LIQUIDITY CONSTRAINTS, RISK PREFERENCES AND FARMERS' WILLINGNESS TO PARTICIPATE IN CROP INSURANCE PROGRAMS IN GHANA

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Invited Paper prepared for the AAEA Session at the ASSA Annual Meeting Atlanta, January 4-6, 2018

CLIMATE CHANGE AND INSURANCE

- Adverse effects of climate change are expected to be a major threat to the agricultural sector of Sub-Saharan Africa (IPCC, 2014)
- Agricultural insurance has been suggested as one of the potential channels for mitigating agricultural production risks, and stabilizing income fluctuations of smallholder farmers (Miranda and Farrin, 2012)
- The Africa Agriculture Status Report (AASR) from 2017 indicates that while globally agricultural insurance is a US$2 billion business, Africa accounts for less than two percent of the market (AGRA, 2017)
- Moral hazard and adverse selection problems are often cited as reasons for the underdevelopment of agricultural insurance markets in Sub-Saharan Africa (Karlan et al., 2014).
- Basis risk insurance (weather-index insurance) may overcome these problems but farmers prefer ideal and not basis risk insurance (Marenya et al 2014)

CONSTRAINTS FOR INSURANCE IN SSA

- Underdeveloped or absence of crop insurance in many SSA countries (none in Ghana)
- Liquidity-constrained farmers are unable to purchase insurance coverage
- Liquidity constrained farmers often trade-off returns for risk reduction (inputs vs insurance)
- Participation in crop insurance programs is closely related to the issue of imperfect capital and insurance markets in low-income countries

OBJECTIVES OF THE STUDY

- Examine farmers' willingness to participate in crop insurance programs by linking liquidity constraints, risk preferences and input use
  - ✓ Is insurance coverage a substitute or complement for inputs?
  - ✓ Area yield insurance for cocoa farmers in Ghana
  - ✓ Theoretical model and experimental framework

ELEMENTS OF THE ECONOMIC MODEL

- Production function: $q = f(x, \varepsilon), \varepsilon \in [\varepsilon_{\min}, \varepsilon_{\max}]$ ordered
- Generic input x, stochastic element ε, p does not vary
- Insurance coverage $\gamma \in [0,1]$
- Reference yield $\bar{q}$
- Paid indemnity $\max\left[p\left(\gamma\bar{q} - f(x,\varepsilon)\right), 0\right]$
- There exist a $\gamma\bar{q} = f\left(x, \varepsilon^{\gamma}\right)$ so that $\varepsilon^{\gamma} = \varepsilon^{\gamma}(x, \gamma\bar{q})$
- If the actual yield is $\leq \gamma\bar{q}$ the farmer's profits are ν^{γ}
- If not the farmer profits are ν

THE ECONOMIC MODEL

- ✓ Liquidity constraint: $\delta\left(E\left[v^{\gamma}+v\right]\right)-p_i(\gamma)>0$
- ✓ Share of profits δ, price of insurance converage $p_i(\gamma)$
- ✓ Farmer's utility function *u*()

- ✓ Farmer maximizes:

$$E\left[u\left(v^{\gamma}\right)+u(v)\right]+\mu\left(\delta\left(E\left[v^{\gamma}+v\right]\right)-p_i(\gamma)\right)=$$

$$\int_{\varepsilon_{\min}}^{\varepsilon^{\gamma}} u\left(v^{\gamma}\right)h(\varepsilon)d\varepsilon+\int_{\varepsilon^{\gamma}}^{\varepsilon_{\max}} u(v)h(\varepsilon)d\varepsilon+\mu\left(\delta\left(\int_{\varepsilon_{\min}}^{\varepsilon^{\gamma}} v^{\gamma}h(\varepsilon)d\varepsilon+\int_{\varepsilon^{\gamma}}^{\varepsilon_{\max}} vh(\varepsilon)\,d\varepsilon\right)-p_i(\gamma)\right)$$

COMPARATIVE STATIC RESULT

$$\frac{d\gamma\bar{q}}{dx} = \frac{d\left(E\left[u\left(v^{\gamma}\right)+u\left(v\right)\right]\right)^{2}/d^{2}x}{u'\left(v^{\gamma}\right)\left[pf_{\varepsilon}p_{x}\frac{u''\left(v^{\gamma}\right)}{u'\left(v^{\gamma}\right)}\frac{H\left(\varepsilon^{\gamma}\right)}{h\left(\varepsilon^{\gamma}\right)}+\frac{\mu\delta\left(pf_{x}\left(x,\varepsilon^{\gamma}\right)\right)}{u'\left(v^{\gamma}\right)}+pf_{x}\left(x,\varepsilon^{\gamma}\right)\right]h\left(\varepsilon^{\gamma}\right)\frac{d\varepsilon^{\gamma}}{d\gamma\bar{q}}} \lessgtr 0$$

