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The effect of crop insurance on the financial risk of smallholder rice farmers in Cameroon

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ABSTRACT

This study examined the effect of crop insurance on the financial risk of smallholder rice farmers in the grass field of Cameroon. Panel data from 76 Smallholder rice farming groups from 2019-2022 was used, while the Panel-corrected standard error technique was used for estimation. The results revealed that crop insurance captured using inputs (fertilizers, herbicides, and treated seeds) and land preparation had a positive and statistically significant effect on financial risk. These results validate the risk balancing hypothesis for smallholder rice farmers. Control variables like Farm size and labour had a positive and statistically significant effect, while training cost and buying price had a negative and statistically significant effect on financial risk. The results therefore, indicate that smallholder rice farmers need to adopt crop insurance practices such as use of quality farm inputs and better land preparation techniques in order to manage financial risk.

Contribution/ Originality: This study contributes in the literature by examining the effect of crop insurance on the financial risk of smallholder rice farmers in the grass field of Cameroon.

1. INTRODUCTION

Promoting agricultural activities remains the key driving force for achieving food security in the world globally and attaining the zero-hunger objective of the sustainable development goals. Food security and poverty reduction efforts are being fought through the activities of the agricultural sector in developing countries, owing to the fact that majority of the poor people live in rural areas and they depend on agriculture as their main economic activities (Carletto, Savastano, & Zezza, 2013; Johannes & Njong, 2012). Among the agricultural products, rice remains a stable dietary for billions globally and Cameroon in particular (Sethanand, Chaiyawat, & Gowanit, 2023). Due to the abundance of natural resources in Cameroon that are favourable for cultivating rice, rice production is a gift to the country which is uncommon in many other parts of the world, Deep, Kumar, Saha, and Singh (2018) and Saito et al. (2023). Countries that are unable to farm rice are forced to carry out importation in order to combat poverty and malnutrition in their nations (Barnes, Flint, & Caldwell, 1990). Though a key global necessity, the cultivation of rice is particularly vulnerable to weather variability, inputs quality and quantity, and other unforeseen events for smallholder farmers (Sethanand et al., 2023).

Four fifth of the ninety-eight per cent of the world's hungry people who live in low- and middle-income countries are engaged in food production (Khoi, Nguyen, Sam, Ky Phung, & Thi Bay, 2020). Their susceptibility to

risks and inability to cope with shocks are the key hindrances preventing the majority of rural poor people who are involved in agriculture from escaping poverty. Financial agricultural risk management (FARM) instruments are proposed, piloted and implemented by the Governments around the world to help smallholder farmers cope with these risks (Salihu, Musa, Ubachukwu, & Mshelia, 2023). However, it is unclear whether risk mitigation and coping policies, such as microinsurance mechanisms (one of which is crop insurance), have improved the welfare or overall well-being of smallholder farmers.

Financial risk in agriculture especially rice farming is indicated by liquidity, solvency, and extreme financial stress (Prager, Burns, & Miller, 2018). Financial risk is classified into Market Risk, Credit Risk, Liquidity Risk, Legal Risk, and Operational Risk which all have an effect on finances, Malz (2021) Due to the ineffective risk management and the inability of the market itself to neutralize the negative effects of the risk faced by farmers resulting to lower income, the Government and other public stakeholders now participate in risk management based on the economic benefits that farmers bring, (Novickytė, 2018).

There is therefore need to use microinsurance services stared by some as a risk management mechanism for the poor to compensate for the lack of appropriate state-sponsored social protection programs, to protect rice farming and related activities (Epule, Chehbouni, Dhiba, & Driouech, 2021). On the other hand, microinsurance is viewed by others as an opening to offer financial services to the low-income market at a profit, (Brau, Merrill, & Staking, 2011).

The principles of Microinsurance services, one aspect of which is crop insurance, are not new (Alando, 2014). Risk transfer and Risk pooling can be traced back to some of the precursors of insurance, such as the Roman burial guilds, (Meuwissen, Mey, & Van Asseldonk, 2018). In the Roman burial guilds, burial costs as a form of insurance were paid out of monthly dues, which later evolved to health and funeral insurance plan without profit consideration in the Anglo-Saxon and German guilds of the Middle Ages, (Robinson, 2023).

In Africa, the supply of crop insurance services is expressed and visible within the various structures: formal sector insurance companies, non-governmental organizations (NGOs), microfinance institutions (MFIs), cooperatives, health mutual, community programs, associations and other support groups, (Debrah, Arku, Kallah-Dagadu, & Sekyere, 2022). Worthy of noting is the fact that the products of formal microinsurance including crop insurance are experiencing remarkable growth, (Nogales & Cordova, 2022). Indeed, between 2011 and 2014, the number of people covered rose by 562% from 1.2 million to 8.1 million, (Médard & Rodrigue, 2021).

The role of crop insurance on farm financial outcomes of farmers in US had traces to indicate that through indemnity payments, Crop insurance lowers a farm's risk by reducing business risk, dismissing credit constraints and improving farm liquidity (DeLay, Brewer, Featherstone, & Boussios, 2023). Crop insurance, according to evidences provided by Agricultural Finance Corporation Ltd. Head Office, (Debrah et al., 2022) would work and make sense in protecting agricultural incomes of millions of farmers in the developing world. The uptrend observed in the past years was confirmed as the turnover registered a 7% increase between 2009 and 2010, according to an analysis of the Association of Insurance Companies of Cameroon (AICC).

