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MAIN WAYS TO INCREASE INVESTMENT EFFICIENCY OF AGRICULTURAL SECTOR DEVELOPMENT

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Abstract. *The purpose* of the article is to identify ways to increase investment efficiency of the agricultural sector, identify factors influencing the formation of investment potential of the sector, which will outline the components of investment support models for the development of the agricultural sector. *Methodology*. The expediency of using the method of principal components is proved, which will solve the problem, because, unlike others, it allows to combine disparate indicators, is able to identify a sufficient number of characteristic factors in factor analysis and has other advantages over simple methods of factor analysis. The initial data were the indicators of investment activity of the agricultural sector of Ukraine for the period 2017–2022. The calculations were performed using the software product Statistica 10.0. *Results*. The use of the main components method allowed to identify four main directions of improving the investment efficiency of the agricultural sector, in particular, "investment architecture", "balancing the investment product", "investment climate" and "stimulating investment activity". *Practical implications*. The practical significance of the results is short- and medium-term prospects, the success of the new system of investment support for agricultural development will combine infrastructure for investment and the formation of growth points that are attractive to investors and eliminate barriers to investment between investors and Ukrainian companies. *Value/originality*. The new model of investment support for the development of the agricultural sector will have the above components and will provide a rationale for choosing priority areas of investment, investment sources, investor selection, identifying investment instruments, forecasting investment for the new period with analysis of previous performance.

Key words: investments, investment support, development, investment architecture, balancing of investment product, investment climate of stimulation of investment activity, agrarian sector.

JEL Classification: Q14, Q19, E22, E27

1. Introduction

Investment security is one of the main factors of effective development of the agricultural sector, however, the investment environment is characterized by variability, stagnation and the presence of sustainable bifurcations, which certainly constrain the development of the agricultural sector. The current state of investment support of the agricultural sector of Ukraine does not allow to ensure further growth and development of agrarian business, which is why the search for new conditions for expanding investment opportunities of agricultural enterprises is particularly important, including by building a model of investment support for the agricultural sector. will help restore the reproductive process in the agricultural sector. The new model of investment support for the development of the agricultural sector aims to intensify investment activity, accelerate the response to changes in the investment climate and timely implementation of appropriate structural changes in investment potential, accordingly, the use of on the array of data used and ensure the identification of common generalizing features of the studied category.

2. Methodology for determining areas

Determining the priority areas for improving the efficiency of investment in the agricultural sector requires exemption from subjective assessment, grouping a large number of factors that determine the development of the agricultural sector and mathematically justified, which is why we consider it reasonable to use the method of main components. it allows you to combine disparate

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indicators, is able to identify a sufficient number of characteristic factors in factor analysis and has other advantages over simple methods of factor analysis.

The principal components method is to obtain the values of each feature by linear combinations in the form of the sum of the contributions of common factors and, mathematically, can be represented as follows (Andrienko, Samisko, 2008):

$$Z_j = a_{j1} \times F_1 + a_{j2} \times F_2 + ...a_{jr} \times F_r + d_j U_j,$$
$$j = \overline{1,n}, \quad R \angle p, \qquad (1)$$

where, Z_j – j – the studied feature (random value); F_1, F_2, …, F_r – common factors (random values, normally distributed), common to all signs; u_j – characteristic factor ; a_{j1}, a_{j2}, …, a_{jr} – factor loads that characterize the significance of the influence of each factor (show the contribution of the corresponding factor in the sign *Z j*); d_j – loading of the characteristic factor only for a sign *Z j*.

Accordingly, formula 1 is a normal multiple regression equation, where the independent variables are the factors *Fk* $\left(k = \overline{1,r}\right)$ and the dependent variable is the sign *Zj*.

General factors are essential for the analysis of all features, and the characteristics show that it applies only to this j-th feature, this specificity of the feature can not be expressed through the factors *Fk*.

The essence of this method is to construct factors – the main components, each of which represents a linear combination of initial features. The first main component *F1* determines the direction in the space of initial features, along which the set of objects (points) has the largest scatter (variance). The second main component *F2 is* constructed in such a way that its direction is orthogonally directed to *F1* and it explains as much as possible of the residual variance, etc. up to the *r-th* main component *Fr*.

The selection of the main components is in descending order in terms of the variance they explain, the features that are included in the first main component with coefficients a_{j1}, $j = \overline{1,m}$, have the maximum influence on the differentiation of the studied objects (Dubrov, 1979).

