

ASSESSMENT OF THE RELATIONSHIP BETWEEN FARM SIZE AND FLEXIBILITY: THE CASE OF UKRAINE

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Abstract

High flexibility is a necessary criterion for an agricultural business to survive in an uncertain environment characterized by chaotic dynamics and an increasing pace of innovation as well as by various weather and market risks. The purpose of this research is to assess and benchmark the flexibility level of differently sized agricultural enterprises. Such research methods as standardization and integrated evaluation (to define the partial and integrated flexibility coefficients), correlation and regression analysis (to assess the interrelation between the farm size and flexibility) as well as techniques of mathematical statistics (to benchmark the flexibility level of agricultural companies varying in size) have been used in this study. It has revealed that the bigger the enterprise is, the more strategic flexibility it has. However, its structural flexibility and the value of the integrated flexibility coefficient are independent of the company size. Smaller agricultural enterprises are less strategically flexible compared to their larger counterparts due to limited resources.

Key words: agricultural enterprise, flexibility assessment methodology, flexibility, operational flexibility, structural flexibility, strategic flexibility.

JEL Codes: Q01, Q12, Q14.

Introduction

High flexibility is essential for an agricultural enterprise to survive in a harsh environment characterized by chaotic dynamics and an increasing speed of innovation. Highly flexible and environmentally adaptable companies are the only ones able to pursue long-term development under unpredictable conditions. Flexibility is topical for agricultural enterprises which both face the risks common to all businesses (economic, fiscal, market, political and other risks) and are susceptible to uncertain climatic and weather conditions. Consequently, there arises a scientific challenge to assess and monitor the level of agricultural enterprise flexibility as well as to identify the features, properties and abilities allowing companies to adapt and develop in an unstable environment.

The object of this research is the agricultural enterprise flexibility. It is a feature of a business (an enterprise in particular) which describes its ability to predict changes in the operational environment and to react to them effectively, thus ensuring resilience of the system (Skydan, Nykolyuk, Pyvovar, Martynchuk, 2019).

The subject of the research covers methodological aspects of the agricultural enterprise flexibility assessment.

Methodological Approaches to Enterprise Flexibility Assessment. Enterprise flexibility as an economic category is characterized by structural complexity, multi-aspectual nature, vague context, and consequent multi-dimensionality. The past two decades have witnessed development of quite a few methodological approaches aimed at assessing the flexibility of economic entities (Sherehiy, Karwowski, & Layer, 2007).

R. Giachetti, L. D. Martinez, O. A. Sáenz and C.-S. Chen note that results of flexibility assessment cannot be used in strategic business planning (Giachetti, Martinez, Sáenz, & Chen, 2003). The scholars have two reasons for this. First, there are too many points (indicators) of flexibility assessment which are contradictory sometimes. Second, the concept of “enterprise flexibility” is rather vague, and this makes it impossible to quantify some of its features. Therefore, it is necessary to validate feasibility of the methodological approach which would not suffer from the drawbacks mentioned above and would be fully consistent with the content of enterprise flexibility.

The team of scientists led by W. Royce suggests taking four steps as a foundation stone of the methodology aimed at assessing any object, process or phenomenon. These steps include 1) assessment of the current state of the system (“as-is” assessment), 2) forecast of the quantitative characteristics of the system’s target state (“to-be” assessment), 3) development of the “roadmap” to make transition from the current state (“as-is”) to the target one (“to-be”), and 4) monitoring and continuous improvement of the process to achieve the target state (Royce, 2011). Y. Gong and M. Janssen emphasize the importance of following the first two steps to assess the flexibility of an enterprise (Gong & Janssen, 2010).

Having reviewed various sources of literature, we can conclude that most researchers build the system of flexibility indicators taking into account either a) the factors of flexibility, or b) the elements or levels of the flexibility structure. S. L. Goldman, R. N. Nagel and K. Preiss state that enterprise flexibility is determined by a set of dimensions. These include the ability to a) meet consumer needs, b) cooperate to increase competitiveness, c) anticipate changes in the environment, and d) attract the necessary labor and information resources (Goldman, Nagel, & Preiss, 1995).

R. J. Vokurka and G. Fliedner as well as R. Dove define the flexibility metrics (points of assessment) within such dimensions of flexibility as cost, time, quality and scope of activity (Dove, 1996; Vokurka & Fliedner,

1998). This approach presupposes substantiation of performance indicators for each dimension as well as their quantitative measurement. C. Yauch mentions that assessment of turbulence (uncertainty) of the environment and the success of an enterprise should be added to the flexibility assessment structure (Yauch, 2011). The uncertainty factors are consumers, suppliers, competitors, government bodies, natural and climatic factors, etc. while the success factors are financial and efficiency indicators of the production processes. The factors listed above are assessed through one or more indicators within each dimension of flexibility.

Another approach claims that flexibility is ensured by the ability to predict external changes and adapt to them in advance. Structural approach to flexibility assessment is used in this case. This approach has flexibility indicators other than those quantifying the flexibility factors or providing a quantitative assessment of its structural components. Researchers usually distinguish three types of enterprise flexibility. These are operational, structural, and strategic flexibilities (van der Weerd, 2009; Volberda, Verwaal, & van der Weerd, 2006). C. Yang and H.-M. Liu promote a structure based on the three types of flexibility associated with responsiveness to the changes in the a) consumer, b) supplier, and c) competitive environment (Yang & Li, 2002).

