Global experiences with subsidising economic insurance in agriculture

Part II

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Abstrakt

The second part of this article focuses on the relationships between insurance subsidies and the demand for risk mitigation products, the negative effects of such intervention, and opportunities for rationalising the budgetary funds allocated to these subsidies. This section is also based on experiences documented by the World Bank, the Food and Agriculture Organization (FAO) of the United Nations, the International Food Policy Research Institute (IFPRI), and the Organisation for Economic Cooperation and Development (OECD), as well as a review of the relevant literature conducted using a modified snowballing backward technique, systematic literature reviews, and the author's expert knowledge. The review is highly up-to-date, ending in the first half of 2024. The article aims to synthesise the diverse experiences, theoretical reflections, and empirical research results in the three aforementioned areas. The analysis can be summarised in three conclusions. Firstly, farmers' demand for agricultural insurance generally exhibits low elasticity, requiring high subsidy rates, particularly for multi-risk insurance (known in Poland as package insurance), to significantly increase demand. Secondly, insurance subsidies may result in numerous demotivating effects among participants in the insurance market, ultimately reducing their social efficiency. Thirdly, insurance subsidies tend to become self-perpetuating, as a strong interest group – comprising farmers, insurers, and agricultural policymakers – advocates for their continuation, making it very challenging to rationalise the system.

Keywords: farmers' insurance decisions, insurance demand in agriculture, subsidising agricultural insurance, agricultural insurance.

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Methodological premises

The methodological premises are generally identical to those in the first part of the article. This means that the approach from the "Journal of Economic Literature" was applied once again, presenting the analysed issues from a historical and evolutionary perspective in terms of their formulation and resolution. A systematic literature review was conducted using a combination of the snowballing backward technique and continuous monitoring of leading publications. The research also draws on the achievements of scholars from the World Bank, FAO, IFPRI, and OECD, as well as predominantly English-language literature (notably from the United States). The article is primarily intended for researchers and professionals dealing with agricultural insurance who are familiar with the terminology used in these discussions. Its main purpose is to synthesise knowledge about the subsidisation of agricultural insurance to better understand its impact on demand for risk transfer instruments and distortions in market participants' behaviours and motivations, as well as the practical and political difficulties of reforming and rationalising this form of public-private partnership.

Insurance demand and subsidies

Demand for insurance services is influenced by various factors. Here, we will only outline the most general issues related to price and income elasticity, using the framework proposed by P. Zweifel, R. Eisen, and D.L. Eccles[1]. The starting point is a simple formula for the gross premium collected by an insurance company:

$$PV = p \cdot I,$$

where:
PV – premium volume/amount, p – premium rate as a percentage relative to the monetary unit of the sum insured, I – insured sum.
Differentiation of the formula fully yields:

$$dPV = dp \cdot I + p \cdot dI.$$

Dividing both sides by $PV = pI$ gives:

1. P. Zweifel, R. Eisen, D.L. Ecles, *Insurance Economics*, Berlin, Heidelberg, Springer, 2021.

$$\frac{dPV}{PV} = \frac{dp}{p} + \frac{dI}{I}.$$

We now observe that changes in premium volume arise from changes in the insurance rate and the sum insured. The latter can be expressed as a function of rate p and income Y:

$$I = I\left(p, Y\right).$$

Full differentiation of the above expression gives:

$$dI = \frac{\partial I}{\partial p} dp + \frac{\partial I}{\partial Y} dY \ .$$

Dividing this by I and expanding it by $1 = p/p$ and $1 = Y/Y$ gives:

$$\frac{dI}{I} = \left(\frac{\partial I}{\partial p} \cdot \frac{p}{I}\right)\frac{dp}{p} + \left(\frac{\partial I}{\partial Y} \cdot \frac{Y}{I}\right)\frac{dY}{Y} = \eta \cdot \frac{dp}{p} + \varepsilon \cdot \frac{dY}{Y},$$

where: $\eta := \frac{\partial I}{\partial p} \cdot \frac{p}{I} < 0$ is the price elasticity of demand; $\varepsilon := \frac{\partial I}{\partial Y} \cdot \frac{Y}{I} > 0$ is the income elasticity of demand.

Let us now examine, in a simplified manner, the theoretical model proposed by J. Cai, A. de Janvry, and E. Sadoule, which incorporates three mechanisms by which insurance subsidies granted in the first year affect the demand for insurance in the second year[2]. These mechanisms are as follows:

1) coverage mechanism – assumes that subsidies increase demand, thereby enhancing the likelihood of receiving claim payments;
2) attention effect – lower insurance costs lead households to pay less attention to claims history;
3) price anchoring effect – low prices paid in the past reduce the current willingness to pay for insurance coverage.

According to J. Cai, A. de Janvry and E. Sadoule, insurance demand may also be influenced by:

1) changes in individuals' and households' risk aversion, as well as their subjectively perceived probability of risk-related or catastrophic events;
2) increased trust in insurers;

2. J. Cai, A. de Janvry, E. Sadoule, *Subsidy Policies and Insurance Demand*, "American Economic Review" 2020, Vol. 110, No 8.

3) liquidity effects – these imply that, for instance, farmers who have received claim payments possess more funds, which should encourage them to renew insurance policies.

Unfortunately, the author of the article did not encounter any studies on the price elasticity of insurance demand among Polish farmers. Out of necessity, only the results obtained by American researchers are cited, while always keeping their specific context in mind. At this stage, the applied methodology and its development are considered more significant than the actual figures.

Unquestionably, most of the research conducted to estimate the price elasticity of farmers' participation in the insurance market – commonly equated with studies on insurance demand – has been conducted in the United States. As shown in Table 1, using various methodologies (which naturally led to differences in results), the researchers focused primarily on maize for grain, soybeans, and wheat. Generally, however, insurance demand was found to be inelastic, meaning that an increase in policy prices resulted in reduced interest, and the level of insurance premiums had little impact on extending coverage to new crops.