On the other hand, since each factor is determined by interrelated features, they can be represented as a linear combination of features (Soshnikova, Tomashevich, Webe, Schaefer, 1999):

$$F_k = w_{k1}Z_1 + w_{k2}Z_2 + ... + w_{kn}Z_n, \quad k = \overline{1,r}, \qquad (2)$$

where, $w_{kj}\left(j = \overline{1,n}\right)$ – factor load of factor *Fk* on the sign *Zj*.

Factor loads are analogs of correlation coefficients that characterize the degree of relationship between the relevant features and factors: the greater the absolute value of the factor load, the stronger the relationship of the feature *Zj* with the factor *Fk*, the greater the contribution of the feature to the factor. the action of the relevant factor.

Using the principal components method implemented in the software product Statistica 10.0, we will identify a small number of factors that most significantly affect the initial characteristics.

It is possible to find the main components under the condition of the significance of the correlation matrix, which is checked using the Bartlett test (Bolch, Huan, 1979):

$$\chi^2 = -\left[n - (1/6)(2p+5)\right]\ln|R,| \qquad (3)$$

which is distributed χ^2 $v = p(p-1)/2$ degrees of freedom.

Thus, we consider it justified to use the method of principal components to determine the main ways to increase investment efficiency of the agricultural sector.

3. Practical approaches to investment development

The first step in applying a certain method is to study the cumulative eigenvalues and the proportion of total variance that explains each component. As a result of calculations in the Statistica 10.0 package, based on the initial data, four factors were identified that explain 100.0% of the variability of the initial indicators that characterize the efficiency of investment support for the development of the agricultural sector (Table 1).

Table 1
Eigenvalues of the initial factors of investment efficiency of the agricultural sector

Value number	Eigenvalue	Total variance, %	Cumulative Eigenvalue	Cumulative, %
1	7,66	54,75	7,66	54,75
2	3,93	28,09	11,60	82,84
3	2,03	14,49	13,63	97,33
4	0,37	2,67	14,00	100,00

Eigenvalues of correlation matrix, and related statistics

The eigenvalue of the first dependent variable is 7.66; the share of total variance 54.75%; cumulative eigenvalue 7.66; cumulative variance 54.75%. The eigenvalue of the second dependent variable is 3.93; the share of total variance 28.09%; cumulative eigenvalue 11.60; cumulative variance 82.84%. The eigenvalue of the third dependent variable is 2.03; the share of total variance 14.49%; cumulative eigenvalue 13.63; cumulative variance 97.33%. The eigenvalue of the fourth dependent variable is 0.37; the share of total variance 2.67%; cumulative eigenvalue 14; cumulative dispersion 100%.

It is possible to determine the rational number of principal components by using the scree-test criterion or the Kaiser criterion, accordingly, the calculation of the initial correlation matrix showed that four of the initial eigenvalues are important because they have one or more units and explain in total 100.0% of the cumulative variance.

The obtained general coefficients of relative importance of influence on the main factors of investment support of agricultural sector development allow to determine the following indicators influencing the formation of the first main component: positive impact *E 1.8* (share of agricultural sector in GDP, %), which is 0.9371; *C.2.1* (number of employees, thousand persons) 0.9770; *Ek 3.2* (level of plowing of agricultural lands, %) 0.7521; *Ek 3.5* (coefficient of ecological stability, units) 0,3359; *Ek 3.6* (anthropogenic load factor, units) 0.1877; *I 4.5* (bank loans (including foreign) and other loans) 0.3091; *B 5.1* (agricultural lands, thousand hectares) 0.8814; *B 5.6* (capital intensity) 0.7890; *B 5.8* (profitability of production, %) 0.3826, the values of other indicators are negative: *E 1.6* (volume of exports of agricultural products thousand US dollars) -0.9291; *E 1.7* (volume of imports of agricultural products thousand US dollars) -0.9680; *C.2.2* (average salary in the industry) -0.9753; *C.2.3* (direct labor costs, UAH million) -0.9534; *B 5.2* (sown area, thousand hectares (agricultural crops)) -0.9168; *B 5.3* (value of fixed assets, million UAH) -0.9186. Thus, the first main component that affects the investment support of the agricultural sector should be defined as "investment architecture".

