For the first time it was determined that the amount of the borrower's limit: is also proportional to such parameters as EBITDA; debt service payments on already received loans for the period of the planned loan; cost; the cost ratio is proportional to the period of turnover of accounts payable; the indicator of inventories is proportional to the coefficient of variation of prices for these types of inventories and quantitative parameters of the conditions of storage of inventory data; the receivables ratio is proportional to the share of overdue receivables; the indicator of financial investments is proportional to the coefficient of variation of the stock index.
New discount rates are calculated, which depend on the conditions and terms of storage of agricultural products, to assess the value of inventories of enterprises. For the first time, it is proposed to calculate the term of a commodity loan using an optimization model.

Deputy of the head of cash management decision of financial department of Deposit Guarantee Fund. Research interests - economic and mathematical modeling in economy and banking.

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Introduction

Commodity lending as a special form of lending provided by sellers to buyers in the form of sale of goods in installments, deferred payment (sale on credit) is an important element of inter-economic relations in the economic activities of enterprises, including in the agricultural sector. In this case, the loan takes the form of goods, the fee for which is paid in the future and represents the repayment of the loan. Commodity lending, on the one hand, allows the lending company to increase inventory turnover, and, on the other hand, helps the borrower to obtain additional resources to develop your own business.

Determining in these relationships the amount that would allow the borrower to settle in time and deprive the lender of unwanted unpaid debts, is a very important topic

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However, there are a number of issues that are insufficiently covered in the scientific literature: consideration of the amount of the limit taking into account the financial performance of both the borrower and the lender, departure from the methodology of expert assessments in obtaining coefficients to calculate the limits, the relationship between loan amount and the term of this loan, taking into account the specifics of the commodity loan for agricultural enterprises, such as, for example, the deadlines for storage of agricultural products - this is a far incomplete list of problems that need further development and solution.

Insufficient elaboration of the outlined problematic issues, as well as their methodological and practical significance determine the relevance of the research topic, its purpose, objectives and structure of the dissertation.

The methodological basis of the research was formed as general scientific research methods: analytical (analysis of existing methods of calculating limits), synthetic (development of calculation of the general limit of commodity lending); and statistical and econometric research methods:

the method of least squares (to find a model for forecasting nonlinear indicators and a model of shelf life of agricultural products), optimization methods (to find credit deadlines).

The information base of the dissertation research was the official statistical materials of the State Statistics Committee of Ukraine, data of the PFTS Stock Exchange, data of the National Bank of Ukraine, data of national and international rating agencies, annual financial reports of agricultural enterprises of Dnipropetrovsk region, information from the Internet.

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Chapter 1.
Theoretical principles of commodity lending to enterprises

1.1. The essence and content of commodity lending

In the modern economic literature, there are 2 main interpretations of the origin of the word "credit". In some sources, this concept comes from the Latin word credo, which means "faith" (for example, [1]). In the second - also from the Latin word “creditum”, which means "debt" (for example, [2]). In the third - both points of view are presented (for example, [3, 4]).

Thus, in general, a loan is a "lending under certain conditions the amount of money" [5, p. 74]. Credit relations are the transfer of use of tangible assets (money or goods) in compliance with the basic principles of lending [6]:

– urgency. The loan is provided for a certain period, with which both parties to the loan relationship agree in advance;

– payment. The loan must be paid. The so-called loan rate, which is presented on an annualized basis, is usually used. The size of this rate is agreed in advance between the two parties to the relationship;

– return. The borrower must repay the entire loan within the period established and agreed in advance by both parties;

– security. The loan must be secured by certain measures that guarantee repayment of the debt in a timely manner. This security is provided by the borrower. Commodity values (real estate, movable property, bank deposits) are usually used as collateral, but sometimes the collateral can be a perfect history of the borrower and the lender or the business reputation of the borrower;

– purpose. The basic prerequisite for ensuring the interests of the parties. The loan must be used by the borrower for the purpose for which it was taken. This appointment is agreed by both parties entering the loan. If the

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borrower has received a loan to purchase certain equipment, it is inadmissible to spend these funds to pay for something else, such as bills from suppliers or payroll.

Thus, the essence of the loan - the economic relationship between the lender and the borrower regarding the transfer of temporarily free value in compliance with the principles of lending.

Hence it is clear that the subjects of credit relations are, on the one hand, the lender, ie the person who provides a loan for temporary use, and, on the other hand, the borrower - a person who receives a loan and undertakes to repay and pay this credit.

The object of credit relations is the debt value, which may be in the form of money, goods or services, which the lender provides for temporary use to the borrower.

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The same companies can act as both a lender and a borrower, depending on the agreement they enter into.

The loan can be in cash (cash loan) or in commodity form (commodity loan) [4].

In the legislation of Ukraine, the concept of "commodity credit" is defined in the Law of Ukraine "On taxation of corporate profits":

"Commodity credit - goods transferred by a resident or non-resident to the ownership of legal entities or individuals under the terms of the agreement, which provides for the deferral of the final settlement for a specified period and at interest.

Commodity credit involves the transfer of ownership of goods (results of works, services) to the buyer (customer) at the time of signing the contract or at the time of physical receipt of goods (works, services) by such buyer (customer), regardless of debt repayment. " [7].

In addition to the definition in the Law of Ukraine, the concept of "commodity credit" was also defined in other regulations. In the Resolution of the Board of the National Bank of Ukraine “On Approval of Supplement

№16 to the Rules of Organization of Financial and Statistical Reporting of Banks of Ukraine" №433 of 01.09.1999: "Commodity loans are payments of loans granted in commodity form. Depending on the maturity, they are divided into short-term and long-term. (Bank loans to finance foreign trade operations do not belong to this category, they are considered together with loans). " [8]. This resolution is repealed in accordance with the Resolutions of the Board of the National Bank of Ukraine "On approval of the Rules for the organization of statistical reporting submitted to the National Bank of Ukraine" №124 of 19.03.2003. [9].

Also, the concept of "commodity credit" was defined in the Resolution of the Board of the Social Insurance Fund for Temporary Disability "On approval of the Procedure for writing off and installment debts of policyholders at the expense of the Social Insurance Fund for temporary disability related to payment of wages in non-monetary form. 2003 №120: "Commodity credit - goods transferred by a resident or non-resident to the ownership of legal entities or individuals under an agreement that provides for the deferral of the final settlement for a specified period and at interest." [10]. This resolution also expired according to the Resolution of the Board of the Social Insurance Fund on temporary disability "On recognition as invalid and cancellation of resolutions of the Board of the Fund" №7 from 02.04.2008 [11].

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In the Resolution of the Board of the National Bank of Ukraine "On approval of the Regulation on lending" №246 of 28.09.1995. the concept of "commercial credit" was defined, which in its content is close to the concept of "commodity credit": "Commercial credit is a commodity form of credit. Participants in credit relations with a commercial loan regulate their economic relations and can create means of payment in the form of promissory notes - the debtor's obligations to pay the creditor the specified amount within a specified period. The object of a commercial loan may be sold goods, work performed, services provided in respect of which the seller

provides deferred payment." [12]. This resolution expired in accordance with the Resolution of the Board of the National Bank of Ukraine "On recognizing as invalid some resolutions of the Board of the National Bank of Ukraine" [54 of 18.02.2004. [13].

Thus, at present, the concept of "commodity credit" in the legislation of Ukraine is defined only in the Law of Ukraine "On corporate income tax". It is in this edition that this concept is presented on the pages of the Ukrainian Wikipedia [6].

In economic dictionaries, the concept of "commodity credit" is defined as a special form of credit provided by sellers to buyers in the form of sale of goods in installments, with deferred payment (sale on credit). In this case, the loan takes the form of goods, payment for which is made in the future and represents the repayment of the loan. Commodity credit is provided under a debt obligation (promissory note) or by opening a debt account "[2, 14].

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Thus, the main feature of a commodity loan is the deferral of payment by the buyer for the goods (services) provided. In addition to the above sources, it is in this sense that commodity credit is defined in [15, 16, 3].

Commodity credit is a "catalyst for barter processes" [17], which are the essence of economic activity of enterprises. It also helps to "accelerate the sale of goods and increase capital turnover" [2, 14].

The benefits of commercial credit for businesses can be divided into two major groups depending about the loan. Thus, the value of a commodity loan is different for the lender and the borrower.

