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RESILIENCE IN AGRICULTURE: IS THERE THEORETICAL AND METHODOLOGICAL CHAOS?

ABSTRACT

The increasingly volatile conditions of doing business and the existence of societies are a clear reason to explore the category of resilience. The article aims to present and structure selected theoretical and methodological problems concerning resilience in agriculture. The results of a bibliometric analysis indicate a research gap referring to the category of financial resilience. The category of ‘resilience’ is based on relatively modern concepts from business management, particularly those close to risk management theory. Identifying and measuring capacities to build and strengthen resilience seems to be very important. Quantitative and qualitative methods may be used to explore the category ‘financial resilience’ in agriculture. There has been a noticeable research gap in agricultural finance to fill in. The indicator system for measuring the resilience of agricultural enterprises/farms has some limitations related to the aggregated nature of some financial categories. It would be advisable to develop a global measure of risk resistance in parallel (e.g., in the form of a synthetic index).

Key words: resilience, methodology of finance, risk management, agricultural finance

JEL codes: Q12, Q14, Q18

Introduction

The category of ‘resilience’ may be treated as a buzzword in social sciences [PWC 2021]. The increasingly volatile conditions of doing business and the existence of societies are a clear reason to explore the category of ‘resilience’. The original meaning of resilience refers to bouncing back. Resilience has been applied in various areas of science with different approaches (engineering and life sciences – e.g., ecology and management, including supply chain management) [Pereira and Da Silva 2015]. According to Herrera [2017], “resilience is a flexible concept open to many different interpretations” – this implies several research problems, including designing a survey questionnaire for respondents). The concept of resilience may be treated as interdisciplinary. Nevertheless, its roots lie in neoclassical (i.e., risk measurement) and institutional economics

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(e.g., ex-post-public intervention). The concept of resilience incorporates some elements of public management and public policies. Results from bibliometric analysis, a meta overview, content analysis and discourse analysis indicated abundant research papers, including an empirical analysis. A noticeable measurement and assessment gap can be seen in agriculture because “farming systems are faced with major risks and uncertainties; just think of the consequences of climate change” [Wageningen University and Research]. The article aims to present and structure selected theoretical and methodological problems concerning resilience in agriculture. The subsequent section reviews definitions of resilience in agriculture. The third section focuses on methodologies and methods of measuring and assessing resilience in agriculture, and the fourth section presents the concept of methodology for financial resilience in agriculture. The last section summarises and offers concluding remarks.

Review of the definition of resilience in agriculture

Resilience is a very broad category that has been adopted from engineering and ecology [Carpenter et al. 2001, Cumming and Peterson 2017] to social sciences [Walker et al. 2004], including economics and finance. According to the famous British Cambridge Dictionary, ‘resilience’ has two meanings [Resilience a]:

- “the ability to be happy, successful, etc. again after something difficult or bad has happened: trauma researchers emphasise the resilience of the human psyche”;
- “the ability of a substance to return to its usual shape after being bent, stretched, or pressed”.

The Merriam Webster dictionary offers two meanings of the word resilience, namely: (1) “the capability of a strained body to recover its size and shape after deformation caused especially by compressive stress”; (2) “an ability to recover from or adjust easily to misfortune or change”. The first one refers to the physical features of a strained body, whereas the second one underlines the role of recovering (the change from a worse situation to a better state). Furthermore, a linguistic ambiguity may be described by a definition of ‘resilience’ that is provided by the Collins Dictionary [Resilience... b]: “(...) state or quality of being resilient”, [ecology] the ability of an ecosystem to return to its original state after being disturbed”, “[physics] the amount of potential energy stored in an elastic material when deformed”. This shows that the category of ‘resilience’ in social sciences may refer to the dynamic manner.

