm households have the highest average total income, at US $2,193; and a number of these farm households also produce coffee. Livestock activities and off-farm activities, together with coffee production, result in high average income.

The coffee farmers at Honduras face at least two problems associated with coffee prices: declining coffee price and volatility of the price (Varangis et al. 2003). It is the hypothesis of this study that they can improve their situation by buying insurance contracts whose parameters are tied to trading opportunities in the international coffee market. Coffee is traded in both spot and futures markets; futures and options are traded on "C" contract of the New York Board of Trade, which calls for delivery of washed Arabic coffee (CRB 2002).

In the remainder of the paper, we will develop appeal to a simple theoretical model of the willingness to pay for insurance in order to construct an simulation model, present results for the forecasts of expected coffee prices and various futures contracts, and finally present results from a simulation analysis of the willingness to pay for coffee price insurance.

2. Model Development & Hypothetical Insurance Contracts

2a. Model Development

In this section, we develop a simple theoretical model of the willingness to pay for coffee price insurance. Following the standard willingness to pay literature, we consider the willingness to pay to be equal to the difference between a person's utility with the insurance and her utility without the insurance, written as follows:

$$WTP = \delta\left(EU^{I}(Y^{I})^{*} - EU^{NI}\left(Y^{NI}\right)^{*}\right) \qquad (1)$$

Where *EU* is expected utility; *Y* is income; δ is a discount factor reflecting the fact that payment for the insurance contract is made at the beginning of the period and income is realized at the end of the period; the superscripts, *I* and *NI*, stand for the insurance vs. no-insurance cases, respectively; and $EU^{i}(Y^{i})^{*} = \max EU^{i}(Y^{i})$. Income is comprised of three sources: coffee revenues: $\pi_{cf} = P_{cf}Q_{cf} = P_{cf}x_1^{\gamma cf} - c_{cf}x_1$, grain crop revenues, $\pi_{gn} = P_{gn}Q_{gn} = P_{gn}x_2^{\gamma gn} - c_{gn}x_2$ and off-farm income, π_{Off}. (P is domestic price for coffee and grain crop respectively; x is input; γ is technical parameter for coffee and grain crop respectively). Coffee and grain crops are risky activities, and both prices and quantities produced vary. In the simulation model, we use a mean-variance approximation to expected utility. The no insurance maximization problem is given:

$$\max_{x1,x2} EU^{NI}(Y^{NI}) = \bar{P}_{cf}\,\bar{Q}_{cf} - c_{cf}x_1 + \bar{P}_{gn}\,\bar{Q}_{gn} - c_{gn}x_2 + \pi_{Off} - \tfrac{1}{2}\phi\sigma^2_{Y^{NI}} \qquad (2)$$

Where bars over the variables indicated expected values, ϕ is the coefficient of absolute risk aversion, and $\sigma^2_{Y^{NI}}$ is the variation in income.

For the insurance case, we assume that farmers insure their entire (expected) output; the maximization problem is given below:

$$\max_{x1,x2} EU^{I}(Y^{I}) = \overline{VC}_{cf}\,\bar{Q}_{cf} - c_{cf}x_1 + \bar{P}_{gn}\,\bar{Q}_{gn} - c_{gn}x_2 + \pi_{Off} - \tfrac{1}{2}\phi\sigma^2_{Y^{I}} \qquad (3)$$

The above expression differs from that in Eq. (2) by the term, $\overline{VC}_{cf}$, which is the expected value of the insurance contract, and $\sigma^2_{Y^I}$, which is the variance of income with the insurance contract (here we only consider the insurance contract for coffee).

As we will see below, the price of coffee and the quantity of coffee produced are not correlated, nor are the price of grain (which we proxy with maize) and the quantity of maize. Thus, the variance of coffee income is as follows:

$$Var\pi_{cf} = \sigma^2_{P_{cf}}\sigma^2_{Q_{cf}} + \left[E\left(P_{cf}\right)\right]^2\sigma^2_{Q_{cf}} + \left[E\left(Q_{cf}\right)\right]^2\sigma^2_{P_{cf}},$$

and similarly for the variance of grain income. For the insurance case, we substitute the forecast value and variance; formulas given below following the estimations. Total income variance is given by thus given by the following standard formulation:

$$\sigma^2_{Y^i} = \sigma^2_{\pi_{cf}} + \sigma^2_{\pi_{mz}} + 2\rho\sigma_{\pi_{cf}}\sigma_{\pi_{mz}}$$

2b. Expected Values, Variances and Forecasts

In this section, we present the results for the coffee and maize price equations, as well as for coffee and maize production. For production data, we used FAO production data; coffee data is available for 1981-2002, and maize production from 1961-2002. Such a series is quite likely to be less variable than household-level realizations, nonetheless the data gives us a base estimate of output variance.

