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LIMITATIONS OF INCOME STABILIZATION INDEX METHODS IN LITHUANIAN GRAIN FARMS: THE CONTEXT OF RISK MANAGEMENT AND MUTUAL SUPPORT FUNDS

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Abstract

Income stabilization tools (IST) and mutual risk-sharing funds have been promoted as innovative instruments to address increasing income volatility in European agriculture. Their effectiveness, however, depends critically on whether sector-level income indices accurately represent the income dynamics of individual farms. This study evaluates the limitations of index-based stabilization methods in the context of Lithuanian grain farms, drawing on Lithuanian FADN data (2006–2023) from farm-level gross margins, revenue structures, and long-term yield and price variability. Using correlation analysis, dispersion measures, and simulated income-trigger scenarios, we demonstrate that Lithuanian grain farms exhibit strong heterogeneity across regions, farm sizes, and production structures. As a result, aggregate or sector-level indices fail to track fluctuations in individual income, leading to significant basis risk. The empirical findings show that: (i) farm-level gross margin and revenue variability differ several-fold even within the same region; (ii) correlations between individual farms' income series are insufficient for effective risk mutualization; (iii) yield and price shocks often co-move at the sector level, creating systemic risks that undermine collective fund solvency; and (iv) index-based triggers distort compensation outcomes, generating overcompensation for some farms and under compensation for others. These results are consistent with the theoretical literature on index insurance, basis risk, and mutual fund design, and highlight the structural constraints on implementing IST-type schemes in grain sectors exposed to spatially widespread, price-driven shocks. Policy implications emphasize the need for: (a) hybrid instruments combining farm-level revenue measures with reinsurance or state guarantees; (b) differentiated contributions based on risk profiles; (c) improved data systems enabling more granular index construction; and (d) cautious expectations regarding IST applicability in highly correlated crop sectors. The study concludes that sector-level index-based income-stabilization tools are unlikely to be effective for Lithuanian grain farms without substantial methodological and institutional adjustments.

Keywords: *Agricultural Risk Management, Mutual Support Funds, Income Stabilization Index.*
JEL Code: *Q14, Q18, Q12.*

Introduction

Income volatility remains one of the most persistent structural challenges in agricultural production. Grain farms are particularly exposed to simultaneous yield and price shocks, driven by climatic variability, global market fluctuations, and rising input costs. These shocks generate substantial uncertainty for farmers, reduce investment incentives, weaken liquidity, and increase the likelihood of financial distress (Boyd & Bellemare, 2020). In response, governments and international organizations have promoted risk management instruments to stabilize farm incomes. Among them, income stabilization tools (IST) and mutual risk-sharing funds have received growing attention, especially within the European Union's Common Agricultural Policy (CAP), which, since 2014, has explicitly enabled such schemes.

The theoretical basis of IST instruments is risk mutualization: farmers contribute to a shared fund that rewards members when their income drops below a set threshold, usually 70% of a multi-year average (Antón, 2009). Unlike traditional yield or price insurance, IST instruments focus on total farm income and can therefore cover multiple risks, including the combined effects of yield drops, price decreases, and rising input costs (Mahul, 2003). From a design perspective, IST programs aim to lower administrative costs by using external indices, proxies, or aggregated income measures rather than assessing individual losses, thereby reducing moral hazard and transaction costs (Larson et al., 2004).

Nevertheless, the practical efficacy of index-based income stabilization is largely contingent upon the extent to which sector-level or regional indices accurately capture the income fluctuations experienced by individual farms. When indices diverge from actual farm-level outcomes, "basis risk" arises – the risk that compensation from the stabilization scheme does not match the farmer's real loss (Stigler & Lobell, 2021). Previous research has shown that basis risk is a key reason why index insurance often fails to attract participants, particularly in contexts where farms are heterogeneous in size, technology, crop mix, and exposure to environmental conditions (Janzen et al., 2020; Falco & Chavas, 2006). Grain production exhibits exactly these characteristics: even within small geographic areas, productivity, risk levels, and income variability differ significantly among individual farms.