In order to handle the financial risk situation in the rice farms of the grassfield of Cameroon, the government of Cameroon has erected a structure that is in charge of organising, coordinating, controlling, educating and provide some basic facilities to the smallholder farmers to ensure risk reduction. Rice farmers equally grouped themselves into smallholding groups to form organisations that can be recognised by NGOs, Financial institutions and even foreign bodies to increase trust as they solicit for support from the external bodies. Hence, understanding the relationship between crop insurance and financial risk has remained in the fore during the past decades. The study therefore, examines the effect of crop insurance on the financial risk of small holder rice farmers in the grass field of Cameron. A better understanding of this objective is explained by the specific objectives which are to;

- Investigate the effect of input insurance on the financial risk of small holder rice farmers in the grassfield of Cameroon.

- Verify the effect of land preparation cost on the financial risk of small holder rice farmers in the grassfield of Cameroon.

For these to be attained, this study is structured into 5 sections; section 1 looks at the evolution of the problem with emphasis on the probable financial risk position of smallholder rice farmers, the actual situation and the gap between the probable and actual crowning with the rationale for the study. The second section focuses on the review of literature in three separate categories; conceptual, theoretical and empirical. This ends with a literature gap between what has been studied and what this study anticipates to embrace. Part 3 expounds on the methodological issues while part 4 presents and discusses the results. Part 5 suggests conclusions and recommendations on based on the results obtained.

2. LITERATURE REVIEW

This section of the study focuses on reviewing and justifying the inclusion of theories related to the issues under investigation, elucidating on pertinent concepts related to the study and reviewing the works of other authors in this line of thought. This explains why the conceptual, theoretical and empirical literatures are the focus of this section.

Crop insurance is a package of insurance to manage risk that is directly related to the growing of crops. These include; input insurance and land preparation cost especially in the case of rice farming in the grassfields of Cameroon. Input insurance includes the cost of fertilizer, fungicides, herbicides and other chemicals needed for rice cultivation. In the case of land preparation insurance, it is considered as large scale ploughing (using tractors and manual labour), irrigation through maintenance of canals and associated preparation costs, (Rosch, Raszap Skorbiansky, Weigel, Messer, & Hellerstein, 2021). Financial risk is the likelihood of losing money on an investment or business endeavor, (Corelli, 2019). This implies financial risk is a type of danger that can result in the loss of capital to interested parties. Financial risk is classified into Market Risk and Liquidity Risk. Losses in positions as a result of movements in market variables like prices and volatility is associated to Market risk. Crop insurance alternatively covers the loss of crops as a result of one or more risks, (Dror, 2019). The greater the number of risks covered, the more complex and costly the insurance becomes, and the greater the likelihood of the need to be insured. Crop losses can be covered through yield loss (yields lower than expected), quality loss (quality of crops lower than expected), revenue loss (owing to fluctuations in prices), or a blend of these.

The fundamental relationship between crop insurance and financial risk can be explained using two theories, that is, the risk balancing theory and the safety net theory. The risk balancing theory (BRT) postulated by Gabriel and Baker (1980) and advocate that an increase when farmers adopt crop insurance as a safety net, farmer always tend to take more risk in other areas of their operation. Such operation could involve expanding acreage, shifting to riskier crops and taking on more debts. The Safety net theory was highlighted in the early 1990s by the Bretton Woods (Helleiner, 2010). It focuses on institutions with purpose to assist those who are impoverished or have experienced various hardships in maintaining the bare minimal level of living. This theory has been adopted in explaining financial risk in the agricultural sector by presenting and postulating that better adoption of insurance policy will help reduce financial risk of framers. From this theoretical underpinning, it can be observed that the relationship between financial risk and crops insurance is contradictory.

Numerous studies have been conducted on this topic; Using farm-level data from Kansas, Regmi, Featherstone, and Tack (2023) investigate crop insurance's effects on farm financial risk of 1600 farms from 2002 to 2015. The result shows that participation in crop insurance decreases the farm's probability of being exposed to critical liquidity risk. Equally, DeLay et al. (2023) empirically showed that no statistical correlation exist between debt and crop insurance liabilities, casting doubt on the federal crop insurance program's risk-balancing theory. According to Kim, Yu, and Pendell (2020) farms with crop insurance have an average lifespan of seven years longer than farms

without it, and they also have a roughly 70% lower chance of going out of business. These results highlight the benefits of crop insurance on farm survival and business risk, mostly through increased cash.

Smith and Glauber (2012) examined the development of agricultural insurance markets and the welfare of the economy. They carried out a survey on the availability of crop and life insurance to farmers through the subsidies they received from Government to assist their farming activities, and its effect on the welfare of farmers and the community in general. The result showed that agricultural insurance in developed countries heavily aided by the Government has a positive effect on the economic welfare, political economy, and trade relation implications of private and public welfare. The Collins and Karp (1993) anticipated utility model of farm capital structure was revisited by Ahrendsen, Collender, and Dixon (1994) with the addition of wealth effects, taxes, depreciation, and investment tax credits. They discover evidence in support of the risk balancing hypothesis using microdata from US dairy farms.