Flexibility of a company is often tied to the concept of “dynamic capabilities” having a system with hierarchical structure (Grant, 1996; Winter, 2003; Teece, 1997). Their structuring is determined by the level of change required to implement a certain dynamic capability. Adaptation of the basic routine business processes is carried out at the lower (zero) and operational levels. Transformations associated with zero- and operational-level capabilities do not involve changes in the existing organization structure and in the goals of the system. Concurrently, these capabilities usually lead to bigger changes, particularly to reconfiguration of the resource base, changes in the line of business, and adaptation of the organization structure to

new conditions (Helfat et al., 2009; Winter, 2003).

The ability to radically change the area of business activity and the business goals is related to the structural capabilities of the company. Strategic capabilities (e. g., change of the product range, strategy, nature of interaction with competitors, etc.) usually occur at a relatively high pace. However, they entail major enterprise transformations (van der Weerd, 2009). Each corresponding type of flexibility (i. e., operational, structural and strategic flexibility) is formed within each of the capability groups listed above. If the company features dynamic capabilities relevant to a particular group (e. g., structural capabilities), it means that it has achieved a sufficient level of flexibility of the corresponding type (structural flexibility).

Van der Weerd and P. Niels researched the factors affecting different types of enterprise flexibility. They indisputably proved that the main factors of flexibility are the technologies used (they influence operational, structural and strategic flexibility), the enterprise structure (it concerns structural and strategic flexibility) as well as the culture and informatization of the processes (they affect strategic flexibility) (van der Weerd, Niels P, Volberda, Verwaal, & Stienstra, 2012). Generally, the bottom line of the two approaches described above is integration of the quantitative points of assessment for the enterprise flexibility factors (the first approach) or its structural elements into a single synthetic coefficient using formalized methods (Kumar & Motwani, 1995) or operation algorithms with fuzzy sets (Lin, Chiu, & Chu, 2006; Tsourveloudis & Valavanis, 2002; Yang & Liu, 2012).

Enterprise Flexibility Lines of Research

The lines of research of enterprise flexibility are determined by scientific hypotheses formulated by the researchers. These hypotheses mainly involve finding

a tight correlation between the indicators that form the triangle “Flexibility Factors → Flexibility Indicators → Results of Business Operation”. Having analyzed the relationship between the enterprise flexibility, network structure and productivity, Ch. Yang and H.-M Liu state that highly flexible companies are characterized by high productivity and active networking (with connectivity significance of more than 0.99) (Yang & Liu, 2012).

The way the size of a business entity affects its flexibility is one of the most widely explored lines of research of enterprise flexibility (Bercovitz & Mitchell, 2007; Boeker, 1991; Kraatz & Zajac, 2001). For example, W. Boeker believes that high flexibility is more common to large enterprises than to the smaller ones (Boeker, 1991). J. B. Quin and S. McDonald contradict this idea and claim that small enterprises are the only ones able to respond to the changes in the environment quickly, and therefore they are highly flexible (Macdonald, 1995; Quinn, 1987). C. Han states that medium-sized companies are the most flexible ones (Han, 2001). His hypothesis rests upon H. Haveman’s findings: large enterprises are over-bureaucratized, and therefore they are unable to adapt quickly, while small businesses lack sufficient resources to do this (Haveman, 1993). C. Han, while proving the hypothesis is plausible for financial and credit institutions, discovered that medium-sized enterprises are more flexible if flexibility is treated as their ability to respond to changes and resist them as well as to pool up resources (Han, 2001). However, large enterprises are flexible in terms of improving their business processes thanks to having access to vast resources. Finally, C. Han concludes that small enterprises are unable to change and restructure their business activities efficiently due to the lack of resources.

To sum up the ideas presented above, we can conclude that the studies have varying results. Additionally, the above-mentioned methodological approaches do not take into account how the agricultural enterprises operate and do not reckon with specific indicators of their activities. The findings associated with the relationship between enterprise flexibility and size should be validated for the companies investigated in this study, namely for the agricultural enterprises.

Purpose. The study showing how the size of agricultural enterprises affects their flexibility has been conducted using the example of Ukrainian agricultural producers. Ukraine is an agricultural country. More than 10 % of its GDP was accrued through agricultural production. Agricultural exports accounted for 44 % of Ukraine's total exports in 2019. Farming lands occupy about 69 % of the country's territory.

The agricultural business in Ukraine is diverse, and its agricultural companies vary both in business model and size. The area of cropped lands utilized by the agricultural companies ranges from one hectare to tens of thousands of hectares. Despite the fact that the share of large enterprises does not exceed 0.1 % when compared to the total number of companies in the market, they account for

more than 12 % of the total added value in the agricultural sector. The share of large agricultural enterprises with farming lands in Ukraine made 1.5 % of the total number of enterprises in 2019 while their share of gross agricultural production was almost 30 %. Agricultural enterprises are acutely vulnerable to both national and global crises. Ukraine has witnessed two crises over the last two decades: the 2008–2010 global financial and economic crisis and the 2013–2015 crisis caused by the escalation of the armed conflict in eastern Ukraine and the annexation of Crimea. Both were accompanied by rising inflation, and its level reached 122 % in 2008, 124.9 % in 2014, and 143.3 % in 2015.

Figure 1 shows that the profits of Ukrainian agricultural enterprises decreased significantly over the first and second years of the crises. Consequently, there was a decrease in the cost of agricultural products during the second year of the crises caused by the drop in profits in the previous year. The reason for the gross output decrease was lower yield of the main agricultural crops (grain, sugar beet and sunflower) in Ukraine. These crops are grown mainly by the agricultural enterprises. It should be noted that the weather conditions were rather favorable for farming in the 2009–2010 and 2014–2015 periods.