Table 1. Price elasticities of demand for insurance of maize for grain, soybeans, and wheat in the US (historical overview)

Year of publication	Author(s)	Years studied	Crop type	Price elasticities and demand measures (dependent variables)
1993	Goodwin	1989–1990	Maize	–0.32 (area) –0.73 (insured sum)
2004	Goodwin et al.	1985–1999	Maize	–0.28 (insured sum)
2001	Goodwin	1996–1998	Maize	–0.24 (insured sum)
2001	O'Donoghue	1997, 2002	Maize	–0.27 (area)
2004	Goodwin et al.	1985–1993	Soybeans	–0.33 (insured sum)
2001	Goodwin	1996–1998	Soybeans	–0.20 (insured sum)
	O'Donoghue	1997, 2002	Soybeans	–0.03 (insured sum)
1996	Smith and Baquet	1990	Wheat	–0.58–0.69 (market share)
2004	Goodwin et al.	1985–1993	Wheat	–0.12 (insured sum)
	O'Donoghue	1997, 2002	Wheat	–0.74 (premium) –0.27 (insured sum)
Working paper	Serra et al.	1993–2000	No crop specified	–0.21 (market share)

Source: Developed based on: J.E. O'Donoghue, S. Tulman, The Demand for Crop Insurance: Elasticity and the Effect of Yield Shock, Selected Paper prepared for presentation for the 2016 Agricultural & Applied Economics Association, Boston, MA, 31.07–2.08.2016.

In 2014, J.E. O'Donoghue estimated his own elasticities of participation in US crop insurance for maize for grain, soybeans, and wheat based on a one-percent change in subsidies per acre. The starting point for this estimation was the following regression model with fixed regional effects:

$$\Delta Y_c = \alpha \Delta S_c + \beta \Delta X_c + \delta w_{r(c)} + u_c,$$

where: ΔY_c – five measures of market participation, identified with changes in insurance demand; ΔS_c – changes in subsidies; ΔX_c – control variables, generally different variants of time-lagged variables; $w_{r(c)}$ – fixed effects; u_c – other unobserved determinants of demand; β and δ – estimated parameters.

The results obtained by the author are summarised in Table 2. It is worth noting from the outset that these differ from the previously shown price elasticities of demand, which indicate how demand changes when prices rise by 1%. J.E. O'Donoghue, in contrast, examined how a one-percent increase in subsidies translates into a price reduction for insurance, which in turn is expected to boost demand.

Table 2. Impact of a one-percent change in per-acre subsidies on market participation in crop insurance (insurance demand)

Crop	Δln (total premiums)	Δln (total premiums per acre)	Δln (sum insured per acre)	Δln (acres insured)	Δln (additional coverage)
Maize	0.86	0.86	0.23	0.10	0.18
Soybeans	0.74	0.77	0.19	–0.02	–0.03
Wheat	0.63	0.81	0.32	–0.15	0.10

Δln – changes expressed in natural logarithms.

Source: Developed based on: J.E. O'Donoghue, The Effects of Premium Subsidies on Demand for Crop Insurance, ERS, Report Number 169, Washington, July 2014.

The data show that subsidies mainly translated into an increase in collected premiums, both in volume and per unit of insured area. However, the sum insured and additional coverage levels responded less to subsidies, with the latter relationship proving statistically insignificant. Furthermore, in the case of soybeans and wheat, an increase in subsidies even led to a reduction in insured acreage. J.E. O'Donoghue summarised these findings succinctly: subsidies encourage American farmers primarily to select higher levels of insurance coverage. This outcome is explained by the already very high proportion of insured crops within the total area of sown crops in the United States.

A frequently overlooked source of significant variation in estimates of farmers' insurance demand elasticities with respect to premium subsidies – and particularly

the conclusion about its inelasticity – is the econometric issues arising from endogeneity in the empirical models used[3]. This endogeneity indicates that some determinants of demand are correlated with random errors in these models, which results in statistically biased parameter estimates. The primary source of endogeneity is the separate modelling of the subsidy's influence on, for instance, the insured crop area (the extensive margin) and the level of yield/revenue coverage (the intensive margin). The aforementioned researchers mitigated the negative consequences of endogeneity by applying a system of equations, using instrumental variable techniques for both margins, and employing a three-stage least squares method to estimate the regression equations. They found that demand responses to changes in subsidy rates were 3–5 times larger compared to those estimated using ordinary least squares methods. Nevertheless, the elasticities remained slightly negative. Demand became more elastic as subsidy rates approached zero. These elasticities were also lower than those found in earlier studies, yet they demonstrated significant variation across different crops and agricultural practices or technologies (irrigation, organic farming, etc.). Additionally, farmers' risk aversion appears to be lower than commonly assumed. This suggests that changes, in particular reductions, in subsidy rates might have less impact on farmers' insurance decisions. Consequently, insurance demand may decline.

Subsidising agricultural insurance and other agricultural risk management instruments in developed countries is most widespread in the United States and Canada[4]. At some point, policymakers in these countries concluded that without intense subsidisation of policy purchases by farmers, it would be impossible to achieve satisfactory rates of crop and livestock insurance coverage (so-called penetration rates). Direct payments play a marginal role in the US and Canada. Farmers in these countries have broad access to risk management instruments other than insurance. Consequently, the issue of relationships between these instruments arises. Even by the beginning of this century, studies had been published showing that price risk management through various contracts (hedging) reduces interest in crop and revenue insurance[5]. However, complementary relationships between hedging and insurance can also emerge when

3. F. Tsiboe, D. Turner, *The crop insurance demand response to premium subsidies: Evidence from U.S. Agriculture*, "Food Policy" 2023, Vol. 119; D.J. Woodard, J. Yi, *Estimation of Insurance Deductible Demand Under Endogenous Premium Rates*, "Journal of Risk and Insurance" 2020, Vol. 87(2).
4. A.P. Ker, B. Barnett, D. Jacques et al., *Canadian business risk management: Private firms, crown corporations, and public institutions*, "Canadian Journal of Agricultural Economics" 2017, Vol. 65(4); X. Liu, T. Duan, G.C. van Kooten, *The impact of changes in the agristability program on crop activities: A farm modeling approach*, "Agribusiness" 2018, Vol. 34(3).
5. K.H. Coble, B.G. Heifner, M. Zuniga, *Implications of crop yield and revenue insurance for producer hedging*, "Journal of Agricultural and Resource Economics" 2000, Vol. 25(2); O. Mahul, *Hedging price risk in the presence of crop yield and revenue insurance*, "European Review of Agricultural Economics" 2003, Vol. 30(3).

individual contract types and insurance policies are analysed separately, along with farmers' attitudes towards risk[6]. Research by P. Slade, who simulated the effects of margin insurance and price hedging in Canada, has shown clearly that substitution between these tools was the most common outcome[7]. In some simulations, the benefits of margin insurance for farmers were even lower than the value of the subsidies provided. In such cases, replacing insurance with direct payments would be a more efficient solution, both privately and socially.