Furthermore, Lee et al. (2024) examined the relationship between agricultural loan delinquencies and Federal crop insurance program participation. They employ county-level panel data for corn output in the Midwestern United States (US) from 1994 to 2015, Their outcome opines that statistically speaking, countries with greater crop insurance participation rates typically have lower rates of agricultural loan delinquency. Furthermore, Ifft, Kuethe, and Morehart (2015) offered hints indicating that farms with crop insurance coverage typically had a higher risk of financial default; nevertheless, this association was simply hints because a causative relationship could not be established. Instead of examining the impact of crop insurance coverage on financial metrics, Kropp and Katchova (2011) assessed the relationship between debt repayment capacity and direct payments, or another farmer safety-net program. They discovered that farmers' capacity to repay debt is positively and significantly correlated with direct payments (particularly for more experienced farmers). DeLay, Thompson, and Mintert (2022) equally estimated the impact of crop insurance liability and insurance indemnity on farm debt, and discovered that subsidized crop insurance may increase farm's financial risk through the mechanism of risk balancing.

Based on the different examinations of empirical and theoretical views above, it can be observed that the effect of crop insurance on financial risk is still a vital topic of major debates globally. It can be equally deduced that most studies were focused in the developed countries while relatively few studies considered developing countries in general. It is within these backdrops that the current study seeks to examine the effect of crop insurance on financial risk for smallholder farmers within the grassfield of Cameroon.

3. METHODOLOGY

3.1. Data Source and Descriptive

Secondary source of data collected from the annual reports of Upper Noun Valley Development Authority (UNVDA) Ndop and from the records of smallholder groups, covering 76 smallholding groups spanning a four-year period from 2019 to 2022, was used for the study. Data collected from the UNVDA include farm size, number of farmers registered in each farm per farm sector, farming groups, yearly selling price per kilogram, number of farmers trained per year, Training cost per smallholder group, the selling price of farmers, registered loans, inputs supply, and much more. The Data from Smallholder farmers' executives include the yields, recorded grades for the years, farm situation, and the transportation cost to transport Paddy for sale.

3.2. The Model

Micro panel models were used for the study, where financial risk is a function of crop insurance, and other control variables like farm size, buying price, farm size, and training cost. In this regard, the different models considered within the framework of this study are presented as follows.

$$LMKTRISK_{it} = \alpha_0 + \alpha_1 LCROPINS_{it} + \alpha_2 LFRMSZ_{it} + \alpha_3 LLABOURSIZE_{it} + \alpha_4 LBUYINGPRICE_{it} + \alpha_5 LTRAININGCOST_{it} + \varepsilon_{it} \quad (1)$$

$$LLQRISK_{it} = \partial_0 + \partial_1 LCROPINS_{it} + \partial_2 LFRMSZ_{it} + \partial_3 LLABOURSIZE_{it} + \partial_4 LBUYINGPRICE_{it} + \partial_5 LTRAININGCOST_{it} + \varepsilon_{it} \quad (2)$$

$$LFINRISK_{it} = \beta_0 + \beta_1 LCROPINS_{it} + \beta_2 LFRMSZ_{it} + \beta_3 LLABOURSIZE_{it} + \beta_4 LBUYINGPRICE_{it} + \beta_5 LTRAININGCOST_{it} + \varepsilon_{it} \quad (3)$$

Wherein MKTRISK denote market risk, LQRISK stand for liquidity risk, FINRISK stand for the financial risk variable which is composite index composed with the aid of principal component analyses using market risk and liquidity risk. CROPINS denotes crop insurance, while FRMSZ, LABOURSIZE, BUYINGPRICE, TRAININGCOST are respectively farm size, labour size, buying prize and training cost. Where α_i , ∂_i, β_i denote the parameters to be estimated and ε_{it} denotes the stochastic error term. Note that the variables are transform in their log form. i denote the different farm areas while t id the time dimension.

3.3. Estimation Technique

This study uses the Panel corrected standard error (PCSE) estimation technique to examine the impact of crop insurance on the financial risk faced by smallholder rice producers in Cameroon's grasslands. The PCSE technique consists of estimating a linear cross-sectional time series model, wherein, the parameters are estimated by either engaging the OLS or Prais–Winsten regression. The PCSE produces OLS estimates of the parameters when autocorrelation is not specified, or Prais–Winsten estimates when autocorrelation is specified, (Greene, 2012). The PCSE technique assumes that the disturbances are contemporaneously correlated and heteroskedastic by default when computing the standard errors and variance–covariance estimates. By this, the PCSE technique corrects for likely problems of heteroscedasticity, cross-sectional correlation and autocorrelation within panels. The technique equally has the ability to curtail small sample biases. The two-step, revised form of inefficient OLS called the Panel Corrected Standard Error (PCSE) estimation as reported by Beck and Katz (1995) operates extensively better than the FGLS (Parks, 1967) technique in several conditions. This technique is adopted in this study based on these aforementioned advantages.