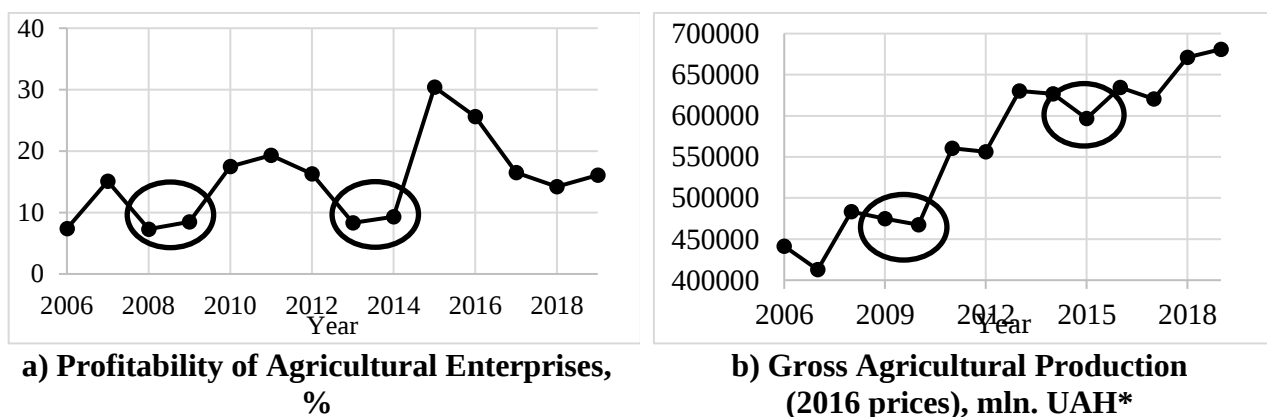


Figure 1. Dynamics of Main Operational Indicators: Ukrainian Agricultural Enterprises
(Source: calculated using the data provided by the State Statistics Service of Ukraine)

* The exchange rate in 2019 was USD 1.00 to UAH 25.80.

The price of fuel was witness to a significant rise due to the 2008–2010 crisis. The prices of almost all agricultural food items decreased in the world and domestic markets

while the loan rates went up to 18–35% per annum (it was rather common for the first quarter of 2009, i. e. when the preparations for the spring planting were under way). It was

accompanied by a huge gap between the price of agricultural products and the cost of fuel and mineral fertilizers as well as by the limitation on the foreign currency purchase. These issues eventually increased the outflow of foreign capital from Ukraine.

Taking into account the state of things, it is obvious that there appeared the need to adapt to the new management conditions as quickly and efficiently as possible. The ability to overcome global crises is associated with high enterprise flexibility.

The article advances the *hypothesis saying that the size of the agricultural company affects its flexibility*. This study concentrates on testing this theory while its purpose is to assess and compare the flexibility level of differently sized agricultural enterprises. The following tasks have been set up to achieve this: 1) to develop a methodological approach to the agricultural enterprise flexibility assessment, 2) to make a quantitative assessment of their flexibility, and 3) to analyze the relationship between the farm size and flexibility.

Research Methods

Methodological foundation of the study lies in the systematic approach to investigation of the economic processes, objects and phenomena. Taking into account the scope of work outlined above, the following research methods have been used: standardization, scoring and integrated assessment (to estimate partial and integrated flexibility coefficients) as well as statistical (to provide descriptive analysis of the results obtained after the flexibility assessment is complete) and regression analysis (to test the hypothesis promoting the relationship between the size of agricultural companies and their flexibility).

The research is carried out to examine the hypothesis claiming that there is a relationship between the size and flexibility of agricultural enterprises. There are two approaches to the distribution of agricultural producers based on their size. Land resources are the bedrock of agricultural activity, and therefore the area of cropped lands is often considered to be a criterion of classification.

However, this approach does not take into account specialization of the enterprises involved in livestock and dairy production (they could have a large number of farm animals, yet operate a small farm).

The distribution of producers by size is based on the classification of agricultural enterprises defined by the laws of Ukraine. It incorporates all the size indicators of the agricultural companies (On approving Methodological..., 2011).

Methodological provisions for the organization of state statistical observation in the agricultural sector define large and medium-sized enterprises as agricultural businesses having their size indicators equal to or exceeding the thresholds provided below (On approving Methodological..., 2011).

These threshold values include the area of cropped lands (200 hectares), the number of farm animals (50 heads) and poultry (500 heads), the number of employees involved in agricultural activities (20 people), and the amount of income (revenue) from the agricultural product sales, works and services (UAH 150 thousand)¹.

Some strategic company decisions to adapt to the new business conditions could be accompanied by a short-term yet significant decrease in the sales revenue during the crisis period. This means that a large/medium-sized company which did not face changes in the volume of available resources during the crisis

¹ UAH 150 thousand = USD 5 814 acc. to the average UAH to USD exchange rate in 2019.

period and had an insignificant income drop could become a medium-sized/small enterprise. However, effective implementation of the anti-crisis strategy could result in its recovery and cash inflow within 1–2 years. Additionally, revenues of the company focused on selling livestock products would be minimal for the first few years of its operation. We suggest that the size of such an enterprise should be determined by its livestock population. That is why the amount of sales revenues should not be taken into account when the company size is determined. The studied region does not have large poultry farms, and the number of poultry is also excluded from the company distribution by size. It is advisable to determine the size of an agricultural enterprise using this formula:

$$V = \begin{cases} \text{low, if } S < 100 \text{ and/or } L < 50 \text{ and } W < 10 \\ \text{average, if } (100 \leq S < 500 \text{ and/or } 0 \leq L < 100) \\ \text{or } (0 \leq S < 500 \text{ and/or } 50 \leq L < 200) \text{ and } W < 50 \\ \text{high, if } S \geq 500 \text{ and/or } L \geq 200 \text{ and } W \geq 50, \end{cases} \quad (1)$$

where S – area of cropped lands; L – number of farm animals; W – number of employees.