Below we present results for the production and price data, for coffee and maize. All equations were run as either ARIMA or mixed ARIMA-Regression equations using first-differenced dependent variables; we fail to reject stationarity for the first-difference series for all variables, using the Dickey-Fuller test for unit roots[i]. As noted above, production data is yearly and is run in levels[ii]. World price data for coffee is the monthly series on spot prices for the "other mild" category of arabicas, in natural logs; domestic price data is also monthly and in natural logs[iii].

Honduras Maize Production

$$\left(Q_{mz,t}-Q_{mz,t-1}\right)=\underset{(1.03)}{5791.69}-\underset{(-2.62)}{.310}*\left(Q_{mz,t-1}-Q_{mz,t-2}\right)-\underset{(-2.26)}{.395}*\left(Q_{mz,t-2}-Q_{mz,t-3}\right);$$

n=41 (1961-2002); Prob > χ^2 =.07; $\sigma_{Q_{mz}}=46066$

Honduras Coffee Production

$$\left(Q_{cf,t}-Q_{cf,t-1}\right)=\underset{(3.00)}{5833.18}-\underset{(-1.77)}{.352}*\left(Q_{cf,t-1}-Q_{cf,t-2}\right);$$

n=21 (1981 – 2002); Prob > χ^2 =.0002; $\sigma_{Q_{cf}}=11794$

Honduras Maize Price

$$\left(\ln HP_{mz,t}-\ln HP_{mz,t-1}\right)=\underset{(1.68)}{.092}+\underset{(2.94)}{.544}*\left(\ln HP_{mz,t-4}-\ln HP_{mz,t-5}\right);$$

n= 29 (1966-1995); Prob > χ^2 =.003; $\sigma_{\ln HP_{mz}}=.130$

Honduras Coffee Price

$$\left(\ln HP_{cf,t}-\ln HP_{cf,t-1}\right)=\underset{(.20)}{.0004}+\underset{(7.41)}{.56}*\left(\ln WP_{cf,t}-\ln WP_{cf,t-1}\right)-\underset{(-4.18)}{.19}*\left(\ln HP_{cf,t-1}-\ln HP_{cf,t-2}\right);$$

n= 222 (1982(2) – 2001(12)); Prob > χ^2 =.0000; $\sigma_{\ln HP_{cf}} = .14$

World Coffee Price

$\left(\ln WP_{cf,t} - \ln WP_{cf,t-1}\right) = -.0035 + .26 * \left(\ln WP_{cf,t-1} - \ln WP_{cf,t-2}\right);$

n=222 (1983(2) – 2002(12)); Prob > χ^2 =.0000; $\sigma_{\ln WP_{cf}} = .08$

The only rather peculiar estimated model is for Honduras Maize price, where a 4th-order autoregressive lag, only, yielded the best χ^2. For our purposes, the most striking result is the standard deviation of the Honduras and world coffee price series; Honduras price variability is nearly double that of the world price series.

As noted earlier, production data, based on national aggregates, is likely to under-estimate the variability that smallholders actually face. Nonetheless, we use the estimated coefficient of variation of production (.25 for maize and .21 for coffee), to baseline the model. Also, the price of maize as provided by FAO is only available up to 1995; we therefore used the variance from the price series but used the subjective prediction of the price of maize from the household survey.

The world coffee price follows an ARI(1,1,0) process, so we can write the forecast equation as the following:

$$\Delta WP_{cf,t} = \phi_1 \Delta WP_{cf,t-1} + \delta + \varepsilon_t$$

where $\Delta WP_{cf,t}$ represents $WP_{cf,t} - WP_{cf,t-1}$, $\Delta WP_{cf,t-1}$ represents $WP_{cf,t-1} - WP_{cf,t-2}$, ϕ_1 is the coefficient capturing the impact of last period's price difference on this period's difference, δ is a constant that determines, in part, the mean of the stochastic process, and ε_t is the error term. Note that, for the series to be stationary, ϕ_1 <1, which holds for the estimated world price equation. The N-month forecast and variance are calculated using the following formulas (Pindyck & Rubinfeld 1991):

$$WP_{cf,t+l}^{Fcst} = WP_{cf,t+l} + \phi_1 \Delta WP_{cf,t+l} + \delta$$

$$E\left[e_T^2(l)\right] = \sigma_\varepsilon^2 \sum_{i=1}^{l} \left(\sum_{j=0}^{l-i} \phi_1^j \right)^2$$

Since prices are in natural logs, we then transform the forecast price and variance, following the formulas given in Greene (2000). Honduras coffee prices were forecasted using the same procedure; but note that, in this case, the forecast depends on the world price, which itself is forecasted. We forecast Honduras prices using the following equation:

$$HP_{cf,t+l}^{Fcst} = HP_{cf,t+l} + \beta_1 \Delta WP_{cf,t+l} + \phi_1 \Delta HP_{cf,t+l} + \delta$$

The variance is calculated following the formula given above for the AR(1,1,0) world price equation. In other words, we did not account for the additional variance introduced by using the forecasted world price to forecast the domestic price of coffee; the estimated variance, then, would be a lower-bound estimate.