4. RESULTS AND DISCUSSION

4.1. Pretest

4.1.1. Autocorrelation Test Results

The Wooldridge Auto/Serial Correlation test (Wooldridge, 2002, 2010) which is appropriate for panel data is used to verify the presence of cross-sectional correlation in the dataset, (Palaniappan, 2017). The null hypothesis of this test is that there is no serial correlation. The results for the different models are presented in Table 1.

Table 1. Wooldridge test for auto/Serial correlation.

Model	Test statistics	P value	Decision
Model 1	1087	0.00	Serial correlation
Model 2	65.9	0.00	Serial correlation
Model 3	70.4	0.00	Serial correlation

The results presented in Table 1 demonstrate a strong rejection of the null hypothesis since the p-values are 0.000 in all the 3 models under consideration. This implies the presence of first-order serial correlation in these models. This demonstrates that, as Gujarati (2004) pointed out, the estimating techniques that have to be applied in this investigation are those that tackle and rectify the issue of serial correlation to ensure goodness of fit and impartial estimators.

4.1.2. Heteroscedasticity Test Results

When a dataset exhibits heteroskedasticity, it means that the error term's variance is not constant over all of the observations. The Wald GroupWise test for heteroskedasticity is conducted in this work (Pillai & Al-Malkawi, 2018; Sheikh, Shah, & Akbar, 2018). The null hypothesis of this test states that there is homoscedasticity, or constant variance of errors across all independent variables. However, as shown in Table 2, the test results rejected the null hypothesis for all 3 models, which suggests the presence of heteroskedasticity. Thus, the results violate the homoscedasticity assumption of OLS.

Table 2. Wald test for groupwise heteroskedasticity.

Model	Test statistics	P value	Decision
Model 1	1.2e+32	0.00	Heteroskedasticity
Model 2	550	0.00	Heteroskedasticity
Model 3	6.0e+06	0.00	Heteroskedasticity

Note: "e" =exponent of the decimal places.

The presence of heteroskedasticity in the models weakens the statistical power of the static panel and standard IV approaches making them inefficient estimators for these models. In addition, it does not validate their standard errors and test statistics (Bascle, 2008). This study therefore follows Gujarati (2004) and employs a robust standard option in the regression models to overcome the heteroskedasticity issue.

4.2. Descriptive Outcomes

The descriptive assessment started by first presenting the different trends of the variables of interest in this study. Figure 1 presents the trend or evolution of crop insurance which is the key independent variable of interest. The trend shows the average evolution of crops insurance during the considered 4 years of this study. The outcome demonstrates that averagely crop insurance stood at about 200000francs in the year 2019. This value increase to about 325000francs in the year 2020 after which it steadily drops through 2021 to about 175000francs in the year 2022.

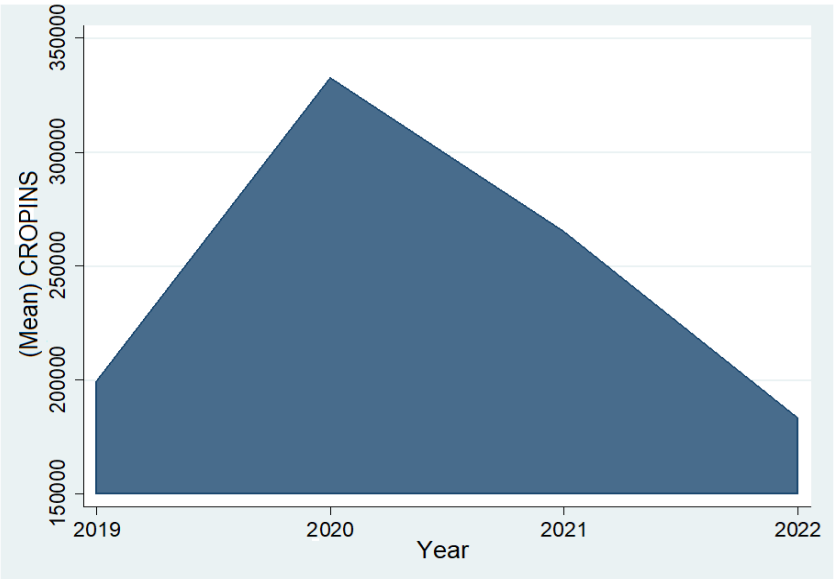

Figure 1. Trend for crop insurance.

This evolution shows the volatile variation of crop insurance of smallholder rice framers within the grassfield. Such volatility can be due to market conditions and financial distress of farmers entanglement in the cultivation process. The evolution of the dimension of financial risk employed in market risk and liquidity risk are presented in

Appendix 1 and 2. The trend equally shows variability of financial risk components within the study period. From the graphical presentation of the variables of interest, we proceed by presenting the correlation existing among the variables.

Table 3. Pairwise correlation.

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)
(1) Log of MARKET RISK	1.00						
(2) Log of LIQUIDITY RISK	0.62	1.00					
(3) Log of CROP INSURANCE	-0.05	0.02	1.00				
(4) Log of FARM SIZE	0.66	0.55	-0.08	1.00			
(5)Log of LABOUR SIZE	0.70	0.36	-0.04	0.71	1.00		
(6) Log of BUYING PRICE	-0.06	-0.11	0.05	-0.05	-0.05	1.00	
(7) Log of TRAINING COST	0.07	-0.02	0.01	0.09	0.03	-0.05	1.00

From the correlation matrices presented in Table 3, it is observed generally that crop insurance has negative correlation with market risk and a positive correlation with liquidity risk. Equally, it is observed that there's no problem of multicollinearity within the panel under consideration since all the coefficient of the correlation matrices are less than 0.8.

