Will I be paid after a Loss?

Evaluating Conventional Versus Index Insurance Contracts in Ecuadorean Agriculture

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Abstract

The recent expansion of agricultural insurance for small farmers in Ecuador was initiated in 2010 thanks to a 60% governmental premium subsidy. The insurance product is a conventional named-peril contract that must affront the relatively large transactions costs of verifying small farm losses. This paper shows an evaluation of this insurance contract by comparing its effectiveness to that of a "shadow" area-yield index insurance contract. The findings suggest an important presence of basis risk in the conventional contract and presents index insurance as an interesting alternative for the areas of study.

I. Introduction

The virtual absence of crop insurance limits farmers' willingness to invest and innovate. The cost of uninsured risk is particularly severe for small farmers whose ability to invest is already constrained by weak access to credit markets. In response to this reality, the government of Ecuador implemented in 2010 a policy oriented to the expansion of agricultural insurance among small farmers through a 60% premium subsidy for specific crops. The insurance product, which is offered by a private company, is a conventional named-peril contract which requires inspection and damage verification on individual parcels after a claim is filed.

There are, however, a number of reasons to doubt the efficacy of this response. Similar efforts in other countries to implement individual insurance contracts for small-scale farmers have presented numerous difficulties, usually leading to failure (Wenner, 2005; Slagen, 2002). The transactions costs of verifying small farm losses are large relative to insured values. Not only does this push up premium costs well above actuarially fair prices, the sheer difficulty of determining losses and their causes exposes the insurer to severe moral hazard problems. The result is either commercially non-viable insurance, or the creation of a claims process that makes it difficult for farmers to receive payments for legitimate losses. The individual contract being rolled out for small farms in Ecuador not surprisingly appears to be expensive and features a claims process with reporting and verification procedures that likely imply significant costs for farmers and may reduce effective insurance coverage. Determining precisely how this kind of insurance works in practice was one goal of our research project.

Index insurance represents an innovative new financial technology that may succeed where conventional insurance has failed. In contrast to conventional insurance contracts, payouts under an index contract are not based on individual outcomes. Instead, they are based on the outcome of an aggregate index –such as average area yields, rainfall, or satellite information on plant growth- that is correlated with individual farm outcomes. Using a data source that is promptly, reliably, and inexpensively available (and not manipulable by either the insurer or the insured), an index insurance contract makes the agreed indemnity payment to insured farmers whenever the data source indicates that the index reaches the "strike point," or insurance activation level.

Because it is not necessary to verify individual losses, transactions costs with index insurance are modest, a feature that is especially important if coverage is to be offered to small farmers. A second advantage of index insurance is that it preserves effort incentives for farmers because no individual farmer can increase the probability of an insurance payout by working less hard. In other words, index insurance does not suffer from moral hazard. The combination of low transactions costs and immunity from moral hazard suggests that the market should be able to sustainably provide index insurance to the small farm sector in the developing world.

Index insurance has, however, its drawbacks. Since it doesn't cover for individual losses, it gives place to basis risk, that is, the risk of being insured and having a loss but receiving no payment. It is the risk bore by the insured of not being represented by the index. As summarized by Carter (2012), basis risk can come from pure idiosyncratic risk, from a bad choice of geographic scale for the index coverage, and/or from prediction errors about the correlation between the index and individual outcomes. Nonetheless, the last two can be minimized with an intelligent design of the index contract (Idid). Another disadvantage of index insurance is its dependence on the quality and quantity of information (Wenner, 2005).

The concept of basis risk seems more relevant for index insurance and it is considered the main drawback for this type of contract (Levin and Reinhard, 2007). However, while conventional named-peril crop insurance contracts are, in theory, immune to basis risk, our analysis suggests that basis risk is also a potentially important concern for conventional contracts.[1] Whether it is because farmers do not report the claim in time, their claim is not processed in a timely manner, or they are not able to document that the loss was beyond their control, insured farmers that have suffered legitimate losses can be left out of the process.

Significant basis risk could cause the farmer to go back to the use of inefficient ex-post risk coping strategies such as borrowing from the much more expensive informal sector or selling assets, precisely the types of last-resort strategies that crop insurance should prevent. In this research we attempt to measure basis risk in the conventional crop insurance contract and compare it with basis risk under a “shadow” index insurance contract so as –together with cost, value of indemnity payments, timing and other criteria- to be able to determine the type of contract that would give small farmers a higher livelihood value.

II. Context and Data

Agriculture is a critical sector of the economy of Ecuador. In 2011, this sector generated direct employment for 26.4% of the economically active population, contributed 8% to the GDP and generated over $4 billion in exports. However, 82% of the rural population suffers from unsatisfied basic needs.[2] A highly unequal land distribution (a Gini coefficient for land of 0.81) and low productivity of small farms can be considered the main causes of this situation. Still, one of the key constraints limiting agriculture’s contribution to poverty reduction and growth is the high degree of weather related yield risk faced by farmers. For example, in 2009 a protracted drought adversely affected more than 20,000 hectares in the Sierra, while excessive rains and flooding significantly lowered yields on 36,000 hectares on the Coast. Even more severe were the losses in 2011, when a severe drought adversely affected about 200.000 hectares in the country, only speaking of maize and rice crops.