Table 1 below gives the prevailing prices for Brazilian washed arabicas[iv] and the domestic price of arabicas coffee in December 2001, and the forecast price and variance for 6, 9 & 12 months forecasts for domestic and world prices (where the latter refer to months before December 2002). Table 2 gives the actual coffee prices obtaining in December 2001 and 2002.

The futures market on the New York Board of Trade offers contracts for “C” arabicas, for which Honduran coffee receives a substantial discount, of 100 points (CRB 2002). This makes it somewhat difficult to make a clean comparison between the NYBOT futures price and the relevant domestic market price for producers. As in the spot market, Honduran coffee is discounted and this adds another source of risk (and, it is risky, because the discounts vary over time). As noted above, the futures price for a 12 month "C" contract is 53.85 cents per pound, and the 9 month is 53.40 (NYBOT). The implied volatility, obtained by applying Black's model, is 47% for the 12 month contract, and 38% for the 9 month contract. As expected, implied volatility is lower than historical spot price volatility; but, again this does not account for increased risk associated with quality discounts. A decision was thus made to base hypothetical insurance contracts on the historical spot price, and not the future's price.

2c. Insurance Contracts

In this section, we present the hypothetical contracts used in the simulation analysis. There are three types of contracts. First, following Sarris (2002), we consider that producer's who purchase insurance will actually receive prices prevailing in the international markets. We considered contracts with a strike price equal to the forecast price, as well as strike prices 10% above and below the forecast price, each for 12, 9 and 6 months.

The assumption that producer's will receive essentially the export price is quite a big assumption – producers' prices were 13% and 20% lower than the prevailing international spot price for Honduran coffee in December 2002 and December 2001, respectively. The second set of contracts considers that producers would consider the mean and variance from the domestic producer price series to represent no insurance scenario; note that the mean is lower and variance higher than when we use the world price series for the no insurance scenario. For contract values, we assume that the variance of the insured contracts are those derived from the world price series as above. However, we assume that producers' receive only a fraction of the world price, so that the expected values of the contracts are equal to a fraction of the contracts specified under the first set of contracts discussed above. We assume the constant fraction is equal to 80%. Finally, we use forecasts made by smallholders surveyed in Honduras in early 2002; respondents were asked to give the most likely, the highest and the lowest prices they might receive in December, 2002. Using formulae for triangle distributions, we recovered the expected price and variance of that price.

3. Simulation Model Results

3a. Willingness to pay

Before presenting results of the willingness to pay, Table 3 presents total household income, and the coffee, maize, other crops and off-farm income for six types of households for which simulations were run.

As noted above, full data was available on only 47 households, but they still provide useful parameters with which to baseline the model. Note that even “rich” households are quite poor. In the model below, we have included maize as the only other agricultural crop since it is the major household staple crop. It can be mentioned, however, that households are quite diversified in terms of number of crops produced, which may offer some risk-spreading benefits that are not accounted for in the model[v]. For all three income categories, off-farm income forms a significant share of income for those households with low coffee shares. In the simulation model, off-farm income is modeled as risk-free but fixed.

Table 4 below present results for the willingness to pay for the 6, 9 and 12 month insurance contracts based on the assumption that producers will receive predicted world prices, given that producers' have constant relative risk aversion (CRR) =.9. In Table 5, results are given for the same scenario, with the exception that CRR=.4[vi].

Looking first at Table 4, we see that with a relatively high coefficient of relative risk aversion, all producer's would purchase the 12 month contract at fair value; many producer's with large coffee income shares would pay 50% more than the fair value contract. Fewer producers would pay for the 9 month contract; here only the poorest households and those with large coffee income shares would purchase the contract. No households would purchase the 6 month contract at fair value[vii]. Furthermore, as shown in Table 5, when we assume a lower coefficient of relative risk aversion, fewer households would be willing to pay for fair value insurance contracts, though the 12 months contracts are still preferred more often than the 6 and 9 month contracts. Interesting to note is that, whereas the willingness to pay as a share of the fair value contract usually decreases as the strike price increases, this is not so for the wealthiest producers with high coffee shares.

