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Models of efficiency of functioning in trading enterprises under conditions of economic growth

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Abstract. The socio-economic situation in Ukraine suggests that there is insufficient research into the applicability of the model of economic development in forecasting the economic environment in which trade enterprises function. Researchers into issues relating to the efficiency of enterprises' functioning focus their interest on comprehensively describing efficiency indicators and determining the factors influencing it. There continues to be insufficient work on measuring efficiency and the extent to which it is limited by types of economic growth (development), based on the theory of marginal product of George Clark and the results of multiple models of production and trade functions (P. Douglas, R. Solow, E. Denison, Harrod, Samuelson-Hicks, Domar and others). Therefore, this study focuses on the process of assessing the effectiveness of trading enterprises in the trade sector in 2010–18 in conditions of economic growth and an economic downturn. This article aims to examine the models of efficient functioning of trading enterprises in conditions of economic growth. It is evidenced that the criterion for measuring efficiency is the evaluation of static and dynamic efficiency of trade activities, which allows changes in the used assets to be taken into account and testifies to the integration of diminishing returns and economic fluctuations in macro and microsystems. The article shows that in order to qualitatively and completely evaluate the efficiency of the functioning of trading enterprises, it is necessary to consider all possible factors. According to Clark's law, the authors substantiate an approach to evaluating performance based on simple one-factor models; the approach evidences that future studies seeking ways to improve efficiency, but that focus on changes in resources, will be erroneous, unjustified, and will most likely reduce the effectiveness of the resource under study. This model will help: determine and forecast the efficiency of enterprises at any point in the economic cycle; provide the necessary information on the required amount of investment, on depreciation rates, and on the optimal amount of labour potential of an enterprise; and define the volume of expected income during economic crisis or recovery. Some applied recommendations in terms of managing the effi-

ciency of trading enterprises are aimed at solving the methodological problem of constructing isoquant maps for a particular product line group and at selecting the optimal predictor for forecasting trade processes. The practical value of the proposed model also lies in improving the parameters of positioning of the enterprise's goods in target market segments, reducing operating costs, accelerating the turnover of inventories and withdrawing illiquid current assets, and increasing the efficiency of retail areas.

Contents:

1. Introduction

The dynamic development of trade activity and constant changes in the national economy require that the measurement of the efficiency of enterprises' functioning be reconciled with the target points, economic behaviour and international standards of evaluating the economic activity of enterprises. This raises the relevance of the selection of adequate methods, models, criteria and indicators for evaluating the efficiency of trading enterprises' functioning, which together will meet the modern requirements of economic development of the global market system and take into account the specifics of trade.

The transformational stage of economic system development significantly increases the responsibility of enterprises, and in particular the area of trade, for the results of their activities. In the face of competition, it is known that those who orient themselves better to the needs of consumers are able to quickly and qualitatively adjust the production or sale of the right products, providing themselves with an acceptable level of profit and goods that provide the buyer with the required consumer properties.

If Project Management systems are used to start a business, then constant economic monitoring and periodic scanning of the enterprise's state and mar-

ket situation should be carried out for the successful management of normal operations. Obviously, the best solution to this is to conduct quality economic work in the enterprise – to analyse the activity of the trading company by the results of operating or financial cycles.

Furthermore, mathematical modelling methods are of particular importance when analysing and forecasting the reporting indicators, and when preparing the models of substantiating measures to regulate the main reporting indicators. Such models are based on the following principles:

- causality, i.e. the inclusion in the model of only those indicators that significantly affect the change in the analysed target point indicator;
- relative independence of the studied indicators, since changes in the parameters included in the model must occur independently of each other;
- comprehensiveness, i.e. the model should contain enough different factors to identify the reasons for the change in the analysed indicator;
- identity, i.e. in use, the model must correspond in qualitative and quantitative terms to the real change in the resultant indicator.

Today, in the theoretical and methodological context, there is a considerable number of results concerning modelling the factors that influence the efficiency of trading business. However, the constant development of trading enterprises, and changes in the internal and external environment of the in-

dustry's functioning, necessitate ongoing systemic research and the development of more complex models that would take into account the impact that costs, fixed assets, current assets, trading and warehouse space and assortment characteristics have on marginal changes in the efficiency and productivity of trading enterprises.

To achieve the goals set during the study, a number of logarithmic functions were used and a system of logarithmic equations was solved. We have also employed parameterised models of dependences (income from operating costs, the value of current and non-current assets, the size of retail space and product lines). With the help of a GAP-analysis method, these allowed us to construct the necessary algorithm and a sequence of actions (determining total market demand in the target segment; finding the average and marginal result by a number of independent factors [determination of static and dynamic efficiency]; drawing up proposals) in order to substantiate management conclusions on the overall efficiency of the trade enterprises' functioning, and to make recommendations concerning the influence of relevant factors that will contribute to productivity growth.

There have been scientific investigations in this direction in at least four areas. The first is related to the results of quantitative and qualitative analysis of the influence of factors on the parameters of development of trading enterprises, as well as the efficiency of using different groups of their resource allocation. For example, the aspect of innovative activity along with the efficiency of the trade business is analysed by Ilyash, Dzhadan, Ostasz (2018). There are attempts to integrally evaluate the impact of various aspects of resource provision of trading enterprises on the volume of their activities. In particular, Lagodiyenko, Lagodiyenko (2019), suggest a methodology for calculating the comparative advantage index as a characteristic of the competitiveness of goods of trading enterprises in the domestic market.

The second direction concerns the construction of various regression models, where the dependent variable is the volume of goods turnover, financial, economic, and other indicators of the efficient functioning of trading enterprises, and the independent variable is all possible aspects of their activity. For example, Panukhnyk, Popadynets, Fedotova (2019) have investigated the regression impact of a range of socio-economic factors (household income, employment, wages, GDP, investment, small business development, etc.) on volumes of sales of goods in the field of trade in the domestic market. Gaydayenko (2018) has researched into the impact of a number of financial and economic indicators of an enterprise's operation (net income, prime cost, net profit, turnover of inventories, etc.) on its financial results (profitability, including sales).

That is why the third direction of scientific research in the analysed area concerns modelling the influence of factors on the efficiency of trading enterprises. Much attention has been paid to these issues in the studies of Danylkiv, Gavran, Gavran et al. (2019). These scientists built a number of reliable multifactorial models of the influence of factors of the external environment on the financial performance of trading enterprises. Since the key indicator of the volumes of trade activity is goods turnover, it is logical that in a number of studies some scientists – in particular, Kryzhanovska (2018) – pay attention to multifactor econometric modelling using dummy variables in the process of forecasting the dynamics of the main indicators of retail trade efficiency. Trusova (2016) uses a systemic and comprehensive approach to modelling the impact of systemic factors (integration, synergy, targeting, integration into the environment, etc.) on the level of financial potential of a trading enterprise. Havlovska, Pokotylova, Rudnichenko et al. (2019) in their research model examined different (assigned, descriptive, constructive-reflexive) modes of functioning of an enterprise and their consequences in the context of the enterprise's economic security.

It is reasonable that the fourth direction of scientific discourse in the field of modelling results and the efficiency of trading enterprises' functioning concerns the managerial aspects of integration of developed models and regression dependencies into the system of management of business economic development. For example, Kudyrko, Sevruk (2016) devised a whole system of strategies that can be used by trading companies depending on the modelling of trends of their development. Nevertheless, the impact of market trends, which often pose significant threats to economic development of business, must also be taken into account. Here

we speak about the import dependence of the internal market and, consequently, of trading enterprises in the context of establishing and developing cross-functional relations (Vasyltsiv, Lupak, 2016). It is clear that, in such circumstances, a country should form an effective system of economic relations in which trading enterprises will be able to integrate into the sphere of domestic production of goods and, accordingly, independently regulate functional areas of economic activity (Vasyltsiv, Irtyshcheva, Lupak et al., 2020).