Currently, there is only one provider of crop insurance in Ecuador. It is a private company who has being using conventional named-peril contracts since year 2000, offering protection to a very modest but growing

[1] Barnett et al, 2005 also suggest the presence of basis risk in conventional multi-peril crop insurance and they explain it can take place because of sampling and measurement errors in the calculation of the historic average yield for the insured farmer and of the actual yields obtained by the farmer. We will see in this research paper that basis risk can also take place because of the miss functioning of other factors.

[2] Result from the 2006 Living Standard Measurement Survey, INEC.

number of large, medium and small farmers. In a pilot program, the government of Ecuador is working with this company since 2010 to extend this type of contracts to a larger number of small farmers by providing a 60% premium subsidy. This insurance is channeled mainly through a State's Bank (Banco Nacional de Fomento, BNF), which is the main source of formal credit for agriculture in the rural areas. There are, however, private financial institutions that are being added to the system. All these financial institutions serve as intermediaries between the farmer and the insurance company by instructing the borrower about the functioning of the policy and by receiving and filing claims to the insurance company. These financial institutions are currently requiring farmers to purchase crop insurance in order to qualify for a loan. Although farmers can directly insure their parcels, most insured farmers get their insurance through the loan transaction. Also, although in theory farmers can pay more to cover all investment costs, the insured amount usually covers only the amount of the loan.

The program so far has achieved about a 30% increase of the insured area.[3] While collecting $1.2 million in premiums in 2011, the insurance paid out over $2 million to 12,645 insured farmers representing 10 covered crops (UNISA, MAGAP).[4] This balance, although negative for the insurer, suggests the importance of government support to expand coverage in order to grant to farmers access to insurance so as to protect their livelihoods under severe shocks such as the 2011 drought.

Crop Insurance expansion would also likely benefit lenders. In 2011, for example, indemnity payments enabled the BNF to recover $1.5 million on loans from affected farmers (UNISA, MAGAP). While the 2011 numbers suggest that important steps have been taken towards the establishment of an agricultural insurance market, it is less clear what impact this conventional, named-peril contract is having on farmers' behavior and well-being. The research summarized in this paper aims to fill this empirical void.

The primary objective of our research project is to evaluate the performance of the insurance contract currently being supported by the Ecuadorian government. We do this in two ways. First, we investigate the functioning and acceptance of this contract among a sample of insured farmers. Second, we compare its

[3] The number of insured hectares that have received the governmental subsidy between May 2010 (beginning of the program) and March 2012 is 43,000 ha. (UNISA, MAGAP).
[4] The eligible crops are: rice, corn, maize, potatoes, wheat, beans, green beans, tree tomatoes, sugar cane and bananas.

effectiveness to that of a range of "shadow" area-yield index insurance contracts which we design using 10 years of historical yield data collected by the Instituto Nacional de Estadísticas y Censos (INEC). The contract comparison is based on the actual indemnity payouts received by insured farmers versus the payouts that these farmers would have received had they instead purchased an index insurance contract.

Primary data for this study come from a survey on yields, shocks and individual experience with the conventional insurance contract, applied to 1,000 insured rice and maize farmers (representing 1,130 different loans) in three cantons of Ecuador (Celica in the southern highlands and El Empalme and Daule on the coast) between October and December of 2011. The survey covered information for both the rainy season (approximately between January and June) and the dry season (approximately between June and December). This information was complemented by focus groups performed early in 2012 in order to deepen our understanding on key variables of the study. All farmers interviewed were also clients of the BNF (82%) or of Banco de Loja, a private bank operating in the Loja Province, where Celica belongs (18%).

Rice and maize were among the first crops with which the governmental subsidy program initiated in 2010, and are among the most important crops for small farmers in Ecuador. Likewise, the cantons for the study were chosen based on their importance for the production of these crops together with other criteria like number of insured farmers and number of rice and maize farms surveyed by the INEC (with their national annual survey on agrarian area and production, ESPAC). That way, Daule was chosen for the study of insurance on rice, while El Empalme and Celica were chosen for maize. Most farmers in the survey are small farmers; however, in general they are not marginal producers, given that marginal producers usually do not have access to formal loans. Average yields of our surveyed farmers are consistent with this, showing in some cases higher yields than the national average (close to 3 TM/ha. for maize and less than 4 for rice) (SINAGAP, MAGAP). Table 1 summarizes planted area and yields per season and canton.