It shows the demand as a function of an increase in inputs:

*The **demand for insurance coverage increases** with inputs if the farmer is **risk-averse** or **risk-neutral** and **inputs are risk increasing** ($f_x < 0$) or if the absolute value of the **negative risk-aversion coefficient dominates** all other effects. The **demand for insurance coverage decreases** with inputs if a non-liquidity constrained farmer is **risk-neutral** or **risk-seeking** and **inputs are risk-reducing**, or if the value of the **positive risk-aversion coefficient dominates** all other effects.*

EMPIRICAL MODEL

- The insurance decision problem can be written as

$$U_{\gamma}^{**} \equiv \max_{\gamma}\left[U_{\gamma}^{*}\right], \text{ subject to } \delta \mathrm{E}\left[v^{\gamma}+v\right] > p_i(\gamma),$$

$$U_{\gamma}^{*} = \max_{x} E\left[U(v^{\gamma})+U(v)\right]$$

- The farmer's willingness to participate in crop insurance depends on farm and household characteristics and risk preferences

$$U_i^{**} = U = (\text{risk preferences, prices, input use, liquidity constraints, wealth}).$$

EMPIRICAL MODEL

- The participation equation:

$$I_i^*(\gamma) = \alpha Z_i + \beta p(\gamma) + \psi C_i + \nu_i \qquad I_i = 1\left[I_i^* > 0, I_i = 0 \ \text{otherwise} \right],$$

I_i^* = expected benefits from participation

α,β,ψ = parameters to be estimated

$\boldsymbol{Z_i}$ = vector or farm and household level characteristics

$p(\gamma)$ = insurance premium with coverage γ

$\boldsymbol{C_i}$ = vector or risk preferences

Data

- The data used in this study come from a survey conducted during April and July 2018 in 24 villages in the Western, Ashanti and Brong-Ahafo regions of Ghana.
- Farmers participated in field experiments after we collected data on their household and farm-level characteristics.
- The experimental part sought to measure four attitudinal variables, including farmers' risk preferences with monetary incentives, as well as stated preferences part to capture participation decisions (no crop insurance programs in Ghana)

Source: Ghana Embassy, Italy

Source: Ghana Embassy, Germany

Table . Descriptive statistics of variables used in the regression models

Exchange rate: 1 US$= GH¢ 4.73 in August 2018

Variable	Variable description	Mean	S.d	Min	Max
WIP	1 if farmer is willing to participate in the insurance, 0 otherwise	0.70	0.46	0.00	1.00
Premium	Price of insurance per acre (GHC)	113.49	18.98	100.00	150.00
Household characteristics					
Farm characteristics					
Trust	1 if generally trust in people, 0 otherwise	0.28	0.45	0.00	1.00
Highly risk-averse	1 if farmer is highly risk averse, 0 otherwise	0.43	0.50	0.00	1.00
Risk averse	1 if farmer is moderately risk averse 0 otherwise	0.19	0.39	0.00	1.00
Risk neutral	1 if farmer is risk-neutral, 0 otherwise	0.06	0.24	0.00	1.00
Risk loving	1 if farmer is risk loving, 0 otherwise	0.30	0.46	0.00	1.00
Inconsistent choice	1 if farmer made inconsistent Choices, 0 otherwise	0.02	0.14	0.00	1.00
Fertilizer expenditure	Fertilizer expenditure per acre	63.64	127.87	0.00	1260.00
Pesticide expenditure	Pesticide expenditure per acre	69.08	78.71	0.00	892.75
Liquidity constraint	1 if farmer is liquidity constrained, 0 otherwise	0.35	0.48	0.00	1.00
Western	1 if farmer is located in the Western region, 0 otherwise	0.48	0.50	0.00	1.00
Ashanti	1 if farmer is located in the Ashanti Region, 0 otherwise	0.27	0.44	0.00	1.00
Brong-Ahafo	1 if farmer is located in Brong-Ahafo Region, 0 otherwise	0.25	0.43	0.00	1.00