The numbers in (1) are the values of the criteria determining the size of the agricultural companies. These have been established by the Statistics Committee of Ukraine (On approving Methodological..., 2011). The study involved 363 agricultural enterprises operating in Zhytomyr region (Ukraine). This accounts for approximately 38 % of the study population. The analysis covers the 2007–2010 period.

Research Results

Agricultural Enterprise Flexibility Assessment Methodology

The approach developed by H. Volberda, E. Verwaal and N. Weerdt has been taken as a starting point for the assessment of the agricultural enterprise flexibility. The researchers distinguish three types of flexibility, namely the operational, structural and strategic one (Volberda et al.,

2006). The study utilizes specific features of the flexibility types mentioned above. The list of these characteristics depends on the features of Ukrainian agricultural business activities as well as on the national statistical data. These types of flexibility are integrated into the overall flexibility of the enterprise which is estimated using an integrated flexibility coefficient. Operational flexibility is characterized by the ability of the company to adapt to the changes in the environment by improving its existing business processes and adapting them to the new conditions. The use of new technologies, raw materials and supplies, equipment, etc. would be an example of such adaptation. Cost stability is the key indicator of high operational flexibility. Generally, economic crisis processes are accompanied by an inflation surge leading to the increase in prices of raw materials, supplies and finished goods. Significant cost reduction means that a violation of a technological process or a drop in production volumes takes place in most of these cases. This can be hardly treated as effective cost control under such circumstances. Therefore, producers whose indicators, which reflect specific costs and the cost structure, barely change during global transformations should be treated as the companies having high operational flexibility.

It makes sense to use the cost per unit of gross agricultural output as the indicator of operational flexibility rather than using the total costs. The cost per unit of output is the indicator inverse to resource productivity. This incorporates the cost per unit of gross agricultural output, the labor costs (the number of employees) per unit of gross agricultural output, the area of cropped land per unit of gross crop production, and the livestock per unit of livestock production. The indicators of operational flexibility also include structural cost indicators such as the share of direct costs (including the cost of seeds, fodder, fuel, services provided by other organizations, etc.), labor and fuel costs, and the relative share of the total direct costs against the overall company costs. Methods of standardization help convert these indicators into non-dimensional comparable values which are further integrated into the single integrated

coefficient of operational flexibility. The methodology to assess the integrated flexibility is described in detail below.

Structural flexibility is associated with structural business transformations which occur at the level of resource provision, production, sales, management, etc. First and foremost, this means a change of the agricultural production structure. Flexible agricultural enterprises usually introduce structural changes to their product range to grasp new resource opportunities and meet the market needs. They respond to serious financial, economic and market challenges this way. It is therefore recommended to use the indicators showing the production structure to assess the structural flexibility of the company. These indicators include the shares of certain types of agricultural products. The following indicators of strategic flexibility are used in this study: 1) the relative share of the harvested area for each particular crop against the total harvested area; 2) the relative share of crop production and animal husbandry against the total costs; 3) the relative share of income from agricultural services against the total revenue.

Strategic flexibility is associated with the ability to change business strategies and objectives in a timely fashion to meet new business conditions. Companies with high strategic flexibility can either have their economic performance indicators unchanged (during financial and economic crises) or increase them (if a significant market transformation takes places). A rigid enterprise would likely have its operation reduced significantly (up to incurring heavy losses), or would face bankruptcy and liquidation. The indicators of strategic flexibility include the level of business profitability in general as well as the crop production and animal husbandry profitability; the amount of profit per unit of land resources; and the indicator showing the profit increase obtained through respecialization (specialization efficiency).

The indicator of specialization efficiency was determined using the method suggested by V. Andriichuk (Andriichuk, 2002):

$$\Delta = P_1 - \left(\sum_{i=1}^n s_i^0 p_i^1 + \sum_{j=1}^m g_j^0 p_j^1 \right), \quad (2)$$

where s_i^0 – cropped area of the i -crop in the base year; p_i^1 – profit per 1 hectare of the i -crop in the current year; g_j^0 – livestock inventory of j -species; p_j^1 – profit per 1 head of j -species in the current year; P_1 – mass of profit in the current year; n, m – the number of crops and livestock species respectively.

The index for the profit increment was calculated using the formula:

$$I_{\Delta} = \begin{cases} 0, & \text{if } \Delta_i < 0 \\ \frac{\Delta_i}{\alpha \max \Delta}, & \text{if } \Delta_i \geq 0 \end{cases}, \quad (3)$$

where Δ_i – value of the profit increment of the i -enterprise; α – the coefficient allowing for the negativeness of the profit increments: $\alpha = \begin{cases} 0, & \text{if } \Delta < 0 \\ 1, & \text{if } \Delta \geq 0 \end{cases}$.

The study of enterprise flexibility should be based on benchmarking analysis of the company's speed and effectiveness to respond to negative external challenges. The benchmarking is carried out against the enterprise itself in the previous period. Therefore, a specific condition is applied for the purpose of this research. It is implied that fundamental changes (mostly negative ones) should take place during the selected period, and all the objects of the studied population must adapt to them. The period between 2007 and 2010 has been chosen for the study. It coincided with the global financial and economic crisis. The assessment is based upon the hypothesis that the most flexible enterprises were able to fully recover or even improve their business results during that period.