Rice is basically the only commercial crop grown in Daule. While maize and rice are the main crops in El Empalme, it is easy to observe a variety of other crops (cocoa, banana, etc.). Maize is the main crop grown by small farmers in Celica. Most of the interviewed farmers rent-in land in El Empalme and Celica, while most are land owners in Daule. As indicated in Table 1, production of rice in Daule takes place mostly during the dry season, after the wet season has allowed lands to get flooded. The ones that grow rice during the rainy season are usually those who have relatively high lands. Also, those who have irrigation (97% of Daule's sample) are able to plant rice twice during the dry season. The main weather risks that rice farmers in Daule have had to face in the last 10 years (based on ESPAC data) are drought and pests (Table 2). Results from our 2011 survey indicate pests as the predominant reason for crop loss in Daule.

Table 1: Statistics per season and canton

	Celica (maize)			**El Empalme (maize)**			**Daule (rice)**		
Season (2011)	% who planted	Average area (ha.)	Yields (TM/ha.)	% who planted	Average area (ha.)	Yields (TM/ha.)	% who planted	Average area (ha.)	Yields (TM/ha.)
Wet	99%	6	1.43	99%	4.8	3.42	43%	4.4	4.61
Dry I	1%	1.9	3.49	15%	1.7	4.19	99%	5.4	4.64
Dry II	0%	-	-	0%	-	-	43%	4.4	4.71

Source: Study survey

Contrary to rice production in Daule, most maize farmers in El Empalme and Celica plant in the rainy season. Those who have irrigation (only 5% of our sample in these cantons) are able to plant in the dry season as well. Main reasons for crop loss in these cantons have been frost and drought for Celica, and pests and drought for El Empalme (Table 2). Our survey indicates drought as the main reason for crop loss for both cantons in 2011.

Table 2: Reasons for crop loss in the 2000-2010 period (2001 missing)

Weather risks	**Celica (maize)**	**El Empalme (maize)**	**Daule (rice)**
Drought	24%	17%	35%
Frost	47%	0.2%	0.4%
Pests	9%	31%	27%
Diseases	3%	2%	1%
Flood	10%	4%	13%
Other	5%	36%	20%

Source: ESPAC, INEC

III. Evaluating the conventional contract

The first step in evaluating the performance of the conventional insurance contract was to investigate its acceptance among a sample of insured farmers. On this topic, the main questions asked had to do with:

a) knowledge about the functioning of the system (who offers the insurance, what is the participation of the government);

b) knowledge about the policy (how much the insurance costs, what it covers, how many days they have for filing a claim);

c) Experience with the insurance (filing a claim or not, timing of the adjustor's visit, having received an indemnity payment or not, satisfaction with the payment and ability to repay the loan when it was due);

d) A final evaluation question: if the insurance were not mandatory with your loan, would you buy it anyway?

Responses to these questions reveal that, although all but 2% of the sample knew they were insured (or had been insured during the rainy season), there was a widespread lack of knowledge of the institutions participating in the insurance system and of the functioning of the insurance policy. More specifically, only 26% of the sample knew that the insurance they paid for was actually cheaper than its real cost thanks to governmental intervention. Out of those, 36% knew the right percentage of the subsidy. About the insurance company, only 38% knew its name.

Since the cost of the insurance is charged to the farmer in the loan transaction, most farmers just accept the total amount they must pay without realizing what portion corresponds to the insurance. Hence, only about 40% had an idea of how much they had paid for the insurance, but not necessarily the correct amount. Coverage was much better understood. Most farmers (between 63 and 88%) knew the insurance covered against the right causes of loss (drought, flood, frost, pest and diseases, strong winds and fire), although a few of them (between 14 and 22%) believed the insurance also covered for causes such as robbery, bad quality seed and low prices. Finally, about the number of days for filing a claim after experiencing a cause of potential loss, only 13% knew they had up to 10 days (33% had answers from 1 to 10 days).

About individual experience with the insurance and given that 2011 was a year characterized by a generalized drought, 50% of the whole sample filed a claim (this percentage jumps to 90% for Celica). However, not all who had losses filed a claim. Focus group research with insured farmers suggested that, even after experiencing a cause of loss, lack of knowledge about the functioning of the policy and/or an estimation of the transaction costs involved in filing and monitoring the status of their claims prevented some of them from filing a claim.

In addition, contrasting information with the insurance company's records, we observe that only 79% of those claims filed were actually processed. The reason for this, as indicated by the insurance company (who also indicated at the beginning of 2012 that all claims received in 2011 had been processed), was either coordination problems with the BNF, who at times failed in reporting claims received, or failure of some clients to complete the claims process in the case of partial loss.[5] As a result, 70% of all claims filed according to our survey (or 89% of claims received by the insurer), received indemnity payouts. Reasons for no payment (for those claims processed), according to the insurer, are mainly claims filed out of time and harvest values being greater than or equal to the insured amount (basically the amount of the loan).