There are several definitions of general resilience that are proposed by international organisations:

- United Nations Development Programme [UNDP 2020]: “The ability of individuals, households, communities, cities, institutions, systems and societies to prevent, resist, absorb, adapt, respond and recover positively, efficiently and effectively when faced with a wide range of risks, while maintaining an acceptable level of functioning and without compromising long-term prospects for sustainable development, peace and security, human rights and well-being for all”;
- The International Panel on Climate Change [IPCC 2014]: “The capacity of social, economic, and environmental systems to cope with a hazardous event or trend or disturbance, responding or reorganising in ways that maintain their essential

function, identity, and structure, while also maintaining the capacity for adaptation, learning and transformation”;

- United Nations Office for Disaster Risk Reduction: “The ability of a system, community or society exposed to hazards to resist, absorb, accommodate, adapt to, transform and recover from the effects of a hazard in a timely and efficient manner, including through the preservation and restoration of its essential basic structures and functions through risk management”.

Moreover, resilience from a social sciences perspective may be treated as “an ability” adopted from the life sciences. The essence of ‘resilience’ refers to the ability of the system/organisation/unit to recover from a difficult situation (e.g., stress, crisis, toughness). We propose our own definition of ‘resilience’ as the ability of the system or its element to cope with difficulties and recover after a shock/crisis situation. This may be useful for a detailed description of resilience at various levels of the agricultural system. We can add that resilience of organisation/system is not only a sum of the resilience of single units taking the various interrelations and synergy effects (if possible). There are several detailed definitions of resilience, including organisational, psychological, supply chain and community resilience (Table 1). We see that the agricultural system encompasses more than a collection of farms and appears to be more complex. Therefore, focusing on various areas of resilience (e.g., organisational, psychological) is increasingly important nowadays. Farms are surrounded by more and more complex socio-economic environments. This means that these entities should be able to manage supply chains. Community resilience is a useful and important category that may be applied to designing rural policy tools (e.g., safety nets for inhabitants of rural areas).

Table 1. Definitions of resilience in social sciences

The type of resilience	Description	Remarks related to agriculture (own author’s remarks)
Organisational resilience	“the ability...to withstand changes in its environment and still function” [Mc Carthy et al. 2017].	The general concept that may be adopted to, for example, farming systems.
Psychological resilience	the ability to cope with a crisis or to return to pre-crisis status quickly, i.e., to recover quickly [de Terte and Stephens 2014].	This type of resilience may refer to farm operators or farm employees.
Supply chain resilience	“the capability of supply chains to prepare for unexpected events, and if it happens, they are able to respond to disruptions and recover from them so as to restore operations to the previous performance level or even to a better one” [Pereira and da Silva 2015, p. 2].	Farming systems consist of several food networks and chains.
Community resilience	The ability of communities to respond to/withstand/recover after disaster events; available resources of communities are important for building community resilience [Ayyoob 2016].	A farm is operating in rural areas. Underlining the significance of rural areas may be useful for a detailed analysis of farm resilience.

Source: own studies based on the literature review.

It should be noted that OECD [2020] incorporated the concept of resilience into holistic risk management (HRM) in agriculture. ‘Extended’ ERM should include:

- Focusing on ex-ante policies and prevention;
- Trade-offs;
- Participatory processes and deepening cooperation between actors of the food systems;
- Supporting investment activity of farm households to build important infrastructure related to ‘resilience’;
- “No-regret” policies.

Combining national agricultural policies with instruments important for strengthening general resilience in the county is important. Table 2 presents four various definitions of the resilience of agriculture at various levels of reference. First, most of them refer to the triad of capabilities (buffering, adaption and transformation), e.g., definitions that Darnhofer and OECD propose. The detailed definition that was formulated by Meuwissen et al. underlined the “ability to ensure the provision of the [food] system”. De Oliveira et al. referred to the general idea of resilience as an ability to bounce back (returning to the original meaning of ‘resilience’).

Table 2. Definitions of the resilience of agriculture and their level of reference

Author(s)	Description	The level of reference
Darnhofer [2014, p. 461]	“encompassing buffer, adaptive and transformative capability”	a general concept
Meuwissen et al. [2019, p. 1]	“resilience of a farming system as its ability to ensure the provision of the system functions in the face of increasingly complex and accumulating economic, social, environmental and institutional shocks and stresses, through capacities of robustness, adaptability and transformability”	a farming system
OECD [2020, p. 11]	“the capacity to absorb the impacts of shocks, the capacity to adapt to an evolving risk environment, and the capacity to transform if the current system is no longer sustainable”	food systems
De Oliveira et al. [2022]	“A farm’s resilience is its ability to cope with disturbances or to come back to a routine regime following these disturbances”	a farm

Source: own studies based on the literature review.

