REVISTA ESPACIOS

Assessment of the level of adaptability to external environment factors of Ukrainian retail trade enterprises

Evaluación del nivel de adaptabilidad de las empresas minoristas ucranianas a factores externos

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Abstract
In recent years, a high level of uncertainty and volatility of the external environment has been observed; the number and power of influence of external environmental factors on the development of retail trade enterprises of Ukraine is increasing and enhancing. As a result, the modern process of improving the management system of retail entities must be adapted to its impact. The mechanism of adaptation of the trading companies to these factors has been developed. Determinants of this adaptation capability have been defined to optimize the interaction with the indicators of the macro environment. The system of indices has been formed and the level of adaptability of Ukrainian retailersto the changes in the surroundingshas been estimated based on the methodology of fuzzy set modeling.
Keywords: Adaptation, retail trade enterprise, flexibility, mobility (reaction), stability, fuzzy set modeling, integrated index.

Resumen
En los últimos años, ha habido un alto nivel de incertidumbre y variabilidad del entorno externo, está aumentando la cantidad e intensidad de la influencia de los factores ambientales en el desarrollo de las empresas de comercio minorista en Ucrania. Como resultado, el moderno proceso moderno de mejora de la gestión de los puntos de venta debe adaptarse a la influencia de los factores ambientales. Se ha desarrollado un mecanismo para adaptar una tienda minorista a ellos. Los determinantes de las propiedades adaptativas del minorista se utilizan para identificar interacciones con factores ambientales. Se organizó un sistema de indicadores y el nivel de adaptación de las empresas minoristas ucranianas a los cambios en el entorno externo, el cual se estimó sobre la base de la metodología de modelado difuso múltiple.
Palabras clave: Adaptación, minorista, flexibilidad, movilidad (reacción), estabilidad, modelado difuso múltiple, indicador integral.

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1. Introduction

The current trends on the retail market in Ukraine are characterized by a high level of uncertainty and volatility of the external environment, the continuous increase in the number of factors and the power of their influence on the development of retail entities.

J.A. Amuzurrutia (2006), V. Grosul, O. Kruglova, O. Rachkovan (Grosul et al., 2017), V. Grosul, O. Zhyliakova (Grosul & Zhyliakova, 2015), A. Hetmantsev, I. Somina (Hetmantsev & Somina, 2013), V. Huta (2014), O. Lysenok (2013), M. Melnyk (2016), N. Prytula (2007), V. Totsenko (2005) and others gave special attention to the study of adaptation processes of enterprises in their works. The author's works reveal the basic principles of forming an enterprise adaptation system in the context of its economic security (Melnik, 2016); the problems of adaptation of entrepreneurial structures to the conditions of the environment are explored, certain aspects of forming the mechanisms of management of external and internal adaptation are revealed, and methodological approaches to the definition of the rank of the turbulence of the environment of the enterprise are proposed (Grosul & Zhyliakova, 2015).

 Their researches are dedicated to the problems of adaptation of entrepreneurial structures to the conditions of the external environment, considering some aspects of the formation of the management mechanisms of external and internal adaptation. At the same time, modern economic studies give insufficient attention to the problems of assessing the level of adaptability of the retail trade enterprise, taking into account the complexity, uncertainty, and dynamism of the external environment according to adaptation criteria: flexibility, mobility (reaction), and stability.

The purpose of this paper is to assess the level of adaptability of Ukrainian retail trade enterprises to the impact of external environmental factors on the basis of fuzzy set theory by the criteria of "flexibility", "mobility", "stability", and to identify the actual state of adaptation to obtain the real estimate of their adaptation possibilities.

2. Methodology

One of the most promising areas of research in the field of analysis, forecasting and modeling of economic phenomena and processes is "the fuzzy logic". It is a theory that is more and more used every day and with many applications of the mathematical sciences that help to present vague concepts of the real world closer to the form of expression of the human language than classical logic (Dubois & Prade, 1980). This type of logic is based on the idea that the key elements on which human thought is built are not numbers, but linguistic expressions (Wang & Bai, 2006). As a part of this theory, it is permissible to compare different models, as well as there is a possibility of quantifying the concepts of "expected", "high", "low", "probably", "unlikely". To formalize such assessments, a so-called linguistic variable is introduced, each meaning of which has a correspondent fuzzy set with its function of belonging to the factor of the given set (Hetmantsev & Somina, 2013).