For creditors, a commodity loan has the following advantages:

1) it, above all, increases the sale of goods [18, 16, 17, 19, 20, 21, 2, 14]. Due to the delay in payment, the goods will be able to buy both those companies that currently have the required amount of cash, and those companies that currently do not have the required amount of cash, but plan

to receive them in the future. Therefore, sales volumes increase due to the increase in the number of buyers.

2) commodity credit accelerates the turnover of inventories (by increasing sales of goods). This is an important (almost critical) point if these stocks have a limited shelf life. We substantiate this statement with the following example. Let the enterprise produce 100 units of production per month, let it pay 50 units per month when paying in advance from this enterprise, and let 90 units per month when paying on credit. In the economic literature there is a formula for calculating the turnover of inventories [22, 23]:

$$O_{TZ} = \frac{CB}{\bar{T}\bar{Z}}, \tag{1.1}$$

where O_{TZ} – inventory turnover; CB – turnover of inventories, cost of goods sold for the period; $\bar{T}Z$ - the average balance of inventories for the same period.

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We represent the calculations in table 1.1. As can be seen from table 1.1 turnover of inventories with prepayment is 9 times less than the turnover of inventories when sold on credit. These indicators mean that in the scheme of sale of goods with prepayment inventories rotate 1.7 times in 6 months, and in the scheme of sales using the mechanism of commodity lending inventories rotate 15.4 times in 6 months.

3) the sale of goods on credit provides the creditor company with additional income [18, 16]. This is due to the cost of the loan, which is characterized by a system of discounts when making payments for purchased products immediately. From here it is possible to calculate the interest rate on the loan on an annualized basis when comparing the term of the commodity loan with these price discounts. The calculated rate must meet the following criteria:

- be higher than the current inflation rate. Otherwise, it becomes unprofitable for the creditor company to sell its products on credit. Because after the expiration of the term of the commodity loan, the creditor company will receive an amount of money, the equivalent of which will be less than the equivalent of a similar amount received without delay. This is described, for example, in [24].

Table 1.1. Calculation of inventory turnover

Period	Production, units	Prepayment, units	Sale on credit, units	The balance of goods on prepayment, units	The balance of goods on credit, units
1	2	3	4	5	6
1-st month	100	50	90	50	10
2- st month	100	50	90	100	20
3- st month	100	50	90	150	30
4- st month	100	50	90	200	40
5- st month	100	50	90	250	50
6- st month	100	50	90	300	60
Total	600	300	540	-	-
Average	-	-	-	175	35
Turnover according to the formula (1.1)				1,7	15,4

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- be lower than the bank loan rate. Otherwise, the borrower becomes unprofitable to obtain a commodity loan. It will be cheaper for the borrower to apply to the bank and get a loan, with which the company will be able to

buy the necessary products from the lending company without delay. This is described, for example, in [16].

4) For manufacturers, commodity lending is a simpler way to increase the turnover of inventories compared, for example, with the way when the company produces as many products as it can sell without providing a commodity loan. Almost any production has some production capacity. And in practice it is impossible to significantly increase or decrease output without a similar change in the same production capacity. For example, in the case of an agricultural enterprise engaged in the production of chicken eggs, a significant reduction in output is possible only in the case of a reduction in production capacity (number of chickens). In addition, sometimes the production cycle of the enterprise is large enough to predict the operational market conditions. Given this, a commodity loan seems to be the best solution.

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In addition to the advantages for the lending company, there are certain disadvantages that are associated with commodity lending:

1) a decrease in the value of money over time [22, 25, 26, 27, 28, 24, 29], which is especially noticeable in periods of increased inflation. As mentioned above, due to the temporary value of money and the presence of such a phenomenon of the modern economy as inflation, this shortcoming can be a very serious obstacle to commodity lending.

2) the risk of non-repayment of trade credit [25, 26, 28]. Due to certain factors, sometimes the borrower cannot repay the loan on time and in full. This may be due to the financial situation of the borrower and macroeconomic factors (for example, the crisis of a particular sector of the economy, the sudden rise in price of certain groups of goods, etc.).

3) lack of collateral, ie such tangible assets that would guarantee repayment on time of the loan, as required by the principles of lending. Thus, the guarantee of repayment of a trade credit is only the business reputation

of the borrower or a positive history of the relationship between the lender and the borrower.

4) the presence of liquidity risk [28], ie the risk that at some point in time the creditor company will not be able to pay its obligations due to lack of free funds. This happens when there is an urgent need to pay money, but at the moment there are no free funds, and under the agreements under which commodity loans were provided, the payment deadline has not yet come.

5) the presence of currency risk [28]. This risk is especially true for exporting companies. During the term of a commodity loan, the national currency may strengthen, and then the creditor company (exporter) will incur losses associated with changes in exchange rates.

6) the presence of operational risk [28]. In any process, there is the concept of "human factor", which can lead to errors and, consequently, to losses. For example, the supplier risks incurring losses if the trading manager makes a mistake. Therefore, appropriate control is needed on the part of employees involved in the commodity lending process. And such employees need to be found and trained, and this is an additional expense of time and money. In addition, the category of operational risk includes fraudulent actions in the process of commodity lending by the staff of the creditor company (e.g., corruption) and counterparties (borrowers).

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Graphically, the advantages and disadvantages of commodity lending by the lending company are shown in Fig. 1.2.

For borrowers, commodity credit solves the following problems [16, p.574]:

1) Commodity credit is a source of financing the working capital of the enterprise, it allows you to smooth out the season's need for such funds, as most of this need is associated with the needs of the formation of stocks of raw materials.

2) The most maneuverable form of financing through loan capital is the least liquid part of current assets - inventories.

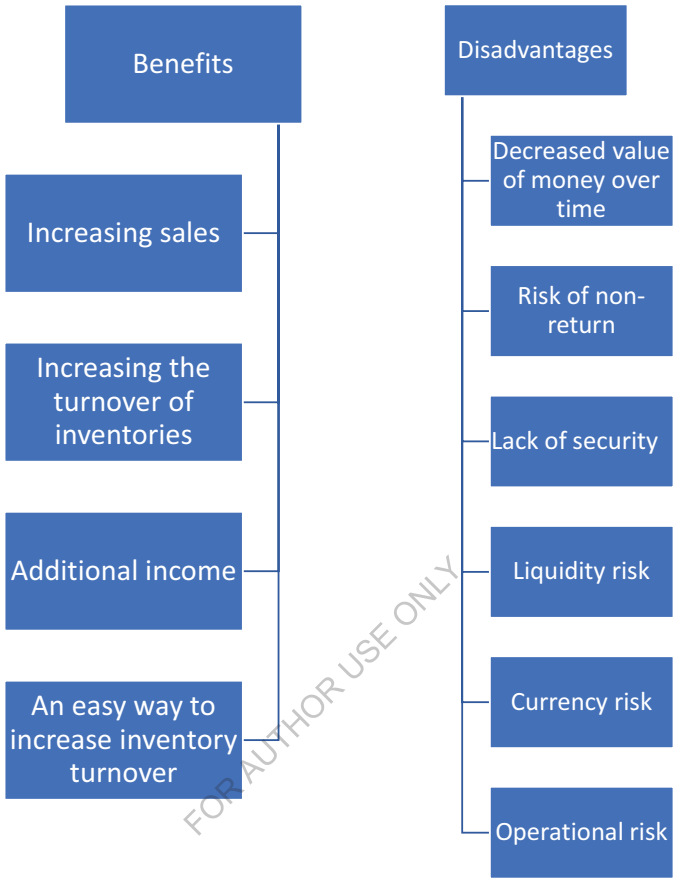

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Fig. 1.2. Advantages and disadvantages of commodity lending by the lender

3) Goods purchased for a commodity loan are not the subject of collateral, as is the case with bank lending. Therefore, the borrower can freely use these goods without asking for the consent of the creditor company to carry out a transaction with these goods.

4) When the interest in providing a commodity, loan comes from the lending company, then such a loan will be able not only companies – "first-class borrowers", but also other companies with worse creditworthiness. This

can happen, for example, in the case when the lender urgently needs to sell the goods within a certain period, or the number of buyers is much less than the number of sellers of goods.

5) The cost of a commodity loan is usually less than the cost of a bank loan, as follows from the restriction on the rate on a commodity loan. Otherwise, commodity credit becomes less attractive than bank credit for borrowers, and therefore the need for such lending disappears.

6) Commodity credit reduces the financial cycle of the borrower.