These challenges are especially relevant for countries like Lithuania, where grain farms experience substantial heterogeneity in gross margins, technological choices, and production risks. Historical data indicate that yield variability, price volatility, and regional production patterns differ widely among farms, reducing the effectiveness of any uniform sector-level index as a trigger for compensation. Moreover, the high correlation of price shocks across the sector creates systemic risks that jeopardize the financial solvency of mutual funds (Mahul, 2001). In such environments, collective income stabilization mechanisms may generate systematic misalignment between contributions and payouts, leading to low participation and potential financial instability.

Given these concerns, it is essential to empirically assess the limitations of index-based stabilization tools when applied to heterogeneous grain-farming sectors. The objective of this study is to evaluate the extent to which sector-level income indices fail to capture individual income dynamics in Lithuanian grain farms and to identify the implications of such limitations for the design and viability of income stabilization funds. Building on established theoretical frameworks in agricultural risk management and on empirical data on farm-level gross margin variability, correlation structures, and income dynamics, this article provides evidence on the structural constraints to implementing IST-type instruments in grain production. The study contributes to the broader literature by offering a country-specific analysis of index limitations while generating insights relevant for policymakers considering mutual fund–based income stabilization as part of their agricultural risk management strategies.

Literature Review

Income Risk in Grain Farming

Income volatility in grain farming arises from multiple, interacting sources: yield variability caused by climatic shocks, market-driven price fluctuations, and changes in variable input costs (Boyd & Bellemare, 2020). Studies repeatedly show that grain producers face higher combined yield–price risk than most other agricultural sectors due to their exposure to global commodity markets and weather-dependent production cycles (Chavas, 2018). Model-based assessments identify that grain farms, compared to livestock operations, exhibit stronger co-movement of revenues across farms within a region, creating systemic risk that is difficult to diversify (Mahul, 2001).

Additionally, grain production systems often feature high capital intensity, thin margins, and sensitivity to input price spikes (fertilizers, fuel, plant protection), which further amplify income volatility (Larson et al., 2004). As a result, policy interest in financial risk management tools for crop producers has increased significantly over the past two decades.

Mutual Risk-Sharing Funds and Income Stabilization Tools

Mutual funds, also known as mutual insurance schemes or income stabilization tools (IST), are risk-sharing arrangements in which participating farmers contribute to a common reserve fund. Compensation is triggered when income falls below a predefined threshold, typically set at 70% of a multi-year historical average (Antón, 2009). These instruments are based on actuarial logic – expected loss calculations, risk pooling, and reserve requirements – like insurance, but without profit-seeking motives (Mahul, 2003).

The theoretical benefits of IST-type funds include:

- multi-dimensional risk coverage (yield, price, cost shocks combined);
- lower administrative costs compared to indemnity-based insurance;
- reduced moral hazard, since losses are assessed via external data or indices;
- alignment with CAP risk management policy in the EU.

However, practical implementation requires strict conditions: sufficient capitalization, moderate risk correlation among participants, reliable data systems, and institutional capacity for monitoring (Larson et al., 2004; Chambers, 1989). Countries such as Canada have long-standing farm income-based programs (e.g., AgriStability), which illustrate both the potential and the challenges of such instruments, including declining participation due to basis risk and administrative complexity (Larson et al., 2004).

Index-Based Income Stabilization: Concept and Challenges

Index-based stabilization tools rely on external indicators – such as aggregated sector revenue, regional gross margins, or yield/price indices – rather than measuring individual farm losses. This design aims to minimize information asymmetry and reduce administrative burden (Mahul, 2003). Index-based tools are considered more resistant to moral hazard, since individual actions have limited influence on aggregate indices.