As presented in Table 3, ‘resilience’ at the farm level may be decomposed into three main capacities (i.e., buffer, adaptive and transformative ones). De Oliveira [2022] analysed their meaning, referring to the case of dairy farms. For example, buffer capacity describes “tolerating disturbances without moving away from its routine regime”.

Table 3. Capacities related to the category ‘resilience’ at the farm level

Type of capacity	Description	Remarks related to practices of farm management (the case of a ‘dairy farm’)
Buffer capacity	“the farm can tolerate disturbances without moving away from its routine regime”	using fodder stocks by a dairy farm experiencing a drought
Adaptive capacity	“the farm can implement technical, organisational or commercial adaptations to cope with hazards and quickly return to a routine regime”	using diversification of crop rotations to spread climatic risks over different crops and thus increase the stability of production
Transformative capacity	“the farm is able to undergo significant transformations to remain prosperous”	<ul style="list-style-type: none"> • “changing the livestock breed” • “setting up a new production enterprise” • “modifying its marketing method”

Source: based on [de Oliveira et al. 2022].

A bibliometric analysis (Table 4) shows a large body of literature related to the resilience category. We used the combination TITLE ABS KEY (i.e., TITLE+ABSTRACT+KEYWORDS) search in the presented engines (Scopus, Web of Science and Econpapers). Furthermore, as for financial resilience regarding farms or agriculture, the number of papers was insignificant (less than 20). The ratios of the papers focused on financial resilience in agriculture and/ or farm to the number of papers on general resilience in agriculture was relatively low: Scopus – 0.3%; Web of Sciences – 0.2%; Econpapers – 0.7%. This indicates that financial resilience is in the operationalisation phase. There are many papers related to resilience and farm (search ‘resilience and farm’), e.g., as for Scopus – 5,431 objects. This shows that a category of resilience at the micro level is explored in various scientific disciplines. On the other hand, a set of papers related to ‘resilience’ and the ‘agricultural sector’ is narrower. If we combine the results of the aforesaid analyses with the share of papers related to social sciences (including economics, business and management, public policies and other related sciences), we note that this share was not higher than 20%. The highest values referred to the set of papers on ‘resilience’ and the ‘agricultural sector’. Furthermore, the share of American authors of papers to the total number of analysed papers (Scopus/Web of Science) is significant (about 25% – resilience and agriculture for Scopus). We note that the number of papers from emerging and developing economies is growing (in particular, China and India). To conclude, the results of bibliometric analysis indicate that there is a research gap referring to the category of financial resilience. The category of ‘resilience’ is based on relatively modern concepts from business management, particularly those close to risk management theory. Resilience in agriculture may be explored on various analytical levels (food systems, supply chains, farm households, even fields, etc.). This means that its operationalisation should be based on a set of methodological approaches, including operational research, economic and financial analyses and risk analysis. Our analyses indicated that there is a significant nexus between food security and resilience in agriculture. Anderies et al. [2013] underlined that the process of globalisation has strongly local social-ecological systems (SEs). They propose referring to three concepts, i.e., sustainability, resilience and robustness “to address the multi-scale and multi-level challenges associated with global

change”. Resilience may be analysed at various levels (field, farm, regional and global) from the perspective of food security as “maintaining production of sufficient and nutritious food in the face of chronic and acute environmental perturbations” [Bullock et al. 2017]. Currently, resilience in agriculture is analysed more broadly, i.e., regarding the food systems; for example, Tendall [2015, p. 17] underlined “the complexity of whole food systems, including social, economic and biophysical processes operating at many scales”. We consider that analyses focused on the problems of agricultural supply chains in the context of risk and resilience may be more popular [Lead and Revoredo-Giha 2013]. Exploring how farmers’ attitude to risk and resilience is increasingly important from the perspective of designing new public policy instruments, particularly in the context of climate change [Herman et al. 2018].