Next, we present results for scenarios based on the domestic price series, for high and low CRR; these are given in Tables 6 and 7.

The main difference with the first set of contracts is that the expected price with no insurance and the expected values of the insurance contracts are all lower, but the reduction in variability vis-à-vis the no insurance case is more pronounced. Nonetheless, these contracts are almost never valued greater than fair value for those households with low coffee income shares except the poorest and most risk-averse households. Most households with large coffee income shares should be willing to pay more than fair value, especially for the 12-month contracts. Nine-month contracts are only attractive to relatively risk-averse households.

3b. Subjective Assessments:

Interviews undertaken between December 2001 and February 2002 included questions regarding the household head's subjective assessment of the coffee prices for December 2002[viii]. The farmer was asked to give his assessment of the most likely price, as well as the best and least likely prices. These values were used to construct a triangle distribution, from which estimates of expected value and variance coffee price 12 months ahead were calculated. Table 8 below presents data on prices just received, expected price 12 months ahead, the percent increase in expected vs. current prices, and variance of expected price. For the 45 households for which price data is available (price per pound of coffee sold in this year's harvest (in December 2001)), the average price just received was 34.04 cents per pound, very close to the producer's price of 33.93 reported above. Because of very few observations for the wealthy category, we combine these categories. Interestingly, the medium and wealthy farmers received higher prices than did poor farmers.

More striking is the fact that nearly all sub-groups of producers expected prices to be much higher in December 2002 than those prevailing in December 2001 – 25-50% higher – for all but the medium income, low share of coffee households who expected only a 5% increase. The forecast price was just under 33 cents per pound, whereas the realized price was quite a bit higher, at just over 40 cents per pound. Nonetheless, even the higher realized price was well below producers' expected price. Such high expectations may be a result of optimism, or respondents may have felt that they could influence government price support policy by stating what they considered to be a “fair” price; it would be worth looking into formation of price expectations more seriously if these types of insurance schemes are to be implemented.

Finally, the variances recovered from the triangle distribution are very low indeed; the coefficient of variation is just .19. This is likely to be, in part, an artifact of the double truncation of the triangle distribution, which may under-estimate true subjective assessment of the price distribution. Nonetheless, it is interesting to note that those with lower share of coffee income perceive much lower price variance.

Given the higher than forecast expected prices, and the much lower variability, we already expect that producer’s with holding these subjective assessment would not be willing to pay for price insurance. Table 9a below gives simulation results using values for expected price and variance from the above table, and values for insurance contracts based on receiving a 80% of the expected value of world price based contracts (as per the domestic price-based scenarios run immediately above); Table 9b gives results when using the producers’ subjective assessments of expected price, but where we then use the variance in price stemming from the domestic producer price series, which is higher than the variance of the insurance contracts, and of course, much higher than the variances recovered from the subjective assessments.

As can be seen above, not only is no one willing to pay for insurance if we use subjective assessments of expected price and variance, but in fact, they would have to be paid – quite substantially! – to take the insurance. When we use actual variance of domestic prices as the relevant price variance under no insurance, still no category of farmers is willing to pay the fair value of insurance. This indicates that it is not just the low subjective assessments of price variance driving the result, but is both the optimistic expectations over prices as well as the low assessed variance.

3c. Allowing producer's to allocate agricultural inputs

In the next set of simulations, we allow the producer's to choose optimal input allocations, but fix the total amount of off-farm income at different levels, USD 1000 and 2000. Given the risk parameters, it was not necessary to restrict total agricultural inputs to some fixed level; in other words, the level of risk and the parameterization of risk preferences nearly reproduce observed levels of total "aggregate" inputs, and total incomes realized, as in the above scenarios, where input levels were fixed. The simulations also work a bit differently in that we allow producer's to maximize expected utility either under the no-insurance scenario, or when forced to purchase the full insurance at the fair value premium price. If expected utility is higher under no-insurance, then producers' will choose not to insure. In the first scenario, we vary the premium price, so we can directly determine whether or not the producer will benefit by purchasing full insurance at the alternative prices, and check the premium price at which the producer is just willing to buy full insurance vs. no insurance. In the other two scenarios, we change the expected value of the contract and change the discount rate. In these cases, when insurance scenarios yield greater expected utility than the no insurance case, we calculate the additional amount producer's would be willing to pay in addition to the fair value based on the difference between expected utility with and without insurance[ix].

