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HOW RESISTANT IS THE AGRICULTURAL SECTOR? ECONOMIC RESILIENCE EXPLOITED

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ABSTRACT. The concept of resilience has wide acceptance in different scientific doctrines and fields, from ecology to disaster management. Nowadays this phenomenon is being more and more intensively exploited in economic sciences in an attempt to measure the ability of economic systems to quickly regenerate from different external shocks or even to avoid them as such. This research paper examines economic resilience of the agricultural sector (including industries) with the example of Lithuanian empirical data. In order to measure the economic resilience of the agricultural sector, the appropriate index was created including a new derivative indicator – volatility of revenues from the desired growth path. Expert interviews, statistical analysis and econometrical modelling were employed in our research. The results show the increasing value of economic resilience of the Lithuanian agricultural sector up to the year 2015, which can be attributed to the accession into the EU, after this year inclination towards more profitable, but considerably more risky export markets lowers the calculated parameter of economic resilience of the Lithuanian agricultural sector. Such a tendency questions the sustainability of economic resilience of the Lithuanian agricultural sector.

JEL Classification: Q11, Q18, O13

Keywords: economic resilience, agricultural sector, SAW, Lithuania

Introduction

The agricultural sector has dominated in Eastern European economies from the start of WWII, it became extraordinary after the Second World War and still today remains very important, both economically, socially and culturally (Granberg, 2017; Karnitis & Karnitis, 2017; Raišienė, & Skulskis, 2018). The agricultural sector is the main employer and source of income for the rural population in Lithuania. This fact makes it very important not only from an economic, but also from a social standpoint: if the agricultural sector experiences significant downturns, it may lead not only to the loss of the income source for a large percentage of citizens in rural areas in Lithuania, but also to increased crime rates, violence and other social

perturbations. The Lithuanian agricultural sector is susceptible not only to turbulences in the world markets, but is also a target of political repercussions (for example, the ban on exporting various Lithuanian agricultural products to the Russian Federation). Therefore, it is socially and economically important to have a sustainable, resilient to external perturbations agricultural sector in the country.

The aim of this research paper is to measure the economic resilience of the agricultural sector (including industries) with the example of Lithuania. In order to achieve this goal, a resilience measuring index for the agricultural sector was created. To begin with, in order to measure inoperability we employed not the inoperability index, suggested by Chopra and Khanna (2015), but also the desired growth path of this economic sector. The limitations of our research are related to the number and the selection of variables researched. Expert interviews, statistical analysis and econometrical modelling were used in order to get the results.

The paper is structured as follows: the introductory part, which emphasizes the importance of this research, followed by the theoretical part, which shows different theoretical approaches to the economic resilience concept. The methodological part shows the logic behind the creation of the economic resilience index and the resulting intermediate calculations. It also contains the results of the expert interviews. The results and discussion show the results of the computation of the economic resilience index for the Lithuanian agricultural sector and also provide insights into the reasons behind its dynamics.

1. Literature review

With the occurrence and reoccurrence of natural disasters, economic downturns, political turmoil and other external factors affecting the global economy, the scholars started to search the concepts and measures to evaluate the vulnerability and resilience of various economic systems. Although the term resilience was first used in materials science and engineering, it soon found an appliance in ecology (Holling, 1973), disaster management (Rose, 2007; Paton & Johnston, 2017; Blackman *et al*., 2017) and social sciences such as organizational management (Sheffi, 2005; Ortiz-de-Mandojana & Bansal, 2016; Annarelli & Nonino, 2016), psychology (Bonanno *et al*., 2015; Obschonka *et al*., 2016; Dooley *et al*., 2017) and economics (Audretsh & Lehmann, 2016; Di Caro, 2017).