2. Research materials and methods

The performance measurement theory offers many types of functional models of trade activity, which express different relationships between the magnitude of the factors that are being used and the sales volume of goods. Therefore, it is important to choose the type of modelling for business activity of trading enterprises from the point of view of the "cost-result" system, which is fundamental in measuring the effectiveness of their operation.

Begg, Vernasca, Fischer, Dornbusch (2014) argue that the model of trade activity efficiency is defined as the functional dependence of the maximum volume of sales of goods that an enterprise can form using the set of available resources.

A valuable tool for studying the effectiveness of trade activities is their geometric interpretation. When there is one independent and one dependent variable ($y = \delta\ (x)$), the continuous function is represented by a line on the plane with the coordinates y and x. At the same time, an adequate reflection of the real ratio between costs of resources and sales volumes of goods is divided into two interdependent tasks: isolation of essential factors and determination of the type of functional dependence; and calculation of numerical values of its parameters on the basis of systematised actual data by means of regression and correlation analysis (Zadorozhna, 2003). A shining example of a two-factor economic function is the Cobb–Douglas model. The parameterisation of such a model or the determination of numerical coefficients can be done in the presence of data on the functioning of a trading enterprise

and by solving the system of logarithmic equations (Canova, 1995; Granger, Terasvirta, 1993).

Since it is quite difficult to test the two-factor function for critical points and characteristic features through the second unknown variable, it is worth presenting the effectiveness of a trading enterprise's activity on the basis of one-factor function of financial and economic activity. The derivative of the efficiency function will be equal to the limit value of the evaluation criteria, according to the basic properties and definition of the areas of ensuring the functional efficiency of the enterprise (Pidkuyko, 2004; Podinovski, 1994). The characteristics of such a model are the fact that, when the limit values are exceeded, the level of efficiency decreases, as evidenced by the effect of the "law of diminishing marginal product". It is obvious that the enterprise will be attracted to any forms of ensuring the effectiveness of trade activities that meet the limit values of the criteria established for its measurement (Fernandez, 2001).

One can also measure the effectiveness of a trading company both in relation to its internal environment (assets [investment efficiency] and its performance during the reporting period [optimality of costs, etc.] [Ilyash, Vasyltsiv, Lupak et al., 2020]), and in relation to the external environment (so-called "market ratios", i.e. the market share occupied by an enterprise; the elasticity of market demand; and competitiveness of the supply of goods [Eugene, 1998; Campbell, 1994]). To do this, a regression model should be built employing the method of substitution of variables that will be selected using mechanisms of expert and mathematical modelling (Daske, Gebhardt, 2006).

Taking into account the negative (cyclical) phenomena of economic development (recession, high rates of inflation, scarcity of resources) the efficiency of a trading enterprise's functioning will change at each stage of economic development, along with the confidence limits for its indicators, and the relativity and reality of such an assessment (Johannesson, Jonsson, Karlsson, 1996). Considering such reasoning, the efficiency of a trading enterprise's functioning should be defined as both a static concept (without change of economic cycles, the scale of activity, etc.), and a dynamic concept (in different phases of the business cycle, with change of the scale of activity).

The indicators of evaluating performance will also differ for a trading enterprise that is at one stage of economic development (static efficiency for a "resting" enterprise) and for an enterprise operating in the market with constant cyclical fluctuations, resulting in changes in the scale of trading activities (dynamic efficiency) (Kydland, Preseott, 1996; Rebelo, 1991; King, Plosser, Rebelo, 1990).

Similarly, in the economic growth context (recession), the functions with diminishing returns have been applied in the existing models of economic development (Solow, 1994; Domar, 1946; Harrod, 1939). J. Hicks (1975) explains the principles of measuring efficiency in the period of economic development, and states that a measure of shifts (economic fluctuations) in the volume of sales of goods is the effect of investment or the effect of acceleration. Such indicators demonstrate the relationship between the change in aggregate supply (income of trading enterprises) and the change in inputs in the system of resources (investment).

Thus, the efficiency of trading enterprises' functioning should be evaluated according to the following algorithm: defining the task and purpose of the evaluation → gathering information → specification and parameterisation of the financial and economic function of trade activity in the conditions of economic development → determining the structure of cash flow → determining the total volume of market demand in the segment of operation and its coverage by a trading enterprise → finding the average and marginal operating result of the functioning for each segment of the market (determination of static and dynamic efficiency of an enterprise's activity) → drawing up proposals for improving the efficiency of trading enterprises. Only such a study will be able to overcome all the shortcomings of measuring the efficiency of trading enterprises' functioning on the basis of traditional one-factor multiple models (ratio analysis), and be able to obtain comparable results and determine the optimal values of the criteria by which it is possible to reliably carry out the evaluation in the chosen field.

Thus, the classical fundamental provisions of economic theories of marginalism, value added, economic cycles and economic growth served as the main methodological basis for the study. Accordingly, standard, widely used methods of analysis of variance (single-factor, multifactor and multidimensional), economic and statistical multiplicative analysis (least squares, principal component analysis, testing of statistical hypotheses) have been employed.

At the same time, a number of aspects and methodological provisions of modern researchers in the field of economic and mathematical modelling of dependences of the integral characteristics of the trading enterprises development on changes in qualitative and quantitative factors of their functioning and development have been taken into account – in particular, Ince, Hahn (2020), Jiang, Qu (2020), Petruchenya, Batraeva, Suslova (2020), Zhao (2020).

3. Research results

The current literature identifies possible stages of economic development of an enterprise in terms of value indicators (Net Sales), as well as optimised models for determining the efficiency of operation (dependence of the main value indicators on independent ones → Gross margin) of trade enterprises in the context of economic development. At the same time, in order to choose a suitable and not cumbersome model, two statistical criteria are proposed: the Akaike information criterion (AIC) and the Schwartz information criterion (SIC). These criteria can be applied to both models that are being evaluated and analysed when finding the order of the auro-regression (AR) component and the order of the moving average (MA) component. If the inclusion of an additional lag does not change the AIC and SIC, then we can decide not to add this lag to the model.

Having carried out the specification of the trade function, we found the best variant of the model, namely, the *n*-factor logarithmic function that looks as follows:

$$Q = a \times log b(\propto X_1 + d) + e \times log f(g \times X_2 + h) + \ldots + s \times log t(u \times X_n + v) + k + u \times sin(X_1, X_2, \ldots, X_n)$$

(1)

where: Q – goods turnover; X_1, X_2, ..., X_n – input resources (or cost); a, b, c,..., v, u, k – coefficients that will determine the return of resources, their substitution, the sectoral affiliation of an enterprise, the minimum amount of resources required for effective activity at the initial stage of development, and so on (parameterisation of the function); $log(X_1, X_2,..., X_n)$ – the return function when entering the technological system (the resource component), which demonstrates the power with which the law of diminishing marginal productivity influences an enterprise; $sin(X_1, X_2,..., X_n)$ – the function of a time factor (cyclic component), economic fluctuations and scientific and technological progress.

This dependence will allow the enterprise's activity to be reflected in the long term in different cycles of economic development. The dependence $X_1, X_2,..., X_n$ under the *sin* sign depends on the resources selected for analysis; with the incommensurability of resources, it is better to apply the sum $sin(X_1)+sin(X_2)+...+sin(X_n)$.