However, the central weakness of index-based schemes is basis risk: the discrepancy between index performance and individual farm losses (Stigler & Lobell, 2021). Basis risk arises when:

- production technologies differ across farms;
- crop rotations and land quality vary;
- farms face different microclimatic conditions;
- input-cost structures are not homogeneous;
- price responses vary based on market access or contracting.

Empirical studies indicate that high basis risk lowers farmers' willingness to participate in index insurance or income stabilization programs (Janzen et al., 2020). Specifically, grain production – due to its variability in soil conditions, yields, and technological levels – tends to show weak correlations between overall indices and individual outcomes (Falco & Chavas, 2006).

Farm Heterogeneity and Diversification Constraints

Farm heterogeneity is widely recognized as a structural obstacle to collective risk-sharing. Research shows that differences in risk exposure between farms – caused by farm size, specialization, soil fertility, machinery, labor availability, and management practices – make it challenging to create a single stabilization index that is fair to all participants (Menapace et al., 2013; Iyer et al., 2019).

Moreover, grain farms often lack effective natural diversification opportunities: crops tend to face similar climatic and price shocks, leading to high intra-sector correlation. This reduces the effectiveness of risk pooling, which depends on low correlation among members (Mahul, 2001). Falco & Chavas (2006) also emphasize that genetic and varietal diversity can decrease risk but is not enough to eliminate systemic shocks, such as large-scale droughts or global price collapses.

Moral Hazard, Adverse Selection, and Behavioral Dimensions

While index-based schemes theoretically reduce moral hazard, real-world evidence shows that behavioral responses still significantly influence outcomes. Fraser (2002) argues that when stabilization tools absorb part of the financial downside, farmers may adjust input levels or cropping choices. Conversely, risk-averse farmers may remain very conservative even with risk mitigation tools, limiting potential gains (Menapace et al., 2016).

Adverse selection presents another issue: farms with higher previous risks tend to choose mutual funds unless contributions are adjusted based on individual risk profiles. Without proper risk adjustment, stabilization funds risk becoming financially unsustainable (Chambers, 1989).

Behavioral studies further demonstrate that risk perception significantly influences the adoption of risk-management tools (Nnaji et al., 2022). Farmers with negative past experiences or low trust in institutions are less likely to participate in mutual schemes, even when they are theoretically advantageous.

International Experiences with Income Stabilization Tools

International empirical evidence demonstrates mixed success of income stabilization schemes:

- Canada (AgriStability): declining participation due to high basis risk and unpredictable payments (Larson et al., 2004).
- United States: farm revenue insurance programs demonstrate that revenue-based tools can be effective but require significant public subsidies and advanced actuarial modeling (Babcock et al., 2000).
- European Union (IST): Despite theoretical backing, adoption across Member States remains limited due to administrative complexity, absence of farm-level data, and farmer skepticism.
- Italy and Spain: regional mutual funds have been effective only in niche sectors with uniform production systems, not in large-scale crops.

The common conclusion across studies is that index-based income stabilization performs poorly in sectors with diverse farms and high systemic risk – exactly the conditions found in grain production.

Implications for Grain Sectors

The literature consistently identifies grain sectors as problematic for index-based stabilization due to:

- systemic climatic and market shocks;
- insufficient within-sector diversification;
- strong price correlation across regions;
- production heterogeneity at the individual farm level;
- limited possibilities for micro-level differentiation.

These systemic patterns directly undermine the mathematical and economic assumptions underlying income stabilization tools (IST) and limit the effectiveness of any mutual fund that relies on aggregated indices.

Data and Methods

Data Sources and Farm Sample

The empirical analysis relies on historical data from the Lithuanian Farm Accountancy Data Network (FADN), covering the period from 2006 to 2023. To account for sector-wide differences, the data were grouped by farm size, farming type (branch), and administrative region. The dataset includes information on:

- annual farm revenues from crop production,
- gross margin (GM) components,
- crop yields for major grains (wheat, barley, rye, oats),
- output prices,
- variable input costs (fertilizer, fuel, crop protection, seeds),
- regional production structures.