Another complication is introduced by the fact that costs of coffee, as found in Varangis et al. (2003), are estimated at 36 cents per pound of output produced in the lowest cost, traditional systems. However, this cost is quite close to the output price, leaving little room for returns to producers (land, human capital, etc.). Since this set of scenarios is trying to capture long-run movements, it can be noted immediately that at costs of 36 cents per pound, no coffee will be grown unless producers' output prices nearly double – insurance or no. In order to generate scenarios more interesting than those repeatedly resulting in no coffee grown, we'll assume that costs of producing coffee are 20 cents per pound. This is similar to assuming that output prices rise, except that costs are non-stochastic whereas output prices are stochastic. Also, with constant relative risk aversion of .9, close to no coffee will be grown – i.e. not more than $0.20 gross value will be produced – by any farm households unless output prices more increase by more than 50%, input costs fall by more than 60%, or coffee income variability falls by more than 60%, or some combination of the above. In other words, when the model allows for farmers to allocate agricultural inputs, this yields the result that, under current parameter values and relatively high risk aversion, no coffee will be grown. In the long run, we would expect risk-averse producers to quit cultivating coffee, if relative profitability and income variability remained constant or worsened. Finally, the poorest households, who have less than $200 a year from off-farm income annually, will nearly always move out of coffee even when they exhibit relatively low risk aversion, unless net profitability nearly doubles and/or variability decreases by more than 75%. Thus, in the scenarios below we only consider the medium and wealthy farm categories (recalling that "wealthy" farmers are still quite poor in absolute terms).

The scenarios are also based on the domestic price scenario outlined above; in the baseline scenario, we assume that producers' expected value of the insurance contract is 80% of the value generated using the world price series. We also discuss results for the 9 month contracts only; 12 month contracts remain somewhat more likely to be preferred, and in these scenarios, 6 month contracts are never purchased. We will also hereafter use OFY in place of off-farm income.

Changing the Insurance Premium

As the insurance premium drops, more coffee will be produced, close to 75% increase for both types of producers, though slightly higher for those with greater OFY. Maize production also increases, but only by about 5%. Results indicate that producers with low OFY would be willing to pay for insurance if the premium were about 4.5 cents per pound, or a premium/expected price ratio of .11; for those with greater off-farm income, insurance becomes attractive at a slightly higher premium.

Increasing Producer Prices (reducing difference between producer prices and world prices):

As with decreasing the premium, no insurance would be purchased under the baseline proportion of 80%, but producers would be willing to purchase insurance if the proportion received rose to 84% for those with low off-farm income, and about 82% for those with high off-farm income. This is equivalent to a premium/expected price ratio of .135 and .14 for low and high OFY producers, respectively. Coffee production expands by about 86% for both types of producers; maize production expands by 10% for low OFY producers, but only by 5% for high OFY producers.

Reducing Variance of Expected Value of Insurance Contract

Reducing the variance of the insurance contract makes insurance attractive when the variance decreases by about 25% for low off-farm income producers, but need only drop by about 8% for insurance to become attractive to those with high off-farm income.

Coffee production expands by about 80% for both producers; as in the previous scenarios, maize production expands by about 11% for low OFY producers and by about 5% for high OFY producers.

Reducing the Coefficient of Absolute Risk Aversion

Reducing the coefficient of absolute risk aversion leads to a decrease in the coefficient of relative risk aversion from .4 to about .2 for low OFY producers, and to a drop from .4 to about .14 for high OFY producers. For low off-farm income producers, insurance becomes attractive only when the coefficient of relative risk aversion reaches .2. For those with high off-farm income, the coefficient of relative risk aversion must reach .15 before insurance is preferred to the no-insurance case. Coffee production expands by 83% and 92% for low and high OFY producers, respectively. Unlike other scenarios, however, maize production also expands dramatically; by 60% for low OFY and 82% for high OFY producers.

To summarize, with no insurance – or insurance at baseline parameters – the mode predicts that nearly all households will move out of coffee, irrespective of whether the households “income” category (again recalling that even “wealthy” households are fairly poor by international standards). Access to insurance contracts that are preferred to the no insurance case generally leads to an expansion of coffee and maize production; though the impact on maize production is fairly limited. Apparently, relatively small changes in the proportion of world prices realized by domestic producers would make insurance contracts attractive; premium prices and variance of the contracts would have to change more dramatically – in percentage terms – in order for insurance contracts to remain viable in the long run. However, these results hold only for producers with a relatively high safe income -- $1000 a year or more. Poorer producers, even of only moderate risk aversion, simply won't be able to manage the risks of coffee production even with insurance, unless expected price increases dramatically, premium prices are very low (e.g. because of subsidies), or the price insurance scheme can offer lower variability than that currently implied by the futures market.