Also important to notice here is the difference in the relationship lender-borrower between the BNF and the Banco de Loja. While the BNF uses a traditional Bank system, Banco de Loja has a special program for their maize clients by which credit officials are sent to the farmers (and not all the way around) in order to promote loan take up. These agents develop a greater involvement with their clients and become responsible for them. Consequently, for Banco de Loja results on claims files and indemnity payments received were much better as compared to the BNF.

The fact that there were unattended claims and that there were farmers with losses that didn't file a claim or that did file one but didn't receive a payment lead us to the analysis of basis risk for this contract. The insurance company pays based on equation 1.

[5] When the insurance adjustor declares partial loss, a second and final claim must be filed before harvest time in order to continue the eligibility for an indemnity payment.

(1) $Y_e * P_{ref} < \frac{Loan}{ha.}$

Where,

Y_e = Yield (production per hectare) of the farmer estimated at the time of field inspection

P_{ref} = Reference price used for valuing the harvest. It corresponds to the average of the previous year's price. For 2011 was $0.125 per pound of maize and $0.15 per pound for rice.

$\frac{Loan}{ha.}$ = Amount of the loan per hectare, which represents the insured amount

Rearranging, the company pays when estimated yields are less than $\frac{\frac{Loan}{ha}}{P_{ref}}$. This last term can be understood as a trigger point for the farmer, below which he should be considered to have had a loss and hence should receive a payment. For the purpose of estimating basis risk, we use here self-reported yields (Y) of the farmers in our survey and compare those to each famer's trigger point. We then consider the farmer a, what we call here, "victim" of basis risk if he should have received a payment but did not receive one (equation 2).

(2) "Victim" of basis risk if $Y < \frac{Loan/ha.}{P_{ref}}$ but received no payment

Our analysis shows that 48% of our sample had actual yields lower than their individual triggers.[6] Therefore, these farmers can be considered as having had a legitimate loss (assuming no moral hazard) and they should have been compensated. However, only 60% of these farmers received a payout, meaning that 40% of those with legitimate losses were "victims" of basis risk. This percentage is made up by farmers who did not even file a claim (21%) and those who filed a claim but received no payment (19%). Table 3 disaggregates the analysis by canton, showing that, while the largest amount of losses took place in Celica; this is the canton with the smallest basis risk. This, as indicated earlier, reflects the positive involvement of Banco de Loja in helping clients with the insurance process. Daule, on the other hand, despite representing the smallest level of losses, has the largest percentage of "victims" of basis risk, especially because they did

[6] These farmers are not necessarily among the same farmers who filed a claim (50% of the sample).

not file a claim.[7] This in turn reveals a poor client-BNF-insurer coordination. Still, as shown in Figure 1 (severity of the losses in 25% ranges for those who were "victims" of basis risk), Celica had more severe losses than the other two cantons: 32 cases or 47% of the "victims" of basis risk in Celica had losses greater than or equal to 50% below the individual trigger points.

Table 3: Percentages of Loss and Basis Risk per Canton

Canton	Distribution of losses	% "Victims" of basis risk (per canton)	% Did not file a claim (per canton)	% Filed a claim but received no payment (per canton)
Celica	58%	23%	7%	16%
El Empalme	26%	46%	15%	31%
Daule	15%	95%	86%	9%
Total	100%	40%	21%	19%

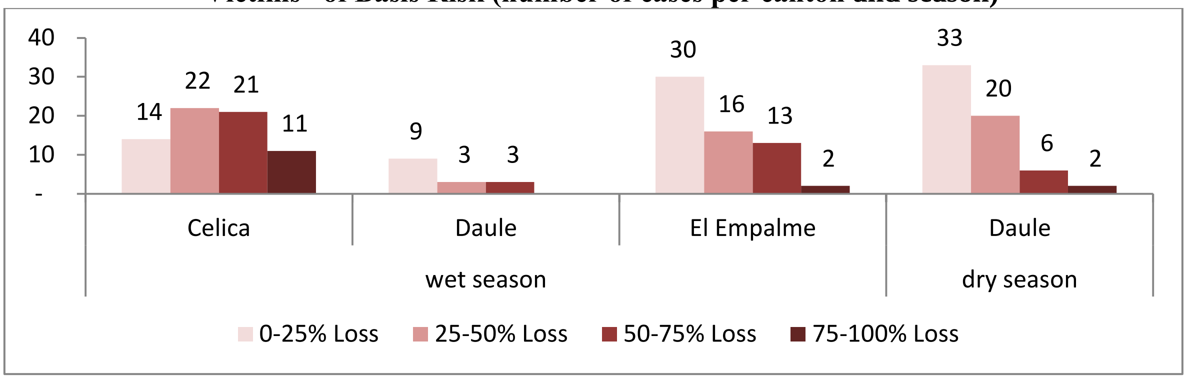
By doing a comparison with a simple area-yield index at the parish level (the smallest political division in Ecuador) using the data from our survey, we see that basis risk could have been reduced to 29%. We do this by observing the number of farmers who had losses (individual yields smaller than individual triggers) in parishes were in average there was no loss (average yield of the parish not smaller than the average trigger). Since an area-yield index insurance at the parish level would have paid farmers if there was average loss for the parish and not otherwise, those farmers who had losses in parishes that would not have received indemnity payments would have been "victims" of basis risk. We see that this simple comparison leads to better results on basis risk than the conventional contract, reflecting the importance of covariant risk in the losses occurred in 2011.[8] A contract like this could be implemented in reality by charging the additional cost of a specialized yield survey at the parish level. We, however, perform a more formal comparison using ESPAC's data in the next section.