4.3. Regression Outcome

This section presents the empirical outcomes obtained from the estimate of model 1, 2 and 3. In the paragraphs that follows we present the outcomes of the PCSE estimate of the three models and proceed to examine the robustness using the panel OLS estimation.

4.3.1. Regression of Crop Insurance on Market Risk

The empirical findings of the effect of crop insurance on the market risk of smallholder rice farmers are interpreted in this section, while controlling for variables like Farm size, buying price, training cost and labour size.

Table 4. Panel corrected standard error technique on crop insurance and market risk.

Variables	(1) LMKTRISK	(2) LMKTRISK	(3) LMKTRISK	(4) LMKTRISK	(5) LMKTRISK
LCROPINS	0.15***	0.08***	0.08***	0.08***	0.09***
	(0.06)	(0.03)	(0.03)	(0.03)	(0.03)
LFRMSZ		0.95***	0.79***	0.78***	0.80***
		(0.05)	(0.10)	(0.10)	(0.10)
LLABOURSIZE			0.24**	0.24***	0.25***
			(0.09)	(0.09)	(0.09)
LBUYINGPRICE				-0.23**	-0.19*
				(0.10)	(0.10)
LTRAININGCOST					-0.04***
					(0.01)
Constant	5.89***	3.35***	2.78***	4.90***	4.81***
	(0.66)	(0.42)	(0.52)	(1.18)	(1.16)
Observations	300	300	300	300	300
R-squared	0.02	0.75	0.72	0.74	0.73
Number of location area code	76	76	76	76	76
chi2	7.35	378	582	578	534
P	0.007	0.00	0.00	0.00	0.00

Note: Standard errors in parentheses.
*** p<0.01, ** p<0.05, * p<0.1.

Table 4 contains estimated outcome on Crop insurance analysis using the Panel Corrected Standard Error technique. By this analysis, a positive relationship between Crop insurance and market risk is observed for the baseline model. The outcome implies that, an increase in crop insurance by 1% will increase market risk by 0.15%. With the introduction of different control variables in model 2 to 5, the coefficient of crop insurance consistently remains positive and statically significant. This indicates that the outcome is robust to different control variables and as such reliable for policy inferences.

With regards to the different control variables employed in this study, farm size and labour size portray a positive relationship with market risk while buying price and training cost demonstrate a negative and statistically significant effect on market risk. The overall model is good as shown by the Chi² test, for all the models.

The result from the regression of crop insurance on market risk shows that crop insurance generally increases market risk. The outcome accords with the theoretical views of the risk balancing theory which contends that increase in crops insurance adoption can lead to increase risk. This result aligns with the empirical outcome of Peng and Zhu (2021) who demonstrated in different studies that insurance may rather increase risk in different economic activities.

4.3.2. Examining Crop Insurance on Liquidity Risk

After examining crop insurance on market risk, we proceed to equally examine crop insurance on liquidity risk which the second dimension of financial risk used in this study.

Table 5. Panel corrected standard error technique on crop insurance and liquidity risk.

Variables	(1) LLQRISK	(2) LLQRISK	(3) LLQRISK	(4) LLQRISK	(5) LLQRISK
LCROPINS	0.15*	0.15*	0.15*	0.191**	0.19**
	(0.09)	(0.09)	(0.09)	(0.09)	(0.09)
LFRMSZ		0.78***	0.84***	0.79***	0.80***
		(0.15)	(0.22)	(0.21)	(0.21)
LLABOURSIZE			-0.07	-0.03	-0.03
			(0.24)	(0.23)	(0.24)
LBUYINGPRICE				-1.97***	-1.95***
				(0.60)	(0.60)
LTRAININGCOST					-0.02
					(0.05)
Constant	13.9***	11.1***	11.3***	29.8***	29.8***
	(1.10)	(1.20)	(1.30)	(5.87)	(5.85)
Observations	300	300	300	300	300
R-squared	0.56	0.54	0.54	0.51	0.51
Number of location area code	76	76	76	76	76
chi2	2.75	30.0	30.3	45.3	45.1
P	0.09	3.12e-07	1.17e-06	3.52e-09	1.39e-08

Note: Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1.
"e" = exponent of the decimal places

Based on the outcome presented in Table 5, there is a positive correlation between crop insurance and liquidity risk. From this regression results of crop insurance and Liquidity risk, a 1% increase in crop insurance will increase liquidity risk by 0.15% and results is significant at the 10% level of significances (based on the baseline model). This implies that increase in adherence to crop insurance will lead to an augmentation of the level of liquidity risk everything being equal. Worthy of note is that when we control for other variables, the coefficient of crop insurance still remains positive and significant.

With regard to the different control variables employed, Farm size and labour are portraying a positive relationship with market risk while buying price and training cost demonstrate a negative and significant effect on market risk. The outcome of the control variables is in line with the market risk models.