The economic resilience of a state, region, economic sector or other type of economic system can be defined as the ability to maintain a pre-existing state (usually assumed to be an equilibrium state) or return to it very quickly, typically, acquiring new abilities, after being affected by some type of exogenous shock. There is an abundant amount of scientific literature dealing with the concept of resilience, but there are only a few economic studies that apparently use the term "economic resilience". It can be noticed that scientific literature examining economic resilience typically focus on the capacity the economic system has to return to its previous level and/or growth rate of output, employment, or population after being hit by significant external shock (Hill *et al*., 2008; Briguglio *et al.*, 2009). This attitude towards economic resilience can be called a static economic resilience, as in this scenario economic system, as an entity, takes no action to avoid being thrown out of the equilibrium state and relies on its flexibility to minimize the negative consequences of the impending exogenous shock. The indicators, which are being used in order to measure this type of economic resilience include GDP per capita, the level of disposable income of end users of products of researched economic system, the volatility of revenues, amount of liquidity, external financial transfers and availability of financial capital at reasonable prices, etc. (Bates *et al.*, 2014; Sensier *et al.*, 2016).

Economic literature offers other scientific views on this phenomenon. There are authors (Barthel & Isendahl, 2013; Tidball & Stedman, 2013; Farley & Voinov, 2016) who research resilience as an ability of the economic system being able to avoid being pulled out of its previous equilibrium state by an exogenous shock. This could be achieved in two ways: having the ability to avoid external perturbations (by producing goods or services that are unlikely to be subject of negative external demand shock etc.) or maintaining the capacity to withstand the impending external shock with little or no negative impact (by producing a wide range of goods sold in different markets, or having broadly diversified economic activities, thus the possible external shock has little adverse effect). It deals with such indicators as the number of export markets, export concentration, internal consumption, debt ratio & etc. (Bates *et al*., 2014; Colding & Barthel, 2013; Martin & Sunley, 2015).

The negative external shock can also be dampened by the economic system, the researched economic structure simply absorbs the negative effects and it does not significantly alternate the main economic indicators (Duval *et al*., 2007). Typically, it requires a possession of large financial resources or free and immediate access to financial markets in order to borrow the necessary financial stocks. Such actions can be considered as a dynamic economic resilience.

There also a small number of authors (Tonts *et al*., 2014; Williams & Vorley, 2014; Boschma, 2015), who perceive economic resilience from the path-dependence perspective. The concept of path-dependence, sometimes called a "historical lock-in," assumes that an economic system has more than one equilibria and that not all of it is efficient enough (regardless of the fact that the static or dynamic state of resilience is being researched). Due to the gamut of the decisions and actions taken during a period of time, an economic system can find itself "locked into" a degree or growth path that is not optimal (Hill *et al*., 2008; Modicca & Reggiani, 2015). It offers a notion of economic resilience in which resilience is understood as a capacity of an economic system to avoid being locked into such a suboptimal equilibrium or, if it became, to transform to a more efficient equilibrium quickly and spatially.

2. Methodological approach

The indicators researched

With the purpose of having an empirical base for measuring the economic resilience of the agricultural sector, we have chosen Lithuania, as it is very similar to two other Baltic countries (Veebel & Markus, 2018) and has a lot in common with the agricultural sectors of other countries in the Baltic sea and East European region (Sutcliffe *et al.*, 2015; Gorb, 2017; Hartvigsen, 2013; Yasnolob & Radionova, 2017). In order to create the index, showing the economic resilience of the Lithuanian agricultural sector in the period from 2004 to 2017 four different indicators were chosen. The cost of additional revenues in agriculture (E_c), the volatility of revenues (V_r), the number of export markets (N_{em}) and the percentage of risky export markets (R_m). They belong to two different concepts of economic resilience. The volatility of revenues can be attributed to the so-called static economic resilience (Briguglio *et al.*, 2009; Hill *et al.*, 2008) as it shows the ability of the economic system to withstand the external demand shock and to maintain its path of growth by not taking some preventive actions or measures and do not flexibly react to changing demand situation. The two others: number of export markets and the costs of additional turnover can be attributed to the so-called dynamic economic resilience (Pant *et al.*, 2014). The fourth one – number of risky markets - was elaborated by the authors in order to more precisely depict the current situation of the Lithuanian agricultural sector.