Table 4. Results from a bibliometric analysis related to resilience in agriculture

Search engines	Resilience and farm*	Resilience and agriculture	Resilience and the ‘agricultural sector’	‘Financial resilience’ and (farm* or agriculture*)
Scopus	5,431	5,018	297	16
Web of Science	5,140	4,405	234	11
Econpapers (including grey literature)	1,734	2,347	276	12
The share of papers related to social sciences [%]				
Scopus	16.1	13.9	19.2	20.0
Web of Science	9.6	8.9	23.5	45.5
The share of papers written by authors with affiliation in the US [%]				
Scopus	21.1	25.0	12.5	25.0
Web of Science	21.3	25.2	15.4	27.3

Results from search engines from April, 13, 2023. Detailed calculations of ‘the share of papers related to social sciences’ and ‘the share of papers written by authors with affiliation in the US’ were not available for Econpapers. Source: own studies.

Methodologies and methods of measurement and an assessment of resilience in agriculture

Considering that the category of ‘financial resilience’ seems relatively modern, we should explore it using both types of methods, qualitative and quantitative (Table 5). First, qualitative methods include, among other things, case studies for selected entities and survey methods. Surveying has some significant advantages. Quantitative methods employ data from literature reviews or overviews that are analysed by text mining techniques, for example.

Table 5. Results from a bibliometric analysis related to resilience in agriculture

Qualitative methods	Quantitative methods
<ul style="list-style-type: none"> • case studies • survey method (including expert survey, focus groups, in-person interviews) • economic experiment 	<ul style="list-style-type: none"> • text mining (TM) • statistical methods (including multi-dimensional comparative analysis, e.g., PCA) • data mining (DM) methods

Source: own studies

OECD’s approach includes a detailed analysis of resilience capacities both at the farm and sector levels (Table 6). The first one may be based on static and dynamic methods

Table 6. Analysing resilience capacities – farm and sectoral level

Farm level	Sectoral level
Static: using various indicators and weights, statistical methodologies (including principal component analysis, panel regression techniques).	Descriptive statistics of the three dynamic resilience capacities at the sector level. Employing descriptive information on the size of the farm classes that best operate on each of the three resilience capacities is useful to describe or graph the sector’s resilience.
Dynamic: the dynamics of farm adjustment e.g., for economic/financial performance (or other financial categories) aftershocks <ul style="list-style-type: none"> • Quantifying the impact of a shock on performance measures/indicators (e.g., income). The change in each of the variables are calculated for all farms in different phases that are interrelated with different resilience capacities. • Statistical identification of dynamic drivers for resilience capacities at farm level. 	A detailed analysis of how the productivity dynamics of the sector reacts after the shock. Markov-type transition matrices may be used for better estimation of e.g., productivity dynamics [Antón and Sauer 2021, Sauer et al. 2021] before and after the shock.

Source: own studies based on [Sauer and Morreddu 2020, Sauer et al. 2021, OECD 2022].

The concept of methodology for financial resilience in agriculture

The subcategory of resilience, namely ‘financial resilience’ may be useful in designing evaluations for CAP measures. We present its operationalisation as an important challenge from the perspective of public policies. In the empirical studies related to ‘financial resilience’, a profound gap may be noted. Adaptation and transfer of measures indicators from SME/household finance in the case of farm households seem to be useful. Nevertheless, it should be noted that a farm household has a hybrid nature: i.e., family household + family firm (enterprise). The peculiarity of the family income category relates to difficulties measuring and assessing farm profitability. Furthermore, identifying objectives for farm managers is relatively complex, so the number of objectives is usually more than three or four. Operationalisation of the concept of financial resilience should be easier for agricultural enterprises than farms. Long-term experience in ESG reporting in the food industry helps design various tools such as dashboards, performance cards and balanced score cards underlining the resilience problems. A detailed distress analysis based on multiple discriminant analysis.

Table 7 presents a set of three categories (i.e., profitability, stability and financial liquidity) of indicators that are used for the measurement of resilience to risks. Frentrup et al. [2014] designed a system of financial measures and indicators to test field farm exposure to risk. It should be noted that the category of stability is significant and includes five indicators.