Another important aspect to consider in the evaluation of the conventional contract is the timing of the indemnity payments, which is crucial for loan repayment. Claims are supposed to be processed in no later

[7] Many interviewed farmers in Daule commented they did not file a claim because they received the paperwork for the insurance out of time.
[8] See Carter et al (2011) for an analysis of the advantages of index insurance on welfare when it is interlinked with credit access and technology adoption in environments with high covariant versus idiosyncratic risk.

than 45 days after field inspection.[9] At the time of the survey (Oct.–Dec. 2011) 39% of the loans for which a claim had been filed during the rainy season were still waiting for an indemnity payment (this percentage becomes 70% for the "victims" of basis risk who had filed a claim in the rainy season). Contrasting with the insurance company's files a few months after the survey, we found that 54% of those waiting for a payout in the rainy season actually received it. It turns out then that for many farmers an indemnity payment was not due, but the fact is that the clients were not clear on what their situation was months after their harvest.[10]

Figure 1: Percent Difference between Actual Yields and Individual Trigger Points for those who were "Victims" of Basis Risk (number of cases per canton and season)



Main reasons for the payment delay, according to the insurer, are the timing of the governmental transfers of the subsidy –without which they cannot process any payouts- and late filing of claims by the BNF. Another and rather obvious reason was that, in a rough year such as 2011, the amount of claims tends to be very large, practically overwhelming the insurance company. That way, field inspections take longer than usual to be completed; hence the rest of the process is delayed.[11] The consequences of this on asset holding and loan repayment are negative. 82% of the "victims" of basis risk whose loans were due at the end of the rainy season was able to pay their loans. How did they do it? 57% did it by borrowing from the more expensive informal sector and 16% by liquidating some assets.

[9] That is, after the final field inspection since, in case of partial loss (less than 85% of the crop planted), at least two field visits are required.

[10] The insurance company sends through the Bank a denial notification to clients whose claims have been processed but who are not granted an indemnity payout. This notification, however, many times does not find its way to the client.

[11] Results from our survey indicate that 51% of the inspections took place in less than a month from the time the claim was filed. The rest took from 1 to 5 months after the claim was filed.

Indemnity payments went from $27 to $920 (in average $163) per insured hectare for our interviewed farmers, but there was a widespread dissatisfaction with the amount of the payment as 93% of the cases said the payment was less than they expected. Even though this may reflect dissatisfaction with the adjustor's yield estimation, focus group research revealed that the discontent many times comes from a lack of understanding on the insurance coverage. That is, most farmers expect the insurance to cover more than they paid for; for example, all their investment –even though they only insured the investment financed by the loan-, or their income.

Results on the final evaluation question indicate that 54% of the farmers would buy the insurance if it were not made mandatory by the Bank (see Table 4). This could reveal that most farmers do not reject the idea of insurance but that their experience has not been as satisfactory. During focus groups farmers indicated their willingness to buy insurance but provided that it works well. As it could be expected, acceptance was greater in Celica, the canton with the lowest percentage of basis risk compared to the other two.

Table 4: Would you buy insurance if it were not mandatory?

Would you buy insurance if it were not mandatory?	Celica	El Empalme	Daule	All
Si	67%	60%	37%	54%
No	33%	40%	63%	46%

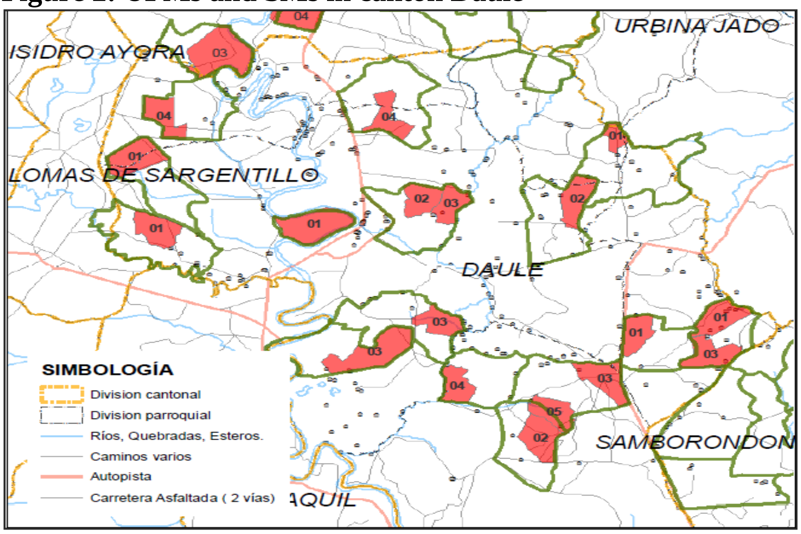
IV. Development of the "shadow" area yield index insurance contract