Consider this statement through the formula for calculating the period of the financial cycle [22]:

$$FC = PO_{DZ} + PO_{TZ} - PO_{KZ}, \quad (1.2)$$

where FC – period of the financial cycle in days; PO_{DZ} – the period of turnover of receivables in days; PO_{TZ} – the period of turnover of inventories in days; PO_{KZ} – the period of turnover of accounts payable in day.

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Therefore, due to the increase in the period of turnover of accounts payable, it is possible to achieve a reduction in the financial cycle. And the increase in the period of turnover of accounts payable can be achieved through an increase in accounts payable itself. That is, when receiving each new loan, the borrower reduces its financial cycle, as shown by formula (1.2).

7) The mechanism for attracting commodity lending is simpler for the borrower, compared to other types of lending. For example, to obtain a bank loan, an enterprise must provide the bank with a number of constituent, financial and other documents, open an account in a subdivision of the bank, and make sure that a certain share of income on current accounts of such enterprises goes through a current account. in the branch of the bank that provides the loan. In addition, the financial performance of the company must meet the criteria set by the bank. Next, you need to provide certain

property as collateral. This property must meet the requirements that exist in the bank for the mortgaged property. Then the company will incur costs associated with the notarization of collateral, insurance, etc. In contrast, a commodity loan requires only the conclusion of an agreement on the sale of goods (services) between the supplier and the buyer, ie between the lender and the borrower.

For borrowing companies there are also certain disadvantages [16, p.575]:

1) The narrow nature of the intended use. Commodity lending is intended only to meet the needs of the borrower in financing inventories as part of working capital. In other types of financing of the borrower commodity crediting does not take part. This is based on the definition of commodity lending as payment for goods, services with deferred payment.

2) Small loan term. In practice, a trade credit is limited to a few months. That is, commodity lending is not a long-term source of financing.

This author also has a third drawback, which is that the loan is a blank and thus, the borrower, not paying on time and in full for a commodity loan, will force the lending company to initiate bankruptcy proceedings of the borrower.

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However, this course of events is possible even with secured lending, and not only with blank lending. According to Article 24 of the Law of Ukraine "On Pledge", the borrower is liable in the amount of the loan, not the amount of collateral: provided by law or contract, to receive the amount that is not enough to fully satisfy the claim from other property of the debtor in the order of priority provided by the legislation of Ukraine "[30]. Therefore, if the borrower does not repay the loan, and the amount of collateral is not enough to repay the debt on the loan, the creditor company can still initiate bankruptcy proceedings against the borrower.

On the other hand, the absence of a mandatory collateral for a commodity loan only increases the attractiveness of this type of loan for the

borrower. After all, the company may not have such property that is acceptable to the lender as collateral, as is the case with bank lending. Thus, the lack of collateral for a commodity loan - this is another advantage for the borrower.

Graphically, the advantages and disadvantages of commodity lending by the borrower are shown in Fig. 1.3.

Thus, commodity lending is a relationship that is mutually beneficial to both parties to this process. And, as you can see from Fig. 1.2 and 1.3, commodity lending is more profitable for the borrower: the borrower has more advantages and fewer disadvantages than the lender in commodity lending. In addition, the lender generally has more disadvantages than advantages. But there is another reason why lenders agree to commodity lending - this is the "tradition of the industry" [28]. If all sellers in the market give their buyers a deferral of payment, then a new seller who enters such a market is also forced to give his buyers a deferral, otherwise he risks losing buyers. Sometimes this reason covers all the disadvantages of commercial credit for the lender.

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There are several types of commodity lending [16, p. 575]:

1) Commodity loan with deferred payment under the terms of the contract. This is the most common form of commodity lending. According to the terms of the contract for the supply of goods, the main conditions of payment delay (amount, term, penalties, etc.) are determined. No other additional loan paperwork is required.

2) Commodity loan with promissory note debt. According to the Law of Ukraine "On Securities and Stock Market" promissory notes can be simple or transferable [31]. Promissory notes may be agreed upon by the parties with the following terms of execution: upon presentation; within a certain period after presentation; within a certain period after assembly; on a certain date. A promissory note issued can serve as a means of payment in the future.

As the promissory note issued by the enterprise is considered less reliable, the mechanism of analyzation by the bank of such promissory note is used.

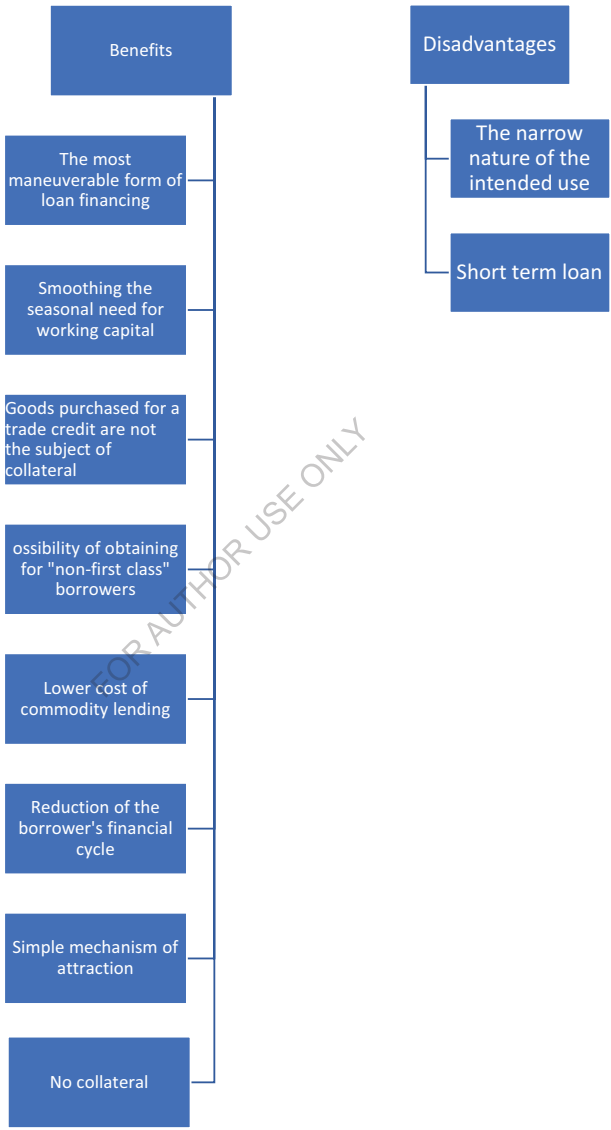

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Fig. 1.3. Advantages and disadvantages of commodity lending by the borrower

3) Commodity credit on an open account. This type of commodity credit is used by lending companies for their regular borrowers with multiple deliveries of pre-agreed range of goods.

4) Commodity loan in the form of consignment. This type of commodity lending is a type of foreign economic commission transaction in which the supplier (consignor) ships the goods to the warehouse of the trading company (consignor) with an order to sell it. Settlement with the consignor is carried out only after the delivered goods are sold.

Thus, commodity lending is an economic process in which certain entities and objects are involved. And as a process, commodity lending has a few advantages and disadvantages for its lender and borrower entities. In addition, in practice there are several types of this lending.

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1.2. Commodity lending as a means of managing receivables

Some authors define receivables in the narrow sense as "amounts due from buyers and customers" [27, p. 378]. But you cannot agree with this definition, because the receivables include other amounts, such as arrears on settlements with staff.

To understand the essence of receivables, we propose a broader definition: receivables - the amount of debts that belong to the company by its debtors (debtors).

For a clearer understanding of the nature of receivables, we divide receivables by type according to the subject of the debt:

- debt for goods, services with contractors. These include commodity credit and payments for goods and services for which the company has made a prepayment.

- arrears on settlements with the budget. These can be tax calculations, such as VAT refunds.

- arrears on settlements with staff. Here are a variety of advance payments that have been provided to employees, but for which no report has yet been received. This type of receivables also includes the amount of fraudulent transactions of staff and losses caused by staff

- debts on internal settlements. In this form are the calculations between the structural units of the enterprise (branches, offices, etc.).

- other types of receivables.