Latest research on insurance demand

Research and modelling of the simultaneous financial and insurance decisions should be based on a set of hypotheses derived from specific theories or combinations of theories. In agriculture, there are two main reference frameworks: (1) risk balancing and (2) the theory of risk homeostasis. The concept of risk balancing originates from S.C. Gabriel and C.B. Baker (1980), R.A. Collins (1985), and A.M. Featherstone et al. (1980), while, the theory of risk homeostasis can be attributed to three authors: P. Slovic and B. Fischhoff (1982) and G.J.S. Wilde (1982). The risk balancing hypothesis suggests that while insurance may reduce production and price risks, it could also lead to an increase in financial risk. In certain cases, subsidising agricultural insurance could result in greater total risk for some farms or even the entire agricultural sector. Upon closer analysis, the theory of homeostasis appears to align closely with risk balancing, albeit being considered more general. The first hypothesis assumes that a farmer sets a specific threshold for total risk exposure that must not be exceeded and flexibly adjusts individual exposures to stay within this limit. This is a highly sophisticated assumption in terms of farmers' financial competencies, access to relevant data, and their ability to process and interpret it. Nevertheless, it would be highly desirable for policymakers and designers of subsidy programmes for insurance, disaster assistance, and low-cost foreign capital injections (including disaster loans), to comprehend the logic underpinning both hypotheses.

Below are the key components of the risk balancing and risk homeostasis hypotheses, as presented in their modern interpretation by D.N. DeLay, B. Brewer, and M.A. Featherstone (2023)[8]. Let us assume that a farmer's total risk (TR) is the sum of

6. B.K. Coffey, T.C. Schroeder, *Factors influencing midwestern grain farmers use of risk management tools*, "Agricultural Finance Review" 2019, Vol. 79(2).
7. P. Slade, *Business risk management programs under review*, "Canadian Journal of Agricultural Economics" 2020, Vol. 68(3); P. Slade, *The impact of price hedging on subsidized insurance: Evidence from Canada*, "Canadian Journal of Agricultural Economics" 2021, Vol. 69(4).
8. D.N. DeLay, B. Brever, M.A. Featherstone, *The impact of crop insurance on farm financial outcomes*, "Applied Economic Perspectives and Policy" 2023, Vol. 45(1).

business/economic risk (BR), which includes the variability of production outcomes, product sale prices, and purchased input costs, and financial risk (FR), stemming from excessive reliance on debt. The relationships in this context can be described as follows:

$$TR = \frac{\sigma_\pi}{E[\pi]} + \frac{\sigma_\pi I}{E[\pi](E[\pi]-I)} \leq \beta,$$

where: E[π] – the expected value of operating profit before interest payments; σ_π – the standard deviation of profit, the first symbol representing business risk; I – interest payable, the second symbol representing financial risk; β – the maximum acceptable level of total risk. This reflects the views of S.C. Gabriel and C.B. Baker (1980), who were the first to use the term risk balancing.

Instead of using the standard deviation as a measure of risk, variance can also be applied, as demonstrated by R.A. Collins (1985) and A.M. Featherstone et al. (1988). These economists used a model in which a farmer, exhibiting risk aversion, selects the optimal debt level D* and optimal insurance coverage L* to maximise the expected return on equity R_E^*. Their approach directly references the well-known DuPont system of financial ratios. This produces the following:

$$R_E \equiv \frac{R}{E} = \frac{\pi(r,c,L) - iD}{A-D},$$

where: R – return (profitability) on production assets after debt servicing costs; E – equity capital, A – production assets; i – expected interest rate on debt; π – operating profit before interest payments; c – operating costs; r – general revenue generation function.

Due to the inherent risks in production, prices, and inputs, the return on equity is a random variable with a mean equal to $\overline{R}_E$ and variance σ_E^2:

$$\overline{R}_E = \frac{E[\pi(r,c,L)] - iD}{A-D} = \frac{\pi(\overline{r},\overline{c},L) - iD}{A-D},$$

$$\sigma_E^2 = \frac{\sigma_\pi^2(L)}{(A-D)^2},$$

where: σ_π – variance of operating profit, which decreases as the insurance coverage level L increases. This indicates that higher insurance protection reduces the downside risk but equally, greater variability in production widens the risk distribution; σ_E^2 – variance of equity increases as business and financial risks increase.

D.N. DeLay, B. Brewer, and A.M. Featherstone maximise the expected return on equity of a farmer using an exponential utility function:

$$\max_{D,L} E\left[U\left(R_E\right)\right] = \frac{\pi\left(\overline{r},\overline{c},L\right) - iD}{A-D} - \frac{\alpha}{2}\frac{\sigma_\pi^2\left(L\right)}{\left(A-D\right)},$$

where: α – coefficient of absolute risk aversion of the farmer.

By setting the first-order condition of the expected utility function to zero, we derive the condition for determining the optimal insurance coverage (sum insured):

$$\frac{\partial\pi\left(\overline{r},\overline{c},L\right)}{\partial L} = \frac{\alpha}{2}\left(\frac{1}{A-D}\right)\frac{\partial\sigma_\pi^2}{\partial L}.$$

If the farmer exhibits risk aversion, the right-hand side of this equation must be negative. This implies that the farmer might be willing to pay more for insurance than the expected claim payment, provided that such additional coverage reduces the variability of their operating profit. In other words, such a farmer might even be interested in purchasing actuarially unfair insurance. In practice, the farmer's purchasing decision is significantly more complex, as illustrated by the following functional formula for the optimal sum insured:

$$L^* = L\left(\alpha,\overline{r},\overline{c},A,D\right).$$

If we differentiate the equation for maximising the expected return on equity with respect to D and set the result to zero, we derive the general expression for the optimal level of debt for a farmer:

$$\frac{\pi\left(\overline{r},\overline{c},L\right) - i\left(A-D\right) - iD}{\left(A-D\right)^2} - \frac{\alpha\sigma_\pi^2\left(L\right)}{\left(A-D\right)^3} = 0.$$

Appropriate transformations to express the optimal debt as a function of parameters and linking it to the sum insured produce the following:

$$D^* = D\left(\alpha,i,\overline{r},\overline{c},A,L\right) = A - \frac{\alpha\sigma_\pi^2\left(L\right)}{\pi\left(\overline{r},\overline{c},L\right) - iA}.$$

In equilibrium conditions, we observe that the optimal level of debt is negatively correlated with risk aversion, fixed interest payments, and business risk volatility. However, if the expected income of a farm increases, the optimal debt may also increase. Additionally, for a fixed insured sum, an increase in claim payment can raise debt if revenues grow by an amount equal to:

$$\frac{\partial D^*}{\partial\sigma_\pi^2\left(L\right)} = -\frac{\alpha}{\pi\left(\overline{r},\overline{c},L\right) - iA} < 0.$$

This last expression captures the essence of risk balancing.