4. Concluding Comments

Results of the analysis give some support to the contention that coffee price insurance would be attractive to smallholders in the short run, when input allocation is essentially fixed. This would be particularly true for longer length contracts: 9 or 12 months. At current parameter values, however, insurance would not be preferred in the medium - long run, particularly by the very poor. Of interest is the fact that increasing the proportion of the world price received by smallholders has a fairly substantial impact on coffee production and the value of insurance, and subsequently on total profits and expected utility. Varangis et al. (2003) emphasize the potential importance of ensuring quality and brand merchandising a ways to capture a greater proportion of prevailing world price. They note this is particularly true in Honduras where agro-ecological conditions and traditional growing methods at least provide the possibility that a greater proportion of world prices can be captured for domestic producers. Of interest to note is that the while the poorest are willing to pay more for insurance when input allocation is fixed, they would not find insurance attractive at all if allowed to re-allocated inputs away from coffee. Rather, the middle – wealthy smallholders are more likely to take advantage of insurance contracts (as parameters improve) in the longer run.

Footnotes:

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[i] All estimations were performed in STATA 8.0

[ii] Whether variables are in levels or logs depends entirely on which variable is better explained by the ARIMA model, in terms of the Wald chi-square statistic. Similarly, various lag structures were specified after visually inspecting the autocorrelation function, and the specification retained was for which the Prob>chi-square was the lowest.

[iii] Because we are interested in forecasting the world and domestic price of coffee, we use the nominal price series; the coffee futures market that any insurance scheme would rely on is obviously in nominal prices. Nonetheless, this assumption masks additional risks associated with domestic inflation; not to mention exchange rate risk; evaluating such risks is outside the scope of the present paper. Estimates presented here can be considered upper-bound estimates of expected price, and lower-bound estimates of the variance of the insured crop.

[iv] As noted above, Honduran arabicas are usually considered in the "other mild" category of coffees traded, but they also trade at a substantial discount. In the recent past for which we have data, Honduran arabica's generally traded closer to the Brazilian arabica price (Other Mild Price – Discount $\cong$ Brazilian Arabica). Because we do not have information on this discount over the entire period 1981-2002, we decided to base our analysis on the Brazilian Arabica price series. The two series are very highly correlated (Pearsson correlation coefficient = .96), and they also exhibit very similar volatility.

[v] We can simulate the effects of reducing maize production variability, but given model parameters, willingness to pay for coffee price insurance is relatively insensitive to changes in maize production variability.

[vi] We chose .9 as the "upper bound" for the coefficient of relative risk aversion since, for most cases, utility was still positive over the range of simulations run. Because our representative households are so poor, and because of the mean-variance specification, holding relative risk aversion constant leads to a utility specification that is quite sensitive to changes in coffee price variability, particular for households with large coffee shares.

[vii] We also ran three month contracts, but the willingness to pay is never greater than the fair value.

[viii] Most of the interviews took place between during the last two weeks of December and the month of January; hereafter, we will refer to these as expected prices for 12 months ahead.

[ix] This latter method of recovering willingness to pay forces output to remain the same – clearly if the price per unit price of insurance actually increases, less output will be produced (which is why we are running this set of scenarios to begin with!). Nonetheless, this would represent the next step in iterating to a solution; the results are thus upper bound estimates of the willingness to pay when increasing the discount rate or increasing expected contract values.

Table 1: Forecasted Prices

	12 Mth	9 Mth	6 Month
World Price			
Forecast Price	40.33	43.25	43.18
Forecast Volatility	54%	43%	33%
Domestic Price			
Forecast Price	32.73	36.48	39.23
Forecast Volatility	61%	57%	44%

Table 2: Actual Prices, December 2001 and December 2002

	December, 2001	December, 2002
World Price	42.21	46.55
Domestic Producer Price	33.93	40.69

Source: International Coffee Organization

Table 3: Total Household Income (in US $) and Income Shares

	Total Income	*% Coffee*	*%Maize*	*%Other Crops*	*%Off-Farm*
Poor					
Low % Income from Coffee	400	10	20	30	40
High % of Income from Coffee	500	65	5	15	15
Medium					
Low % Income from Coffee	1200	10	10	25	55
High % of Income from Coffee	1900	60	15	10	15
Rich					
Low % Income from Coffee	2400	10	0	30	60
High % of Income from Coffee	2400	50	20	15	15