Some authors (for example, [22]) do not distinguish between receivables from the sale of goods with deferred payment and prepayment for goods and services and call both - commodity (commercial) credit. Indeed, both the first and the second are included in the concept of receivables as the amount of debts owed to the company by its debtors. But these are completely different things. First, a commodity credit, as shown in paragraph 1.1., Is defined as the sale of goods in deferral. Secondly, in the case of a commodity loan, the creditor company determines its credit policy for the sale of deferred goods, and in the case of prepayment, the buyer company agrees with the terms of the seller. Third, when recovering debt on commodity lending, the creditor company receives funds, and when collecting debt on prepayment, the creditor company receives its goods and services. Thus, refinancing receivables from prepayments seems a difficult, if not impossible. Therefore, prepaid receivables cannot be included in the concept of commodity lending, both by definition and in essence.

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This division of receivables is graphically represented in Fig. 1.4.

Thus, commodity lending is an integral part of receivables.

The level of receivables is influenced by many factors. These factors can be divided into 2 major groups depending on the source of these factors:

1) External. Factors that do not depend on the company.

- Market capacity;
- The degree of saturation of the market with these goods;
- Solvency of buyers;

- Macroeconomic processes (crises, upswing, etc.);
- inflation;

2) Internal. Factors that depend on the company.

- Type of goods;
- Increase / decrease in sales on credit
- Presence / absence of credit policy
- Type of credit policy
- The presence / absence of a system of control over receivables
- The system of calculations, which is accepted in the organization;
- Late submission of claims for emerging debts;
- etc.

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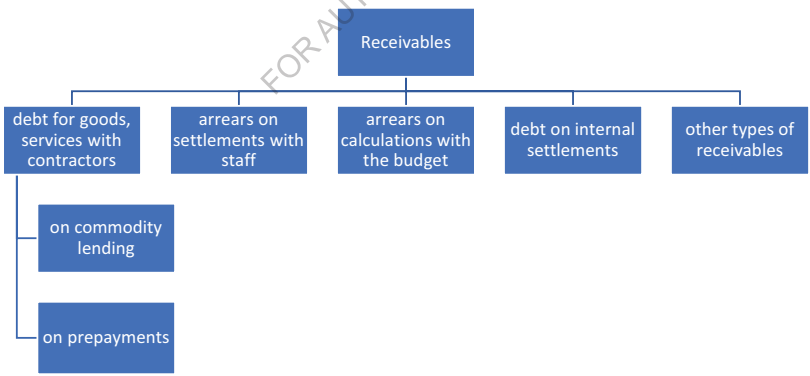

Fig. 1.4. Types of receivables

The company can manage the impact of internal factors and reduce the negative impact of external ones.

Most authors understand the problem of receivables management as managing commodity lending as part of receivables [18, 16, 28].

All ways to manage receivables can be divided into 2 major groups:

1) Analysis and control over the current state of existing receivables

2) Development of conditions, rules and principles for the formation of receivables in the future (the so-called credit policy).

1) The above groups coexist and complement each other. The methods of analysis reveal current trends and problems in loans, and the conditions and rules of credit policy are designed to reduce the negative impact of the problems found in the provision of subsequent commodity loans. Therefore, these methods should be used at the creditor company simultaneously and in parallel.
2) The method of analysis and control includes regular calculation of a few financial indicators on the basis of which management decisions will be made:
3) 1) The total amount of receivables at the reporting date. This indicator is expressed in hryvnias and represents the total amount of debt of counterparties to the enterprise [27];
4) 2) The number of overdue receivables at the reporting date. This indicator is expressed in hryvnias and represents the total amount of debt, the due date of which has already come, but under some circumstances this debt has not been paid [27];
5) 3) The share of receivables in current assets of the enterprise [27, 16, 26]:

$$PB_{DZ} = \frac{DZ}{OA},$$

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where PV_{DZ} – the share of receivables in current assets of the enterprise; DZ – the amount of receivables; OA – the amount of current assets.

6) This indicator characterizes the share of receivables in current assets of the enterprise. Expressed as a fraction of a unit or as a percentage. The higher this figure, the less mobile current assets.
7) 6) The share of overdue receivables [27, 16, 26]:

$$PB_{DZPR} = \frac{DZpr}{DZ}, \quad (1.3)$$

where PV_{DZPR} – the share of overdue receivables; DZ – the amount of receivables; DZ_{PR} – the amount of overdue receivables.

This indicator characterizes the quality and degree of liquidity of receivables. It also characterizes the work of the company with overdue debt. Expressed as a fraction of a unit or as a percentage. The higher this figure, the worse the quality of receivables of the enterprise.

Also, to analyze the quality of receivables, some authors [25] use in the numerator the value of the net realizable value of receivables:

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$$PB_{DZ4} = \frac{DZ4}{DZ},$$

where PV_{DZ4} – the share of net realizable value of receivables; DZ – the amount of receivables; DZ_4 – the amount of net realizable value of receivables.

Turnover of receivables [27, 16, 75, 22, 26, 25]:

$$O_{DZ} = \frac{OP}{DZ},$$

where O_{DZ} – turnover of receivables; OP – sales volume for a certain period; $\overline{DZ}$ – the average value of receivables for the same period.

This indicator characterizes the number of turnovers (repayments) of receivables for the period. The indicator is expressed in revolutions for the period. The higher this figure, the faster the receivables, which can mean, for example, improved payment discipline or reduced sales of goods on credit.

Accounts receivable turnover period [27, 16, 75, 33, 22, 26, 18]:

$$PO_{DZ} = \frac{DZ}{OP}T = \frac{T}{O_{DZ}},$$

where PO_{DZ} – the period of turnover of receivables; O_{DZ} – turnover of receivables; OP – sales volume for a certain period; DZ – the average value of receivables for the same period, T - the number of days in the period.

This indicator characterizes the period for which 1 turnover (repayment) of receivables takes place. The figure is expressed in days. The higher this figure, the longer the repayment of receivables, which may mean, for example, a deterioration in payment discipline or an increase in sales of goods on credit.

8) Grouping of receivables by maturity.

To calculate the entire amount of receivables is divided into terms when it arose. To give an idea of this indicator, we give an example. Suppose the company has receivables in the amount of UAH 1,000, UAH 150. arose 11 days ago, 200 UAH. - 45 days, UAH 100. - 87 days and UAH 550. - 33 days. The results are presented in the form of table 1.2.

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Table 1.2. Grouping of receivables by terms

Period	Sum, UAH	Specific weight
1	2	3
0 – 30 days	150,00	15%
31 – 60 days	750,00	75%
More then 60 days	100,00	10%
Total	1 000,00	100%

Different authors offer different time frames for grouping receivables:

- 0-10, 11-30, 31-45, 46-60 and more than 60 days [18]
- 0-15, 16-30, 31-45, 46-60 and more than 60 days [16]
- 0-30, 31-60, 61-90, 91-120 and more than 120 days [22, 26]
- 0-90, 91-180, 181-360, and more than 360 days [25]
- 0-30, 31-60, 61-90, 91-120, 121-150, 151-180, 181-360 and more than 360 days [74].

Thus, each company decides on the size and number of time periods for themselves independently from the standpoint of ease of accounting, expressiveness and other criteria.

This grouping allows you to analyze the structure of receivables by maturity. Having a larger share of long-term receivables can mean, for example, incorrectly chosen credit policy or low payment discipline.

8) Statement of outstanding balances [18]. Information on outstanding balances (receivables) can be presented in the form of a comparison of sales for each month and the amount of outstanding balance (receivables) that remained at the end of the quarter of the debt. This type of information presentation eliminates the difference in sales in different quarters. In table 1.3. an example of outstanding balances is given.

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8) In the 1st and 4th quarters, the company received UAH 180,000 each. from the sale of goods, and in the 2nd and 3rd quarters – 270 thousand UAH. Also, different balances of receivables at the end of different quarters. However, as for the structure of such debt in terms of months of origin, it remains the same throughout the four quarters, which indicates a stable payment discipline of the company's counterparties. If the total amount of interest will increase, it will mean a deterioration in payment discipline of the company's counterparties.

9) Therefore, this grouping characterizes the payment discipline of counterparties, in addition, this approach is convenient when the volume of sales for different quarters.

The average period of overdue receivables [16, 26]:

$$PO_{DZPR} = \frac{DZ_{PR}}{OP} T,$$

where PO_{DZPR} – the period of turnover of overdue receivables; OP – the volume of sales for a certain period; DZ_{PR}– the average value of overdue receivables for the same period, T – the number of days in the period.