Fuzzy set modeling is relevant in those conditions where it is necessary to obtain the most complete data in the absence of accurate information about the phenomenon (Hetmantsev & Somina, 2013).

According to the methodology of fuzzy set modeling, the first stage involves the formation of a system of indices for assessing the level of adaptability of retail trade enterprises to the impact of external environmental factors (Zimmermann, 2000).

During the next stage, the hierarchy for each index of the system for assessing the level of adaptability of the retail trade enterprise to the factors of the external environment G_i, M_i, S_i is determined along with the level of its significance φ_i {0;1} in such a way to comply with the following Fishburn's rule (Fishburn, 1978):

$$\phi_1 \geq \phi_2 \geq \ldots \geq \phi_\kappa$$

We note that if the system´s indices for assessing the level of adaptability of the retail trade enterprise to the factors of the external environment have different orientations, then the priority of the index G_i, M_i, S_i is determined as follows (Lysenok, 2013):

$$\varphi_i = \frac{2(l - i + 1)}{(l + 1)l}$$

where *l* is the number of indices in the ordered series.

The significance of G_i, M_i, S_i indices for assessing the level of adaptability of the retail trade enterprise to the impact of external environmental factors (φ_i) is calculated on the basis of the ranking method (Totsenko, 2005).

The third stage provides for the construction of a trapezoidal membership function (fig. 1) and the definition of subsets for a term set on the basis of a five-level classifier stated in the work of A. Nedosekin (Nedosekin, 2000).

Figure 1
The system of trapezoidal membership function of
influential factors of 01-support (Nedosekin, 2000).
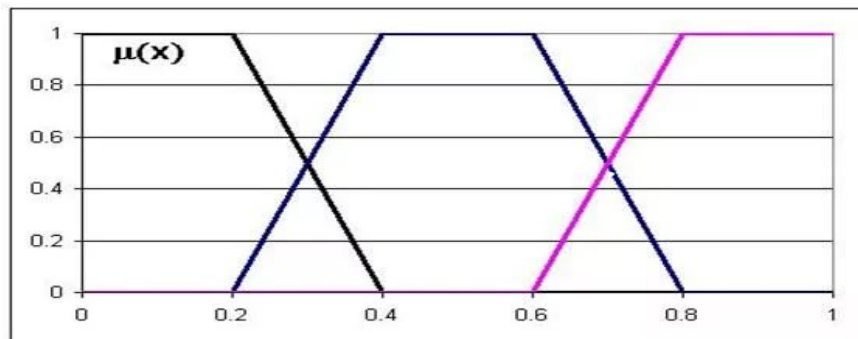
$$\mu_A(x;\, a,\, b,\, c,\, d) = \begin{cases} 0, & x \le a, \\ \dfrac{x - a}{b - a}, & a \le x \le b, \\ 1, & b \le x \le c, \\ \dfrac{d - x}{d - c}, & c \le x \le d, \\ 0, & x \ge d. \end{cases}$$

where " a" and "d" are a support of fuzzy set containing a pessimistic estimate of the values of the variable;

"b" and "c" are a kernel of fuzzy set containing an optimistic estimate of the values of the variable.

The upper base of the trapezium corresponds to the complete assurance of the expert in the membership of the relevant fuzzy subset G_i, M_i, S_i, and the lower one provides for the certainty that none of the values of the interval [0, 1] reach the selected fuzzy subset (Zadeh 1976)

At the next stage, the linguistic variable $\tilde{\omega}$ is introduced with the defined term-sets of properties divided into five levels: "very low level of G_i, M_i, S_i (DN^i) index", "low level of G_i, M_i, S_i (N^i) index", "medium level of G_i, M_i, S_i (S^i) index", "high level of G_i, M_i, S_i (V^i) index" and "very high level of G_i, M_i, S_i (DV^i) index", thus the set of selected properties $\tilde{\omega}$ is as follows:

$$\tilde{\omega} = \{G_i^{DN},\, G_i^{N},\, G_i^{S},\, G_i^{V},\, G_i^{DV}\}$$

$$\tilde{\omega} = \{M_i^{DN},\, M_i^{N},\, M_i^{S},\, M_i^{V},\, M_i^{DV}\}$$

$$\tilde{\omega} = \{S_i^{DN}, S_i^N, S_i^S, S_i^V, S_i^{DV}\}$$

A five-level classifier is calculated for each indicator for assessing the level of adaptability of a retailer to environmental factors according to which the formation of the convolution matrix is carried out, where the comparison of the value of the G_i, M_i, S_i index to the membership function of a certain fuzzy subset is conducted (Zadeh 1965), according to the trapezoidal membership, if the received value of G_i, M_i, S_i satisfies the range, then "1" is put in the matrix input put, if not, then "0".

The next stage involves an aggregation of indices that identify the level of flexibility (g), mobility (m), stability (s) in a single complex integrated index, which is found by the formula of double convolution:

$$I_{g,m,s} = \sum_{j=1}^{5} \varpi \sum_{j=1}^{n} (\varphi_i \times G_{ij}, M_{ij}, S_{ij})$$

$$(j = \overline{1, N})$$

where $\tilde{\omega}$ is the significance of a linguistic subset in a two-dimensional convolution;

G_i, M_i, S_i are current value of the ith index of the trapezoidal membership graph of the assessment of the level of adaptability of the enterprise to the impact of external environmental factors;

φ_i is significance of the ith G_i, M_i, S_i index for assessing the level of adaptability of the enterprise to the impact of environmental factors.

For the next linguistic recognition, the boundary values of the calculated indices for the determination of the generalized level of flexibility, mobility, and stability based on the application of the three-sigma rule should be substantiated, considering the right and left-hand distribution asymmetry and the correction factor "k" proposed in the paper (Prytula, 2007). Taking into account the above conditions, the range of values of the integrated index will fluctuate within the following range: [0; M -3σk]; (M −3σk ; M + 3σ(k+1)]; (M + 3σ(k+1);1], which forms the basis for determining the scale and levels of integrated indices for assessing the level of flexibility, mobility and stability, and generalized integrated index of assessment of the level of adaptability of the retail trade enterprise to the impact of external environmental factors. Thus, as a result of scaling and distribution functions, the following scale of values for the integrated index $I_{g,m,s}$ is formed (table 1).

Table 1
Boundary values of the integrated index of assessment of the level
of flexibility, mobility, and stability of the retail trade enterprise

Linguistic assessment of the level	Distribution scale	Interval value
low	[0; M -3σk]	[0;0.35]
medium	(M −3σk; M + 3σ(k+1)]	(0.36;0.71]
high	(M + 3σ(k+1);1]	(0.72;1]

Source: compiled by the authors

The final stage of assessing the level of adaptability of the retail trade enterprise to the impact of external environmental factors involves the calculation of a complex integrated index as follows (Grosul& Zhyliakova, 2015):

$$I^{AZ} = \frac{1}{2}\sin 120(I_g + I_m + I_s)$$

The ranking of the obtained value of the integrated index is based on the method of analytical grouping by Sturges (Tkach & Storozhuk, 2009):

$$i_{I^{AZ}} = \frac{I_{max}^{AZ} - I_{min}^{AZ}}{1 + 3.32 \times \lg n}$$

Where "n" is a number of observations.

This approach enables an integrated assessment of the level of adaptability of retail enterprises to the effects of environmental factors.

3. Results

The activities of retail entities are closely related to the external environment, the change of which may lead to the disintegration of the existing enterprise management system in the absence of adequate changes in the management structure itself. In these conditions, to maintain the desired level of competitiveness and efficiency of retail trade enterprises, the increase in flexibility, adaptability, and integration may be suggested. This allows the enterprises to create such a property as immunity to crisis phenomena.

Taking into account that the current external environment is characterized by a high level of uncertainty, dynamism and complexity, and whatever strategic objectives are set by retail entity management –ensuring sustainability, development, reduction, or survival- it will always have to search for means of adaptation to external environmental factors (fig. 2).