It should be noted that the proposed model would reveal both the effect of the law of diminishing returns and changes in the activity of a commercial enterprise due to economic development. We also want to add that parameterisation of such a model or determination of numerical coefficients can be done if there are data on the functioning of an enterprise and by solving the system of logarithmic equations. This will allow the overall efficiency of an enterprise to be determined, which can be calculated for the *n*-factor function of financial and economic activities as:

$$E(AP)=\frac{a\times logb(c\times X_1+d)+e\times logf(g\times X_2+h)+...+s\times logt(u\times X_n+v)+t\times sin(X_1,X_2,...,X_n)+k}{\sum(X_i)}$$
(2)

If a two-factor model is used in the simplified version, after removing the multipliers from the logarithm sign, and forming a constant C, we obtain:

$$E(AP)=\frac{\log_a x+\log_b y+sin(x)+sin(y)+C}{x+y}$$
(3)

This expression, as a result of simplification and reduction of logarithms to one basis, will look as follows:

$$E(AP)=\frac{\log_a x\times \log_a b+\log_a y+C\times \log_a b}{\log_a b\times(x+y)}+\frac{sin(x)+sin(y)}{x+y}$$
(4)

or:

$$E(AP)=\frac{\frac{ln(x)}{ln(a)}+\frac{ln(y)}{ln(b)}+sin(x)+sin(y)+C}{x+y},\ x,y,a,b>0$$
(5)

We want to emphasise that the efficiency of trade activity (*AP*) can reflect not only the productivity of an enterprise (through Q), if certain resources (X_i) are used, but also profitability, turnover, etc. with proper data extrapolation.

It should be noted that Ukraine's retail trade performs quite important and fundamental functions in the context of the market economy functioning. In this context, it is essential to point to the growth of retail trade turnover, which is typical for the analysed period 2010–18 (Table 1).

Of course, inflation is, to a large extent, the factor that reinforced such trends, but in absolute terms for most years of the analysed period there is also an increase in the volume of sales of goods and services in the domestic market, which is evidence of a growing influence of retail trade on production and consumption of goods and services. Therefore, the results of modelling have high applied value in the context of forming an information and analytical basis for managing the development of retail trade enterprises and the impact of these processes on the economy.

The observations of the volume of a commodity turnover in the regions of Ukraine give grounds to conclude that there are certain disparities and differentiations, which may ultimately affect and even lead to inefficient functioning of enterprises. For example, there is a significant predominance of Kyiv in relation to other regions of the state (Fig. 1). Such concentration of trade is objectively negative for the balanced functioning and development of the economy, as it results in excessive business activity in a small area, while other areas of the state become an "economic periphery" and less investment-attractive.

Table 1. Retail trade turnover in Ukraine and its structure (2010-2018)

Indicators	Years									Absolute deviations, ±	
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2018 / 2010	2018 / 2017
Retail trade turnover, UAH billion	541.5	685.7	812.1	888.8	901.5	1031.7	1175.3	815.3	930.6	389.1	115.3
Including											
- retail commodity turnover of enterprises (legal entities)	271.4	350.1	405.1	420.1	427.5	487.6	556.0	586.3	668.4	397.0	82.1
- retail commodity turnover of natural persons-entrepreneurs	230.7	311.3	375.2	411.5	415.6	472.5	537.1	229.0	262.2	31.5	33.2
- turnover of organised markets for the sale of agricultural products and of informal markets	39.5	40.5	47.1	56.9	58.6	71.2	82.3	87.4	95.1	55.6	7.7
Shares in retail trade turnover (including), %											
- of retail commodity turnover of enterprises (legal entities)	50.1	47.9	47.9	47.3	47.4	47.3	47.3	71.9	71.8	21.7	-0.1
- of retail commodity turnover of natural persons-entrepreneurs	42.6	45.4	46.2	46.3	46.1	45.8	45.7	28.1	28.2	-14.4	0.1
- of turnover of organised markets for the sale of agricultural products and of informal markets.	7.3	5.9	5.8	6.4	6.5	6.9	7.0	9.4	10.2	2.9	0.8

Source: State Statistics Service of Ukraine

Therefore, we selected 30 enterprises (objects of their trade are located in all regions of Ukraine) that best demonstrate the economic characteristics of regional enterprises and that publicise the results of their activities. Among them, with the help of a multivariate analysis of variance we determined the sample size, the indices of which will deviate from the total number of indicators by no more than 5% with a 95% probability. The volume of such sample was determined at the level of ten enterprises.
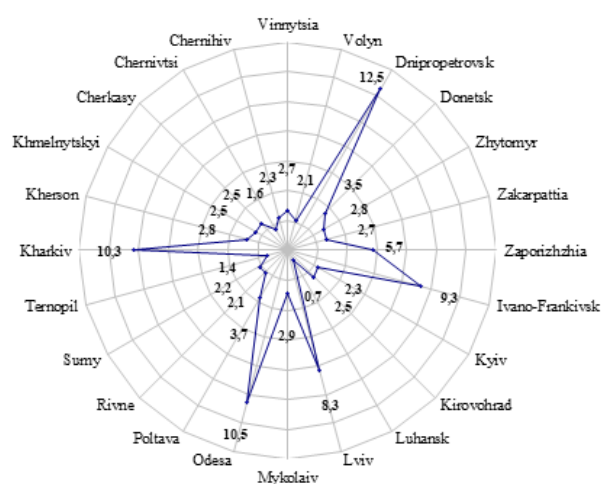

Fig. 1. Regional structure of the trade industry of Ukraine (2018), %
Note: without Kyiv, the figure is 23.4% of the total volume
Source: State Statistics Service of Ukraine

$$S = \cfrac{\cfrac{1{,}96^2 \times 0{,}99 \times (1-0{,}99)}{0{,}05^2}}{1+\cfrac{\cfrac{1{,}96^2 \times 0{,}99 \times (1-0{,}99)}{0{,}05^2}-1}{30}} = \frac{15{,}21}{1{,}47} = 10{,}33 .$$

With this aim in view, it is advisable to begin by defining the model of operation of the sampling enterprises, namely the dependence of operating income on operating expenses, although it has already been stated that the operating costs model ([Selling, General & Admin Expenses + Cost of Goods Sold] → net income [Net Sales]) is fully additive with a correlation coefficient of 0.999916. That is why we parameterise the model for operating expenses without taking into account the prime cost of goods turnover (Cost of Goods Sold according to IFRS standards or the purchase price according to domestic methods).

Therefore, based on empirical data of the sample over a period of five years, the following specified dependence on net operating income was found:
y=758477×Ln(x)+134136×sin(1.044×x)-8287396
at which the coefficient of determination is 0.694, and the respective correlation coefficient is 0.833, indicating a close relationship between the variables (Net Sales and Selling, General & Admin Expenses) (Fig. 2).
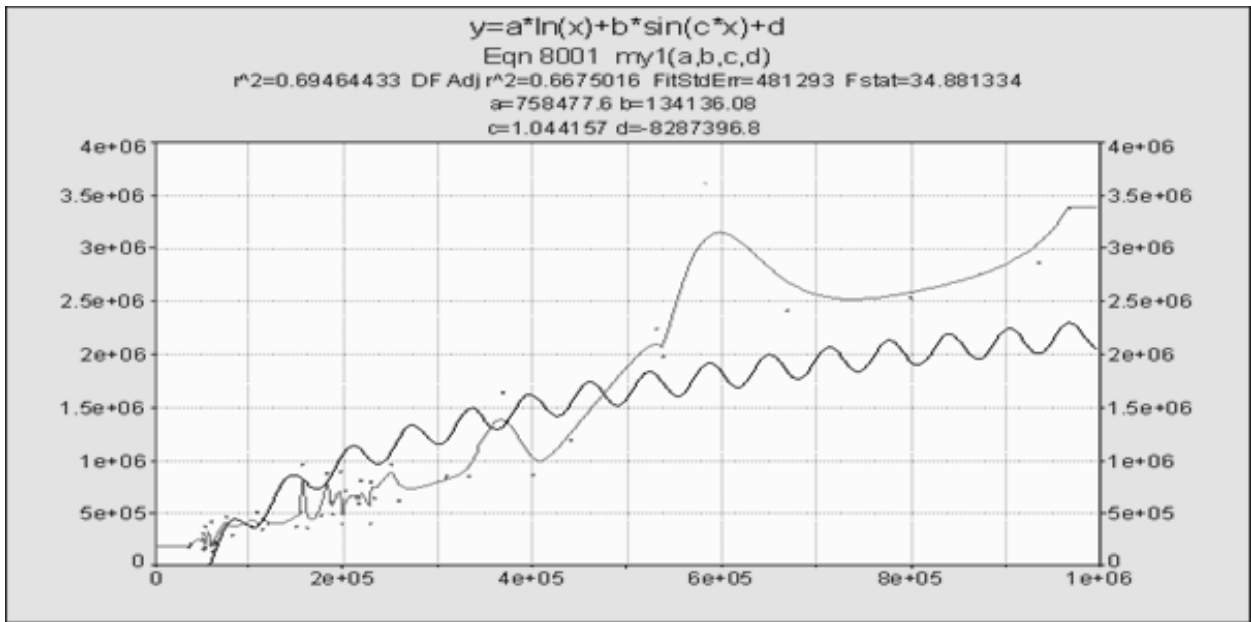
Fig. 2. Parameterised model of the dependence of net income on the value of administrative, material and sales costs of the sampling enterprises (2016–19, sinusoidal model and moving-average model)
Source: authors' calculations