The simultaneous decision-making regarding insurance and financial matters is most often empirically examined using a simultaneous equations model (SEM). D.N. DeLay, B. Brever, and A.M. Featherstone applied this approach, constructing the following two equations:

$$Debt_{i,t} = \mu_i + \tau_t + \beta_1 Liab_{i,t} + \beta_2 Ind_{i,t} + \beta_3 IntRate_{i,t} + X'_{i,t}\varphi + v_{i,t},$$

$$Liab_{i,t} = \delta_i + \lambda_t + \gamma_1 Debt_{i,t} + \gamma_2 \Pr em\, Rate_{i,t} + X'_{i,t}\omega + u_{i,t},$$

where: $Debt_{i,t}$, $Liab_{i,t}$ – are, respectively, the debt and insured sum of farm *i* in year *t*, with the latter also expressed as the ratio of farmers' insurance expenses to the premium rate; $Ind_{i,t}$ – is the claim payment; $IntRate_{i,t}$ – is the interest rate on debt; Prem $Rate_{i,t}$ – is the insurance premium rate, i.e., the ratio where the numerator is the difference between the premium and the subsidy received for it, and the denominator is the insured sum; X – is a vector of control variables (income, costs, cultivated area, manager's age, farm type, assets); τ_t i λ_t – are fixed effects; μ_i i σ_i – are unobserved farm characteristics that remain constant over time but influence insurance and debt decisions (e.g., soil quality, agro-climatic conditions, manager's risk aversion); β_1,β_2,Y_1 – are coefficients to be estimated, primarily for testing the risk balancing hypothesis in the study sample – over 3,000 farms in Kansas between 2002 and 2018. The calculations were based on a double least squares method. The findings generally indicated no statistically significant relationship between the insured sum and debt, meaning the risk balancing hypothesis could not be accepted for the studied population. At the same time, it was observed that receiving claim payments increased short-term debt but did not affect total debt levels.

For decades, efforts have been underway worldwide to develop sustainable, affordable insurance products for farmers that are cost-effective for insurers and make rational use of budgetary funds[9]. The goal is to minimise farmers' vulnerability to various shocks, including those associated with the climate crisis, increasingly frequent extreme weather events, and growing geopolitical risks. Without effective solutions in this area, many farmers will face increasing challenges in rebuilding productive capacity, achieving satisfactory incomes, and improving their quality of life. These threats will undoubtedly be most acute in developing countries.

Despite the widespread allocation of significant budgetary funds to agricultural insurance programmes, global interest in these schemes remains low. This is due to numerous economic, social, and behavioural factors on both the demand and

9. M.R. Carter, A.D. January, E. Sadoulet et al., *Index-based wheather insurance for developing countries: a review of evidence and a set of proposition for up-scaling*, Working Paper P111, FERDI, 2014.

supply sides of the insurance market[10]. In this context, one of the most critical yet often overlooked issues is the knowledge gap between insurance product providers and the perception and attitudes of farmers towards these products[11]. A particularly challenging aspect in this regard is the problem of basis risk[12]. Some empirical findings on these issues are already well documented. A summary of key points includes:

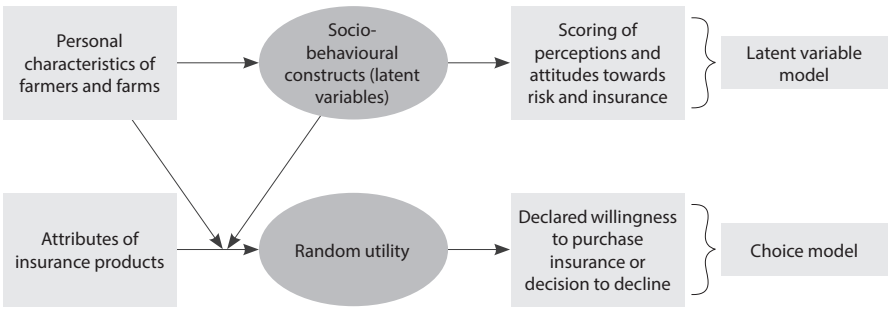
1) older farmers generally exhibit less interest in insurance, especially innovative products; similarly, women are less likely than men to opt for insurance; education is almost always positively correlated with the purchase of insurance, as is prior experience with insurance[13];
2) membership in agricultural organisations increases the likelihood of purchasing insurance[14];
3) access to credit often initially involves the purchase of insurance, but many farmers voluntarily choose to insure themselves even without pressure from lenders[15];
4) larger farms are more inclined to purchase insurance[16];
5) among small-scale farmers, there is growing interest in hybrid insurance, which combines traditional insurance for frequent but less severe risks with index-based coverage for catastrophic and systemic risks[17];
6) farmers' interest in single-risk insurance and multi-risk products varies significantly across the globe[18].