Figure 2
Mechanism of adaptation of the retail trade Enterprise
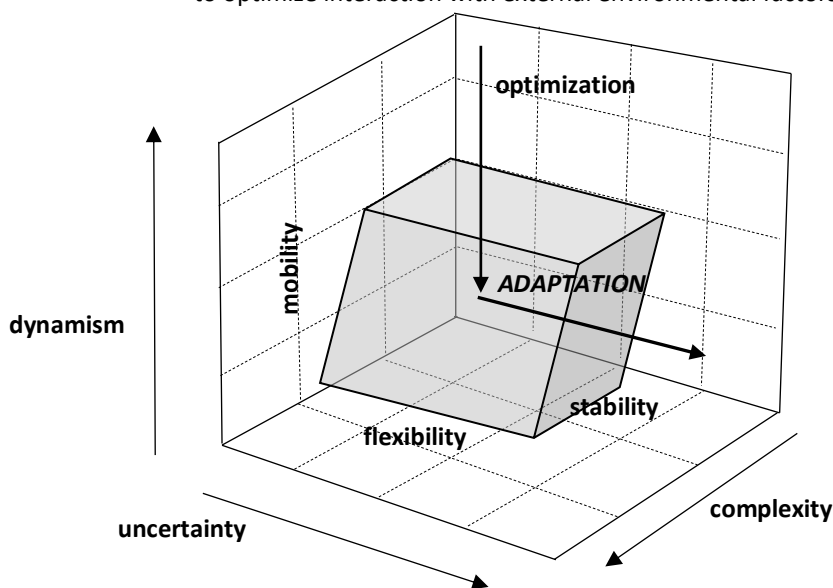to the external environmental factors
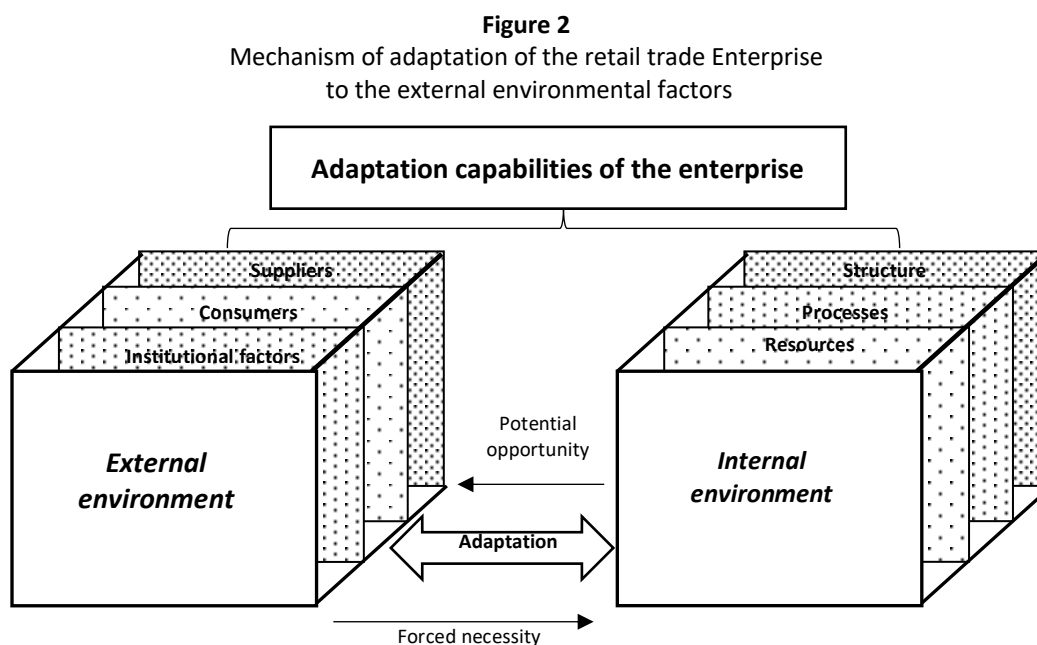
Source: compiled by the authors

The state of the external environment creates the conditions to which the retail trade enterprise must adapt in order to ensure that it has the appropriate level of competitiveness in the market, and the internal environment of the enterprise determines the possibilities to mobilize the necessary resources to achieve the desired level of competitiveness (Grosul, Kruglova & Rachkovan, 2017).

One of the most optimal approaches to assessing the level of adaptability of an enterprise to the factors of the external environment, which allows eliminating this shortcoming- is the application of the system of assessment indices that must meet the adaptation criteria, namely: flexibility, mobility (reaction), and stability. Such an approach to the formation of a system of indices makes it possible to determine the equilibrium position of the retail trade enterprise based on the calculation of the specified characteristics of the external environment (fig. 3).