The data in Fig. 2 indicate that the maximum errors are observed for the company that received the highest net income for 2016–19, i.e. Intermarket Trading Company LLC. For enterprises with lower levels of net income, there is a discrepancy between economic cycles, which is caused by the forced aggregation of the enterprises' income data into one array. Therefore, we will further measure the productivity of non-current assets in the context of the trading enterprises.

The data in Table 2 show that most trading companies lack the synergistic (or multiple) effect of the introduction of non-current assets, which is demonstrated by a negative constituent. A negative indicator (parameterised factor of the natural logarithm of the variable) indicates the declining nature of the return on non-current assets and their passivity (inappropriate structure of assets to the area of activity). Secondly, considering Fisher's criterion, it is worth trying to specify another model (Fig. 3).

However, it should be noted that this function, which was specified using AIC and SIC statistics, with the highest value of the coefficient of determination, is not able to fully describe the studied dependence ($F_{stat} = 4.989$).

Continuing the study, we want to emphasise that taking into account changes is an important feature of a study into economic development of commer-
cial enterprises. That is why, when explaining the level of returns, it was noted that such returns are average for (inherent in) the enterprise, whereas market changes shift returns relative to the average level. It is apparent that the stage and degree of economic development is reflected by the cyclic component $sin\ (x)$, which can be specified differently, but in this case we resorted to the simplest trigonometric function. The function sin at the point $(P_i/2) + 2 \times n \times P_i$ reaches its peak with the value 1; at the point $n \times P_i$ it is 0 (the function will be reduced to the ordinary one, if Clark's law is taken into account); and at the point $(P_i/2) + n \times P_i$ it reaches its minimum – 1, where n is an integer. Hence, to determine the length of the economic cycle, it is necessary to weigh the coefficient under the sign sin by the figure $P/2$, and the parameterised multiplier of the function sin shows the depth of the economic cycle.

Thus, having a large proportion of passive (or unrenewed, outdated, inefficient) non-current assets will diminish the marginal product, so the cyclical part of the function will be negative. Thus, based on a specified function of economic development, LLC Ukrainian Trading Networks experiences, in some periods of development, a decrease in income due to the negative cyclical component (Fig. 4).
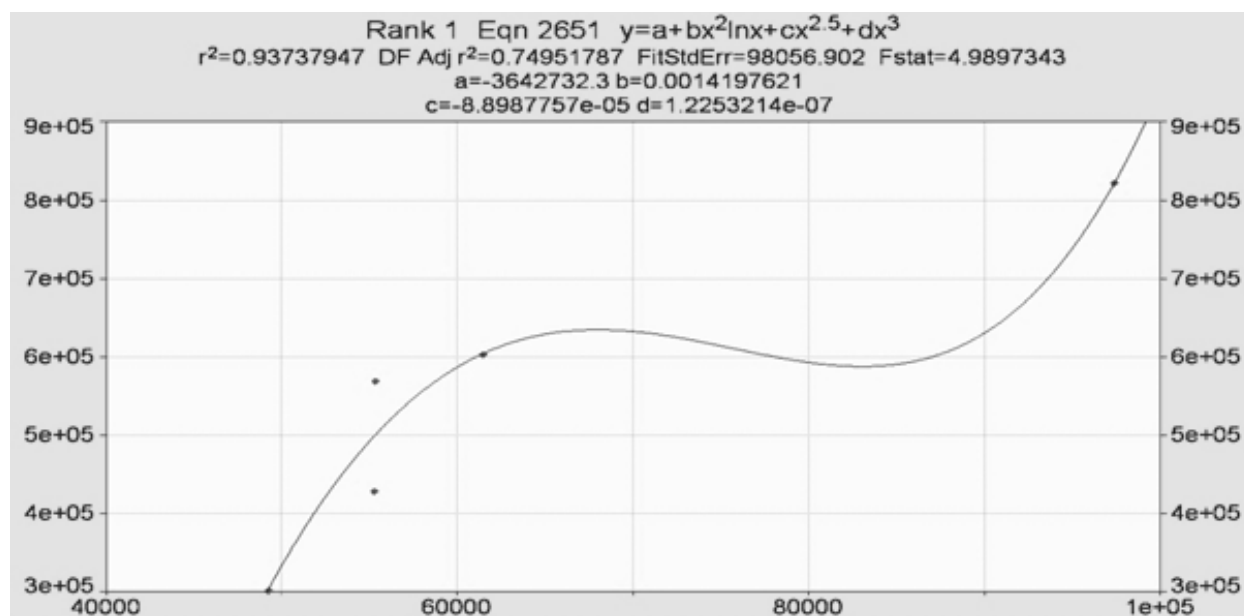
Table 2. Functional dependencies of net income on the value of non-current assets in the conditions of economic development of trading enterprises (2016–19)

Enterprise	Logarithmic-cyclic equations of the dependence of net income on non-current assets (y=)	Coefficient of determination	Max. marginal error of confidence interval, thousand UAH	Fisher criterion / assessment of adequacy (Ftable = 10.13 for significance level of 0.05)
LLC "Desiatka"	$28842 \times ln(x) + 959 \times sin(x/21056) - 324810$	0.886	742	7.80
"Elvo-Market" Ltd	$39539 \times ln(x) + 2445 \times sin(x/28580) - 411285$	0.796	1,012	2.98
Intermarket Trading Company LLC	$248557 \times ln(x) - 63617 \times sin(x/49522) - 30540$	0.898	2,359	18.87
Lvivholod trade manufacturing company, LLC	$21125 \times ln(x) + 9026 \times sin(x/143583) - 199403$	0.923	1,337	31.65
Fozzy-Food LLC	$22523 \times ln(x) + 2052 \times sin(x/155934) - 249104$	0.960	225	44.52
LLC Ukrainian Trading Networks	$71470 \times ln(x) - 15612 \times sin(x/159749) - 915590$	0.969	204	919.77
LLC "Continuum-trade"	$39375 \times ln(x) + 6801 \times sin(x/19440) - 444445$	0.743	3,596	7.19
LLC "Vopak"	$29696 \times ln(x) + 9212 \times sin(x/31009) - 344542$	0.911	272	80.31
LLC "Trading network 'Barvinok'"	$504425 \times ln(x) + 43142 \times sin(x/29887) - 60121$	0.987	510	78.17
PJSC "Furshet"	$-46335 \times ln(x) - 43614 \times sin(x/180278) + 677246$	0.806	1,200	4.16

Source: authors' calculations

It should be added that economic fluctuations will be much better demonstrated by dependencies on current assets, the turnover of which will form the net income of trading enterprises. The data in Table 3 suggest that net income from the sale of goods or services depends much more strongly on current assets than on non-current assets, which is further proof of the scope of activities of the surveyed enterprises. In addition, compared to traditionally used models of measuring economic effectiveness for our sample of businesses, the specified models of economic development have higher coefficients of determination and coefficients of correlation, as well as lower marginal errors, and are adequate by the statistical criteria under study.