Table 1.3. Statement of outstanding balances

Month and quarter	Sales volume, thousand UAH	Accounts receivable that arose in the quarter	
		thousand UAH	%
1	**2**	**3**	**4**
January	60	12	20%
February	60	36	60%
March	60	54	90%
1st quarter	180	102	170%
April	60	12	20%
May	90	54	60%
June	120	108	90%
2nd quarter	270	174	170%
July	120	24	20%
August	90	54	60%
September	60	54	90%
3rd quarter	270	132	170%
October	60	12	20%
November	60	36	60%
December	60	54	90%
4th quarter	180	102	170%

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This indicator characterizes the period for which 1 turnover (repayment) of overdue receivables takes place. The figure is expressed in days. The higher this figure, the longer the repayment of overdue receivables, which may mean a deterioration in payment discipline or an increase in overdue receivables.

10) The amount of the effect of commodity lending [16, 26]:

$$E_{ДЗ} = P_{DZ} - PB_{DZ} - БZ_{DZ},$$

where E_{DZ} – the economic effect of commodity lending; P_{DZ} – additional income received from commodity lending (due to increased sales on credit) for a certain period; PV_{DZ} – current additional costs associated with the organization of lending for a certain period; BZ_{DZ} – the amount of bad receivables that the company is forced to write off at a loss for a certain period.

This indicator shows the effect in monetary terms was obtained from commodity lending over a period. The indicator is expressed in hryvnias.

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10) The efficiency of commodity lending [16]:

$$KE_{DZ} = \frac{E_{DZ}}{DZ},$$

where KE_{DZ} – an indicator of the effectiveness of commodity lending; E_{DZ} – economic effect of commodity lending; DZ – the economic effect of commodity lending for a certain period.

This indicator shows the effect in monetary terms was obtained from commodity lending in relation to the amount of receivables for the same period of time. The indicator is expressed in fractions of a unit. The higher this figure, the greater the effect of commodity lending.

The above indicators are calculated on the date and compared with one or more of the following indicators:

- with planned indicators;
- with their values in previous periods;
- with industry averages;
- with normative values.

This comparison helps to compare, assess the receivables of the enterprise, and then on the basis of data to develop and make management decisions.

After analyzing the existing receivables, the company within the process of managing receivables must develop or refine the conditions, rules and principles that make up the loan policy of the company.

Credit policy in the economic literature is understood as "part of the general policy of current assets management and marketing policy of the enterprise, which aims to expand sales and which is to optimize the total amount of this debt and ensure its timely collection" [16 p. 328].

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The authors identify the following components of credit policy [18, 16, 28, 107, 108]:

1) Choosing the type of credit policy (aggressive, moderate, conservative);

2) The choice of commodity lending;

3) Formation of a system of credit conditions (term, amount, discounts, loan payment, penalties);

4) Creditworthiness standards (customer differentiation);

5) Payment collection policy (external and internal collection);

6) Refinancing of receivables;

7) Systems for control over the movement and collection of receivables.

These components of credit policy will be discussed in more detail below.

1.2.1. Choice of credit policy type

It is to determine the method of managing commodity credit from the standpoint of different ratios of profitability and risk. There are 3 main types of credit policy:

1) Conservative (hard) type of credit policy. This type of policy is aimed at minimizing the risks mentioned in paragraph 1.1. (risk of non-return, risk of decline in the value of money over time, liquidity risk, currency risk and operational risk). The creditor company sets stricter criteria for selecting customers who are granted deferral. The company tries to minimize both the terms of commodity lending and the total amount of such lending. The creditor enterprise does not try to receive additional profit by means of commodity crediting.
2) Aggressive policy is aimed at maximizing additional profits at a set level of risk. This type of credit policy is characterized by an increase in sales of deferred goods by easing the criteria for buyers, increasing credit terms, increasing both the amount of credit as individual for each buyer and the total amount of credit.
3) Moderate policy. This type of credit policy is halfway between conservative policy and aggressive policy in terms of risk and return.

To determine the type of credit policy, the company must consider the following factors [16, p. 336]:

- modern commercial and financial practice of trade operations;
- the general state of the economy, which determines the financial capabilities of buyers, the level of their solvency;
- the potential ability of the enterprise to increase production while expanding the possibilities of its implementation through the provision of credit;
- legal conditions for securing the collection of receivables;

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- financial mentality of owners and managers of the enterprise, their attitude to the level of acceptable risk during economic activity, i.e. their propensity to risk.

In addition, to this list should be added such a factor as certain conditions and traditions that have developed in a particular market in which the creditor company operates.

1.2.2. Choice of type of commodity crediting

This is done from the existing types of commodity lending, which were considered in paragraph 1.1:

- Commodity loan with deferred payment under the terms of the contract;
- Commodity loan with promissory note debt;
- Commodity credit on an open account;
- Commodity loan in the form of consignment.

The choice of type of commodity lending depends on the type of product, the relationship between seller and buyer, market conditions.

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1.2.3. Formation of a system of credit conditions

Includes a choice of:

- loan term. The choice of loan term means the choice of the time period after which the creditor company must receive all necessary payments for the delivered goods from the borrower company. Increasing the term of crediting attracts additional buyers and leads to an increase in sales, but at the same time increases the amount of receivables and increases the financial cycle of the creditor company according to (1.2). The lender may need to raise additional funds to replenish current assets.

- the size of the loan. The size of the loan (credit limit) characterizes the maximum amount that the lending company can allow the buyer when buying products with deferral. More details on determining the size of the limits will be written below.

- loan payments. The amount of payment for the loan means how much the buyer overpays the seller for the purchase of goods with deferral, compared to the amount that he could pay when buying goods with payment immediately. Expressed as a percentage per annum. In the economic literature there are formulas for calculating this rate [16, p.339]:

$$C_K = \frac{CZ \times 360}{SP_K},$$

where C*K* – the annual rate for the granted credit; *CZ* – the amount of the price discount provided to the buyer when making an immediate payment for the products purchased, in%; SP_K – loan term, in days. Criteria for choosing this rate were specified in paragraph 1.1., The main of which - is the average rate on bank loans and inflation.

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In practice, a whole system of discounts can be used to stimulate the calculation of borrowers on time. For example, a creditor company gives a 3% discount to the buyer when buying goods immediately, a 2% discount on the purchase of goods within 10 days after delivery and payment of the full cost of the goods within 30 days.

Sanctions for breach of credit terms. The lending company must develop a system of sanctions for breach of credit conditions in advance and notify the buyer before granting the loan. Sanctions can include various fines and penalties regarding the term and amount of payment of a trade credit. The amount of penalties should cover the financial losses of the creditor company (inflation, loss of income, etc.).

1.2.4. Creditworthiness standards

Include the development and implementation of a system of differentiation of potential borrowers, which includes the following components:

1. The choice of methods and indicators for assessing potential borrowers in terms of their reliability. That is, the lending company must choose such methods and indicators to determine the creditworthiness of the borrower, so that at the end of the analysis to get an answer to the question of what is the probability that the borrower will repay the loan. There are already developed models for assessing solvency, for example:

- - Multiplicative discriminant analysis (MDA), the purpose of which is to build a line that divides all companies into 2 groups: if the point that characterizes the firm is located above the line, the firm is not threatened by financial difficulties and bankruptcy. And vice versa. This line is called a discriminant function "[18, p. 505];
- - The most famous model of MDA - Altman model [18, 22], which has the following form:

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$$Z = 0{,}012X_1 + 0{,}014X_2 + 0{,}033X_3 + 0{,}006X_4 + 0{,}999X_5, \quad (1.4)$$

where X_1 – the ratio of working capital to assets; X_2 – the ratio of retained earnings to the amount of assets; X_3 – the ratio of profit to interest and taxes to the amount of assets; X_4 – the ratio of the market value of ordinary and preferred shares to the balance sheet valuation of loan capital; X_5 – the ratio of sales revenue to the amount of assets.

In this case, if Z is more than 2.99, the probability of bankruptcy is insignificant, if Z is in the range from 1.81 to 2.99, then nothing

specific can be said about the company, the so-called "zone of ignorance". But if Z is less than 1.89, then the probability of bankruptcy is high. That is, the larger the value of Z from (1.4), the lower the probability of bankruptcy.

- Model of generalized assessment of the financial condition of the enterprise [25], which consists of 6 groups of indicators: 1 - the state of assets; 2 - solvency; 3 - financial stability; 4 - business activity; 5 - efficiency of economic activity; 6 - market activity. Each group includes 5 financial indicators, on the basis of which the integrated indicator of the financial condition (development) of the economic system is calculated:

$$I_j = \sum_{i=1}^{n} y_{ij} \cdot W_i,$$

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where I_j is an integral indicator of the financial condition (development) of the j-th economic system; y_{ij} – normalized i-th indicator of financial condition (development) in the j-th economic system; W_i – weighting factor for a separate indicator y_{ij}, which characterizes the financial condition (development) of the economic system; n – the number of indicators that characterize the financial condition (development) of the economic system.