Figure 3
Determinant adaptation properties of the retail trade enterprise
to optimize interaction with external environmental factors.

Source: compiled by the authors

For example, a retail trade enterprise operates under a high level of uncertainty and complexity of the external environment. To maintain the necessary level of competitiveness, it must have the ability to adapt flexibly to the situation; the reversed situation is also correct. Under such conditions, the appropriate level of adaptability of the retail trade enterprise can be determined only by taking into account the key characteristics of the external environment and adaptation of the enterprise.

Figure 3 confirms the need to adhere to the criteria for adaptation, namely flexibility, mobility and sustainability, during the development of a system of indices, for assessing the level of adaptability of retail trade enterprises to changes in the external environment under constant complexity, uncertainty and dynamism. This approach makes it possible to assess the response of the retail trade enterprise to internal and external changes, and characterizes its level of protection against the negative impact of external environmental factors. At the same time, mobility (reaction) is one of the main adaptability properties of the enterprise, since the experience and qualification of management personnel determine the time when the measures responding to external factors will be taken, and the extent to which the monitoring of factors of a complex external environment will be carried out in detail; stability is an integral part of the enterprise's adaptation, since the efficiency of the process of adapting to changes in external environmental factors depends on the enterprise's ability to maintain its equilibrium position under the influence of the criteria of dynamism and uncertainty.

Taking into account these requirements, the following system of indices for assessing the level of adaptability of retail trade enterprises to changes in the external environment is proposed (table 2).

Table 2
The system of indices for assessing the level of adaptability of
retail trade enterprises to changes in the external environment

Criteria requirements	Signs
Flexibility	
diversification ratio of the main commodity products	G_1
diversification ratio of the main markets	G_2
index of the potential for mobilizing financial resources	G_3

income reinvestment ratio	G_4
structural flexibility ratio	G_5
level of the product line update	G_6
level of competitiveness	G_7
repeated appeals of consumers ratio	G_8
level of consumer awareness	G_9
sales channels efficiency ratio	G_{10}
level of constancy of suppliers	G_{11}
Mobility (reaction)	
index of production efficiency of managerial expenses	M_1
index of economic efficiency of managerial expenses	M_2
level of initiative activity of the personnel	M_3
level of ability to proactive vision and planning	M_4
level of ability to improve trade business processes guiding by the principles of lean production	M_5
level of innovation orientation of the enterprise	M_6
ratio of economic efficiency of communication tools for the promotion of goods / services	M_7
level of qualification of management personnel	M_8
level of efficiency of marketing communications	M_9
finished products excess ratio	M_{10}
Stability	
autonomy ratio	S_1
ratio of stock availability with own working capital	S_2
financial stability ratio	S_3
financial tension ratio	S_4
ratio of financial stability fluctuations and organizational structure	S_5
ratio of reinvestment of net profit into development	S_6
ratio of maneuverability of equity capital	S_7
current liquidity ratio	S_8
growth ratio of the economic value of the enterprise	S_9

Source: compiled by the authors

The developed system of indices for assessing the level of adaptability of retail trade enterprises to changes in the external environment (table 2) integrates holistically three groups of indices that integrate key adaptation properties (flexibility, mobility and stability) into the external environmental factors, taking into account the specific sectorial features of the retail business, and makes it possible -on the basis of the established level of adaptability- to determine the possible zones of the state of adaptation, in consideration of the properties of uncertainty, complexity and dynamism.

Considering that business owners constantly need information not only about the degree of the adaptability to the external environment in comparison with competitors, but also about their real and actual level of adaptability, there is a need to calculate an integrated index that consists of uncertainty factors.

Considering the main characteristics and properties of the external environment (complexity, mobility, uncertainty and interdependence of factors), the use of the approach engaging the apparatus of fuzzy logic and fuzzy sets to solve the task of assessing the level of adaptability of retail trade enterprises to the factors of the external environment is justified.