Fig. 3. Possible distribution of dependencies of net income on non-current assets for PJSC "Furshet" for 2016–19
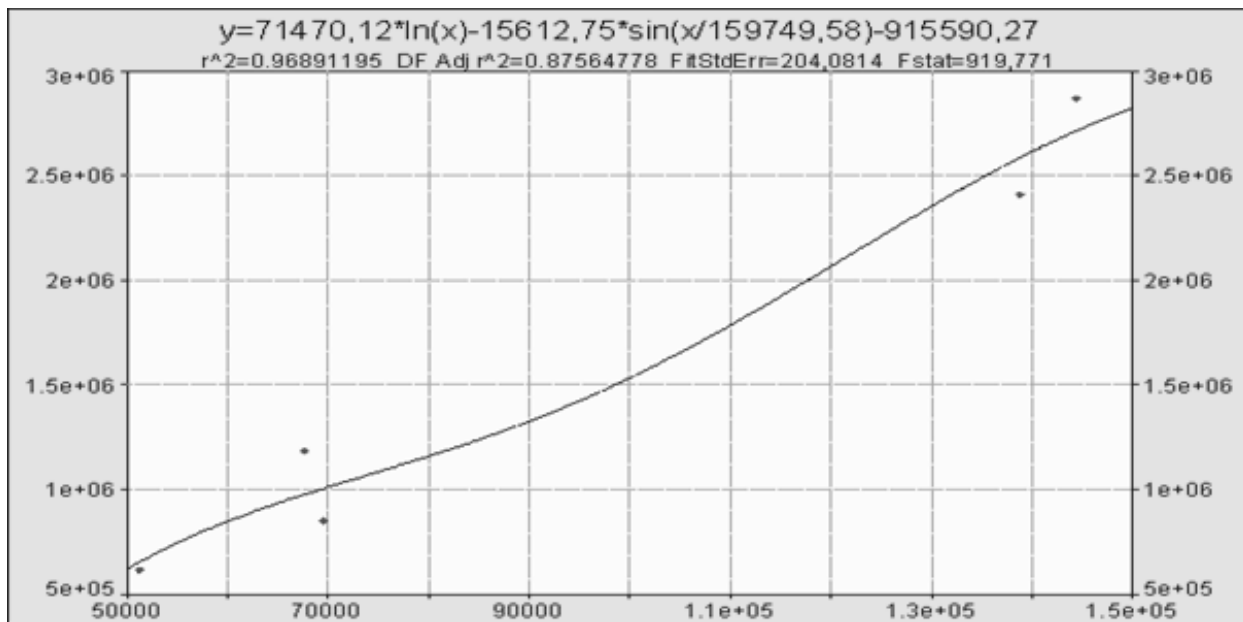Source: authors' calculations

Fig. 4. Parameterised function of economic development of LLC Ukrainian Trading Networks for 2016–19
Source: authors' calculations

Table 3. Functional dependencies of net income on the value of current assets of trading enterprises in the conditions of economic development (2016–19)

Enterprise	Logarithmic-cyclic equations of the dependence of net income from current assets ($y=$)	Coefficient of determination	Max. marginal error of the confidence interval, thousand UAH	Fisher criterion / assessment of adequacy (Ftable = 10.13 for significance level of 0.05)
LLC "Desiatka"	$121087 \times ln(x) - 58995 \times sin(x/6587) - 121130$	0.988	2,613	86.54
"Elvo-Market" Ltd	$251442 \times ln(x) + 321205 \times sin(x/9874) - 28185492$	0.570	95,619	1.32
Intermarket Trading Company LLC	$396727 \times ln(x) - 92716 \times sin(x/11052) - 46419541$	0.929	26,763	13.23
Lvivholod trade manufacturing company, LLC	$1524525 \times ln(x) + 194937 \times sin(x/8112) - 16279521$	0.918	13,725	11.32
Fozzy-Food LLC	$15798813 \times ln(x) - 3117135 \times sin(x/4962) - 173868124$	0.980	4,654	50.62
LLC Ukrainian Trading Networks	$4113982 \times ln(x) + 944094 \times sin(x/5148) - 43933721$	0.878	49,183	7.21
LLC "Continuum-trade"	$92130 \times ln(x) - 21137 \times sin(x/9670) - 713449$	0.965	900	27.99
LLC "Vopak"	$148620 \times ln(x) + 28261 \times sin(x/3874) - 1190253$	0.985	1,496	68.39
LLC "Trading network "Barvinok"	$-19334 \times ln(x) + 54488 \times sin(x/3997) + 639567$	0.957	1,176	22.75
PJSC "Furshet"	$616998 \times ln(x) + 142569 \times sin(x/5043) - 6085905$	0.981	3,784	52.61

Source: authors' calculations

The decrease in marginal product from current assets observed in LLC Trading Network "Barvinok" is a negative indicator, which was not found in the traditional analysis; by contrast, there was a rise in turnover, which reflects an obvious increase in the efficiency of the use of current assets. In fact, when we know about a decrease in the marginal product from current assets, we can say that an increase in the turnover is possible for this enterprise provided it continues to operate. It is possible only

if there is a decrease in the current assets and a further decrease in the net income (the rate of change in assets is higher than the rate of change in net income → a consequence of an increase in turnover), which indicates a reduction in the operation. This statement results from the fact that with an increase in current assets, net income will grow at lower and lower rates (a negative slope of the curve of the dependence of sales volumes on current assets, which is shown in Fig. 5).
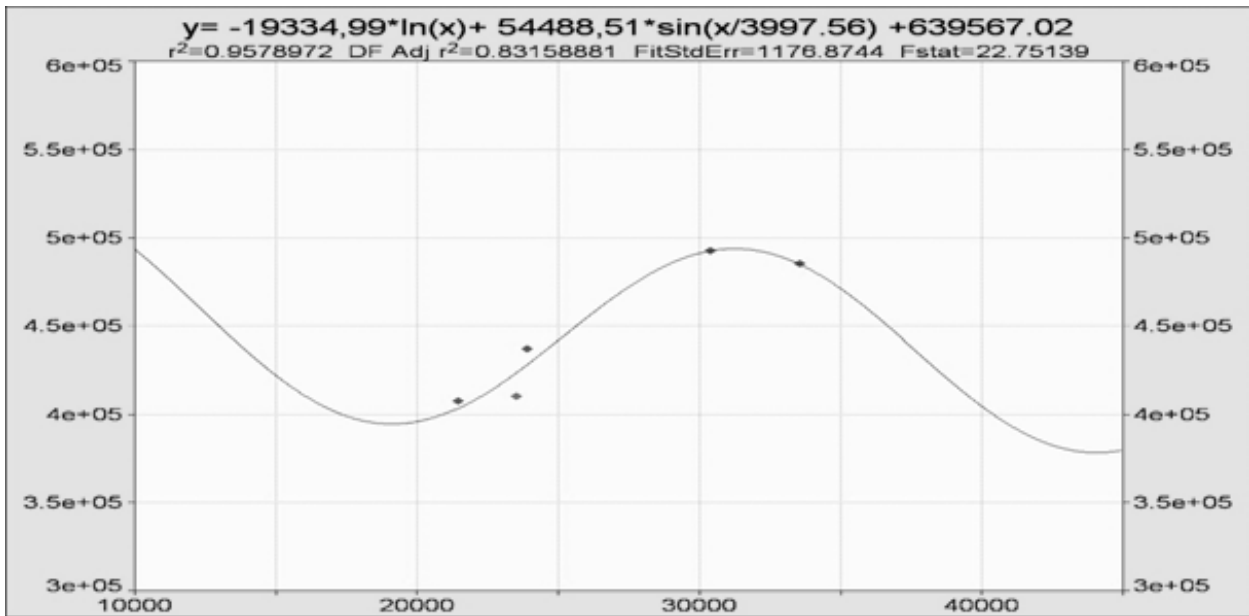
Fig. 5. Parameterised function of the net income from current assets of LLC Trading Network "Barvinok" (2016–19)
Source: authors' calculations

In order to better measure the effectiveness of using current assets of LLC Trading Network "Barvinok" it is necessary to find a function of the average product from the use of current assets in the enterprise, which will reflect the static efficiency of the current assets use. Let us examine the average product (in this case the adjusted turnover of assets in times) for the nature of the relationship with the current assets of the enterprise. For this, it is worth exploring the function:

$$y = \frac{-19334 \times \ln(x) + 54488 \times \sin(x/3997) + 639567}{x}, x \in (10000; 60000).$$

.