Studies on insurance demand relatively rarely consider the attributes of insurance products, even though their impact on farmers' purchasing decisions is crucial[19]. Modelling the relationships in this context is challenging, and the tools employed to date often involve the problem of endogeneity, leading to statistical bias in the estimated parameters[20]. In this context, the work of O.N. Mensah, E. Owusu-Sekyere,

10. J.P. Platteau, O. De Bock, W. Gelade, *The demand for microinsurance: a literature review*, "World Development" 2017, Vol. 94.
11. D.A. Ankraft, N.A. Kwapong, D. Eghan et al., *Agricultural insurance access and acceptability: examining the case of smallholder farmers in Ghana*, "Agricultural Food Security" 2021, Vol. 10(1).
12. E. Owusu-Sekyere, A. Abdulai, W. Ali, *Preferences for crop insurance attributes among cocoa farmers in Ghana*, "Journal of Agricultural and Development of Emerging Economies" 2021, Vol. 12(5).
13. L. Guiso, *Trust and Insurance Markets*, "Journal of Economics Notes" 2012, Vol. 41(1–2).
14. E. Owusu-Sekyere, A. Abdulai, W. Ali, op. cit.
15. D.A. Ankraft, N.A. Kwapong, D. Eghan et al., op.cit.
16. J.P. Platteau, O. De Bock, W. Gelade, op.cit.
17. S. Chantarat, A.G. Mode, C.B. Barreti et al., *Welfare Impacts of Index Insurance in the Presence of a Poverty Trap*, "World Development" 2017, Vol. 94.
18. E. Owusu-Sekyere, A. Abdulai, W. Ali, op. cit.
19. J. Yu, A.D. Summer, H. Lee, *Premium rates and selection in specialty crop insurance markets: Evidence from the catastrophic coverage participation*, "Food Policy" 2021, Vol. 101.
20. E. Doherty, S. Mellet, D. Norton et al., *A discrete choice experiment exploring farmer preferences for insurance against extreme weather events*, "Journal of Environmental Management" 2021, Vol. 290.

and C. Adjec (2023)[21] is particularly important. It integrates the sociological and behavioural characteristics of farmers and their farms with insurance product attributes such as product type, claim payment, premium cost, coverage period, risks insured, and methods of damage assessment, to estimate farmers' willingness to pay for insurance. The model comprises two main components: identification of latent variables that reflect farmers' general attitudes and preferences with respect to insurance but are not directly observable, and analysis of the selection of the most suitable insurance product based on the theory of random utility. This method is illustrated in Figure 1. The experiment involved 383 cashew farmers in Ghana – a tree crop known for its delicious edible fruits – yielding a total of 10,341 observations. After performing the necessary calculations, it was found that farmers showed the greatest interest in hybrid insurance. Among the insurance product attributes, the most significant were the premium cost, expected claim payment, risks covered, and methods of damage assessment. Three latent variables (sociological and behavioural constructs) influenced farmers' preferences for the offered insurance products and their trust in insurers. These were subjective knowledge about the products and perceived benefits of purchasing insurance coverage.

Figure 1. Conceptual model of choice based on farmers' latent attitudes and preferences and random utility theory



Source: Produced by the author based on: O.N. Mensah, E. Owusu-Sekyere, C. Adjec, Revisiting preferences for agricultural insurance policies: Insights from cashew crop insurance development in Ghana, "Food Policy" 2023, Vol. 118.

Demand studies for agricultural insurance inspired by the framework of O.N. Mensah, E. Owusu-Sekyere, and C. Adjec (2023) have also been indirectly continued

21. O.N. Mensah, E. Owusu-Sekyere, C. Adjec, *Revisiting preferences for agricultural insurance policies: Insights from cashew crop insurance development in Ghana*, "Food Policy" 2023, Vol. 118.

by German researchers M. Michels, H. Wever, and O. Mußhoff, who are focused on broader dissemination of subsidised multi-risk insurance and index-based insurance[22]. In Germany, subsidised package insurance is available only in Bavaria, where the state government subsidises 50% of the cost. Saxony is considering introducing it, and an ex-ante analysis of this instrument was the subject of research conducted by M. Michels, H. Wever, and O. Mußhoff. This research was based on the opinions of 228 farmers, collected through an online survey conducted from February to May 2022. In Germany, insurers also offer weather-index insurance to farmers, but demand for these products is minimal.

The study by M. Michels, H. Wever, and O. Mußhoff is rooted in the increasingly common typology of agricultural holdings, designed to reflect their considerable diversity. In this context, the research aligns with the taxonomy theory, which aims to identify similarities between farms. Recent typology proposals focus on socio-environmental and behavioural characteristics of farmers, as well as the technical and production-specific features of farms. This approach allows farmers, researchers, and agricultural policymakers to better understand the behaviour of agricultural producers, thereby facilitating the rational design and targeted implementation of policy instruments based on robust ex-ante evidence.

The starting point for the farm typology developed by M. Michels, H. Wever, and O. Mußhoff was the creation of four blocks of farmers' opinions on package insurance and its subsidisation:

1) farmers' satisfaction with current risk management practices;
2) satisfaction with available market instruments for risk management;
3) farmers' perception of package insurance;
4) farmers' attitudes towards subsidising agricultural insurance in general.

In each block, farmers were asked to respond to specific statements by selecting the appropriate options on a five-point Likert scale.

In the second phase, four homogeneous groups (clusters) of producers were identified:

1) a group seeking cheaper risk management instruments that do not involve government intervention (32 entities);
2) a group of farmers willing to transition to package insurance (76 farmers);
3) advocates of government involvement in risk management (70 entities);
4) a group satisfied with the current market offerings (50 farms).

22. M. Michels, H. Wever, O. Muβhoff, *Cultivating Support: An ex-ante typological analysis of farmers' responses to multi-peril crop insurance subsidies*, "Journal of Agricultural and Applied Economics" 2024, Vol. 56(2).

An integral part of the analysis conducted by M. Michels, H. Wever, and O. Mußhoff was an examination of farmers' attitudes towards estimating the willingness to pay (WTP) for package and index-based insurance. In general terms, WTP is the maximum amount farmers are willing to pay insurers to transfer risk. The study assumed that WTP would be measured as a percentage of agricultural production value per hectare of farmland. For package insurance, the average WTP was 2.60% (without subsidies) and 1.58% (with subsidies). For index-based insurance, the values were very similar – 2.52% without subsidies and 1.60% with subsidies. Experts generally agree that WTP without subsidies for both products should fall within the range of 5.5–6%. This discrepancy highlights a significant gap between the expectations of farmers and insurers, indicating a mismatch between demand and supply. Insurers should carefully consider this issue, exploring ways to reduce insurance costs and improve communication with farmers by convincingly demonstrating the benefits of purchasing coverage.