As one of the main economic indicators measuring economic resilience of regions and urbanized agglomerations, the costs of additional revenues is a suitable indicator for analysing the resilience of particular sectors of the economy, as it shows the flexibility of analysed economic systems to react to a changing demand in external markets (Hunady *et al.*, 2017) not becoming deeply bounded by increasing financial liabilities, therefore lowering external risks. Such an indicator can be attributed to a dynamic resilience concept. Thus, to achieve the purpose of this research, the above-mentioned indicator was calculated by dividing output of the agricultural 'industry' (O_{ai}), based on basic prices, by intermediate consumption (I_c) at basic prices, which includes seeds and planting stock; energy and lubricant; fertilizers and soil improvers; plant protection products, herbicides, insecticides and pesticides; veterinary expenses; feeding stuffs; maintenance of materials; maintenance of buildings; agricultural services; financial intermediation services indirectly measured (FISIM); other goods and services, where:

$$E_c = {}^{O_{ai}}/_{I_c} \quad (1)$$

The second analysed economic resilience indicator is a volatility of revenues (V_r). This indicator takes into account the past external shocks, experienced by the Lithuanian agricultural sector. It shows the deviation of revenues from the desired sustainable trend, calculated by taking into account the growing productivity, labour costs and managerial abilities of the Lithuanian agricultural sector. In essence, the positive deviation of revenues from the trend may seem desirable, in the longer run it increases risks, as it becomes harder to plan a new investment in production capacities, therefore increasing the chance of over-investment, which may lead to higher fixed costs or, even, insolvency. A trend was based on 2004-2017 fluctuation of revenues. As the revenue indicator is not so commonly used in analysing agricultural economy (Gollin *et al.*, 2014; Kelly & Grada, 2013), it was changed to an affiliated indicator – volatility of output of the agricultural 'industry' (V_{oai}).

The third indicator, also belonging to the group of economic resilience measuring indicators, showing the ability of the economic system to dampen the possible negative external shock, is a number of export markets (N_{em}). The more the revenues of the economic system are diversified, the greater the ability of an economic system to withstand the negative turbulences in its external environment (Duval *et al.*, 2007). This indicator is calculated on the basis of data on countries where agricultural and food products of Lithuanian origin are exported. The total number of such countries reflects the indicator N_{em} value.

The fourth indicator is a percentage value of risky markets (R_m). In order to define it risk-taking markets are calculated taking into account the share of value of agricultural industry goods exported to one country to the total export of the agricultural industry goods. If the country's export volume is up to 10 % of all agricultural industry goods (EX_t) to one country, the risk is assessed as minimal, if export volumes are more than 10 % – assessed as a risky market[1]. According to that rule and taking into account the value of the products exported to these markets (EX_r), their share in all exports of agricultural industry goods is calculated by the formula:

$$R_m = {}^{EX_r}/_{EX_t} \quad (2)$$

All primary values to create indicators have been exported using the Eurostat and Lithuanian statistics databases. The selected indicators were also applied for correlation analysis to determine whether there are highly correlated indicators in order to avoid data anomalies and false conclusions.

[1] If there are small differences between the percentage, then the three first markets with the highest export share should be taken into account

The resilience measuring index created

All mentioned indicators (E_c; V_{oai}; N_{em}; R_m) are influencing economic resilience of the Lithuanian agriculture sector. To sum them up and create an economic resilience index of the Lithuanian agriculture sector, the SAW (Simple Additive Weighting) method was employed. It is a typical, very well-known and commonly used method (Hwang, Yoon, 1981; Podvezko, 2011). The method criterion S accurately reflects the idea of quantitative multi-criteria methods-combining the values of the indicators and their weights into one combined value, i.e. method criteria.

To sum indicator values by the SAW method in S value of agricultural sector economic resilience, firstly the expert survey was carried out. According to Libby, Blashfield (1978), 7 experts were selected in order to estimate the weights for indicators. The experts were selected on the basis of 2 criteria: either they work in the field of agricultural science or in the Ministry of Agriculture of the Republic of Lithuania for at least 5 years.