In such conditions, in Fig. 5, one can notice a negative effect of the scale of trade activity of the enterprise, which was mentioned above. It is obvious that the study is conducted at a constant value of net income, which is a weakness of traditional approaches.

The clear results and recommendations for changing assets can be deduced from the marginal product due to the change in the value of current assets (Fig. 6).

The data in Fig. 7 indicate that the net income growth is to be expected due to an increase in the current assets.

We want to add that, in applied research, it is considered that an increase in the efficiency of using constant (unchanged) current assets leads to a rise in net income. However, in market conditions, current assets in trade are not constant due to a change in their structure (an increase in stocks, surplus of "frozen" funds on accounts, etc.) and cost (changes in accounts receivable, a slowdown in the operating cycle, etc.). In the case of LLC Trading Network "Barvinok", the marginal change in the current assets turnover will be demonstrated by the function shown in Fig. 8:

$$y = \frac{\frac{-19334/x + 13 \times \cos(0.25 \times x)}{19334 \times \ln(x) + 54488 \times \sin(0.25x) + 639567}}{x_2}, x_2 \in (10000; 60000)$$

We want to note that, despite the large scale of activity, Lvivholod Trade Manufacturing Company LLC has shown quite successful growth rates. The current assets of LLC "Vopak" also have a similar return, while Fozzi-Food LLC, in spite of having the highest return among the surveyed trading companies (i.e. a turnover), experiences a reduced result of its activities due to the negative components of economic development and the negative minimum limit of current assets at the beginning of its activities (Fig. 9).

It should be emphasised that the purposes of the technical and economic analysis in the context of comprehensive measurement of the efficiency of the trading enterprises' functioning are: to evaluate trade activity; to identify the causal relationships and interaction between various factors of technol-
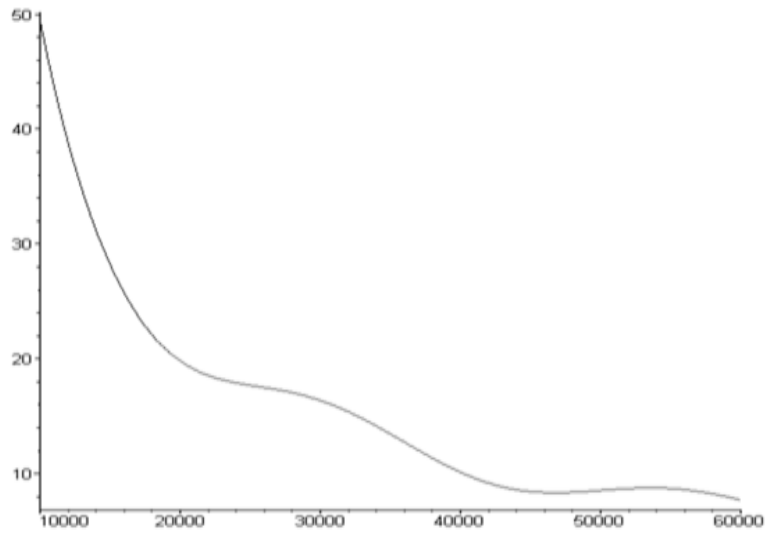
Fig. 6. Function of the efficiency of using current assets of LLC Trading Network "Barvinok" for the value of assets ∈ (10000; 60000)
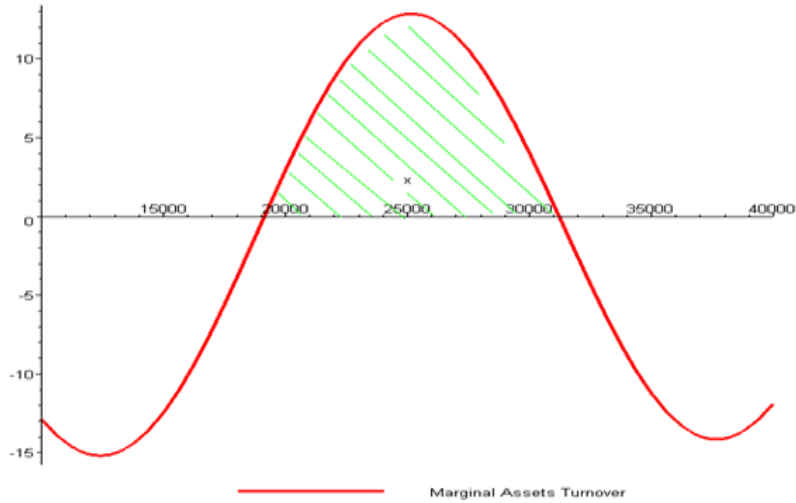Source: authors' calculations

Fig. 7. Marginal product from using current assets of LLC Trading Network "Barvinok" (2016–19)
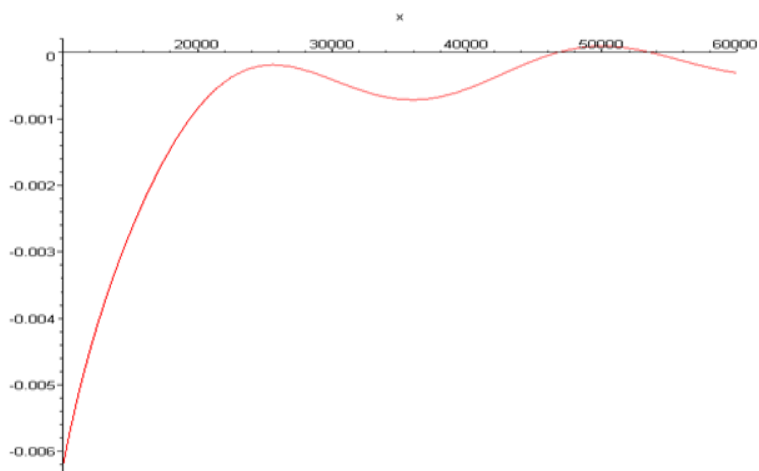Source: authors' calculations