Table 4: Willingness to Pay, World Price Contracts, CRR=.9

6 Month Contract	Strike Price 10% Below	At Expected Price	10% Above
Poor			
Low % Income from Coffee	48.9	64.7	74.2
High % of Income from Coffee	95.8	96.5	97.4
Medium			
Low % Income from Coffee	45.2	62.2	72.4
High % of Income from Coffee	93.8	95.1	96.2
Rich			
Low % Income from Coffee	46.4	63.0	72.9
High % of Income from Coffee	85.0	89.1	91.9

9 Month Contract	Strike Price 10% Below	At Expected Price	10% Above
Poor			
Low % Income from Coffee	**109.1**	**105.7**	**103.6**
High % of Income from Coffee	**162.8**	**146.2**	**135.5**
Medium			
Low % Income from Coffee	66.4	74.1	79.5
High % of Income from Coffee	**125.2**	**118.4**	**114.3**
Rich			
Low % Income from Coffee	67.8	75.2	80.3
High % of Income from Coffee	**114.8**	**110.6**	**108.2**

12 Month Contract	Strike Price 10% Below	At Expected Price	10% Above
Poor			
Low % Income from Coffee	**111.4**	**108.2**	**109.4**
High % of Income from Coffee	**178.7**	**162.0**	**150.2**
Medium			
Low % Income from Coffee	**107.6**	**105.1**	**103.4**
High % of Income from Coffee	**176.8**	**160.4**	**148.8**
Rich			
Low % Income from Coffee	**107.5**	**105.0**	**103.3**
High % of Income from Coffee	**129.4**	**122.0**	**139.4**

Table 5: Willingness to Pay, World Price Contracts, CRR=.4

Willingness to Pay as a Percent of Fair Value Premium; Assume CRR=.4

6 Month Contract	Strike Price 10% Below	At Expected Price	10% Above
Poor			
Low % Income from Coffee	42.4	60.3	70.9
High % of Income from Coffee	62.6	74.0	80.9
Medium			
Low % Income from Coffee	40.5	59.0	70.0
High % of Income from Coffee	62.6	73.9	80.8
Rich			
Low % Income from Coffee	40.9	59.3	70.2
High % of Income from Coffee	58.3	71.1	78.8

9 Month Contract	Strike Price 10% Below	At Expected Price	10% Above
Poor			
Low % Income from Coffee	**101.3**	99.8	98.9
High % of Income from Coffee	**124.6**	**117.4**	**112.7**
Medium			
Low % Income from Coffee	60.5	69.7	75.9
High % of Income from Coffee	86.7	89.4	91.4
Rich			
Low % Income from Coffee	61.2	70.2	76.3
High % of Income from Coffee	82.1	86.0	88.7

12 Month Contract	Strike Price 10% Below	At Expected Price	10% Above
Poor			
Low % Income from Coffee	**102.3**	**100.8**	**103.3**
High % of Income from Coffee	**132.2**	**124.7**	**119.5**
Medium			
Low % Income from Coffee	**100.6**	99.5	98.7
High % of Income from Coffee	**131.9**	**124.5**	**119.3**
Rich			
Low % Income from Coffee	**100.6**	99.5	98.7
High % of Income from Coffee	92.4	92.4	**116.7**

Table 6: Willingness to Pay, Domestic Price Contracts, CRR=.9

Willingness to Pay as a Percent of Fair Value Premium; Assume CRR=.9

9 Month Contract	Strike Price 10% Below	At Expected Price	10% Above
Poor			
Low % Income from Coffee	80.0	79.5	79.4
High % of Income from Coffee	**190.2**	**162.3**	**144.2**
Medium			
Low % Income from Coffee	33.9	45.3	53.1
High % of Income from Coffee	**165.3**	**144.1**	**130.5**
Rich			
Low % Income from Coffee	34.4	45.7	53.4
High % of Income from Coffee	**137.5**	**123.3**	**114.3**

12 Month Contract	Strike Price 10% Below	At Expected Price	10% Above
Poor			
Low % Income from Coffee	**124.7**	**115.0**	**111.0**
High % of Income from Coffee	**293.5**	**249.9**	**222.0**
Medium			
Low % Income from Coffee	91.1	73.9	62.1
High % of Income from Coffee	**289.6**	**246.5**	**218.9**
Rich			
Low % Income from Coffee	**103.0**	97.7	95.3
High % of Income from Coffee	**238.0**	**205.1**	**202.6**

Table 7: Willingness to Pay, World Price Contracts, CRR=.9

Willingness to Pay as a Percent of Fair Value Premium; Assume CRR=.4

9 Month Contract	Strike Price 10% Below	At Expected Price	10% Above
Poor			
Low % Income from Coffee	59.7	64.2	67.4
High % of Income from Coffee	**108.8**	**101.1**	96.3
Medium			
Low % Income from Coffee	21.3	35.8	45.6
High % of Income from Coffee	79.9	79.9	80.1
Rich			
Low % Income from Coffee	21.2	35.7	45.6
High % of Income from Coffee	67.7	70.7	73.0