To determine the level of adaptability of the retail trade enterprise to the impact of the external environmental factors on the basis of the theory of fuzzy logic, the boundary values of the integrated index for assessing the level of adaptability of the retail trade enterprise to the impact of the external environmental factors have been defined (table 3).
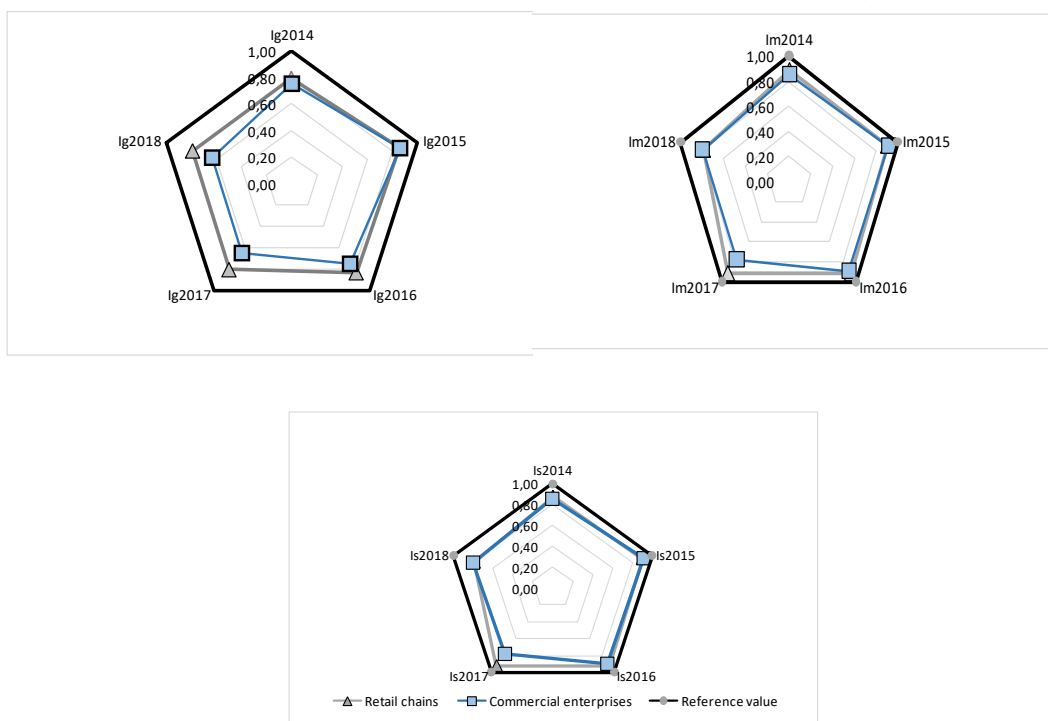
Table 3
Boundary values of the integrated index for assessing the level of adaptability
of the retail trade enterprise to the impact of the external environmental factors.

Integrated index for assessing the level of adaptability of the enterprise	Level	Zone of adaptation to the impact of the external environmental factors	Description
$I^{AZ} \geq 0.82$	High (V)	Zone of high state of adaptation (ZVA)	the enterprise uses capabilities for adaptation to the factors of the external environment as productive as possible
$0.81 \geq I^{AZ} \geq 0.61$	Medium (S)	Zone of normal state of adaptation (ZDA)	the value of one or several adaptation determinants has come close to a certain limit of their capability; the enterprise's adaptation policy is focused on preventive solutions
$0.60 \geq I^{AZ} \geq 0.31$	Low (N)	Zone of inflexible state of adaptation (ZNA)	the enterprise is not able to actively adapt to the changing factors of the external environment, while there are signs of irreversibility of the decline in sales and partial decline in potential
$I^{AZ} \leq 0.30$	Irretrievable (K)	Zone of crisis state of adaptation (ZKA)	the enterprise does not meet the requirements of the external environment, the indices of adaptation are low, with the present decline in sales and total loss of potential

Source: compiled by the authors

In order to determine the level of adaptability of the retail trade enterprises to the impact of the external environmental factors, a sample of retail trade enterprises was formed. The first group includes retail entities that meet the criteria of network structures, and the second group includes enterprises that do not belong to network structures, but which in terms of turnover belong to large enterprises. The graphic interpretation of the results of calculations of integrated indices is given in figure 4.