From the overall analysis by M. Michels, H. Wever, and O. Mußhoff, it is evident that an appropriate ex-ante typology of agricultural holdings should be a critical component in conducting economic and financial studies, designing, and evaluating the entire array of agricultural policy instruments. Farmers represent a highly diverse group requiring nuanced approaches to ensure agricultural policy is more effective and efficient. Another conclusion suggests that, in many cases, investments in research, advisory services, and agricultural education might be more effective solutions than subsidising agricultural insurance. However, surveyed farmers were reluctant to reduce direct subsidies to redirect the resulting funds towards subsidising insurance.

Negative impacts of subsidising

The earlier sections of this article outlined the potential benefits of budgetary support for agricultural insurance. However, it is equally important to examine the main risks associated with this approach. Firstly, the multi-objective nature of subsidising insurance is a common policy in both developed and developing countries' agricultural sectors. Unfortunately, this is not always preceded by a thorough and comprehensive ex-ante analysis of alternative ways to achieve the originally intended outcomes. Another issue is the frequent failure to adequately consider the risks and challenges associated with prolonged subsidisation. Drawing from generalised global

experiences in this area, it is worth referencing the review conducted by P. Hazell and P. Varangis[23], who identify several significant risks.

1. Subsidies distort farmers' incentives (disincentive problems). This can lead to farmers being willing to take on greater risks. Reduced risk aversion is necessary for adopting new technologies and production methods that may yield potentially higher profits. An indicative boundary here could be the absence of subsidies for actuarially fair premium rates.
2. Disaster assistance for farmers, which can in some sense be equated with fully subsidised insurance premiums, also creates disincentive problems. To minimise this risk, assistance should be conditional, for example, on the purchase of insurance.
3. Insurance subsidies often result in creditors being less diligent in assessing and monitoring the creditworthiness of indebted farmers. The remedy for this is to precisely link claim payments to insured risks or indices.
4. Direct subsidies to insurers and reinsurers also weaken their motivation to improve efficiency and diligence in assessing the risk profile of farmers seeking coverage.
5. If insurance subsidies distort farmers' incentives and influence agricultural production, they can disrupt international agri-food trade and be challenged under WTO regulations. These disputes are complex since WTO regulations are not particularly precise or unambiguous, leading many countries, especially the US and China, to breach them.
6. Insurance subsidies can be costly if their application is not part of a well-designed socio-economic strategy. These costs largely stem from the inelastic price elasticity of insurance demand, meaning significant support is required to generate broader farmer interest in insurance. An additional challenge arises when public authorities cease supporting agricultural insurance. The difficulties increase immeasurably when the support is not precisely targeted or provided on a proportionate basis. In such cases, both farmers and the insurance sector are keen to maintain the status quo. At a certain point, agricultural policymakers may also join in, recognising that subsidies are a convenient tool for building and strengthening political patronage and clientelist systems. The situation becomes even more problematic when agricultural insurance is expected to serve multiple, often conflicting objectives, and policymakers fail to address imperfections in insurance markets and external costs. These issues and mechanisms can only be fully understood by referencing the political economy of agricultural insurance.

23. P. Hazell, R. Sberro-Kessler, P. Varangis, op. cit.

Subsidies for agricultural insurance should always be evaluated from a fiscal perspective, examining who in fact benefits from them and in what amounts. Although V.H. Smith does not explicitly use the term fiscal incidence, he notes that in the United States, approximately 58% of such budgetary support ultimately benefits insurance companies, agents, and brokers selling these policies to farmers[24]. Smith calculated that for every dollar of subsidy provided to American farmers, the insurance intermediary sector receives between USD 1.40 and USD 1.50. These figures clearly demonstrate that it is the entire agricultural insurance system, not just farmer interest groups, as often claimed, that is genuinely invested in the continuation of these subsidies.

V.H. Smith challenges the use of market imperfections as a standard justification for government intervention in both traditional and index-based agricultural insurance. To this end, he analyses farmers' willingness to pay for such protective services, concluding unequivocally that in none of the four studies conducted did farmers accept a premium markup exceeding 10% over the actuarially fair rate. For Smith, this suggests either that farmers do not perceive a favourable ratio between expected claim payments and the cost of purchasing the service or that they find adverse selection – effectively a skewed subsidisation of other, riskier producers – too significant a drawback. Furthermore, farmers were shown to be much more sensitive to the choke price, which is the price point at which demand for insurance drops to zero, than other customers of insurers.

According to Smith, and he is consistent in this view, systemic and catastrophic risks do not provide a compelling argument for state intervention in agricultural insurance. At least in developed countries, reinsurers have sufficient capacity to effectively mitigate the impact of natural disasters affecting agriculture, using both traditional and innovative financial instruments. Moreover, index-based insurance can, to some extent, protect farmers against the consequences of natural disasters.

According to V.H. Smith, the popularity of insurance subsidies has its roots in political economy. Both farmers and the insurance intermediary sector benefit from budgetary support. Politicians, in turn, are eager to assume the role of the 'Good Samaritan', helping farmers affected by random events—a stance that is widely accepted by many taxpayers. In practice, however, most insurance subsidies, like other forms of state assistance, go to wealthier farmers who already possess sufficient resources to largely self-insure. V.H. Smith clearly highlights, however, that insurance subsidies have a lesser impact on distorting economic incentives, allocation, and welfare compared to other forms of public assistance.

24. H.V. Smith, *Premium Payments. Why Crop Insurance Costs Too Much. Fixing the 2012 Farm Bill*, American Enterprise Institute, Washington, DC, 2011.

Opportunities to rationalise insurance subsidies

P. Hazell, R. Sberro-Kessler, and P. Varangis, drawing on years of research conducted by the FAO and IFPRI, present a highly compelling framework for rationalising agricultural insurance subsidies[25]. They begin by stressing that this is a challenging endeavour, as subsidies, once introduced, create a strong network of political interests that defend them, while also distorting farmers' motivations (referred to as disincentive problems). In such cases, little attention is paid to the inefficiencies and welfare losses they cause, as well as potential environmental degradation and the redistribution of income and wealth in favour of wealthier farmers. An equally significant issue is that despite claims that subsidies for agricultural insurance will reduce or eliminate the need for disaster aid, the two instruments often coexist, creating additional burdens on state budgets. This is partly because disaster aid is inherently intended to compensate for catastrophic losses, which are notoriously difficult to insure under traditional policies. However, subsidising traditional insurance discourages insurers and policymakers from seeking innovative solutions that could expand coverage to include catastrophic risks. This challenge is frequently addressed from a static perspective, even though developments in digital risk management and alternative risk transfer methods are opening up entirely new possibilities. These advances could revolutionise the way we think about the insurability of risks. In the near future, such changes will undoubtedly influence insurance practices[26]. In other words, if both instruments are to remain in use, efforts must be made to ensure that they do not deteriorate but instead create unique complementarities, effectively covering the full spectrum of risks faced by farmers.