The result of the effect of crop insurance on liquidity risk is positive and statistically significant. However, the results contradict Smith and Glauber (2012) who settled on a risk reduction effect of crop insurance. This outcome can be explained in the sense that when these farmers subscribe to crop insurance, they are often tempted to shift to riskier rice cultivation areas or higher yield crops which might be more prone to pest and diseases making them riskier but potentially more profitable.

4.3.3. The Effect of Crop Insurance on Financial Risk (Composite Index of Market and Liquidity Risk)

In this section, the outcome of crop insurances on the constructed index of financial risk made up of market risk and liquidity risk is presented.

Table 6. Panel corrected standard error (PCSE) of crop insurance on financial risk.

Variables	(1) LFINRISK	(2) LFINRISK	(3) LFINRISK	(4) LFINRISK	(5) LFINRISK
LCROPINS	0.09*	0.05**	0.05**	0.06***	0.06***
	(0.05)	(0.02)	(0.02)	(0.02)	(0.02)
LFRMSZ		0.80***	0.73***	0.72***	0.74***
		(0.05)	(0.07)	(0.07)	(0.07)
LLABOURSIZE			0.09	0.10	0.10
			(0.07)	(0.07)	(0.07)
LBUYINGPRICE				-0.48***	-0.45***
				(0.14)	(0.13)
LTRAININGCOST					-0.03**
					(0.01)
Constant	-1.29**	-3.62***	-3.81***	0.63	0.62
	(0.53)	(0.29)	(0.35)	(1.35)	(1.31)
Observations	300	300	300	300	300
R-squared	0.01	0.46	0.46	0.49	0.50
Number of location area code	76	76	76	76	76
chi2	3.72	318	344	410	427
P	0.05	0.00	0.00	0.00	0.00
r2	0.01	0.46	0.46	0.49	0.50
df_m	1	2	3	4	5

Note: Standard errors in parentheses.
*** p<0.01, ** p<0.05, * p<0.1.

In Table 6, the result from the baseline model shows a positive link between crop insurance and financial risk. This shows that everything being equal, an increase in adherence to crop insurance will result to an increase in financial risk and this outcome is observed to be statistically significant at 10%. This result can be better interpreted as such; a 1% increase in crop insurance will lead to a 0.0858% increase in financial risk. The positive outcome of crop insurance is consistently significant and positive when control for other variables. Two control variables farm size and labour size equally had a positive effect on financial risk. Farm size is statistically significant at 1% level of significance, while labour size is statistically insignificant. Buying price and training cost were negatively correlated to financial risk with a 1% and 5% levels of significance respectively.

The result obtain is in line with the risk balancing theory and the safety net theory. The study by DeLay et al. (2023) equally explains that crop insurance may increase farms' financial risk through the mechanism called 'Risk Balancing'. Moreover, the cause of such positive effect from crop insurance can be due to the increase in acreage that the farmers tend to cultivate after adopting crop insurance. The increase in activities will result to an increase

in profits but equally boost potential losses if a bad year hits. This is evident because the study period focuses on the period of the anglophone crisis and equally the Covid 19 period that could worsen the risk of small holder farmers.

4.3.4. Robustness Check Outcome

In this subsection, we examine the outcomes presented in Table 7, 8 and 9 using the panel OLS estimate as a robustness check of the interpreted outcomes of the PCSE.

Table 7. Robustness check of the regression of crop insurance on market risk using panel OLS.

Variables	(1)	(2)	(3)	(4)	(5)
	LMKTRISK	LMKTRISK	LMKTRISK	LMKTRISK	LMKTRISK
LCROPINS	0.05*	0.10**	0.10***	0.10***	0.11***
	(0.03)	(0.04)	(0.04)	(0.04)	(0.04)
LFRMSZ		0.98***	0.84***	0.83***	0.84***
		(0.06)	(0.09)	(0.10)	(0.09)
LLABOURSIZE			0.20***	0.21***	0.21**
			(0.07)	(0.07)	(0.08)
LBUYINGPRICE				-0.30*	-0.26*
				(0.17)	(0.15)
LTRAININGCOST					-0.04**
					(0.02)
Constant	7.06***	3.10***	2.66***	5.50***	5.30***
	(0.38)	(0.59)	(0.63)	(1.50)	(1.41)
Observations	300	300	300	300	300
Number of location area code	76	76	76	76	76
P	0.07	0	0	0	0
chi2	3.22	250	386	391	287
P	0.073	0.00	0.00	0.00	0.00

Note: Robust standard errors in parentheses.
*** p<0.01, ** p<0.05, * p<0.1.

A Robustness test using panel OLS (Ordinary least square) technique with robust standard errors is used to verify if the outcome will remain consistent. Based on the outcome of the robustness estimated result presented in Table 7 as regard market risk, it is observed that crop insurance demonstrates a positive effect on market risk in the baseline model and when the model is controlled for different variables. This result is consistent with the result obtained in the panel corrected standard errors (Table 6). This result confirms that the result obtained using the panel corrected standard errors are robust, efficient and good for policy insight.

Table 8. Robustness check of the regression of crop insurance and liquidity risk using panel ordinary least square technique.