The sample includes a diverse range of production systems, differing in size, crop focus, soil types, and technological use. This stratification reflects the actual structure of the Lithuanian grain sector, highlighting notable differences in GM levels and risk exposure among farm groups and regions. Income values were adjusted to

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comparable real terms using agricultural producer price indices. Multi-year averages (3–5 years) were used to develop reference income measures for stabilization threshold calculations.

Gross Margin and Income Variability Indicators

To evaluate income stability and heterogeneity across farms, the following indicators were calculated:

- Farm-level gross margin (GM):

$$GM_{it} = P_{it} \cdot Y_{it} - C_{it},$$

where $\boldsymbol{P_{it}}$ denotes output prices, $\boldsymbol{Y_{it}}$ yields, and $\boldsymbol{C_{it}}$ variable input costs.

- Coefficient of variation (CV):

$$CV_i = \frac{\sigma(GM_{it})}{\mu(GM_{it})},$$

capturing income volatility relative to average farm profitability.

Yield and price volatility are measured using standard deviations and year-to-year percentage changes for both yields and prices. Farm-to-farm correlation matrices evaluate how much income movements are synchronized across farms. These metrics provide the essential basis for determining whether pooled risk-sharing or index-based stabilization is practical for a sector characterized by structural heterogeneity.

Given the long time series (2006–2023) and the distinct upward trend in crop yields due to technological advancements, the standard Coefficient of Variation (CV) tends to overestimate risk by conflating growth with volatility. Therefore, we calculated the Detrended Coefficient of Variation, which isolates stochastic fluctuations from the deterministic trend.

Sector-Level Index Construction

A sector-level income index was constructed as follows:

$$I_t = \frac{\sum_{i=1}^{N} GM_{it}}{N},$$

where $\boldsymbol{I_t}$ represents the aggregated gross margin index for all grain farms in year $\boldsymbol{t}$. This index mirrors the structure of income triggers used in income stabilisation tools (IST) implemented in EU Member States.

For comparison, regional indices were also calculated to capture geographic differentiation:

$$I_{rt} = \frac{1}{N_r} \sum_{i \in r} GM_{it},$$

where $\boldsymbol{r}$ denotes region and $\boldsymbol{N_r}$ the number of farms in region $\boldsymbol{r}$.

These indices were later compared with individual farm income dynamics to measure basis risk.

Basis Risk Measurement

Basis risk was defined as the discrepancy between individual farm losses and index-implied losses:

$$B_{it} = (GM_{i,t}^{ref} - GM_{it}) - (I^{ref} - I_t),$$

where $\boldsymbol{GM_{i,t}^{ref}}$ is the multi-year average (reference) income for farm $\boldsymbol{i}$, $\boldsymbol{I^{ref}}$ is the multi-year average for the sector index.

Positive values of $\boldsymbol{B_{it}}$ indicate under-compensation, while negative values indicate over-compensation relative to actual farm losses.

We report:

- mean basis risk per farm,
- variance of basis risk,
- share of farms with misaligned compensation outcomes,
- asymmetry in basis risk during extreme events (downside risk).

Income Stabilization Trigger Simulation

Following standard IST methodology (Antón, 2009), income compensation is triggered when:

$$GM_{it} < 0{,}7 \cdot GM_i^{ref}.$$

Simulations were conducted using:

- farm-level triggers, and
- sector-level triggers based on $\boldsymbol{I_t}$.

The following formulas were used to determine compensation:

$$Payout_{it} = \alpha \cdot (0{,}7 \cdot GM_i^{ref} - GM_{it}),$$

where $\boldsymbol{\alpha}$ is the compensation rate (set to 70% in line with EU IST precedent).

Comparison between farm and index-based payouts measures the distortions created by indices.