P. Hazell with his colleagues divide their recommendations for rational application of agricultural insurance subsidies into two main groups:

1) recommendations for commercial farms,
2) recommendations for small-scale, low-income farms

The discussion here will focus exclusively on the first group. Fundamentally, the issue centres on creating an environment conducive to the development of the insurance sector through appropriate policies and technical-instrumental infrastructure.

25. P. Hazell, R. Sberro-Kessler, P. Varangis, op. cit.; P. Hazell, P. Varangis, *Best practices for subsidizing agricultural insurance*, "Global Food Security" 2020, Vol. 25.
26. J. Block, M. Michels, O. Mußhoff, *Digitale Risikomanagementtools in der Landwirtschaft – Status Quo und Anforderungen*, "Berichte *über* Landwirtschaft" 2021, Band 99, Ausgabe 1; J. Block, M. Michels, O. Mußhoff, *A Trans-theoretical model for farmers' perceived usefulness of digital risk management tools – A case study from Germany*, "German Journal of Agricultural Economics" 2023, Vol. 72(3/4).

This infrastructure would enable the registration of risk events and facilitate self-insurance and self-protection measures by farmers. In such an environment, most insurance contracts could be concluded on a commercial basis. Subsidies could then be applied selectively to address external costs or to overcome initial challenges posed by existing structures (referred to as the establishment problems). Below are the key recommendations for the first group:

1. Risk assessment and insurance solution design within broader policy frameworks aimed at mitigating risk. This entails first mapping risks across the agricultural sector and individual farms to identify threats, assigning responsibility for addressing them, and determining the best tools and strategies. Within farms, the highest priority should be given to internal risk management instruments.
2. The objectives that public authorities wish to achieve with insurance subsidies should be communicated clearly and transparently to all stakeholders. This recommendation underscores the fundamental principle that every policy should have a robust ex-ante justification and be subject to professional ex-ante evaluation.
3. Development of a financing and evaluation plan for insurance subsidies. If subsidies are intended as a tool to address initial difficulties (establishment problems) in the insurance sector, then sunset clauses are additionally required in each case. In public policy, this means clearly defining when a given regulation will cease to be in effect. However, this recommendation is particularly challenging to implement, given the political economy of agricultural insurance subsidies.
4. Budgetary support for agricultural insurance must be delivered through credible institutions or robustly designed and monitored programmes. Without these, success is unlikely. Also, despite the use of even the most sophisticated and advanced risk management tools, residual or baseline risk will remain in farms. Farmers must handle these risks independently, for instance by creating reserves in the broad sense.
5. Encouraging competition among agricultural insurance providers, particularly in the commercial insurance segment. Subsidised products could also be offered through tenders. In practice, this is difficult because agricultural insurance is significantly more risky than other types, requiring insurers to have specialised knowledge, procedures, and processes. For example, as seen in Poland, the agricultural insurance market can be oligopolistic, giving insurers an advantage over governments[27]. This imbalance could be mitigated through financial and insurance awareness programmes for farmers and intervention by state authorities responsible for competition and consumer protection.

27. J. Kulawik, *Teoretyczne podstawy ubezpieczeń szkód majątkowych w rolnictwie*, Warsaw, IERiGŻ PIB, 2020.

6. Avoiding subsidies below actuarial premium levels. Insurance subsidies should not result in premiums for farmers being lower than actuarially sound rates, as this triggers disincentive problems. A radical solution to this issue could involve reimbursing insurers for part of the administrative and operational costs associated with providing coverage to farmers, thereby lowering the cost of insurance. However, the political economy and US experience suggest that such an approach is hardly feasible in practice. Thus, the focus should shift to limiting subsidies for the agricultural activities and farms facing the greatest risk. This requires careful coordination between such policies and the provision of disaster relief.
7. Careful consideration should be given to the selection of the type of subsidy for the given conditions and contexts. A standard example is deciding whether to compensate insurers for increased costs associated with providing coverage to farmers or to support the reinsurance of agricultural portfolios instead.
8. To avoid the redistribution of income and wealth caused by subsidies favouring economically stronger farms, capping the amount of support may be justified. At the same time, efforts should be made to ensure that these entities do not discontinue insurance coverage, as their presence in the market helps diversify the risk profiles of entire portfolios.
9. A system should be established to monitor and evaluate agricultural insurance subsidy policies, both ex-ante and ex-post, in terms of achieving their stated objectives. This system should reflect the position of all stakeholders, track rapid changes, and detect threats and risks early to enable proactive corrective measures. If budgetary support aims to facilitate farmers' access to credit, monitoring and evaluation should also encompass their relationships with creditors.
10. Cost-benefit analyses of the agricultural insurance subsidy system should be conducted systematically, comparing the cost-effectiveness of alternative public policies aimed at achieving the same objectives.

Based on research from the FAO, IFPRI, and OECD, J. Glauber, K. Baldwin, and J. Antón[28] provided a compelling synthesis of global experiences in designing efficient agricultural insurance programmes supported by public funds. Their key recommendations are outlined below:

1. Subsidies should only be applied when farmers have access to commercial insurance and other risk management tools.
2. Insurance premium-setting processes must be transparent and based on reliable data to minimise the risks of adverse selection and ensure actuarial soundness.

28. J. Glauber, K. Baldwin, J. Antón et al., *Design principles for agricultural risk management policies*, "OECD Food, Agriculture and Fisheries Papers" 2021, ISSN: 18156797 (online).

Ideally, premiums should be tailored to individual farms. Furthermore, all procedures, datasets, and subsidy amounts should be publicly available and subject to external review. This would enhance competition among insurers.