In addition, it is possible to develop your own model of solvency assessment, having a list of certain financial indicators. Such a list can be obtained from almost any textbook on financial analysis of the enterprise or from periodicals [78, 33, 26, 75, 109, 110, 111, 112, 113]. There is also a list of financial indicators in the Resolution of the Board of the National Bank of Ukraine "On approval of the Regulations on the formation and use of reserves to compensate for possible losses on credit operations of banks" [279 of 06.07.2000] [114].

Then all indicators are assigned a certain number of points, and the latter are weighed by special weights. As a result of the analysis, a certain number will be obtained, which characterizes the creditworthiness of the enterprise, according to the financial indicators of which this analysis was made.

It is also possible to use already developed estimates of enterprises, which can be obtained from rating agencies. In Ukraine, there is a well-known agency "Credit Rating", which evaluates legal entities by national rating [115]. In addition, there are well-known international agencies, such as Fitch Ratings, Moody's, Standard & Poor's, which independently assess not only legal entities but also entire countries [116, 117, 118]. On the official websites of these agencies you can find the current rating of a legal entity. If a potential borrower has a high rating from an international rating agency - this may mean a high probability of repayment of the commodity loan.

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International ratings have a certain rating scale, the comparison of which for the leading rating agencies is given in Table 1.4. [115]:

Table 1.4.

Comparative credit ratings of leading international rating agencies

Moody's	**Standard & Poor's**	**Fitch Ratings**	**Brief description**
1	**2**	**3**	
Aaa	AAA	AAA	Maximum degree of security
Aa1	AA+	AA+	High degree of reliability
Aa2	AA	AA	
Aa3	AA-	AA-	
A1	A+	A+	Get reliability above average
A2	A	A	
A3	A-	A-	
Baa1	BBB+	BBB+	

Moody's	Standard & Poor's	Fitch Ratings	Brief description
Baa2	BBB	BBB	Rate the reliability average and slightly below average
Baa3	BBB-	BBB-	
Ba1	BB+	BB+	Non-investment, speculative degree
Ba2	BB	BB	
Ba3	BB-	BB-	
B1	B+	B+	Highly speculative degree
B2	B	B	
B3	B-	B-	
C22	CCC+	CCC+	Significant risk of non-refund, the issuer is in a difficult situation
-	CCC	-	
-	CCC-	-	
Ca	-	-	Super-speculative degree, possible refusal of payments
C	-	-	
-	-	DDD	Refusal of payments
-	-	DD	
-	D	D	

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1. The choice of criteria and standards for cutting off and grouping borrowers, which is based on the analysis and accumulated over a period of default statistics. The choice of these standards and criteria is also influenced by the type of credit policy chosen. For an aggressive credit policy, the standards will be softer, which will be able to "miss" more potential borrowers. For a conservative policy, the standards will be stricter, which are able to "miss" fewer potential borrowers, but for them there is an increased likelihood of repayment of the commodity loan.

2. Selection of criteria for grouping potential borrowers. In addition to the above financial evaluation criteria, borrowers can be further evaluated into grouped based on criteria related to marketing policy. For example, on the following grounds of buyers: large, small, image, political, new, old, and

so on. But in general, the grouping identifies three large groups of borrowers [16]:

- Buyers who are given the maximum possible credit and / or for the maximum possible term with a minimum number of additional restrictions;

- Buyers who are granted a loan with certain restrictions on the amount and / or term or with additional conditions (insurance at the expense of the buyer, penalties, etc.).

- Buyers who are not granted a trade credit.

There may also be subgroups in the middle of these three groups. This will allow you to more accurately determine the terms of the loan for each individual borrower.

1. Differentiation of lending conditions depending on the borrower's group. Each group of borrowers may be offered "their" credit terms and / or the presence of no additional terms. The "better" the group (ie the group with the highest probability of loan repayment) the more favorable conditions will be offered. Conversely, the "worse" the group, the more unfavorable for the buyer conditions will offer the seller (lender).

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2. Analysis of the potential borrower according to the chosen methodology and assigning it to a certain group, which means the process of carrying out the above in paragraphs 1-3. at specific enterprises. This component includes procedures for interaction with a potential borrower before granting a loan, a list of necessary and sufficient documentation for the differentiation of the borrower.

1.2.5. Payment collection policy

Means a system of standards of rules and conditions of the creditor company in the recovery of debt from borrowers. In the economic literature it is noted that one of the main rules when collecting payments - to make it

clear to the debtor that the debt will still be collected from him. After all, often the debtor hopes to win as much time as possible, assuming that over time he may be left alone [28]. This policy, depending on who is engaged in debt collection (collection) is divided into:

- Internal, when the debt is collected by the creditor company itself. This policy should formalize the timing and forms of prior and subsequent reminders to customers of the date of payment; the possibility and conditions of debt extension for the loan; conditions for initiating bankruptcy proceedings, etc.
- External, when the debt is collected by a third company that specializes in such work, a collection agency (collection company). This policy should provide for the conditions under which the creditor applies for the services of a collection agency. Payment for the services of such an agency depends on the amount and term of debts and, as a rule, is a certain percentage of the amount owed. The "older" the debt, the higher the percentage of the amount owed by the collection agency.

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The two payment collection policies above can coexist and complement each other.

1.2.6. Refinancing of receivables

Means the receipt of funds by the creditor company on the loan debt before the due date from a third party. There are several types of refinancing, the main of which are:

- Factoring, which means a financial transaction, which consists in the assignment by the seller of rights to receive cash on payment documents for the delivered products in favor of a bank or specialized company - "company factor" [16, p. 343]. For their services, the bank (factor company) charge a fee, which is usually

calculated as a percentage of the amount of debt. The bank (factor company) immediately pays the lender 70-90% of the agreed amount. The remaining 10-30% is paid by the bank (factor company) when the borrower pays the debt in full, which is to some extent an insurance reserve.

- Promissory note accounting means their sale to a bank or other enterprise that specializes in promissory note accounting, with a certain discount, which depends on the amount of the promissory note, the term of payment and the rate on the promissory note. This operation can be performed only with a bill of exchange [16].
- Forfaiting is a financial transaction to refinance receivables from an export commodity (commercial) loan by transferring (endorsement) a bill of exchange in favor of a bank (factoring company) with payment of the latter commission. The bank (factoring company) undertakes to finance the export operation by paying on a promissory note, which is guaranteed by providing a guarantee to the bank of the importing country. As a result of forfeiting, the buyer's debt on a commodity (commercial) loan is transformed into a financial debt (in favor of the bank). " [16, p. 345]. This operation includes the features of a factoring operation for the sale of debt and operations for the accounting of promissory notes (with their endorsement only in favor of the bank).
- Assignment of claims (cession), which consists in signing an agreement between the assignor (the person transferring the debt) and the assignee (the person receiving the debt). In this case, the assignor and the assignee must not obtain the obligatory consent of the debtor (unless expressly stated in the agreement between the assignor and the debtor). But after the conclusion of the assignment agreement, the assignor is obliged to notify the debtor by providing him with documents confirming this fact. Usually in this way the

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debt is bought by companies that are themselves debtors to the debtor. It is advantageous for them to buy the debt at a discount and then present it in full.

The system of control over the movement and collection of receivables means the presence of the following elements at the enterprise:

- methodologies. Availability of relevant provisions, methods, rules, etc., which would describe the procedure of commodity lending, as well as the procedure for development and timely updating.
- working analysis system. Availability of regular relevant analytical reports on current data.
- working credit accounting system. The creditor company must keep records of loans, borrowers, terms, etc. for the entire period of existence of the loan.
- The system of support of loans from the analysis of the borrower from the issuance to full repayment or write-off of debt. This system should include both certain units and certain procedures of interaction between the lending company and the borrower company, as well as between units of the lending company.
- The system of reducing the negative factors of commodity credit, which includes ways and methods to reduce the impact of negative factors that carry commodity lending for the lender.

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In addition, such a system provides for the presence of the creditor company staff who have the appropriate qualifications to carry out these types of operations.