Enterprise flexibility is associated with the ability to both forecast and adapt to economic transformations. The study period is subdivided into two timeframes: 2007–2008 (when the crisis was forecast to happen) and 2009–2010 (when businesses fully experienced its effects). Two indices are calculated for each of the selected periods with each indicator of operational, structural and strategic flexibility in mind. The indices for the 2007–2008 period demonstrate the ability to forecast negative changes in the environment while the 2009–2010 period shows how the companies effectively respond to these changes.

The indices obtained are summarized into synthetic flexibility indicators through standardization and integrated evaluation. Consequently, a three-level system of indicators is created: level 1 – indices of the flexibility indicators for the 2007–2008 and 2009–2010 periods; level 2 – synthetic coefficients of operational, structural and strategic flexibility; level 3 – generalized synthetic coefficient of agricultural enterprise flexibility. In-depth analysis of the ability of the reviewed enterprises to adapt to external challenges was based on descriptive statistical data of the flexibility indicators.

The main issue while calculating the flexibility indicators for a large population of companies lies in the fact that there would probably be division by zero. This is possible for such operational flexibility indicators as cost amount, area of agricultural lands, and livestock inventory per 1 UAH¹ of the sales revenue (if the costs are incurred, and land resources and livestock are utilized, but the products are not sold); relative share of the harvested area in terms of crops as well as the cost of crop and livestock conversion into marketable products (if the enterprise is not involved in relevant activities); level of profitability – the net profit to the total costs ratio (when the costs make 0 or the company does not carry out relevant activities); and profit per 1 hectare of the farming lands (when a business entity does not have land resources).

Traditional formulas used to calculate the indicators of enterprise flexibility have been modified to overcome this issue. Logical approach is used – if the denominator equals 0, the following options are possible:

a) flexibility indicator equals the numerator (for costs per 1 UAH of the sales revenue);

b) flexibility indicator equals 0: 1) for the area of farming lands and livestock inventory per 1 UAH of the sales revenue; 2) when the company is not involved in relevant activities, meaning both the numerator and the denominator have zero values – for the number of employees per 1 UAH of the sales revenue; 3) when the company does not cultivate crops – for the relative share of the harvested area of the main crops against the total harvested area; 4) when it is economically inactive and its total costs (which are equal to the costs of crop production and animal husbandry) make 0 (for the relative share of the costs of crop production and animal husbandry against the total production costs as well as for the share of the revenue obtained from providing services against the total revenue); 5) when the enterprise makes profits but does not have farming lands (for the amount of profit per 1 hectare of land);

c) flexibility indicator equals either 0 (if business activity is not carried out) or equals the numerator (if the numerator differs from 0 and the denominator is equal to 0) – for profitability levels.

The same issue occurs when you calculate the indices if the values of the flexibility indicators equal zero during the base years (2007 and 2009). This is especially relevant for flexible enterprises which changed their production structure during the financial and economic crisis and started producing novel agricultural goods. Taking into account the fact that it is impossible to divide by 0, the index formula is as follows:

¹ The exchange rate in 2019 was USD 1.00 to UAH 25.80.

$$I_{ik} = \begin{cases} 1, & \text{if } p_{ik}^b = p_{ik}^l \\ p_{ik}^l, & \text{if } p_{ik}^b = 0 \\ \frac{p_{ik}^l}{p_{ik}^b}, & \text{if } p_{ik}^b \neq p_1 \text{ and } p_{ik}^b \neq 0 \end{cases} \quad (4)$$

where I_{ik} – index of the k flexibility indicator which corresponds to the i flexibility component; p_{ik}^l, p_{ik}^b – value of the indicator corresponding to the i flexibility component in the last (2008 or 2010) and base year (2007 or 2009) respectively.

It is worth noting that the indicator for a particular type of product remains unchanged if the flexibility indicators and their indices equal zero. This means that the enterprise failed to respond to external challenges by introducing changes to the production or marketing process. However, production of the other types of goods at this company could undergo major changes. Therefore, zero value of the flexibility indicators and/or their indices does not imply that the company has low flexibility in general.

Indices of the flexibility indicators are standardized at the next stage of assessment, and standardized coefficients are determined hereat. They can take values from 0 to 1. One of the easiest ways to determine the standardized coefficients is to use the following formulas (5):

$$\begin{aligned} k_{ik}^+ &= \frac{I_{ik} - I_{ik}^{\min}}{I_{ik}^{\max} - I_{ik}^{\min}}; & \text{– for stimulating} \\ & & \text{indices with high} \\ & & \text{values denoting high} \\ & & \text{flexibility;} \\ k_{ik}^- &= \frac{I_{ik}^{\max} - I_{ik}}{I_{ik}^{\max} - I_{ik}^{\min}}, & \text{– for destimulating} \\ & & \text{indices that have to} \\ & & \text{be as low as} \\ & & \text{possible,} \end{aligned} \quad (5)$$

where k_{ik}^+, k_{ik}^- – respective standardized coefficients for the stimulating

and destimulating indices for the k -indicator which corresponds to the i flexibility component; I_{ik} – index of the k - indicator which corresponds to the i flexibility component; $I_k^{\max}, I_k^{\min}$ – maximum and minimum values of the k - indicator for the entire population.