Correlation Structure and Systemic Risk Assessment

To assess the potential of mutual funds to diversify risk, pairwise income correlations between farms were calculated.

$$\rho_{ij} = Corr(GM_{it}, GM_{jt}).$$

Low correlations indicate potential for risk pooling; high correlations signal systemic risk. Given the nature of grain farming, price shocks were expected to be highly correlated across farms, while yield correlations were expected to vary by region and microclimate.

Systemic risk was measured as:

$$SR_t = \frac{\sigma(I_t)}{\frac{1}{N}\sum_i \sigma(GM_{it})},$$

indicating the extent to which aggregate volatility reflects individual volatility.

High $\boldsymbol{SR_t}$ values signal strong co-movement and low diversification potential.

Sensitivity and Robustness Checks

Three additional checks were implemented:

- Regional stratification comparisons of indices and basis risk across production zones.
- Crop-mix stratification testing whether farms with different crop structures (e.g., wheat-dominant vs. mixed cereals) experience different basis risk.
- Stress-testing with extreme price shocks simulation of price collapses and yield shocks corresponding to historically observed worst-case events.

These tests assess whether IST designs remain viable under realistic production and market conditions.

Results

Gross Margin Variability Across Farms

The analysis revealed significant variability in farm-level gross margins (GMs) across Lithuanian grain farms. Even within the same production region, GM levels varied by 2–4, indicating substantial differences in productivity, cost structures, and crop rotation practices. The coefficient of variation (CV) ranged from 12–18% for the most efficient farms to 40–55% for smaller or more input-intensive farms.

This wide dispersion shows that average or overall income measures don't accurately reflect the true distribution of risks. High CV values on some farms indicate vulnerability to both price and yield swings, while more stable farms tend to have better soils, benefit from scale, or use more advanced technology.

Yield and Price Volatility

The analysis of risk components for winter wheat – the dominant crop in the sample – reveals distinct volatility patterns. Table 1 shows the descriptive statistics and risk indicators calculated for 2006–2023. It is important to note that, over the long period studied and amid significant technological advances in Lithuania, crop yields displayed a strong upward trend. As a result, the standard Coefficient of Variation (CV) tends to overestimate production risk by mixing this deterministic growth with random fluctuations. To fix this, we use the Detrended Coefficient of Variation (Detrended CV), which separates random variation from the long-term trend. As shown in Table 1, the detrended yield variability (0.123) is much lower than the standard CV (0.207), providing a clearer measure of the actual production risk farmers face. Notably, the volatility of output prices (Detrended CV = 0.182) is higher than that of yields, confirming that price risk is a key factor. Importantly, the data show a positive correlation between yield and price (r = 0.287). In many agricultural markets, a negative correlation is expected (the "natural hedge" effect), where lower yields are offset by higher prices. However, for Lithuanian grain farms, this natural buffer is missing. The positive correlation indicates that price and yield shocks tend to move together or do not cancel each other out, which increases revenue volatility. This is confirmed by the income correlation analysis, where farm income strongly correlates with both price (r = 0.810) and yield (r = 0.784), but the combined effect results in higher income volatility (Detrended CV = 0.223) than the individual volatilities of the components.

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Table 1. Risk indicators and correlation structure for winter wheat (2006–2023)

Indicator	*Mean*	*Std. Deviation*	*CV (Standard)*	*CV (Detrended)*	*Correlation with Yield (r)*	*Correlation with Price (r)*	*Correlation with Income (r)*
Yield, t/ha	4,35	0,9	0,207	**0,123**	1	**0,287**	0,784
Price, EUR/t	154,62	35,1	0,227	**0,182**	**0,287**	1	0,81
Income, EUR/ha	681,31	225,61	0,331	**0,223**	0,784	0,81	1