The compatibility of expert answers was verified using the Kendall concordance coefficient according to the formula (Kendall, 1955):

$$W = \frac{12\sum_{i=1}^{m}(e_i-\bar{e})^2}{r^2 m(m^2-1)}. \quad (3)$$

Here m – number of comparable indicators; r – number of experts;

$$e_i = \sum_{j=1}^{r} e_{ij}\ ,\bar{e} = \frac{\sum_{i=1}^{m} e_i}{m} = \frac{\sum_{i=1}^{m}\sum_{j=1}^{r} e_{ij}}{m}. \quad (4)$$

In order to calculate S_j values (SAW method) of agricultural and food sector economic resilience, the values of selected indicators were normalized. Maximizing indicator values were normalized by formula (Hwang, & Yoon, 1981):

$$\bar{r_{ij}} = \frac{r_{ij}}{\max\limits_{j} r_{ij}}. \quad (5)$$

Conversion of minimized metrics into maximizers was made by formula (Hwang, Yoon, 1981):

$$\bar{r_{ij}} = \frac{\min\limits_{j} r_{ij}}{r_{ij}}. \quad (6)$$

Here r_{ij} is the value of the i^{th} indicator for the j-object (in our case – year). $\max\limits_{j} r_{ij}$ – the maximum value of the i^{th} indicator of all the alternatives (years), $\min\limits_{j} r_{ij}$ – the lowest value of the i^{th} indicator.

In order to calculate normalized values of V_{oai} indicator, when best value is 0, the following transformation was made:

$$\bar{r_{ij}} = \begin{cases} 1 + r_{ij}, if\ r_{ij} \le 0 \\ 1 - r_{ij}, if\ r_{ij} > 0 \end{cases} \quad (7)$$

The sum S_j of the normalized values weighted for all indicators is calculated for each year by formula:

$$S_j = \sum_{i=1}^{m} \omega_i \tilde{r}_{ij} \quad (8)$$

Here ω_i – is the weight of the i^{th} indicator.

3. Conducting research and results

The results of the statistical indicator analysis show, although small, the negative trend in costs of the additional sales indicator trend (Table 1).

It means that in recent years the agricultural sector in Lithuania has become more inertial, less adaptable and less flexible in exploiting the possible positive trends in demand of

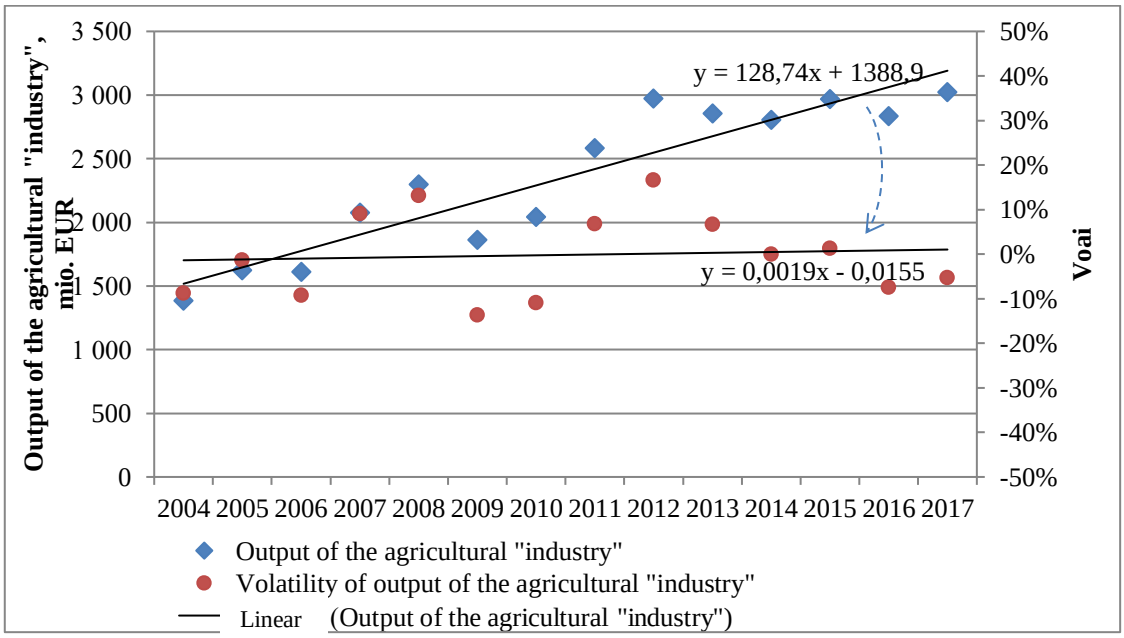
export markets, therefore, showing growing dependency on the accession of external sources of financial capital in order to increase the productivity. This indicator also indirectly shows the lowering return on investment in the Lithuanian agricultural sector by lowering increase in turnover of additional investment, that, by far, lowers the resilience of the economic system (Hill *et al.*, 2008), as by decreasing the rate of return, the total amount of investment falls down making technological development of economic entities slower.