The next stage involves checking the sample population and excluding the outliers. The index values for the shares of the harvested areas of each individual crop against the total harvested area can be distributed through the $[0; +\infty]$ interval. If the index is less than 1, the area of the corresponding crop has decreased. If it is more than 1, the cropped area has increased. If the index of the share of the harvested area equals 1, it means that it has not changed. Bigger area changes mean that the company has higher flexibility. However, both the increase and the decrease must be taken into account. The indices of the share of the harvested area were converted into scores to calculate the coefficients of operational flexibility. It is recommended to use the following logical formula (6) for this:

$$B_{ik} = \begin{cases} 1, & \text{if } I_{ik} = 1 \\ 2, & \text{if } 0,8 < I_{ik} < 1 \text{ or } 1 < I_{ik} < 1,4 \\ 3, & \text{if } 0,4 < I_{ik} < 0,6 \text{ or } 1,6 < I_{ik} < 1,8 \\ 4, & \text{if } I_{ik} < 1 \text{ or } I_{ik} > 2 \end{cases} \quad (6)$$

where B_{ik} – numerical index score of the k -indicator corresponding to the i flexibility component.

There is no need for scoring the other indices because they cannot take very high or very low values. Integral coefficients of flexibility are calculated using the formula for the arithmetic mean:

$$K_i^f = \frac{\sum_{k=1}^n k_{ik}}{n} \quad (7)$$

$$K^f = \frac{\sum_{i=1}^3 K_i^f}{3}, \quad (8)$$

where K_i^f – integrated coefficient of the i -type flexibility; K^f – integrated coefficient of enterprise flexibility; n – the number of indices-indicators of the i -type flexibility.

Analysis of the relationship between the agricultural enterprise size and its flexibility has been carried out in two stages. The first stage involves preparation of the descriptive statistical data for the agricultural companies. It is calculated using the coefficients of operational, structural and strategic flexibility as well as the integral coefficient. The data is further benchmarked for small, medium-sized

and large enterprises. The second stage, dedicated to the testing of the size-to-flexibility hypothesis, involves regression analysis. Simple linear regression with one regressor was used in this study. It depicts the linear model of the relationship between the company size and each flexibility coefficient. The independent variable is the enterprise size estimated on the scale of 1 to 3 (1 point – small enterprise, 2 points – medium-sized enterprise, 3 points – large enterprise).

Figure 1 shows the generalized scheme of the enterprise flexibility assessment methodology.