**Correlation Structure and Systemic Risk.*

To assess the potential for risk pooling and the representativeness of sector indices, we examined the correlation matrix of wheat producer incomes across different administrative regions (Table 2). The analysis centers on winter wheat as a “best-case scenario” for index-based tools, due to its relative stability compared to other crops. However, even for wheat, the results show significant regional differences. While the correlation between neighboring or agronomically similar regions (e.g., Panevėžys and Kaunas, r=0.95) is high, the synchronization diminishes considerably between distant regions. For example, the correlation between incomes in Telšiai and Alytus regions is only 0.42. This suggests that a single national or broad macro-regional index would carry substantial basis risk—failing to trigger payouts for farmers in specific areas facing localized climatic shocks, while causing unnecessary payouts elsewhere. Notably, although farm size appears to be a less critical factor for wheat (where correlations across size groups remained above 0.85 in our analysis), preliminary tests on rapeseed and other cereal farms revealed much larger divergences. In those sectors, small farms often showed near-zero income correlation with the sector average. Therefore, the spatial heterogeneity documented in Table 2 should be seen as the minimum baseline of basis risk; for other crops and smaller farm structures, the mismatch between individual outcomes and the overall indices is likely even more significant.

Table 2. Homogeneity Assessment of Wheat Producers by Region (Correlation Matrix)

Region	Alytaus	Kauno	Klaipėdos	Marijampolės	Panevėžio	Šiaulių	Tauragės	Telšių	Utenos	Vilniaus
Alytaus	*1,00*									
Kauno	*0,90*	*1,00*								
Klaipėdos	*0,60*	*0,83*	*1,00*							
Marijampolės	*0,81*	*0,93*	*0,83*	*1,00*						
Panevėžio	*0,83*	*0,95*	*0,80*	*0,89*	*1,00*					
Šiaulių	*0,72*	*0,91*	*0,87*	*0,81*	*0,93*	*1,00*				
Tauragės	*0,72*	*0,81*	*0,84*	*0,77*	*0,84*	*0,80*	*1,00*			
Telšių	*0,42*	*0,65*	*0,78*	*0,51*	*0,68*	*0,84*	*0,59*	*1,00*		
Utenos	*0,78*	*0,86*	*0,72*	*0,67*	*0,90*	*0,89*	*0,72*	*0,75*	*1,00*	
Vilniaus	*0,88*	*0,91*	*0,79*	*0,82*	*0,91*	*0,84*	*0,72*	*0,65*	*0,92*	*1,00*
FADN weighted average	*0,67*	*0,81*	*0,82*	*0,82*	*0,80*	*0,73*	*0,90*	*0,45*	*0,63*	*0,70*

**Divergence Between Farm-Level Income and Sector-Level Index.*

Comparisons between individual farm incomes and the sector-level GM index reveal distinct divergence patterns. Variations in individual incomes exceeded index fluctuations in nearly all cases, especially on farms with high yield CV or high input-cost sensitivity. Sector-level indices smoothed out extreme fluctuations and did not reflect severe income drops experienced by individual farms during climatic shock years. Farms with above-average technological intensity tended to face more pronounced GM volatility due to sensitivity to fertilizer and fuel prices. The correlation between farm-level income deviations and sector index deviations was generally well below 1 (ranging from 0.55 to 0.75), indicating imperfect co-movement and significant basis risk.

Basis Risk Assessment

Basis risk findings showed that sector-level indices often misrepresent individual farm losses. Between 45% and 65% of farms experienced under-compensation, where index-based triggers failed to activate despite significant income drops. Conversely, 15–25% of farms were over-compensated, receiving payouts even when incomes remained stable or only slightly declined. Basis risk increased notably during climate extremes and sharp price drops, when the gap between sector averages and individual farm results was at its widest. The scope of basis risk expanded in scenarios involving farms with mixed crop structures or heavy reliance on external inputs.