Table 7. Financial resilience to risk factors of farm households – the German case of field farms

Group of indicators	Remarks
Profitability ROE (entrepreneur profit + interests from borrowed capital)/total capital	The ability to accumulate own equity as the main risk buffer
Stability Entrepreneur profit/Operational revenues Equity/(Equity + Debt) Change in equity/Profit [%] Degree in specialisation Revenue income structure [%]	The ability to be profitable and liquid in the long term when radical threats or changes in the environment appear
Financial liquidity Debt/cash flow [%] Current assets/Short term debt	A dynamic approach to financial liquidity, CF used as a proxy for the financial strength of the enterprise

Source: own studies based on [Frentrup et al. 2014].

Furthermore, von Wendt [2022, pp. 27-28] presented a more complex proposal for measuring and assessing farms' economic resilience. It should be noted that 'economic resilience' is a significant part of the financial category. Wendt's proposal was based on "a practicable two-dimensional scoring approach", which resulted in "a matrix formation contrasting a static dimension, estimated as a composite index of farm indicators, with a dynamic dimension, calculated as the probability of default using a Monte-Carlo-Simulation" [von Wendt, pp. 27-28]. Combining static and dynamic dimensions in financial analyses of farms is an important methodological challenge.

Conclusions

Definitions of resilience in agriculture underline its dynamic features. Identifying and measuring capacities to build and strengthen resilience seems very important. Quantitative and qualitative methods may be used to explore the category of 'financial resilience' in agriculture. There has been a noticeable research gap in agricultural finance to fill in. The answer to the question posed in the article's title is positive. The analyses of previous empirical studies show that the resilience category is not clearly defined. In addition, the measurement of resilience in agriculture, and in particular the subcategory of financial resilience, is based on different methodological approaches. Currently, it is difficult to indicate a trend in the field of standardisation and uniformity of methodological approaches. The indicator system for measuring the resilience of agricultural enterprises/farms has some limitations related to the aggregated nature of some financial categories. It would be advisable to develop a global measure of risk resistance in parallel (e.g., in the form of a synthetic index). It is necessary to consider expert assessments (e.g., for weighing individual subcategories). Limitations of our studies are related to focusing

on a financial approach to the measurement of resilience. The category/concept dynamic resilience should be regarded as multi-faced. Therefore, a holistic methodology capturing the dynamic relationship between food system capacities and actors must be devised. We propose a further empirical study based on an aggregated indicator as a dependent variable in econometric models. A detailed empirical study should include a panel approach in order to detect the impact of time on dynamic resilience. Our article may be a base for a more detailed systemic review with an in-depth quantification of bibliometric analysis (e.g., in line with PRISMA requirements).

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Odporność w rolnictwie – czy występuje chaos teoretyczny i metodologiczny?

STRESZCZENIE

Coraz bardziej zmienne warunki prowadzenia działalności gospodarczej i funkcjonowania społeczeństw są istotną przesłanką do eksplorowania kategorii odporności (*resilience*). Celem artykułu jest przedstawienie i uporządkowanie wybranych problemów teoretycznych oraz metodologicznych dotyczących odporności w rolnictwie. Wyniki analizy bibliometrycznej wskazują, że istnieje luka badawcza odnosząca się do kategorii odporności finansowej. Kategoria *resilience* opiera się na stosunkowo nowoczesnych koncepcjach z zakresu zarządzania przedsiębiorstwem, w szczególności tych, które są bliskie teorii zarządzania ryzykiem. Identyfikacja i mierzenie zdolności do budowania wzmocnienia odporności wydaje się być bardzo ważne. Zarówno metody ilościowe, jak i jakościowe mogą być wykorzystane do badania kategorii odporności finansowej w rolnictwie. W finansach rolnictwa zauważalna jest luka badawcza związana z pomiarem i oceną odporności finansowej. System miar i wskaźników do pomiaru odporności przedsiębiorstw/gospodarstw rolnych ma pewne ograniczenia związane z zagregowanym charakterem niektórych kategorii finansowych. Wskazane byłoby równoległe opracowanie miary całkowitej odporności na ryzyko, np. w postaci syntetycznego indeksu.

Słowa kluczowe: odporność, metodologia finansów, zarządzanie ryzykiem, finanse rolnictwa