Fig. 8. Marginal change in turnover from the change in value of current assets of LLC Trading Network "Barvinok" (2016–19)
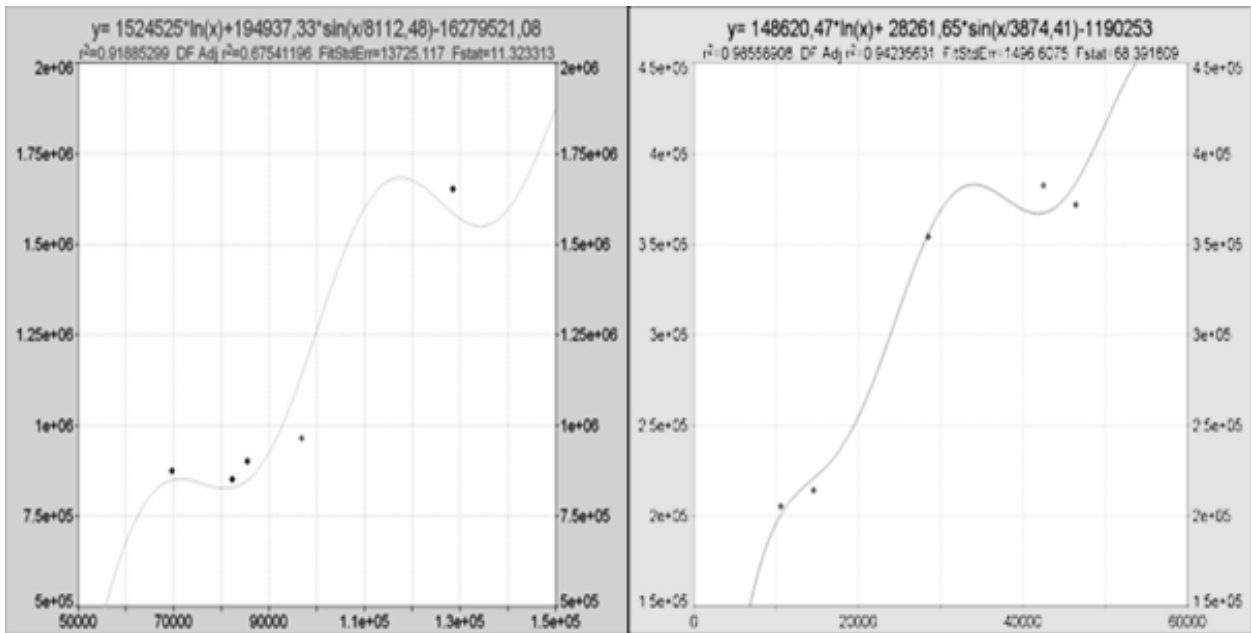Source: authors' calculations

Fig. 9. Functions of net income of Lvivholod Trade Manufacturing Company LLC (left) and LLC "Vopak" (right) from current assets (2016–19)
Source: authors' calculations

ogy and economy, reserves of production and trade activity; and to work on measures for rationalising the use of resources.

That is why in the process of measuring the efficiency of the enterprises' functioning, it is worth measuring the coordination / dependence between trading areas and product line positions and assessing the impact of their change on the net income of the studied enterprises. Such measurement is advisable if the two-factor function of the efficiency of trading areas and product line groups is used in the study (Table 4).

For example, the most effective use of trading areas was demonstrated by LLC Ukrainian Trading Networks, for which it is reasonable to expand only trading space because, despite lower Fisher's criterion, one can expect excess costs for developing additional product line groups (we see a negative return for the variable *y*). Conversely, Intermarket Trading Company LLC should pay more attention to expanding the range rather than increasing trading space, since the multiplier for the element of return on product line positions (*ln (y)*) is the maximum in the sample and greatly exceeds the return on trade space (more than 100 fold) (Fig. 10).

Furthermore, the fact that the company has high elasticity of goods turnover from the range is evidenced by the coefficient before the function of

economic development (*sin (y)*), which is relatively high in modulus. In general, based on Fig. 9, it can be seen that the critical area for the enterprise is a trading area of 11,700 m. When approaching this area, Intermarket Trading Company LLC reduces the marginal return from the trading space, resulting in a decrease in its productivity. As to product groups, in terms of economic cycles, we can say that the positive performance peak of the current cycle occurs in the segment of 195–200 product groups. If they increase, the company will incur additional expenses; it will have to change the way of doing business, which will lead to a decrease in its net income.

Based on the results obtained, it can be argued that the specific proposals in terms of managing the efficiency of trading enterprises presuppose two directions of measures: the first being methodological in nature, and the second, practical in nature (Fig. 11).

4. Discussion

Given the current trends in economic development, a cyclical component should be included in the regression representation of the efficiency of trading

Table 4. Two-variable functional dependencies of net profit from the size of trading areas and product line positions in the conditions of economic development of trading enterprises (2016–19)

Enterprise	Two-factor functions of dependence of net income on the size of trading space and product line positions ($z=$)	Coefficient of determination	Max. marginal error of the confidence interval, thousand UAH	Fisher criterion / assessment of adequacy (Ftable = 19.00 for significance level of 0.05)
LLC "Desiatka"	$1023013×ln(x)+1097940×ln(y)+20387×sin(x/85)+54765×-sin(y/21)-13220254$	1.000	0.00	$4.85×10^{15}$
"Elvo-Market" Ltd	$-2213163×ln(x)+6847507×ln(y)+10695775×sin(x)+4911316×sin(y)-21140327$	0.999	0.68	285.70
Intermarket Trading Company LLC	$2454152×ln(x)+269233651×ln(y)+367052×sin(x/986)-139141573×sin(y/1147)-1170201144$	1.000	16	$3.76×10^{31}$
Lvivholod trade manufacturing company, LLC	$1474703×ln(x)+3726458×ln(y)+162332×sin(x/841)-23177562×sin(y/982)-28207123$	1.000	2	$3.18×10^{33}$
Fozzy-Food LLC	$3590647×ln(x)-16532763×ln(y)-250015×sin(x/953)+139755653×-sin(y/1295)+31556011$	0.947	82,716	4.49
LLC Ukrainian Trading Networks	$8094177×ln(x)-42823368×ln(y)+4057591×sin(x/4905)+206473762×sin(y)+78335416$	0.973	26,527	9.14
LLC "Continu-um-trade"	$638528×ln(x)-4411243×ln(y)+6694152×sin(x)+213537234×sin(y)+5397503$	0.993	2,179	40.82
LLC "Vopak"	$2620648×ln(x)-16676765×ln(y)-44735045×sin(x/469)+72556653×sin(y/526)+20891793$	0.966	7,845	7.32
LLC "Trading network "Barvinok"	$408446×ln(x)-381418×ln(y)+34125×sin(x/14692)+7420799×sin(y/15821)-2150054$	0.995	312	59.90
PJSC "Furshet"	$410195×ln(x)-4176873×ln(y)-79627×sin(x/193)-8617081×sin(y/207)+29246753$	1.000	3	$1.16×10^{34}$