As noted in 1.1., Commodity lending has a number of disadvantages for the lending company:

1) decrease in the value of money over time.

2) the risk of non-repayment of the trade credit.

3) lack of security.

4) liquidity risk

5) currency risk

6) operational risk.

The lending company can reduce the impact of these negative factors using the following methods:

1) Payment for a commodity loan, which neutralizes the effects of inflation.

2) Calculation of limits (limitation), which reduces the impact of default risk and improve the quality of receivables.

3) An established control system that neutralizes operational risk.

4) Refinancing of receivables, which minimizes liquidity risk. In addition, in the absence of recourse requirements, this method also minimizes the risk of non-return. Also, the forfaiting operation with exporters allows to reduce currency risk, and the factoring operation with additional receivables management services [28] also minimizes operational risk.

5) Formation of a reserve, which mitigates the impact of the risk of non-return.

6) Receivables insurance, which avoids the risk of non-repayment.

7) Diversification of borrowers, which reduces the risk of default.

8) Comprehensive analysis of the borrower, which reduces the risk of default.

Graphically, the shortcomings of commodity lending and ways to reduce them are presented in Fig. 1.5.

More details on how to minimize the impact of negative factors will be described below.

The payment for the commodity credit proceeds from the system of discounts for immediate payment or payment with a short term, as it was shown above in item 1.2. when describing the component of credit policy - the formation of lending conditions. Therefore, if the calculated rate

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according to formula (1.11) is higher than the inflation rate, the lender can be sure that the risk of depreciation of money over time is minimized.

Although in case of non-repayment of the loan or repayment on time, simply paying for the loan will not help reduce the impact of inflation. Then there will be penalties, which are also part of the formation of credit conditions as part of credit policy. Limiting, as noted by many authors, can improve the quality of receivables and reduce the impact of default risk [16, 18, 28].

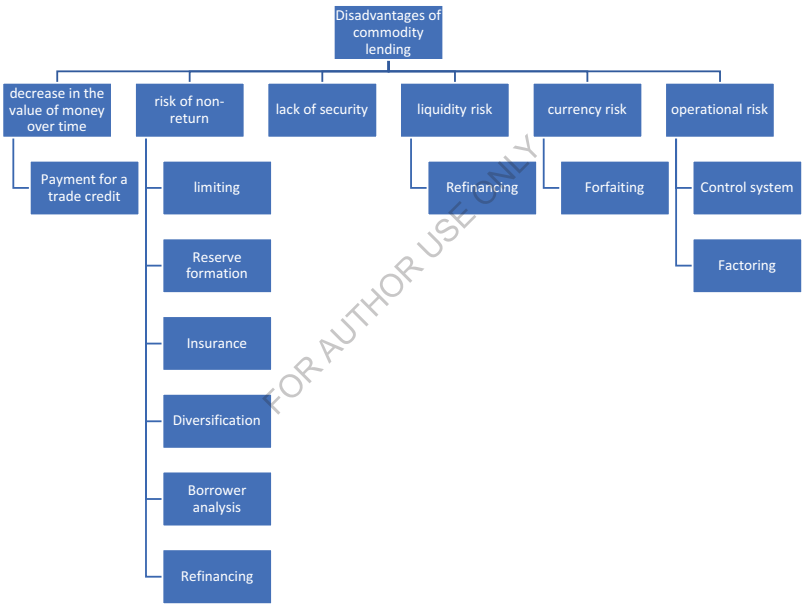

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Fig. 1.5. Disadvantages of commodity lending for the lender and ways to minimize their impact

Limiting is applied by economic entities when selling goods on credit (by credit cards), by traveler's checks and euro checks, determining the amount of capital investment, etc. The importance of calculating the optimal value of the limit is due to the fact that too high a limit value will not reduce the credit risk of the enterprise (the risk will remain the same), and a small value - will not allow the company to make additional profits.

Here are some definitions of "limit" and "limitation".

"Limiting - setting a limit, ie the maximum amount of costs, sales, credit, etc. Limiting is an important way to reduce risk." [120, p. 64].

"The limitation is the establishment of systems of restrictions, both above and below, which help to reduce the degree of risk." [123, p. 329], [121, p. 358].

"Credit limit per borrower is the regulatory or internal limit of the maximum loan amount that a bank is allowed to issue to one company or group of related companies." [119, p. 620].

"Limiting financial risks is considered a milder form of avoidance. It means setting limits on the freedom to make decisions on risks while doing business. " [128, p. 161].

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As a rule, limiting means setting the maximum amounts of costs, credit, investment. [120, 119, 127, 128, 121, 135, 136].

However, the following types of limits are also used [127, p. 351], [123, p. 329]:

- In terms of (loans, investments, etc.);
- By structure (share of costs in total, share of each type of securities in the total value of the portfolio, share of preference shares in total issue, etc.);
- By level of return (setting the minimum level of profitability of the project).

Also, the limits per borrower can be divided [124 p. 418], [127 p. 351]:

• for certain operations or types of services;

• in total for all types of transactions with this client;

• by types of products sold.

Existing methods of determining the creditworthiness of the enterprise (bankruptcy forecasting), given in such works as, for example, [76, 34, 16, 137, 138], do not allow to determine the limit, but give only two answers to the question of creditworthiness of a particular enterprise: , the company is creditworthy "or" no, the company is not creditworthy ", which helps little in determining the size of the limit for a particular counterparty.

In the modern literature there are techniques that allow you to use them to calculate the limits in terms of determining the amount of the limit and no way to calculate the limit in terms of determining the term. In addition, there are certain criteria that must meet the method of calculating the limit [124, p. 416-418], [16, p. 339]:

• the share of capital of the creditor company, which it is willing to risk;

• financial condition of the creditor company;

• industry affiliation of the borrower;

• the size of the borrower's assets;

• financial stability of the borrower;

• quality of management of a potential borrower;

• prospects for the borrower's development;

• the relationship of the creditor company with the borrower;

• expected profitability considering the risks of transactions with the borrower;

• general state of the economy;

• regulatory requirements;

• type of credit policy implemented (level of acceptable risk),

• the planned volume of sales by the creditor on terms of deferred payments;

• the average volume of transactions for the sale of finished products by the lender;

• other factors.

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Among the methods of calculating the limit, the most interesting and expressive are the following:

1) Percentage of equity [119, 127];

The limit is calculated as a percentage of equity according to the following formula:

$$L = K \times BK, \tag{1.5}$$

where L is the sum of the limit; K – correction factor; VK – equity of the creditor company.

Different sources determine the value of the correction factor in different ways. It is sometimes said that the limit should be 10-20%, and in some countries it reaches 30-40% [119, p. 620], [127, p. 142].

The advantage of this method is the simplicity of calculation, this method also considers the performance of the creditor company. The method includes two criteria from the above list:

• the share of capital of the creditor company, which he is willing to risk;

• regulatory requirements.

But in practical application there are a number of complications:

1) There is no clear justification for the value of the correction factor K. Different sources differently determine the value of the correction factor K. Sometimes it is said that the limit should be 10-20% [119, p. 620], and in some countries it reaches 30-40 % of equity [127, p. 142].

2) The financial position of the counterparty is not considered at all. It is possible that the same amount of limit will be acceptable to some company, and too large to some. It is easy to imagine a situation where there is a large manufacturer that sells its products to regional dealers. The financial performance of dealers is much more "modest" than similar performance of the manufacturer. If the manufacturer wants to give such

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companies a commodity loan, the question immediately arises about the size of such a loan. It is intuitively clear that 25% of the manufacturer's equity may be excessive for one regional dealer. Most likely, the dealer simply will not be able to fully sell the product. That is, the manufacturer will look for another approach to determine the size of the limits on trade credit.

3) The method does not consider the principle of temporary value of money [22]. Since a commodity loan is issued for a certain period and at a certain rate, it means that the value of money that will be returned to the lender after the expiration of the loan will not be equal to the value of the same amount of money now.

2) Limit depending on the international rating [139]

International ratings are set by international rating agencies (e.g. Fitch I124A, Moody's, S&P [115]). In Ukraine, international ratings are held by enterprises that need to obtain external borrowing (in international foreign exchange markets). The instruments of such borrowing can be, for example, Eurobonds, syndicated loans, etc. Thus, the rating is a measure of the creditworthiness of the enterprise. It only remains to establish a correspondence between the rating and the limit. This possibility is discussed in [139]. As an example, the author gives a scale of compliance of the borrower's rating to the amount of the limit (Table 1.5).