12 Month Contract	Strike Price 10% Below	At Expected Price	10% Above
Poor			
Low % Income from Coffee	91.5	88.5	89.2
High % of Income from Coffee	**169.0**	**150.4**	**139.2**
Medium			
Low % Income from Coffee	78.7	72.2	68.3
High % of Income from Coffee	**167.0**	**148.7**	**137.6**
Rich			
Low % Income from Coffee	84.6	82.9	83.0
High % of Income from Coffee	**131.1**	**119.6**	**131.5**

Table 8: Coffee Prices: Realized and Subjective Assessments

	Price Just Received	Expected Price, 12 months	% Expected Increase in Price	Variance of Expected Price
Poor				
Low % Income from Coffee	30	42	40	24.7
High % of Income from Coffee	32	48	50	104.2
Medium				
Low % Income from Coffee	36	39	5	68.2
High % of Income from Coffee	37	48	26	144.5
Wealthy	35	49	36	177.9

Table 9a: Willingness to Pay, Subjective Price, CRR=.9

12 Month Contract	Strike Price: 10% Below	At Expected Price	10% Above
Poor			
Low % Income from Coffee	-79.80	-45.49	-17.67
High % of Income from Coffee	-158.96	-106.81	-69.71
Medium			
Low % Income from Coffee	-29.87	-19.97	-13.33
High % of Income from Coffee	-141.24	-93.04	-58.66
Rich			
Low % Income from Coffee	-157.96	-106.98	-70.89
High % of Income from Coffee	-181.03	-125.07	-67.23

Table 9b: Willingness to Pay, Subjective Price, CRR=.4:

Subjective Price, Actual Variance

12 Month Contract	Strike Price 10% Below	At Expected Price	10% Above
Poor			
Low % Income from Coffee	-18.50	2.55	20.77
High % of Income from Coffee	-51.39	-22.50	-1.29
Medium			
Low % Income from Coffee	73.61	61.14	52.50
High % of Income from Coffee	-43.83	-16.69	3.30
Rich			
Low % Income from Coffee	-130.56	-85.49	-53.45
High % of Income from Coffee	-100.24	-61.75	-15.84

References

CRB (The CRB Commodity Yearbook), 2002. Commodity Research Bureau. Hoboken, New Jersey: John Wiley & Sons, Inc.

FAO (Food and Agriculture Organization of the United Nations). http://apps.fao.org/subscriber/

Greene, William H. 2000. *Econometric Analysis* (Fourth Edition). Upper Saddle River, New Jersey: Prentice Hall. Pg. 69 & 901

Hearne, Robert, Bruno Barbier and Jose Manuel Gonzalez, 2002. Development of Minimum Cost, Incentive Based Plan for the Implementation of a Technology Standard for Coffee Processing in Honduras. Paper presented at the 2002 AAEA Annual Meetings, Long Beach, CA.

HTH (Heart to Honduras), 2003. Current Activities: Coffee from Honduras. http://www.hth.org/activities/current/coffee

ICO (International Coffee Organization). http://www.ico.org

Jansen, Hans G.P., Amy Damon, John Pender, Willem Wielemaker, and Rob Schipper. 2003. Paper presented for the international workshop on “Reconciling Rural Poverty Reduction and Resource Conservation: Identifying relationships and Remedies”, Cornell University, NY

NYBOT (New York Board of Trade). http://www.nybot.com

Partners (Partners of the Americans, Washington, DC), 2003. Small scale coffee production in Honduras. http://www.partners.netT

Pindyck, Robert S., Rubinfeld, Daniel L. 1991. *Econometric Models and Economic Forecasts* (Fourth Edition). New York, NY: McGraw-Hill Companies, Inc. Pg. 525-528

Sarris, Alexander. 2003. The Demand for Commodity Insurance by Developing Country Agricultural Producers: Theory and an Application to Cocoa in Ghana. World Bank Policy Research Working Paper No. 2887, World Bank, Washington, DC

Varangis, Panos, Paul Siegel, Daniele Giovannucci and Bryan Lewin. 2003. Dealing with the Coffee Crisis in Central America: Impacts and Strategies. World Bank Policy Research Working Paper No. 2993, World Bank, Washington, DC

Wyeth, John. 1989. Diversification: Eight Lessons from Honduran Experience in the Coffee Sector. Discussion paper 259 of Institute of Development Studies at the University of Sussex, Brighton, England.