Table 1. Statistical characteristics of indicators E_c; V_{oai}; N_{em}; R_m

Statistical characteristics of indicators	E_c	V_{oai}	N_{em}	R_m
min	1.08	-13.7%	98.0	0.23
max	1.26	16.7%	143.0	0.54
standard deviation	0.05	0.09	14.5	0.09
median	1.18	-0.6%	120.0	0.43
average	1.18	-0.2%	120.6	0.43
linear trend direction[2]	-	++	++	--

Source: *compiled by authors, 2018*.

Analysing the trend of volatility of revenues from the main desirable calculated Lithuanian agricultural industry growth path, which is equal to 128.74x + 1388.9, we see no clear deviation, suggesting a fairly balanced and sustainable growth of the Lithuanian agricultural sector. Graph 1 provides information on the output of the agricultural "industry" and its volatility, according to the 2004–2017 trend line (y = 128.74x + 1388.9).



Graph 1. The output of the agricultural 'industry' and its volatility (V_{oai}) in Lithuania in 2004–2017

Source: *compiled by authors based on Eurostat, 2018.*

[2] weakly positive / negative is marked as +/-
positive / negative is marked as ++/--
strongly positive / negative is marked as +++/---

According to this trend, the transformed rates rotate around zero (trend line y = 0.0019x – 0.0155), the greater the distance of which shows a stronger fluctuation in comparison to the theoretical norm. This indicator, attributed to the number of indicators, describing the ability of the economic system to avoid being thrown out of an equilibrium state, shows the very positive results.

The trend of the number of export markets shows the clear increase in export markets in numbers, indicating the increasing potential of the Lithuanian agricultural sector to sustain possible external shocks with no or marginal negative effects (Table 1). Such results clearly indicate the increasing economic resilience of the researched sector.

Although, the number of export markets is a quite popular indicator of economic resilience indices (Angeon & Bates, 2015), in our opinion, from a risk management and resilience evaluation perspective, it is not very correct to assess only the number of export markets as a main indicator, as it does not show the weight of export to each market, or the dependency on it, and how dangerous it is from the resilience perspective. Taking into account the above mentioned, we have chosen to add the fourth, derivative, indicator.

Looking into the results of export risk market values (R_m), a positive trend in lowering the number of risky export markets of the Lithuanian agricultural sector can be noticed. The only negative short term slant can be noticed during the period from 2008 to 2012, caused by global economic recessions' influencing the desperate search of markets for agricultural production. Faced with such a challenge, Lithuanian agricultural producers accepted the risk of dependency on a few export markets in order to generate the much needed revenues to finance their operations. The secondary, but equally important reason for such a decision, was the inability to freely access the financial resources required for maintaining everyday operations (Rajnoha *et al*., 2016), as during the financial crisis dominating Lithuanian banks of Scandinavian origin began to extract capital from the Baltic States to home markets, creating the deficit of free accessible short term loans . If we do not take into account this short period of time, we can state that the trend showing the number of risky export markets of agricultural products of Lithuanian origin is very positive, indicating the growing resilience of the Lithuanian agrarian sector as a whole.