Trigger Simulation: Farm-Level vs. Index-Based Activation

Simulated IST-trigger conditions showed clear discrepancies between individual and index-based activation:

- At the farm level, 70% income drop thresholds were exceeded by 20–40% of farms in critical years.
- Using the sector index, triggers are activated in only 5–15% of years, often failing to align with the farms experiencing the largest losses.
- When the sector index did activate, it generated payouts to some farms with minimal losses, while withholding compensation from those suffering severe income drops.
- This distortion undermines the fundamental fairness and efficiency of an index-based stabilization scheme.

Compensation Distortion and Fund Solvency Risks

When compensation levels were calculated according to IST rules, total payouts based on individual farm losses exceeded index-based payouts by 30–60%, indicating a systematic under-coverage of actual losses. Index-based payouts were misallocated:

- Low-risk farms received disproportionately higher compensation than their contributions warranted.
- High-risk farms received insufficient compensation despite higher contributions and greater exposure.

In extreme years, the mismatch between needed and index-implied payouts jeopardized fund solvency, as simultaneous sector-wide losses left the mutual fund with capital deficits. These patterns reflect a core challenge identified in the literature: collective stabilization tools fail in sectors dominated by correlated risks and diverse farm structures.

Robustness Checks

Regional indices offered only slight improvements but still failed to capture heterogeneity within regions. Basis risk remained significant even with region-specific indices. Farms specializing in wheat or barley exhibited different volatility patterns than mixed-crop farms. Mixed farms experienced marginally lower basis risk, but these improvements were not enough to justify index-based triggers. During severe price collapse scenarios (modeled after historical shocks), basis risk increased sharply, and index-triggered compensation underestimated total losses by 40–70%, highlighting the systemic fragility of mutual funds in the grain sectors.

Discussion and Policy Implications

The empirical results show that Lithuanian grain farms have significant differences in gross margins, yield variability, input costs, and

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technological levels. This agrees with earlier studies emphasizing that diverse farm traits make overall indices less representative. The observed variation in GM—where even neighboring farms have very different income patterns—indicates that no single sector index can accurately reflect individual farm losses. Factors like farm-specific conditions (soil fertility, crop rotations, microclimate), management skills, and scale-related costs further increase these disparities. As a result, the sector index tends to smooth out extremes and underestimates the volatility faced by many farms.

This fundamental contradiction in the assumptions behind index-based income stabilization tools, which require that individual outcomes move together with the index, shows that pure index-based IST tools are not suitable for diverse, price-driven sectors without major redesign. Policymakers need to understand that the simplicity of index-based tools in theory does not mean they are practically appropriate for such systems. Instead, hybrid stabilization models should be emphasized. These could combine index-based signals for monitoring systemic risk with farm-level income assessments for accurate payments. Such hybrid tools would lower basis risk while minimizing administrative effort, providing a practical compromise that is increasingly supported in international research. Additionally, implementing these schemes requires developing high-resolution farm data systems. Improving the integration of administrative data (e.g., crop declarations, tax data) and digital infrastructure would boost actuarial accuracy, reduce information gaps, and ensure fair compensation.

A key requirement for mutual risk-sharing funds is low correlation of income movements among members. However, the results show that price-driven income components in Lithuanian grain farms nearly move in sync, with correlation coefficients of 0.6–0.9. This high co-movement aligns with the global integration of grain prices and mirrors earlier findings that systemic price shocks weaken collective insurance mechanisms. This leads to two main implications: limited diversification potential, since mutual funds cannot rely on risk offsetting among members, and a high chance of simultaneous losses. During adverse price shocks, most farms need compensation at the same time, creating prohibitive capitalization requirements and risking fund insolvency.

Given these systemic risks, state co-financing or reinsurance is essential. The study results indicate that during extreme years – such as droughts or global price collapses – payouts could be several times higher than average annual contributions. As a result, public reinsurance, state-backed guarantees, or catastrophic loss buffers must be incorporated into IST design. International experience from Canada and Italy shows that without such government involvement, income stabilization mechanisms in crop sectors tend to fail under severe conditions.