For the development of an index insurance contract the availability of information is crucial. Weather data (rain millimeters and temperature) in Ecuador is scarce: weather stations are usually dispersed and there are only two automatic stations, the rest are manual and data is not collected as often as it should be. Therefore, we found weather data to be insufficient for the development of a weather index insurance.

Yield data, on the other hand, is more complete. Since about a year after the last agrarian census in 2000, the INEC has been carrying out an annual national survey on agrarian area and production (ESPAC) to a smaller sample of farmers than that of the census but using the same sample frame as the census. The ESPAC hence uses what they call primary and secondary sampling units (UPMs and SMs respectively). The first ones are units of about 10 km^2, which are distributed along a province (the largest political division inside the country), while the second are units inside the UPMs and they cover an area of about 2km^2. In Figure 2 we can observe the UPMs (green contour areas) and their SMs (pink areas) that fell in canton Daule (yellow contour area). For purposes of the ESPAC survey, it is all farmers inside the SMs who are interviewed.

Because of the instability of agriculture, farmers in Ecuador often change jobs or move to different pieces of land. Hence, not the same farmers are interviewed every year but INEC does go to the same SMs every year to interview all farmers. Therefore, we have a panel data of SMs (and hence UPMs) which we use for the development of the index for our "shadow" contract.

Figure 2: UPMs and SMs in canton Daule



In the following lines we analyze the results of a "shadow" area-yield index contract at the UPM level. We generated this index by computing the average historic yield for each UPM.[12] The trigger point was defined at 80% of the historic average yield for the UPM.[13] By comparing average yields for each UPM between 2011 ($UPMY_{avg}^{2011}$) and the trigger point ($(0.8)UPMY_{avg}^{hist}$) we find whether or not a payment would have been due in 2011 (equation 3). The UPMs used for the analysis are those closest to our interviewed farmers (gray dots in Figure 2 for Daule). See Table 5 for the UPM averages per canton.

[12] We compute the UPM historic average by taking the average of the annual ratio: total maize or rice production to total maize or rice planted area during the period 2000-2010 [2001 is missing].

[13] Since most UPMs have historic mean yields considerably smaller than the minimum yield necessary to recover production costs, we considered that the trigger point should not be any lower than 80% of the historic mean yield.

(3) Payment due if $UPMY_{avg}^{2011} < (0.8)UPMY_{avg}^{hist}$

Table 5: 2011 and historic average yields (averages of selected UPMs per canton), TM/ha.

	2011 mean		Historic mean	
Canton	Rainy season	Dry season	Rainy season	Dry season
Celica	1.99	0.35	2.00	0.55
El Empalme	3.03	1.15	3.26	2.54
Daule	4.18	3.96	4.74	4.63

As shown in Table 6, insured farmers in 80% of the UPMs in Celica would have received payment in the rainy season of 2011. This is by far more UPMs receiving payment in Celica compared to the other cantons, which reflects the previously found fact that Celica had significantly more losses than El Empalme or Daule. In the dry season, the top place with more UPMs receiving payment corresponds to El Empalme, followed by Celica, which likely reflects the severity of the drought, carrying the effects even to those with some type of irrigation.

Table 6: Percentage of UPM that would have received payment in 2011 with an 80% trigger point

Canton	Total UPMs close to our interviewed farmers, rainy season	UPMs per canton that would have received payment in rainy season (%)	Total UPMs close to our interviewed farmers, dry season	UPMs per canton that would have received payment in dry season (%)
Celica	10	80%	6	67%
El Empalme	23	48%	21	86%
Daule	18	39%	19	32%
Total	51	51%	46	61%

V. Contract comparison

Basis risk with the "shadow" index insurance contract is measured as the percentage of farmers whose yields in 2011 (Y^{2011}) were lower than their "normal" yields[14] (Y^{norm}) but the 2011 average yield for their closest UPM was not lower than the historic average yield for that UPM (equation 4). These farmers would have been "victims" of basis risk with this contract as they wouldn't have received a payment despite their individual loss.

[14] Farmers' specification of "normal" yields is taken as an approximation of the farmers' historic average yields.