Variables	(1)	(2)	(3)	(4)	(5)
	LLQRISK	LLQRISK	LLQRISK	LLQRISK	LLQRISK
LCROPINS	0.15*	0.15**	0.15**	0.19**	0.19**
	(0.08)	(0.07)	(0.07)	(0.07)	(0.08)
LFRMSZ		0.81***	0.86***	0.80***	0.81***
		(0.06)	(0.10)	(0.11)	(0.12)
LLABOURSIZE			-0.08	-0.02	-0.02
			(0.10)	(0.12)	(0.13)
LBUYINGPRICE				-2.17**	-2.16**
				(0.93)	(0.94)
LTRAININGCOST					-0.01
					(0.03)
Constant	13.8***	11.0***	11.2***	31.7***	31.7***
	(0.89)	(0.88)	(0.87)	(9.17)	(9.19)
Observations	300	300	300	300	300
Number of location area code	76	76	76	76	76

Variables	(1)	(2)	(3)	(4)	(5)
	LLQRISK	LLQRISK	LLQRISK	LLQRISK	LLQRISK
chi2	3.84	218	230	124	118
P	0.05	0	0	0	0
df_m	1	2	3	4	5
Rank	2	3	4	5	6
N_clust	76	76	76	76	76
thta_max	0	0	0	0	0

Note: Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1.

Robustness check of this model using the Panel ordinary least square technique with robust standard errors in Table 8 shows a positive correlation of crop insurance and liquidity risk which is significant at 10%. The outcome remains consistent with the introduction of control variables. The outcome aligns with PCSE outcome in Table 6. All the estimated models are globally significant given that the Chi square Wald test statistics is significant at the 1% and 10% level for all adopted estimated models. This implies that the results are efficient and good for policy inferences.

Table 9. Robustness check of crop insurance and financial risk using panel ordinary least square technique (POLS).

Variables	(1)	(2)	(3)	(4)	(5)
	LFINRISK	LFINRISK	LFINRISK	LFINRISK	LFINRISK
LCROPINS	0.06**	0.08***	0.08***	0.09***	0.09***
	(0.03)	(0.02)	(0.02)	(0.02)	(0.03)
LFRMSZ		0.80***	0.73***	0.72***	0.73***
		(0.04)	(0.06)	(0.06)	(0.06)
LLABOURSIZE			0.09**	0.11**	0.112**
			(0.05)	(0.05)	(0.0481)
LBUYINGPRICE				-0.57**	-0.54**
				(0.23)	(0.22)
LTRAININGCOST					-0.03**
					(0.01)
Constant	-0.93***	-4.05***	-4.21***	1.16	1.04
	(0.29)	(0.34)	(0.36)	(2.24)	(2.12)
Observations	300	300	300	300	300
Number of location area code	76	76	76	76	76
chi2	4.89	411	548	615	475
P	0.03	0.00	0.00	0.00	0.00

Note: Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1.

A robustness regression output presented in Table 9 is analysed using Panel Ordinary least square (POLS) technique, and the result shows a positive correlation of Crop insurance and financial risk. This outcome confirms and validates the outcome obtained using the panel corrected standard error estimation technique. Equally the control variables outcomes align with those of the PCSE outcomes. The different robustness check affirms all established relation when the PCSE was employed. This indicates consistency and efficiency in the obtained outcome and build confidence on subsequent policy discuss base on outcomes.

5. CONCLUSION AND POLICY RECOMMENDATION

The importance of the agricultural sector in promoting economic development and improving livelihood is indispensable. However, inadequate policies are being made by the government of many countries especially Cameroon towards its enhancement and sustainability. This study was therefore, conceived to investigate the effect of crop insurance on the financial risk of smallholder rice farmers in the grassfield of Cameroon. It made use of the Panel corrected standard error technique to estimate the results of the study, using micro panel data collected from

76 different smallholder rice farming groups located in different areas of the grassfield of Cameroon for the period running from 2019 to 2022. The results revealed that Crop insurance rather increases financial risk during the study for small holder farmers of the grassfield. This outcome was consistent for different dimension of financial risk and equally consistent when simulation and other robustness checks are employed. The null hypothesis indicating that crop insurance has no statistical significant effect on the financial risk of smallholder rice farmers in the grassfield of Cameroon, is rejected

In line with the findings of this work, it is recommended that in order to minimize financial risk and encourage rice farming, state actors especially the government should adopt policies aimed at integrating crop insurance. In addition, farm lands should be bulldozed and prepared to ease cultivation; canals in the farms and drainage systems should be well developed and irrigational facilities made accessible to dry plots. Equally the unexploited land should be developed to boast production. Government should continue to subsidise farm inputs used by farmers. Researchers should research into improved rice species resistant to flood and drought. More technology should be developed to ease the cultivation process. The government and rural authorities should also pay a closer attention towards rice farming for sustainable development which goes to contribute positively to the country's Gross Domestic Products (GDP). Furthermore, multilateral institutions like the World Bank should be encouraged to provide Aid to countries that produce rice like staple food in order to fight hunger across the globe.

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Competing Interests: The authors declare that they have no competing interests.
Authors' Contributions: All authors contributed equally to the conception and design of the study. All authors have read and agreed to the published version of the manuscript.