The formation of the second main component is influenced by: *E.1.3* (current liquidity ratio) value is 0.7921; *E 1.5* (return on equity) 0.7113; *E 1.6* (volume of exports of agricultural products thousand US dollars) 0,2013; *Ek 3.2* (level of plowing of agricultural lands,%) 0,6572; *I 4.4* (own funds of enterprises and organizations) 0.1348; *I 4.6* (funds of domestic investment companies, funds, etc.) 0.4220; *B 5.6* (capital intensity) 0.6097; *B 5.7* (volume of production (gross output), thousand tons) 0.2272, however, taking into account the negative values of other indicators of factors influencing the investment support of the agricultural sector, namely: *Ek 3.5* (coefficient of environmental stability, units) -0.9174; *Ek 3.6* (anthropogenic load factor, units) -0.9298; *I 4.5* (bank loans (including foreign) and other loans) -0.9288; *B 5.8* (profitability of production, %) -0.8576, it seems appropriate to justify the second main component as "balancing the investment product".

The formation of the third main component determines the value of the following indicators: *E.1.1* (volume of sold products (plant. + goods) UAH million) 0.4708; *E 1.7* (volume of imports of agricultural products thousand US dollars) 0.2330; *C.2.2* (average salary in the industry) 0.2131; *C.2.3* (direct labor costs, UAH million) 0.2349; *I 4.1* (capital investment in agriculture, UAH million) 0.5484; *I 4.4* (own funds of enterprises and organizations) 0.6320; *I 4.6* (funds of domestic investment companies, funds, etc.) 0.3843; *I 4.7* (funds of foreign investors) 0.4057; *I 4.8* (other sources of funding) 0.9544; *B 5.1* (agricultural lands, thousand hectares) 0.2219; *B 5.2* (sown area, thousand hectares (agricultural crops) 0.3686; *B 5.3* (value of fixed assets, million UAH.) 0.3731; *B 5.7* (production volume (gross output), thousand tons) 0 , 5972; *B 5.8* (profitability of production, %) 0,2239, with negative values are: *Ek 3.1* (share of investment in protection and rational use of natural resources, %) -0,9638; *Ek 3.3* (volume of mineral fertilizers on 1 ha of sown area, tons. -0.8025; *E 1.4* (coefficient of financial stability) -0.8057, which allows to define this main component as "investment climate".

The fourth main component is formed under the influence of the following indicators: *E.1.3* (current liquidity ratio) 0.2044; *E 1.8* (share of agricultural sector in GDP, %) 0.1373; *C.2.4* (labor capital) 0.4503; *Ek 3.6* (anthropogenic load factor, units) 0.3027; *I 4.1* (capital investment in agriculture, UAH million) 0.7249; *I 4.2* (state budget funds, UAH million) 0.4930; *I 4.3* (local budget funds, UAH million) 0.7738; *I 4.4* (own

funds of enterprises and organizations) 0.7602; *I 4.6* (funds of domestic investment companies, funds, etc.) 0.3667; *B 5.1* (agricultural lands, thousand hectares) 0.2792; *B 5.8* (profitability of production,%) 0.2609 and negative values: *B 5.5* (return on assets) -0.5393, *B 5.7* (volume of production (gross output), thousand tons) -0.2802, *E 1.6* the volume of exports of agricultural products (thousand US dollars) -0.2855, which determine the fourth main component as "stimulating investment activity".

4. The results obtained

Thus, the formation of the first main component, defined as "investment architecture" can be represented as a linear relationship:

$$F_{InAr} = -0,9291E_{1.6} - 0,9680E_{1.7} + 0,9371E_{1.8} + 0,9770C_{2.1} - 0,9753C_{2.2} - \ldots$$
$$-0,9534C_{2.3} + 0,7521E\kappa_{3.2} + 0,3359E\kappa_{3.5} + 0,3091I_{4.5} + 0,8814B_{5.1} - \ldots \quad (4)$$
$$-0,9168B_{5.2} - 0,9186B_{5.3} + 0,7890B_{5.6} + 0,3826B_{5.8}$$

The formation of the second main component "balancing the investment product / balancing the investment product" has the following linear relationship:

$$F_{B.In\,\mathrm{Pr}} = 0,7921E_{1.3} + 0,711E_{1.5} + 0,6572E\kappa_{3.2} - 0,9298E\kappa_{3.6} + 0,1314I_{4.4} - \ldots$$
$$\ldots - 0,9298I_{4.5} + 0,4220I_{4.6} + 0,6097B_{5.6} + 0,2272B_{5.7} - 0,8576B_{5.8} \quad (5)$$