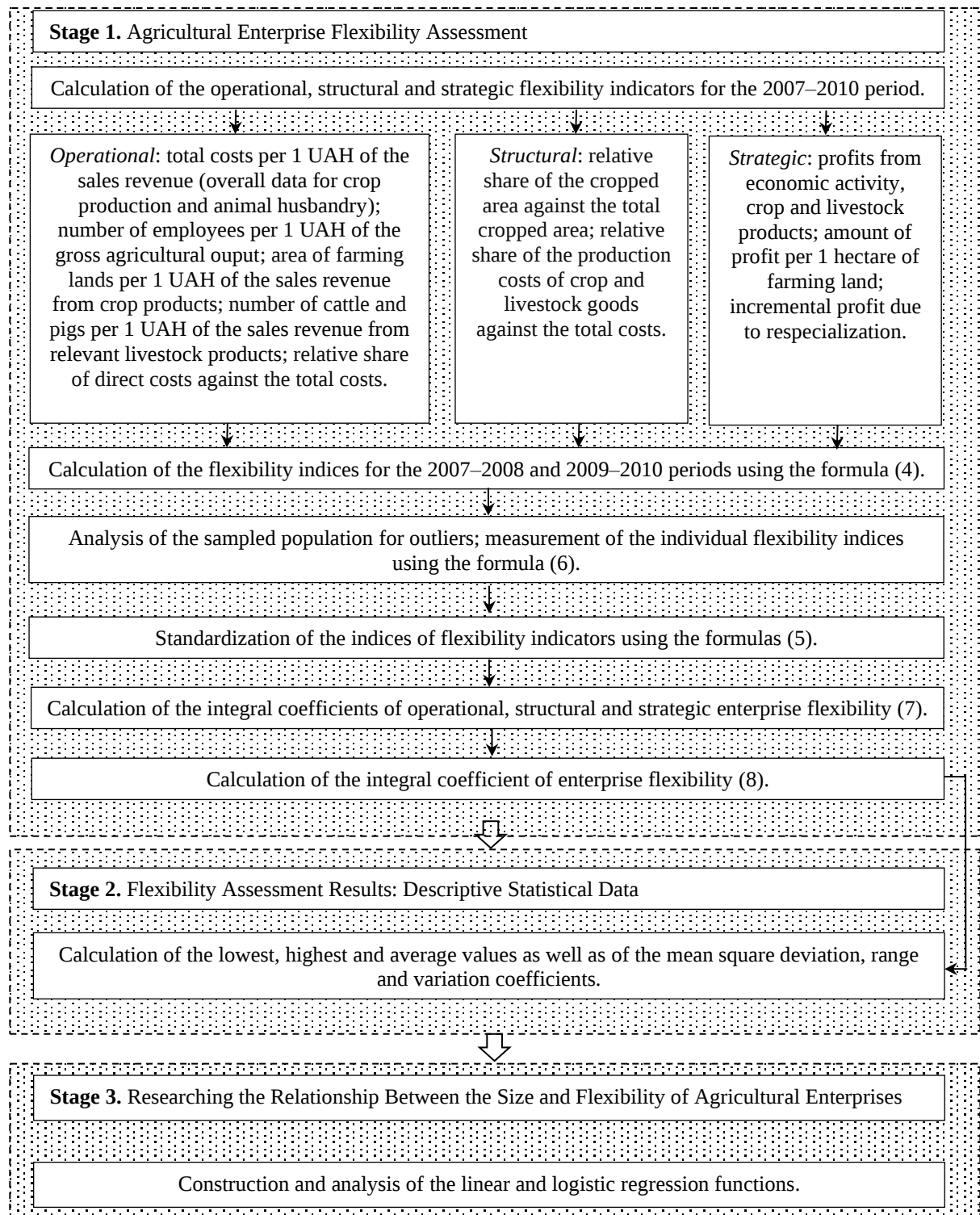


Figure 1. Agricultural Enterprise Flexibility Assessment Methodology

–Agricultural Enterprise Flexibility: Post-Assessment Results

Testing of the research methodology used in this study involved 363 agricultural companies operating in Zhytomyr region (Ukraine) during the 2007–2010 period. Descriptive statistical data of the flexibility coefficients of these enterprises have been analyzed, and we may draw the following conclusions (Table 1):

1) values of the structural and strategic flexibility coefficients are much lower than the values of the operational flexibility coefficient. This means that agricultural enterprises are mostly unable to 1) quickly react to adverse external conditions by optimizing their production structure, and 2) are unable to

maintain the current level of financial and economic efficiency during global crises;

2) agricultural enterprises were able to keep the indicators of resource intensity and cost structure at a relatively stable level during the crisis;

3) significant variation range is quite common for strategic and structural flexibility coefficients. However, the coefficients of variation for all types (except the strategic flexibility one) are low, and this indicates their low variability within the studied population;

4) due to the fact that the coefficients of variation for all flexibility indicators are low (less than 30 %), the studied population is homogeneous. The average values of these coefficients are typical and depict the real state of the population.

Table 1. Agricultural Enterprise Flexibility Coefficients: Descriptive Statistical Data
(Source: report on the main economic indicators of agricultural enterprises' activity)

Statistical characteristic	Flexibility coefficient			Integral flexibility coefficient
	Operational	Structural	Strategic	
Mean value	0.77	0.39	0.40	0.52
Median	0.76	0.39	0.39	0.52
Mode	0.82	0.39	0.39	0.53
Mean square deviation	0.06	0.04	0.02	0.03
Coefficient of variation, %	8.16	11.10	5.83	5.50
Lowest value	0.56	0.28	0.26	0.44
Highest value	0.95	0.57	0.51	0.60
Variation range	0.39	0.29	0.25	0.16
Variation range to lowest value ratio, %	69.55	104.68	95.00	36.85

* The level of reliability makes 95 %.

The same analysis was conducted for small, medium-sized and large agricultural producers to examine how they react to external challenges. These enterprises were classified according to the quantitative estimate of their size which was obtained using the expression provided (1). The mean value of the integrated flexibility coefficient is almost the same for all companies regardless of their size (see Table 2).

Small, medium-sized and large enterprises have significant differences in terms of homogeneity. This applies to the

structural and strategic flexibility coefficients: the values of the variation coefficients for large agricultural enterprises are 94 and 307 % higher than for the small ones. Large companies have the highest values of the relative variation range of the structural and strategic flexibility coefficients as well. This allows us to claim that there are “atypical” companies among the large enterprises, and those have flexibility coefficients that are much higher and/or lower than the average ones.

Table 2. Flexibility Coefficients of Differently Sized Agricultural Enterprises: Descriptive Statistical Data

Statistical characteristic	Size of agricultural company			Deviation of large from small ones, %
	Small	Medium-sized	Large	
Operational Flexibility Coefficient				
Mean value	0.77	0.78	0.75	-3.02
Mode	0.79	0.83	0.83	1.42
Coefficient of variation, %	6.40	8.82	6.88	-33.12
Variation range	0.18	0.39	0.30	-15.85
Relative deviation of the highest value from the lowest one, %	26.89	64.40	45.35	-21.16
Structural Flexibility Coefficient				
Mean value	0.39	0.39	0.39	-1.28
Mode	0.39	0.39	0.37	-4.30
Coefficient of variation, %	7.83	10.41	12.24	56.26
Variation range	0.16	0.23	0.29	82.29
Relative deviation of the highest value from the lowest one, %	44.74	69.78	86.66	93.71
Strategic Flexibility Coefficient				
Mean value	0.39	0.39	0.41	3.34
Mode	0.39	0.39	0.39	0.00
Coefficient of variation, %	2.08	4.67	6.68	220.88
Variation range	0.04	0.22	0.16	318.70
Relative deviation of the highest value from the lowest one, %	10.59	71.29	43.14	307.39
Integral Flexibility Coefficient				
Mean value	0.52	0.52	0.51	-0.84
Mode	0.53	0.54	×	×
Coefficient of variation, %	4.12	5.97	5.06	22.85
Variation range	0.10	0.16	0.13	28.99
Relative deviation of the highest value from the lowest one, %	22.08	35.76	27.46	24.36

Source: report on the main economic indicators of agricultural enterprises' activity

Small, medium-sized and large agricultural enterprises were grouped according to the level of their integrated flexibility coefficient for the purposes of further analysis. Taking into account the variation range of the flexibility coefficient, intervals for the three groups of differently sized enterprises have been defined:

– small enterprises: low flexibility – up to 0.54; average – 0.54–0.58; high – more than 0.58;

– medium-sized enterprises: low flexibility – up to 0.54; average – 0.54–0.60; high – more than 0.60;

– large enterprises: low flexibility – up to 0.56; average – 0.56–0.60; high – more than 0.60.