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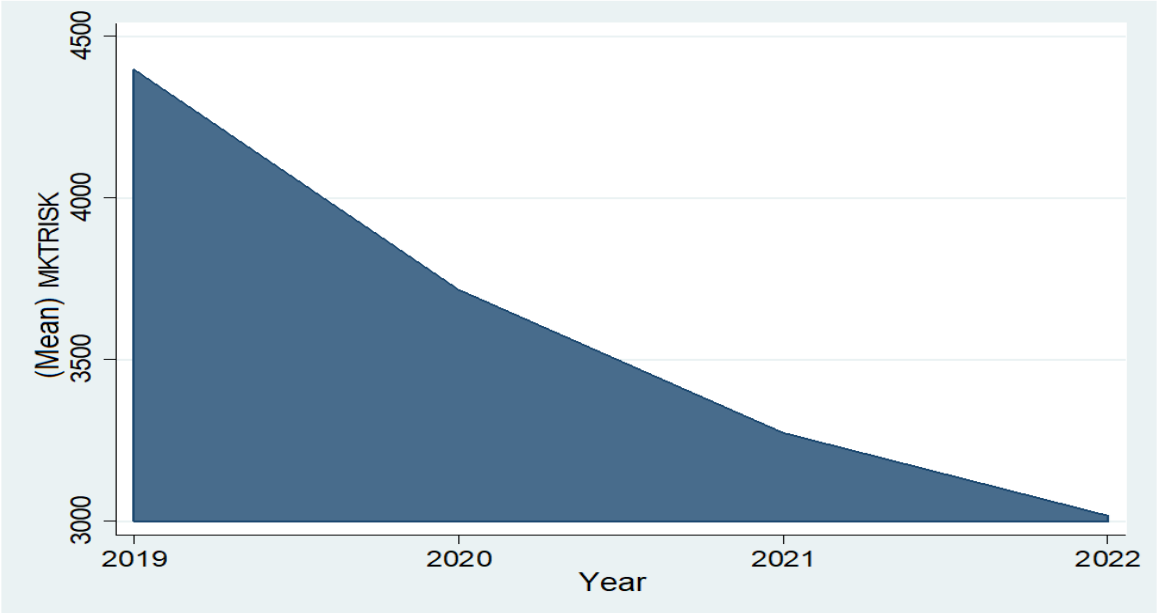
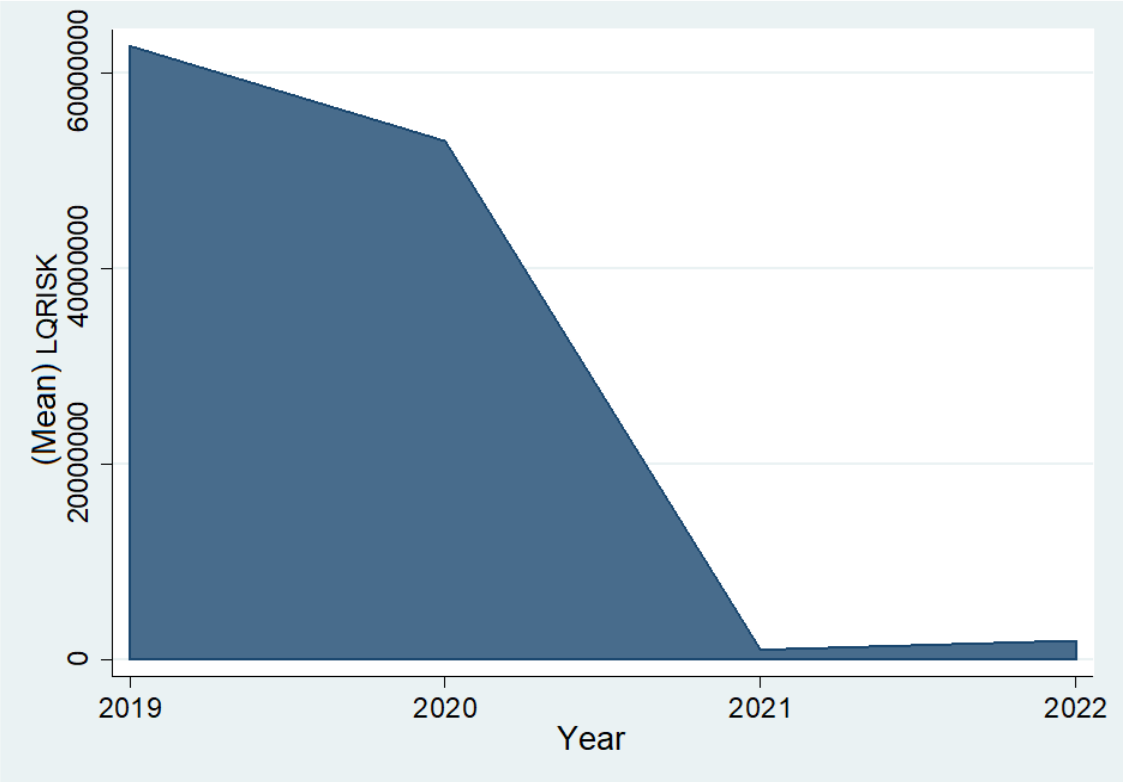
APPENDICES



Appendix 1. Trend for market risk.



Appendix 2. Trend for liquidity risk.