The linear dependence of the third main component "investment climate" is as follows:

$$F_{In.Cl} = 0,4708E_{1.1} - 0,8571E_{1.4} + 0,2330E_{1.7} + 0,2131C_{2.2} + 0,2349C_{2.3} - 0,9638E\kappa_{3.1} - \ldots$$
$$\ldots - 0,8025E\kappa_{3.3} + 0,5484I_{4.1} + 0,3843I_{4.6} + 0,4057I_{4.7} + 0,9544I_{4.8} + 0,2219B_{5.1} + \ldots \quad (6)$$
$$\ldots + 0,3686B_{5.2} + 0,3731B_{5.3} + 0,5972B_{5.7} + 0,2239B_{5.8}$$

The formation of the fourth main component, defined as "stimulating investment activity" is presented in the form of the following linear relationship:

$$F_{Ct/In.Ac} = 0,2044E_{1.3} - 0,2855E_{1.6} + 0,1373E_{1.8} + 0,4503C_{2.4} + 0,3027E\kappa_{3.6} + 0,7249I_{4.1} + \ldots$$
$$\ldots + 0,4930I_{4.2} + 0,7738I_{4.3} + 0,7602I_{4.4} + 0,3667I_{4.6} + 0,3667I_{4.6} + 0,2792B_{5.1} - 0,5393B_{5.5} - \ldots \quad (7)$$
$$\ldots - 0,2802B_{5.7} + 0,2609B_{5.8}$$

The obtained results allow to build a system of linear dependences of the influence of certain main components *(Fn)* on the investment support of the agricultural sector *Z* in the *i-th* period, which will be as follows:

$$\begin{cases} Z_{2017} = 5,651F_1 + 3,073F_2 + 0,871F_3 + 0,03F_4; \\ Z_{2018} = 2,401F_1 - 4,823F_2 + 0,591F_3 - 0,561F_4; \\ Z_{2019} = -1,537F_1 + 0,771F_2 - 4,233F_3 - 1,237F_4 \\ Z_{2020} = -2,119F_1 - 0,129F_2 - 0,294F_3 + 3,079F_4 \\ Z_{2021} = -4,396F_1 + 1,109F_2 + 3,065F_3 - 1,314F_4 \end{cases} \quad (8)$$

The principal components method allowed to obtain a combined and reduced amount of output information, which includes the main component of indicators that simulate 100% of the data, while the noise remaining after the projection leaves a percentage of the original data is absent. Based on the interpretation of the main factors, the main components that affect the overall result of investment support for the development of the agricultural sector, in particular, "investment architecture", "balancing investment product", "investment climate", "stimulating investment activity".

5. Conclusions

Using the method of the main components allowed to identify four main areas of investment efficiency of the agricultural sector, including: "investment architecture", "balancing the investment product", "investment climate", "stimulating investment activity". In accordance with the proposed directions of improving the investment efficiency of the agricultural sector, the strategic priorities for the development of investment support of agricultural enterprises are identified, including: active activity in the investment market, commercialization and

support of market innovations, strengthening the information and analytical support of investment activities, the implementation of investment incentives for intellectual and creative activities of employees, increasing the level of staffing of investment activities, increasing the level of investment attractiveness of enterprises, investing capital in new approaches to trade, logistics and warehousing, investing in modern technical means of managing trade and technological innovations, investing in the creation and introduction of product innovations, increasing market share and forming internal investment funds, strengthening cooperation with entities external financial sector investment environment. The use of the principal component method has reduced the amount of source information that includes the main component of indicators that simulate 100% of the data, so that the noise left after the projection leaves a percentage of the original data is absent. The obtained general coefficients of relative importance of the impact on the main factors of investment support for the development of the agricultural sector allowed to determine the indicators that affect the formation of certain components, which allowed to present their impact in the form of linear dependence. The practical significance of the results is short- and medium-term, the success of the new system of investment support for agricultural development will combine infrastructure for investment and the formation of growth points that are attractive to investors and will eliminate inhibitions of investor-Ukrainian companies. The new model of investment support for the development of the agricultural sector will have the above components and will provide a rationale for choosing priority areas of investment, investment sources, investor selection, identifying investment instruments, forecasting investment for the new period with analysis of the previous. The expediency of introducing an effective system of investment support for the development of the agricultural sector is substantiated.

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