The smallest share of low-flexibility producers is typical for small enterprises. It makes 3.7 %, which is 24.4 p. p. lower than the large enterprises and 7.7 p. p. lower than the medium-sized ones (see Table 3). The share of highly flexible producers is much bigger among small companies. It is 43.7 p. p. higher

than the one of the large enterprises and 20.3 p. p. higher than the one of the medium-

sized companies. Producers with high integral flexibility prevail among smaller businesses.

Table 3. Agricultural Enterprise Structure: Distribution by Integral Flexibility Coefficient
(Source: report on the main economic indicators of agricultural enterprises' activity)

Groups by level of integral flexibility coefficient	Share of enterprises in the group against their total number, %			Deviation of large from small ones, p. p.
	Small	Medium-sized	Large	
Low level	3.70	11.36	28.13	24.42
Average level	40.74	53.41	60.00	19.26
High level	55.56	35.23	11.88	-43.68

Simple regression models with a single explanatory variable show that there is a tight relationship between the enterprise size and its operational flexibility (see Table 4). This is confirmed by the fact that the absolute value of the test statistic (3.92) is greater than the critical value for the 0.05 degree of freedom (1.64). The relationship between the operational flexibility and the company size is non-positive. This means that smaller enterprises have higher operational flexibility. This happens because the decision-making process (e. g., a change of the production structure) is much easier for small enterprises than for the large ones. For instance, bigger companies have a more complex management structure, and many more people are involved in decision-making. Managerial decisions on urgent changes to the production processes have to be agreed by multiple managers at

different levels in a large company. These managers usually work in different cities and even regions of Ukraine. However, two people – the agriculturist and the company CEO – are usually enough to make relevant decisions in a small enterprise. This cuts the time and resources needed to implement the decision drastically.

Nevertheless, large enterprises are more strategically flexible. One of the reasons for this is that they (especially the vertically integrated agricultural holdings) have access to significantly larger amounts of financial resources (both their own and credit ones). It is important because the money can be received very quickly if needed while small businesses cannot achieve this. This means that large companies are able to attract additional finance and quickly direct it to crucial business areas in times of need.

Table 4. Flexibility Indicators and Enterprise Size: Regression Analysis Results
(Source: report on the main economic indicators of agricultural enterprises' activity)

Statistical characteristic	Regression coefficient			
	Operational	Structural	Strategic	Integral
(Intercept)	0.8191	0.3958	0.3741	0.5296
Regression coefficient	-0.0220	-0.0027	0.0099	-0.0049
t-value*	-3.92	-0.67	4.81	-1.89
p-value	0.0001	0.5010	0.0000	0.0595

*The t statistic critical value for the 0.05 degree of freedom equals 1.64.

An inverse linear relationship between the company size and the operational flexibility coefficient has been discovered as well. The smaller the enterprise, the stronger its ability to keep the values of its resource intensity and cost structure constant is. Lack of the tight relationship between the company size and the structural flexibility coefficient

indicates that business of any size can respond to external challenges in a timely manner by changing its production structure. Similarly, insignificance of the linear and logistic regression applied to model the integrated flexibility coefficient suggests that company size is not the key factor for predicting the

changes in the environment and adapting to them effectively.

Regression analysis was applied to determine how the company size affects its ability to forecast negative changes in the environment. The coefficient of flexibility estimated using the 2008–2009 indices served as the explanatory variable. It has been proved that smaller enterprises are less capable of forecasting negative changes (the p-value for respective regression is 0.0000). However, there is no connection between the size of agricultural enterprises and their ability to react to negative changes. This conclusion stems from statistically insignificant regression of the integral coefficient of flexibility (based on the 2009–2010 indices) with regard to the company size. It means that small enterprises can become more flexible by improving their forecasting capabilities.

Conclusions

Enterprise flexibility is associated with its ability to forecast changes and adapt to them in a timely and effective way. Quantitative assessment of the enterprise flexibility is carried out by measuring its three components (operational, structural and strategic). Application of the flexibility indicators determined through expert assessment is a commonly shared feature of most existing methodologies. The issue related to the assessment of the agricultural company flexibility remains under-investigated. Distinctive feature of the methodological approach suggested in this study comes from the fact that it uses financial and economic indicators of agricultural enterprises, and these values are not subjective. The assessment methodology is based on the indicative data which is collected by statistical authorities. This makes the procedure for initial data

collection much easier and allows to analyze large populations of agricultural enterprises.

The study has proved that there is still room for discussion as to which agricultural enterprises are more flexible. This differs from the other findings (e.g., Macdonald 1995; Quinn 1987; Boeker 1991) because flexibility of the agricultural companies has its own features. The larger the size, the lower the level of the company's operational flexibility is. This is generally caused by complex hierarchical management systems that larger enterprises have. Consequently, decisions on urgent changes necessary to reduce production costs and eliminate negative consequences of inflation are amiss. To sum it up, large agricultural companies have to find alternative ways to improve interaction at the management level. First of all, the rigid multi-level management hierarchy, used by vertically integrated holding structures, should be reformed.

The larger the enterprise is, the higher level of strategic flexibility it has. This is confirmed by the results of the regression analysis. Large companies have access to necessary resources which must be accumulated quickly and in large quantities during crises. These findings confirm that wider access to additional resources (especially financial ones) is expedient for smaller companies. This means that small businesses could become more strategically flexible but it would be difficult to do this on their own. They should have better access to additional financing, and this can be achieved through financial market improvements and introduction of the corresponding government regulations. Large enterprises have to focus on increasing their operational flexibility. Establishment of a decentralized management system with a more autonomous decision-making process would be one of the ways to achieve this.

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