Figure 4
Average values of integrated indices of retail trade enterprises by the criterion of "flexibility" (I_g),
"mobility" (I_m), "stability" (I_s) for the period 2014-2018 (compiled by the authors).

Source: compiled by the authors

This graphic interpretation (fig. 4) makes it possible to conclude that retail chains and supermarkets are more stable, flexible and mobile than commercial enterprises, which is confirmed by the balance of all criteria and the strive to come to the reference value; at the same time, the commercial enterprises are less flexible and mobile since integrated values are asynchronous during 2014 – 2018.

Thus, the calculated integrated indices of retail entities, according to the criteria of "flexibility", "mobility", "stability", provided the analytical basis for further determination of the complex integrated indicator of assessment of the level of adaptability of the enterprise to the impact of the external environmental factors (table 4), and also allowed making conclusions regarding its qualitative level (fig. 5).
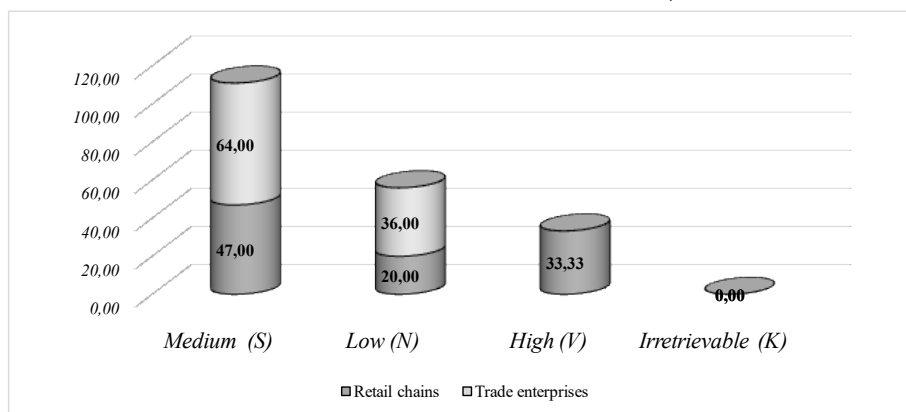
Table 4
Results of calculation of integrated indicator of assessment of the level of adaptability
of retail trade enterprises to the impact of the external environmental factors.

Item No	Enterprise	I^{AZ}_{2014}	I^{AZ}_{2015}	I^{AZ}_{2016}	I^{AZ}_{2017}	I^{AZ}_{2018}	Rate of change (% 2018; until 2014)	Rate of change (% 2018; until 2017)
				Retail chains and supermarkets				
1	C_1	0.70	0.76	0.75	0.78	0.72	103.57	92.09
2	C_2	0.67	0.80	0.51	0.51	0.40	59.90	77.89
3	C_3	0.72	0.79	0.71	0.76	0.85	117.27	111.31
4	C_4	0.81	0.72	0.68	0.59	0.55	67.79	92.25
5	C_5	0.78	0.76	0.78	0.82	0.84	107.93	102.73
6	C_6	0.58	0.52	0.82	0.82	0.76	131.67	92.46
	Average value	0.71	0.72	0.71	0.71	0.69	98.02	94.79
				Commercial enterprises				
1	T_1	0.72	0.82	0.66	0.66	0.72	99.88	108.99
2	T_2	0.69	0.76	0.72	0.56	0.73	105.99	130.52
3	T_3	0.66	0.58	0.72	0.69	0.63	96.15	91.58
4	T_4	0.74	0.79	0.69	0.65	0.58	78.77	90.45
5	T_5	0.64	0.70	0.70	0.56	0.41	63.93	72.68
6	T_6	0.71	0.69	0.47	0.36	0.35	49.51	96.86
	Average value	0.69	0.72	0.66	0.58	0.57	82.37	98.51

Source: compiled and calculated by the authors

Figure 5
The structure of retail trade enterprises by assessing the level of adaptability
to the factors of the external environment, %.