(4) “Victim” of basis risk if $\frac{Y^{2011}}{Y^{norm}} < 1$ but $\frac{UPMY_{avg}^{2011}}{(0.8)UPMY_{avg}^{hist}} >= 1$

We found that in total, 49% of those with individual losses would have been “victims” of basis risk. This percentage is lower for Celia but higher for El Empalme during the rainy season, and higher for Daule during the dry season (see Table 7). Total basis risk with the index insurance contract is relatively larger than total basis risk under the conventional contract, but this is not so for Daule, where it is 33 percentage points lower. It is important to emphasize here that basis risk is to be expected in an index contract but not in a conventional contract since the latter is supposed to cover individual losses while the former would only cover covariant risk. What this research is showing then is that there is an unexpected important percentage of basis risk that is taking place under the conventional contract, a percentage that is not so different from basis risk under an index insurance contract.

Table 7: Losses and “victims” of basis risk under the “shadow” index insurance contract

Canton	Distribution of losses	% "Victims" of basis risk (per canton), rainy season	% "Victims" of basis risk (per canton), dry season	% "Victims" of basis risk (per canton), total
Celica	36%	32%	0%	32%
El Empalme	29%	53%	0%	53%
Daule	35%	38%	68%	62%
Total	100%	44%	67%	49%

For a complete contract comparison we also need to consider other criteria like the value of indemnity payments and the contracts’ premium, among others.

The average indemnity payment per insured hectare for the index contract is computed as the product of the lag between the trigger point and the 2011 yield for each UPM times the reference price (same P_{ref} as specified for the conventional contract). For the purpose of doing a more representative contract for our surveyed farmers from Celica and El Empalme, who have better productivity than the average farmer in the ESPAC data, we scale up the ESPAC averages by 1.5 based on our farmers’ self-reported normal (historic) yields. Similar to the conventional contract, which uses a 30% deductible, we use the same deductible here.

The final indemnity payment per UPM in Celica and El Empalme is then computed as shown in equation 5. (For Daule the calculation does not include the 1.5 scale up).

(5) Indemnity payouts when due: P_{ref}*(0.8 $* \, UPMY_{avg}^{hist} - UPMY_{avg}^{2011}$)*1.5*0.7

Table 8 summarizes indemnity payments per contract, canton and season. Indemnity payments with the index contract turn out to be a little larger than payments with the conventional contract but this difference is statistically significant (although only at 90% confidence level) only for the rainy season. This is because of the high variability of the UPMs' indemnity payments and also due to the much less availability of data for the conventional contract for the dry season compared to the rainy season (the number of claims and indemnity payments is much smaller), hence reducing the degrees of freedom.

Table 8: Comparison of average indemnity payments per canton and season

	Conventional contract (average of individual payouts per canton)		Index Insurance Contract (average of UPM payouts per canton)	
Canton	Rainy season	Dry season	Rainy season	Dry season
Celica (maize)	$161.36	-	$182.02	$158.65
El Empalme (maize)	$161.91	-	$208.80	$487.45
Daule (rice)	$177.38	$240	$217.03	$151.76
Total	$161.56	$240	$202.77	$368.54

Timing of the indemnity payments, however, may be considered less advantageous for the index insurance contract since it would occur not only after the harvest has taken place but also after the chosen responsible –independent- institution has been able to collect information on the average yields per insured area (UPM in this case). As indicated earlier for the conventional contract, if the claims are sent in time to the insurer, and it is not a catastrophic year, indemnity payments under this contract would be expected to be received during the next 45 days after the final field inspection. Depending on the case, this may be faster than under the index insurance because the 45 days for the conventional contract are counted before harvest takes place. Nevertheless, as pointed out previously, in a tough year such as 2011, the timing of the conventional insurance's payments may take considerably longer than they should.

The system or institutional coordination required for each type of crop insurance contract also differs. The design of an index insurance contract can be more complicated than that of a conventional contract;

however, once the contract has being designed and the institutions involved identified, its functioning should be smoother than the functioning we have observed of the conventional contract.

What is required for the index insurance contract to work is to have an independent institution in charge of periodically collecting yield data (ideally at the end of each crop cycle) and notifying this to another institution (public or private) in charge of, depending on the trigger previously identified, determining if a payment is due and proceeding with the payment. Financial institutions as intermediaries could be used as well but the difficulty of coordination in the filing of claims and transmitting resolutions from the insurance company to the clients would be avoided with index insurance. This, together with the fact that no field inspections are necessary, makes the involvement of the financial institutions much less costly.

Precisely because field inspections are not necessary, the cost (premium) of index insurance for the farmer is expected to be less than the cost of the conventional contract. The cost of the conventional contract for rice and maize is $47.7 and $71.25 per hectare respectively (that is, 5.3% and 9.5% of the production costs). For computing the actuarially fair premium for the index contract we estimate the probability function of the UPM yields assuming a Weibul probability distribution function as shown in equation 6. Then, we calculate the actuarially fair premium by estimating the expected value of the indemnity payments in time (equation 7).