Probit estimates of farmers' willingness to participate in crop insurance

Variables	coefficient	marginal effect
Premium	-0.0556***	-0.0161***
	(0.0037)	(0.0013)
Age of household head	0.0532	0.0154
	(0.0378)	(0.0109)
Age squared	-0.0006	-0.0002
	(0.0004)	(0.0001)
Gender (female)	-0.2736	-0.0831
	(0. 1902)	(0.0610)
Read and write	0.3403**	0.09732**
	(0.1652)	(0.0047)
Off-farm work	0.1116	0.0322
	(0.1347)	(0.0391)
Total land owned	0.1466*	0.0423*
	(0.0819)	(0.0236)
Trust people	0.3627**	0.0977**
	(0.1543)	(0.0383)
Liquidity constraint	-0.3146**	-0.0940**
	(0.1350)	(0.0411)
Highly risk averse	0.7224***	0.1992***
	(0.2422)	(0.0623)
Moderately risk averse	0.9923***	0.2151***
	(0.2961)	(0.0439)
Risk loving	-0.2935	-0.0886
	(0.2399)	(0.0756)
Inconsistent choices	0.0691	0.0194
	(0.5025)	(0.1371)

Probit estimates of farmers' willingness to participate in crop insurance

Variables	coefficient	marginal effect
	(0.5025)	(0.1371)
Awareness of Agric. Insurance	0.5570***	0.1399***
	(0.1912)	(0.0394)
Amazon	0.6412***	0.2042***
	(0.2268)	(0.0771)
Hybrid	0.5372*	0.1346*
	(0.2796)	(0.0599)
Fertilizer expenditure per acre	0.0012*	0.0004*
	(0.0007)	(0.0002)
Fertilizer expenditure residual	0.0027	0.0008
	(0.0030)	(0.0009)
Pesticide expenditure per acre	0.0022***	0.0006***
	(0.0008)	(0.0002)
Pesticide expenditure residual	-0.0052	-0.0015
	(0.0054)	(0.0016)
Western	0.2625	0.0754
	(0.2759)	(0.0787)
Ashanti	-0.0378	-0.0110
	(0.1996)	(0.584)
Constant	4.2801***	
	(1.2220)	
McFadden R^2	0.48	
Wald $\chi^2(22)$	308.65***	
Number of observations	747	

consistent estimates

Robust standard errors are in parentheses, *** p<0.01, ** p<0.05, * p<0.1;
Risk neutral is the base variable; Amelonado; (Tetteh Quarshie) is the reference variable for variety

Take Aways

- Develop a theoretical model to examine the impacts of risk preferences, liquidity constraints, and input use on farmers' willingness to participate in crop insurance programs
- We show that not only risk preferences, but also risk-increasing or risk-reducing input use, and liquidity constraints can significantly influence farmers' willingness to participate in crop insurance programs.
- We find that liquidity constraints are not only an obstacle for the purchase of inputs but also for taking out an insurance.

- **Policy implications:**
  - a) improve access to credit or
  - b) shorten the time period between payment of the premium (up-front) and indemnity payment.
  - c) schooling, membership in farmer organizations, off-farm work support participation in insurance programs.

THANKS FOR YOUR ATTENTION!

Stochastic Dynamic Games

- A : (20 GH₵ with 100% chance) versus B: (40 GH₵ with 50% or 0 GH₵ with 50% chance, (E(x)=20)
- A : (20 GH₵ with 100% chance) versus C: (24 GH₵ with 50% or 0 GH₵ with 50% chance, (E(x)=12)
- A : (20 GH₵ with 100% chance) versus D: (56 GH₵ with 50% or 0 GH₵ with 50% chance, (E(x)=28)

- Highly risk-averse three times A
- Moderately risk-averse A, A and D
- Risk-neutral A or B, A and D
- Risk-loving B, C, D

- Inconsistent choices: e.g.: A, C, A

First-stage Tobit estimates of Fertilizer and Pesticide expenditures

	Model 1 Fertilizer Expenditure model	Model 2 Pesticide Expenditure
Variables		
Age		-0.4733*
		(0.243)
Read and write	19.5284*	-13.9324**
	(11.562)	(6.029)
Gender	-30.1794**	-23.0695***
	(13.789)	(7.119)
Household size	6.6097**	
	(3.1619)	
Children_school	-8.3857**	
	(4.289)	
Indigene		22.1830***
		(5.939)
Farm size	-0.3842	-0.5505*
	(0.604)	(0.322)
Cocoa years		0.4814
		(0.5577)
Cocoa years squared		-0.0053
		(0.007)
Hybrid	37.2492***	12.0898
	(13.751)	(7.470)
Livestock value	0.9918**	
	(0.475)	
VSLS	46.815**	21.4543**
	(18.782)	(9.759)
Western	58.6843***	37.2967***
	(14.056)	(7.261)
Ashanti	-11.702	9.7768
	(15.730)	(8.086)
Constant	-14.4933	64.4667***
	(18.114)	(15.035)
Log-likelihood test	76.18***	65.92***
Degrees of freedom	10	12
Observations	750	

Input use expenditures could be potentially endogenous in crop insurance participation decision