By applying correlation analysis to all selected indicators, it turned out that there are no strong correlations between the indicators (Table 2).

Table 2. Correlation matrix of selected indicators

Indicator	E_c	V_{oai}	N_{em}	R_m
E_c	-	0.485	-0.023	-0.355
V_{oai}	0.485	-	0.223	0.102
N_{em}	-0.023	0.223	-	-0.578
R_m	-0.355	0.102	-0.578	-

Source: *compiled by authors, 2018*

The maximum correlation value (-0.58) was between N_{em} and R_m indicators. Both of them are related to exports. Negative value is logical as it characterizes a larger distribution, i. e. the bigger number of markets (countries), the lower possibility of exported products concentration to a single market. The correlation of other indicators is lower than medium.

According to the experts, the weights were distributed as indicated in Table 3. The indicators according to their characteristics can be divided by minimizing, maximizing, following the concrete value and other.

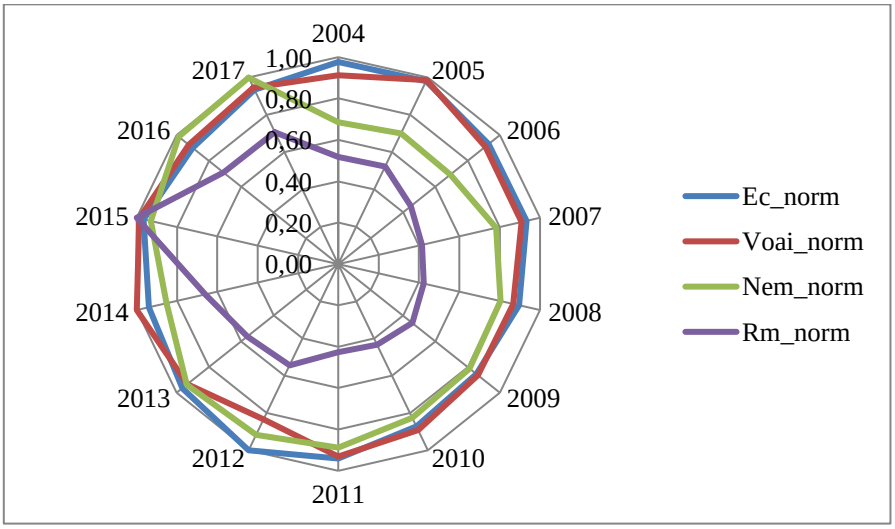
Table 3. Characteristics and weights of selected indicators

Indicators	Weights (ω)	Characteristics of the indicators
E_c	0,29	maximizing
V_{oai}	0,26	best value – 0
N_{em}	0,22	maximizing
R_m	0,23	minimizing

Source: *compiled by authors according to expert survey, 2018.*

The value of the Kendall concordance coefficient is greater than 0.5 (W=0.63), which means that expert answers are compatible.

Based on the transformations, provided in methodology, the normalized values of selected indicators – E_{c_norm}, V_{oai_norm}, N_{em_norm}, R_{m_norm} are presented in Graph 2.