(6) $f(y_u) = a_u b_u^{-a_u} y_u^{a_u - 1} e^{-\left(\frac{y_u}{b_u}\right)^{a_u}}$

Where,

$a_u = \ a_0 + a_1 y_{hu}$

$b_u = \ b_0 + b_1 y_{hu}$

y_u = annual mean yield

y_{hu} = historic mean yield

(7) $E(I_u) = \int_{-\infty}^{\infty} I(y_u) f(y_u) dy_u$

Where, $I(y_u)$ is the contract's indemnity function

Since the estimation of these functions faces limited ESPAC data availability for Celica,[15] we compute the fair premium only for El Empalme and Daule. The average UPM fair premium is $29/ha. in Daule (rice) and $51.5/ha. in El Empalme (maize). Assuming a usual 20% mark up for administrative costs, the final premium would be $34.8/ha. for Daule and $61.8/ha. for El Empalme. These premiums are lower, 27% and 13% respectively, than their conventional counterparts.

On another criterion, coverage should be more complete with index insurance in cases like Celica were farmers tend to leave their maize in the plant for longer than other cantons. Since the conventional insurance covers only a period of 120 days from the planting of the crop, this is less than required for farmers in Celica. Index insurance, by measuring yields after harvest time, should cover the entire period of the crop. A similar situation can also happen in the other cantons: as it was found in the focus group research, there are cases when a pest or disease attacks the crop when it is very close to harvest time, missing then the farmer the eligibility for an indemnity payment.

Finally, ease of understanding on the functioning of the contract (a process easy to follow) makes index insurance preferable to conventional insurance. This is so because farmers don't need to file a claim and therefore they don't have to be alert about the maximum amount of days they have for filing a claim or use time for bringing the claim to the bank and making sure the claim has reached the insurance company. With index insurance, farmers only need to understand what the trigger yield is for the UPM and what realized yields are in each cycle in order to find out if they should receive an indemnity payment (which has been predetermined at the time the contract is signed). Nevertheless, education is crucial in order to avoid generating false expectations on farmers with the index insurance.[16]

Table 9 summarizes what contract should be preferred based on the effect of each analyzed criterion on insured farmers. Index insurance seems to be preferred in terms of premium, value of indemnity payments, risk coverage and ease of process understanding.

[15] Canton Celica is relatively new growing the type of maize analyzed in this study; they started after year 2000 and production grew little by little but now Celica is one of the most important cantons in Ecuador producing this crop.

[16] Carter et al (2008) explain the importance of education in index insurance since the risk reducing ability of this insurance can only be realized if there is an informed demand for it. Both underestimation and overestimation of the benefits of the insurance should be avoided.

Table 9: Summary of preferred contract by different criteria

Criteria	Conventional	Indexed
Basis risk	X	
Premium for El Empalme and Daule		X
Value of indemnity payments (for rainy season, although not highly significant)		X
Timing of indemnity payments	X	
Risk coverage		X
Process easy to follow		X

VI. Conclusions and further research

This paper summarizes the initial findings of an action oriented research that seeks to identify ways in which the Ecuadorean government can improve the performance of crop insurance for small-holders.

The findings are consistent with what has been found around the globe when conventional insurance contracts are offered to small farmers. First, farmers' general understanding of the contract is low and this translates into an artificially low rate of claims being filed. Second, in years with major climate shocks like 2011, claims quickly overwhelm the insurance company's claims verification and processing capability. Client dissatisfaction with the timing of indemnity payments (or the lack of them) was common especially in Daule and El Empalme. In many cases, clients have had to repay their loans by borrowing from the much more expensive informal sector or selling their assets, precisely the types of last-resort strategies that crop insurance should prevent. Third, we find that institutional design of insurance delivery and processing is critical. In Celica, the more active involvement of Banco de Loja allowed for the highest rate of claims being filed, processed and paid out compared to the other two cantons.

Having an effective program in the field is what can ensure both program dissemination and sustainability. The presence of high basis risk reduces the intended productivity and income enhancing effects of insurance. While the conventional insurance contract has allowed many farmers to avoid default, there is an important measure of basis risk (40%) that threatens its effectiveness and sustainability. Although basis risk is a little larger for the "shadow" index insurance contract (except for Daule), a more complete comparison using criteria like the amount of the indemnity payments, premium, risk coverage and ease of process understanding suggest that index insurance offers an interesting alternative for the areas of the study.

The comparison then shows that a similar level of basis risk can take place but with a rather less costly and simpler contract.

This research will continue to include 2012 data so as to deepen the analysis and to investigate as well the viability of hybrid contracts; that is, contracts that cover not only covariate but also a portion of idiosyncratic risk.

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