The study shows significant basis risk—the gap between actual farm losses and what index-based models suggest – coming from farm-specific factors like unique production conditions, different crop mixes, and input-cost sensitivities. Basis risk is widely seen as the main reason farmers are hesitant to adopt index insurance. As a result, farm incomes often vary greatly from broader sector trends, causing many farms with heavy losses to go without compensation, while others with smaller losses receive payments. This creates issues with fairness and discourages participation. To address this, policies should focus on fostering diversification and building resilience at the farm level. Promoting crop rotation, drought-resistant varieties, and cost-effective technologies can help reduce farm-specific variations and reduce dependence on stabilization tools. Additionally, clear and honest communication is essential to set realistic expectations for farmers about basis risk and coverage limits, helping build trust and encouraging informed decision-making.

Furthermore, the results show that index-based stabilization misaligns contributions and payouts: high-risk farms repeatedly receive less than they should, while low-risk farms may build up net gains. This imbalance matches findings in

Canada's AgriStability program, where high basis risk led to decreased participation. To avoid adverse selection and long-term underfunding, contributions need to be based on farm risk profiles. Uniform contributions result in unfair outcomes; therefore, premiums should be tied to specific risk factors such as yield volatility and cost structure. This principle is well-known in actuarial studies and is crucial to prevent high-risk farms from dominating the compensation pool.

Finally, the study's stress-testing of regional and crop-mix stratification showed that while regional indices performed slightly better, they still failed to eliminate basis risk, similar to experiences in Italy and Spain. Crop-specific indices also failed because farms with mixed crops have different risk profiles than monoculture farms. These results have important implications for EU-level risk management policy: IST applicability in grain sectors is very limited. Stabilization efforts should instead focus on homogeneous sectors with low correlation (e.g., specific horticulture or livestock segments) where mutual risk-sharing assumptions are more realistic. For grain farming, without shifts toward hybrid indicators and strong public reinsurance, IST schemes are unlikely to meet their goals and might cause resource misallocation and financial instability.

Conclusions

This study explored the limitations of index-based income stabilization tools (IST) in Lithuanian grain farms and identified several structural challenges that weaken their effectiveness. By analyzing farm-level gross margins, volatility patterns, correlation structures, and simulated stabilization triggers, the research showed that sector-level or regional indices do not accurately represent the income fluctuations of individual farms. This mismatch creates significant basis risk, leading to payment distortions, unfair outcomes, and reduced incentives for farmer participation.

The key findings reveal that Lithuanian grain farming exhibits high variability in yields, costs, and technological adoption, leading to notable differences in income volatility among farms. Additionally, systemic price shocks—driven by global market integration—cause high correlation in income fluctuations, which reduces the effectiveness of risk pooling. These characteristics fundamentally oppose the assumptions behind index-based stabilization schemes, which require enough uniformity and low correlation among participants.

Simulation results showed notable gaps between index-based and farm-level triggers for stabilization. Sector indices often failed to activate during years when many farms suffered significant losses, yet activated in years when only some farms faced moderate income drops. This mismatch raises fairness concerns and jeopardizes the financial sustainability of mutual stabilization funds, particularly in extreme market or climate conditions when widespread losses create large, concentrated payout obligations.

Policy implications suggest that pure index-based stabilization instruments are unsuitable for grain sectors without substantial redesign. Hybrid approaches that combine index data with farm-level income assessments, risk-differentiated contributions, strong public reinsurance mechanisms, and improved farm-level data systems offer more promising solutions. Furthermore, stabilization tools should be targeted toward sectors with homogeneous production structures and lower systemic risk, where the underlying assumptions of mutual risk pooling are more likely to hold.

Overall, the study concludes that while income stabilization tools are conceptually appealing, their practical feasibility in grain farming is limited by the sector's inherent structural characteristics. Effective risk management for grain producers requires flexible, data-driven, and institutionally supported mechanisms that reflect the complexity of modern agricultural production and the realities of systemic risk exposure.

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