3. The optimal approach would be to subsidise only the distribution costs of insurance products while ensuring that actuarially sound premiums are lower than expected claim payments. Subsidising actuarially sound premiums should be allowed only incidentally and temporarily, with clear sunset clauses defining their duration. Without such limitations, distortions in the motivations of both farmers and insurers are inevitable. Unfortunately, once subsidies are introduced, they are commonly extended indefinitely.
4. To enhance subsidy efficiency and minimise behavioural distortions, the following principles should be adhered to:
   1) premium subsidies must not favour specific crops and should be as detached as possible from farmers' production decisions;
   2) subsidising premiums should be restricted to covering production risks and should not support price or revenue risks;
   3) subsidies should not be granted unless the deductibles meet the WTO's requirement of at least 30% of guaranteed yield. This is theory, but practice is usually quite different, and the 'leading transgressors' are the US, the EU and China;
   4) subsidies must be clear and transparent to the public.
5. Index-based insurance products are cost-effective and more competitive than traditional insurance, particularly when subsidies are not applied. If subsidies are available, it is still preferable to compensate for offering costs rather than supporting actuarially sound premiums.
6. Private insurers can deliver cost-effective coverage if appropriate contracts incentivise competition in fees and margins while deterring fraud.
7. All data regarding monitoring, evaluation, participation, premiums, claim payments, sums insured, and beneficiaries of state support should be freely available to the public without restrictions.

When discussing the possibilities for rationalising subsidies for agricultural insurance, we must not forget that in several European countries (Belgium, Denmark, Ireland, Germany, Sweden, and Switzerland), such insurance operates quite effectively without any budgetary support[29]. In some of these countries, up to half of the cultivated land is insured, whereas in Poland, despite the availability of subsidised insurance

29. J.E. Belasco, *WAEA Presidential Address: Moving Agricultural Policy Forward: Or, There and Back Again*, "Journal of Agricultural and Resource Economics" 2020, Vol. 45(3); C.M. Reyes, A.D. Agbon, C.D. Mina et al., *Agricultural insurance program: lessons from different country experience*, "PDS Discussion Paper Series", 2017.

premiums, insurance penetration rates remain low and have essentially stagnated over recent years[30]. In line with the premises stated in the study methodology, this issue is not explored in this article. In countries where agricultural insurance is not subsidised, socio-demographic characteristics of farmers and the economic and technical features of farms play a more significant role in determining the demand for policies[31]. The theoretical framework for designing commercial insurance in these contexts should be the safety-first model rather than the expected utility theory. The former assumes that decision-makers primarily aim to minimise the probability of their income falling below a certain threshold, rather than maximising their expected utility[32]. This approach further implies that farmers rely more on lexicographic preferences when considering the purchase of insurance. For modelling insurance demand, regression methods that better capture the non-linear influence of its determinants, such as quantile regression, are more suitable. It is, of course, easier to forgo agricultural insurance subsidies when the available model offers coverage against single (named) risks, rather than, for instance, the bundled multi-risk policies available in Poland. However, this does not mean that such bundled policies should be abandoned altogether. On the contrary, coverage for various business risks-such as liability, those associated with employing foreign labour, and even social and health-related risks-can be offered within a single insurance contract[33].

Summary

Farmers' demand for risk transfer and mitigation products depends on numerous factors: the price and other attributes of the insurance contract, risk aversion and perception of threats, trust in insurers and the history of claim payments, the availability of sufficient funds to purchase insurance, the possibility of obtaining subsidies, and any income transfers embedded in these products. Generally, the price elasticity of demand is low, meaning that stimulating demand may require high levels of premium subsidies. However, this area is fraught with significant economic

30. J. Herda-Kopańska, C. Klimkowski, J. Kulawik et al., *Trzy problemy w finansach polskiego rolnictwa*, "Zagadnienia Ekonomiki Rolnej" 2024, in print.
31. J. Loughrey, H. Vidyaratne, *The empirical demand for farm insurance in Ireland: a quantile regression approach*, "Agricultural Finance Review" 2023, Vol. 80(4/5).
32. T.M. Hurley, *A review of agricultural production risk in the developing world*, "Harvest Choice Working Paper" 2010, International Food Policy Research Institute (IFPRI), Washington, DC.
33. J. Loughrey, H. Vidyaratne, *The empirical demand for farm insurance in Ireland: a quantile regression approach*, "Agricultural Finance Review" 2023, Vol. 80(4/5); J.L. Lusk, *Distributional effect of crop insurance subsidies*, "Applied Economic Perspectives and Policy" 2017, Vol. 39(1).

challenges. Consequently, much hope is placed in the widespread adoption of models and estimation tools that assume that farmers make insurance and financial decisions simultaneously.

Opponents of extensive budgetary involvement in subsidising agricultural insurance primarily highlight issues related to the distortion of resource allocation in agriculture and the national economy, which reduces efficiency and social welfare. In terms of distribution, such subsidies mainly benefit the owners of production factors. Any form of subsidisation weakens the motivational frameworks of all participants in the system of agricultural risk transfer to the insurance and financial markets. As a result, farmers place less emphasis on improving self-insurance and self-protection measures, take greater risks, and often assume the role of free riders (e.g., benefiting from biosecurity investments made by other farmers) while engaging in rent-seeking. For insurers and reinsurers, such subsidies reduce their incentive to continuously improve risk valuation and classification procedures, which typically leads to higher rates and premiums and, at times, to the underpayment or delay of claim payments.

The long-term experiences of many countries worldwide in subsidising agricultural insurance have led to the development of principles for its rational application. Although the list of such principles may seem extensive, some recommendations possess universal value. Chief among these is the integration of subsidies into a comprehensive/holistic risk management system in agriculture. Another critical area involves the techniques, mechanisms, and institutional frameworks for offering protective products to farmers. This should generally be carried out through a competitive, efficient, and innovative insurance and reinsurance sector. The foundation for transferring risk from agriculture to this sector must rest on actuarial soundness and avoiding situations where net (actuarially correct and fair) premiums are subsidised. Additionally, insurance programmes should include appropriate awareness, training, and advisory initiatives for farmers.

Future research on farmers' demand for subsidised crop and livestock insurance should focus on aligning it with the supply side of the market to establish the conditions necessary for achieving market equilibrium. It would undoubtedly be valuable to continue analyses aimed at gaining a deeper understanding of farmers' decision-making processes when considering such products, drawing on the advances in modern behavioural economics. Another area ripe for scientific exploration is the impact of subsidised insurance on technical efficiency, productivity, competitiveness, and the resilience of agriculture. The realm of ex-post evaluations of these insurance schemes remains largely underexplored, particularly regarding the use of advanced impact evaluation tools.

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