Source: authors' calculations
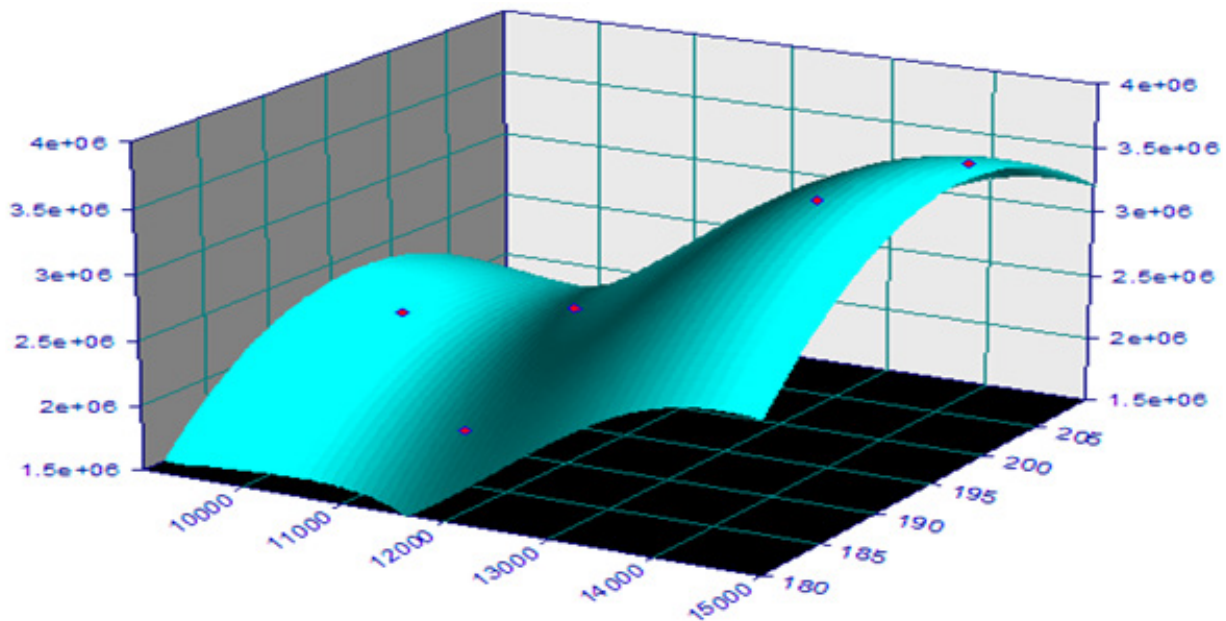
Fig. 10. Function of productivity of trading space and productivity of product line positions of Intermarket Trading Company LLC (2016-–19)
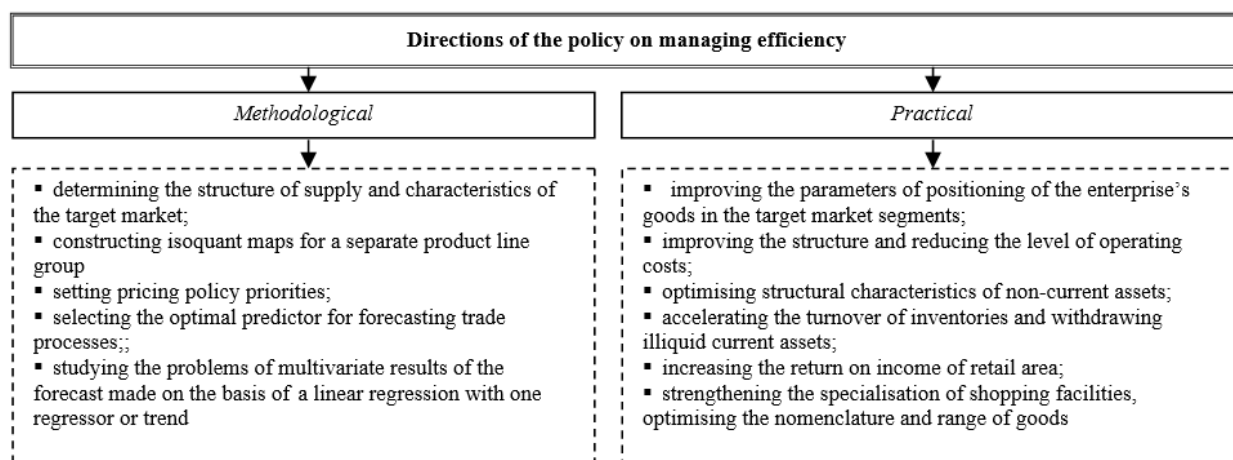Source: authors' calculations

Fig. 11. Directions and means of the policy to increase the efficiency of trading enterprises
Source: compiled by the authors

enterprises' functioning. Such a functional component reflects the depth and duration of economic cycles, as well as allowing us to properly plan trading activities and objectively measure dynamic performance, which cannot be done using traditional methods. At the same time, the comparison of economic development indicators for different trading enterprises makes it possible to direct analytical work at the search for factors minimising and preventing economic downturns, and to develop internal economic mechanisms (within trading enterprises) that are more flexible to market changes.

We regard the functional dependencies of the criteria of financial and economic activity as a partial variant of measuring the efficiency of trade activity on the basis of attracted resources. Hence, it should be taken into account that measuring the efficiency of the trading enterprises' functioning also includes assessing the possibility of optimising the structure of the retained gross cash flow and the level of competitiveness of the enterprise. It is possible to analyse the interrelation of the factors of all parts of the model and according to the results of the analysis to determine their contribution to the financial result and, accordingly, to the efficiency of the trading enterprise's functioning.

After supplementing the conducted study with changes in the result of the trading enterprises' operation under conditions of economic development, we want to note that the functional cyclical nature arises due to the transition of enterprises (in particular, by changing the scale of activity) from one dependence between volume of effect and volume of resources to another. It is determined that along with the changes in the first part of the balance function of measuring the efficiency of the trading enterprises, due to economic development, the structure and volume of net income will change. As a result of economic development, in the target market of the enterprise, the demand curve will shift under the influence of changes in consumer incomes and their preferences, and then the enterprise will transfer from one point on the demand curve (segment) to another due to changes in prices.

When justifying the need to determine the effectiveness of trade activities in terms of static and dynamic efficiency, it should be kept in mind that during a certain period of the company's activity, extensive growth causes a decrease in efficiency; however, the way of doing business remains unchanged. In this case, it is not enough to define and compare the performance of different businesses through static assessment (return on assets, turnover, productivity, profitability – all simple multiple efficiency models). Thus, along with the traditional measurement, it is crucial to evaluate the tendency of the trading enterprise to change its efficiency, peak areas of its activity (the extrema affected by the law of diminishing returns). At the same time, measuring the dynamic efficiency of trading activities allows reserves of efficiency to be identified, contributes to an increase in the margin of safety, and minimises the costs and losses of the enterprise.

Based on the determination coefficients of the parameterised functions of trade activity, it is pos-

sible to speak about the extent of coverage of factor changes by the models, although in many cases Fisher's criterion may indicate the inadequacy of the model. As the first independent variable represents the size of assets, in many trading companies, additional capital investment can also lead to a decrease in net profit, which will once again prove the effect of the law of diminishing marginal returns. At the same time, further research into enterprises that are at an early stage of the life cycle and businesses that sell highly specialised goods will show the need for additional investment, which will confirm the findings of the analysis by traditional methods. The declining nature of additional capitalisation, in this case, may be primarily, due to market volatility, crises and the inability to change the market segment.

5. Conclusions

Efficiency is, basically, a reflection of certain dependence, proportionality between resources and the end product. This confirms the possibility of using criterion econometric models to measure the efficiency of trading enterprises in the context of economic development. It is established that in today's market conditions, taking into account as many factors as possible when measuring the effectiveness of trading activities is an important prerequisite for intensive economic growth, use of scarce resources and achievement of strong end results, and finding dependences between them is of great importance too.

The process of measuring the effectiveness of trade activities sets the task of specification and parameterisation. In the context of solving such problems, taking into account the "law of diminishing marginal product", there is a need to develop a logarithmic model of the efficiency of a trading enterprise. At the same time, Clark's law allows the effect of the scale to be determined when measuring the efficiency of trading enterprises and costs to be minimised by adjusting operating leverage. The performed calculations allow us to show that the parameterisation by means of solving equation systems most accurately determines the objectivity of choosing regression parameters of the efficient functioning of trading enterprises and, thus, increasing the degree of appropriateness and ade-

quacy of the developed econometric regressions to empirical data.

By specifying and parameterising the functional dependencies of trade activity in the context of economic development, it is possible to evaluate not only the static efficiency of an enterprise, but also the impact of "the law of diminishing marginal product" on its results of activity. This allows us to determine the optimal limits of doing business and the most effective marginal size of changes of resources in order to achieve the best cost indicators and the effect of economic synergy.

Because the existing methods of measuring the efficiency of trading enterprises show excessively differing results, there will always be a need to improve the algorithm for measuring the efficiency of an enterprise in the conditions of economic development. At the same time, such factors as the availability of sources of information, the formation of mechanisms to ensure the effectiveness of functioning, and the predictability of the management system of an enterprise will have the greatest influence on conclusions drawn based on evaluations of the effectiveness of trading enterprises' functioning.

The proposals in terms of managing the efficiency of trading enterprises presuppose two directions of measures. The first direction is methodological in nature and includes determining the structure of supply and market characteristics; constructing isoquant maps for a particular product line group; defining pricing policy priorities; selecting the optimal predictor for forecasting trade processes; and studying the problems of multivariate results of the forecast made on the basis of a linear regression with one regressor or trend. The second has a practical orientation and comprises: improving the parameters of positioning of the enterprise's goods in target market segments; improving the structure and reducing operating costs; optimising structural characteristics of non-current assets; accelerating the turnover of inventories and withdrawing illiquid current assets; increasing the return on income of retail areas; strengthening the specialisation of shopping facilities; and optimising the nomenclature and range of goods.

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