Source: compiled and calculated by the authors

Analyzing the general trends of the dynamics of the integrated indicator of the assessment of the level of adaptability to the impact of the external environmental factors (table 4, fig. 5), general conclusions can be made,

namely: during 2014-2018, the value of the integrated indicator determined for retail chains is 0.69 in 2018, which is 1.98% more than in 2014, and 5.21% more than in 2017. The results of the calculation indicate that for 50% of the studied retail chains the value of the integrated indicator for the period 2014–2018 gradually decreased by 9.29%. A similar trend of reducing the level of adaptability to the impact of the external environmental factors was found for commercial enterprises. During 2014–2018 the integrated index dropped by 17.06% and amounted to 0.58 in 2018. The analysis shows that 64% of enterprises had an average level of adaptability, and 36% of them had a low level of adaptability.

An analysis of the data presented in figure 6 evidences that 16.66% of retail trade enterprises operate in a supportive environment and have a high level of adaptation, as they are in the zone of high adaptation; 41.6% of enterprises have a medium level of adaptation and are in the zone of normal adaptation; the remaining 41.6% of retailers have a low level of adaptation to external factors as they are in the zone of inflexible adaptation. 53.4% of retail trade enterprises are experiencing constant turbulent changes in the environment and are not able to react promptly to them, as the enterprise management system and its business processes are not flexible.

Figure 6
Results of a qualitative assessment of the level of adaptability of retail trade
enterprises to the impact of the external environmental factors in 2018
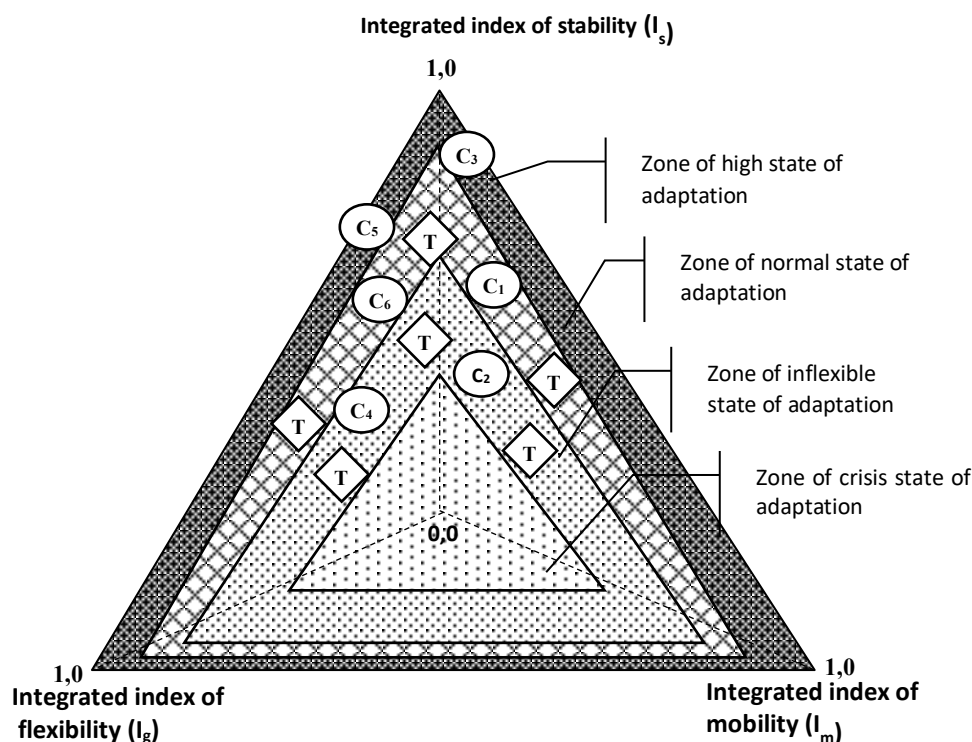
Source: compiled and calculated by the authors

Thus, the analysis of the definition of the level of adaptability is the ground for the development of measures for the management of retail trade enterprises which consider the impact of the factors of the external environment. At the same time, the ability of enterprises to implement adaptive changes play an important role in assessing the adaptive capacity and implementation of the adaptation strategy, which makes it expedient to assess the state of their adaptability.

4. Conclusions

The proposed approach to assess the level of adaptability of retail trade enterprises to the impact of the external environmental factors on the basis of the fuzzy set theory made it possible not only to determine the level of adaptability in numerical form, but also to obtain a qualitative assessment with a linguistic description. This

contributes to the increase on the reasonability of managerial decisions when determining the areas of growth the level of adaptability of retail trade enterprises to the impact of environmental factors.

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