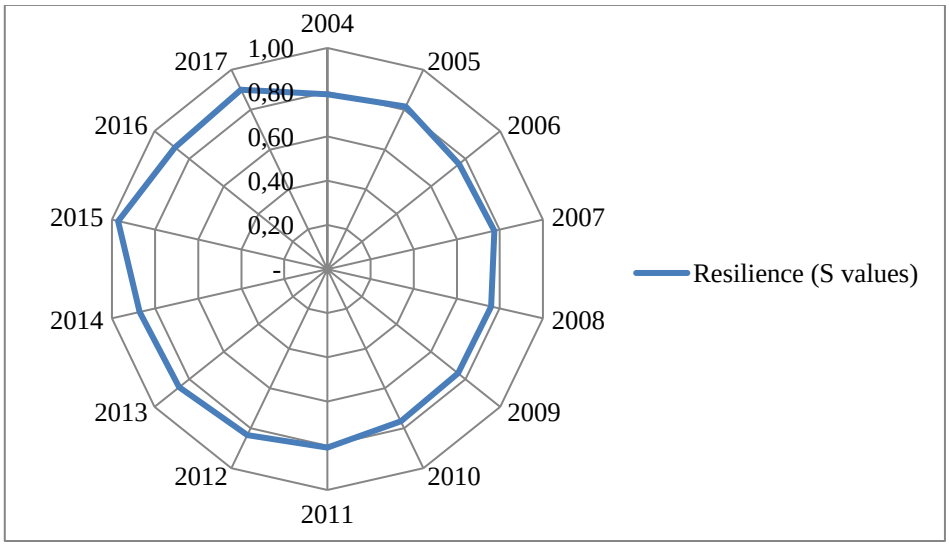


Graph 2. Normalized values of selected indicators in 2004–2017 in Lithuania.
Source: *compiled by authors*

The fluctuation and values of the normalized indicators are distributed unevenly. Particular attention is paid to the R_m indicator, which describes the risk of export markets. Its values differ more than other normalized indicators in comparison to the best value. Such a phenomenon is more characteristic of countries that concentrate a larger share of exported products on just a few (up to 3) markets.

Based on these normalised values and expert weights, using the SAW method, the agricultural sector's (incl. industries) economic resilience index was calculated, indicating that resilience in Lithuania has an increasing trend (Graph 3).

Even the crises of 2008–2009 had a mild effect on it. However, in 2014 Ukraine's territorial sovereignty crisis and the Russian embargo had a major positive impact on the search for new export markets, thus greatly improving the value of the resilience index in Lithuania in 2015. Although the value of the resistance index in later years shows a slight decrease compared to 2015, the index values of years 2016 and 2017 are greater than from the period 2004–2014.



Graph 3. Values of agricultural sector's (incl. industries) economic resilience in 2004–2017 in Lithuania.
Source: *compiled by authors, 2018*

Summarizing the results, we can state that in the period from 2004 to 2015 the economic resilience index of the Lithuanian agricultural sector increased by ¼, which is a very positive result, attributed largely to Lithuania's entrance into the EU (the number of easily accessible export markets increased significantly, the additional revenues from the same number of crop land had a positive influence due to EU financial support mechanisms to farm modernization under the CAP and etc.). After the peak in 2015, however, the resilience index took on a lower trend. It can be attributed to the allurance of more profitable, thus, more risky markets. After 2015 the shift to export concentration towards more profitable, but politically and economically unstable markets can be observed. It raises the questions about the sustainability of resilience of the Lithuanian agricultural sector.

Conclusion

The economic resilience phenomena is quite new and is being researched from different perspectives and using different measuring indicators, thus making it a scientifically important task to decide on the selection of appropriate criteria according to the specifics of the economic system researched. The new indicator to measure the inoperability – a volatility of revenues from the desired growth path has been introduced.

The created index for measuring the economic resilience of the Lithuanian agricultural sector clearly indicates the lowering vulnerability and improving resilience of the Lithuanian agricultural sector. It can be attributed to the accession into the EU and the influence of the financial support mechanisms under the CAP.

The fluctuations of the index that measures the resilience of the Lithuanian agrarian sector values show the inclination of Lithuanian agricultural producers to accept the higher risk of more profitable markets. Such a step ameliorates the financial results of Lithuanian agricultural entities, but makes them more susceptible to demand shocks in external markets, thus lowering the resilience of the whole agricultural sector. The focus towards more profitable and risky markets is so significant that it outweighs the positive influence of other researched indicators and lowers the whole resilience mark.

In order to deepen scientific insights into economic resilience phenomena, it would be viable to create an economic resilience measuring indices for all separate and specific sectors of country's/region's economy. It would not only allow us to identify the most vulnerable sectors of national/ regional economy and to stipulate appropriate decisions from the executive powers of particular region/country, but would also allow a more comprehensive comparison of the development of particular economic sectors in different countries and to precisely evaluate its perspectives.

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