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Table 1.5 Correspondence of the borrower's rating to the amount of the limit

International rating	**Credit limit, thousand $**
1	**2**
AAA	25 000
AA	15 000
A	10 000

International rating	Credit limit, thousand $
BBB	5 000
BB	1 000
B	500
CCC	100
CC	25
C	0
D	0

In addition, the author proposes to limit the amount of the limit by the size of the borrower's assets and equity. Therefore, the limit according to this method is calculated by the following formula:

$$L = MIN\{L_r; 20\% K; 5\% A\},$$

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where L is the estimated amount of the limit; L_r – limit based on the rating according to table 1.5; K – the value of equity of the borrower; A – the value of the currency balance of the borrower.

The advantage of this method is its ease of use. If the company has an international rating, it will be easy to determine the limit using the scale of credit ratings (see table 1.4). The method includes four criteria from the above list:

- the size of the borrower's assets;
- financial stability of the borrower;
- quality of management of a potential borrower;
- general state of the economy.

The last 3 points are provided by the value of the international rating.

At practical application of this method there are a few complications:

1) Only large enterprises engaged in obtaining such a rating. For example, as of June 1, 2010, 8 enterprises in Ukraine had international ratings, which is 0.001% of the total number of legal entities [115].

2) There is no relationship between the size of the borrower and the amount of the limit. Although the author [139] tries to solve this problem by introducing 2 restrictions: 20% of equity and 5% of the balance sheet currency. However, the paper does not substantiate these restrictions.

3) There is no calculation of the limit amounts based on the international rating (Lr). The author proposes an upper limit based on a rating of $25 million. However, again, there is no justification for calculating this amount.

4) The relationship between international rating and country rating. For example, due to the global financial crisis, all leading rating agencies downgraded Ukraine's sovereign rating in late 2008. from BB to B (and S&P lowered to CCC). And the rating of a resident enterprise of Ukraine cannot be higher than the sovereign rating of the country. Accordingly, the ratings of all entities in Ukraine were lowered. According to the data on April 29, 2010. Ukraine's sovereign ratings have not been restored to pre-crisis levels, although S&P has raised Ukraine's sovereign rating to B- [115].

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5) In situations where the country's rating and the ratings of enterprises are constantly declining, and the source of foreign attraction of resources is practically stopped, some Ukrainian companies have begun to abandon the services of rating agencies. In addition, the support of the rating itself is "expensive pleasure" (according to the Business newspaper [140 p. 31], the cost of maintaining the international rating is 100 thousand dollars a year). This further complicates the calculation of the limit by this method.

6) This method does not consider the financial capabilities of the creditor company. It is possible to imagine a picture when the enterprise-buyer (borrower) is larger than the enterprise-seller (creditor). Therefore, the loan amount may be small for the borrower and too large for the lender.

7) The method does not consider the principle of temporary value of money [22]. Since a commodity loan is issued for a certain period and at a certain rate, it means that the value of money that will be returned to the lender after the expiration of the loan will not be equal to the value of the same amount of money now.

3) The total amount of trade credit [16]

"Determination of the possible amount of working capital sent to receivables for commodity (commercial) and consumer credit, is carried out according to the following formula:

$$ОК_{DZ} = \frac{ОР_{К} \times К_{S/C} \times (\overline{PPK} + \overline{PP})}{360},$$

where OK_{DZ} – the required amount of working capital sent to receivables; $OP_{к}$ – the planned volume of sales on credit; $Ks_{/c}$ – the ratio of cost and price of products, expressed as a decimal fraction; $\overline{PPK}$ – the average period of credit to buyers, in days; $\overline{PP}$ – the average period of overdue payments on the loan, in days. " [16, p. 350].

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This method of calculating the limit will be needed by the company for periodic planning of costs and revenues. The method includes one criterion from the above list: the planned volume of sales on the terms of deferred payments.

But the technique has several disadvantages:

1) The main disadvantage of using this method for calculating limits is that this method does not involve calculating the value of the limit for each specific counterparty.

2) The planned volume of sales on credit, which is included in the formula (1.16) as a pre-known value, in fact, requires a very careful and thoughtful calculation. On the one hand, it is advantageous for the company's

management to sell all products on credit, so that the products do not depend on the warehouse (especially for perishable products). But on the other hand, the company needs working capital, and if all products are sold on credit, the company due to lack of working capital will not be able to produce products.

3) This calculation does not consider the financial condition of the borrower.

4) The method does not consider the principle of temporary value of money [22]. Since a commodity loan is issued for a certain period and at a certain rate, it means that the value of money that will be returned to the lender after the expiration of the loan will not be equal to the value of the same amount of money now.

3) Limit as average quarterly revenue with adjustment factors [133]:

The method proposed in [133] is as follows: the limit is defined as the sum of average quarterly revenues, which is adjusted by certain coefficients:

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$$L = BL \times K_p \times C,$$

where L is the limit of credit operations; BL – base limit, which is defined as the average for the quarter amount of cash receipts from sales; Kp – growth rate, which is the product of the growth rates of sales revenue and equity growth and is within [1..1,5]; C – synthetic coefficient obtained as the probability of non-payment on the basis of the probability of non-payment by quantitative and qualitative indicators (60% of the weight of quantitative and 40% of qualitative indicators).

This method is a comprehensive approach to determining the value of the limit of the borrower, analyzing both quantitative and qualitative indicators. The method includes four criteria from the above list:

- the size of the borrower's assets;

- financial stability of the borrower;
- quality of management of a potential borrower;
- the relationship of the creditor company with the borrower.

Of the minuses, I would like to note the following:

1) the value of the coefficient *Kp* as a growth factor is unreasonable. After all, cash inflows can both increase and decrease during the period, and this ratio can only increase the final amount of the limit.

2) when calculating the scale for qualitative indicators, the step size ranges from 75 points for classes 9, 8 and 7 to 35 points for all other classes (while for quantitative indicators the step was constantly 9 points). This gradation is unfounded;

3) in the list of quantitative indicators there are no indicators that would characterize the dynamics of the cost of production, which could affect the final results of calculations.

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4) in the article [133] the method is not fully described: there is no description of the calculation of quantitative indicators (although the qualitative indicators are described in full);

5) this technique does not consider the financial capabilities of the creditor company. It is possible to imagine a picture when the enterprise-buyer (borrower) is larger than the enterprise-seller (creditor). Therefore, the loan amount may be small for the borrower and too large for the lender.

6) The method does not consider the principle of temporary value of money [22]. Since a commodity loan is issued for a certain period and at a certain rate, it means that the value of money that will be returned to the lender after the expiration of the loan will not be equal to the value of the same amount of money now.

3) Residual value method [134].

The method proposed in [134] is as follows: from the financial statements of the enterprise is allocated 8 elements, which are added by the following formula:

$$L = VP + ChP + TZ + DZ + KZ + FV + GK - PP, \quad (1.6)$$

where *VP* – Deferred payments to suppliers; *PE* – Net profit on an annualized basis; *TK* – Sale of inventories (taken 70%, 40% or 10% for calculation depending on the liquidity of inventories); *DZ* – Accounts receivable (taken 30%, 20% or 10% for calculation depending on the quality of the debt); *KZ* – Accounts payable (taken 30%, 20% or 10% for calculation depending on the relationship with creditors); *PV* – Financial investments (taken 40%, 25%, 10% a certain part depending on the liquidity of investments); *GK* – Cash; *PE* – Tax payments.

This method is easy to calculate. It also relies on the capabilities of the borrower. The method includes three criteria from the above list:• the size of the borrower's assets;

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• financial stability of the borrower;

• quality of management of a potential borrower;

• regulatory requirements.

Of the minuses, it should be noted that:

1) It is not entirely clear in the article how the specific weights for the assets and liabilities involved in the calculation were obtained. The author says that this technique is the result of an analysis of the development of more than 250 companies, but the article does not refer to statistical calculations for this set of companies;

2) Expert determination of the share of indicators of *TK, DZ, KZ* and *FV*, which are considered, greatly reduces the scientific value of this technique. After all, different experts may have different views on the same

problem. Also, in practice it is sometimes difficult to understand the quality / liquidity of an asset due to the lack of complete information (for example, due to a large list of product balances or debtors of the enterprise);

3) The indicators of *VP* and *KZ* are essentially the same, ie the amount that can be delayed by suppliers for payments for a certain period. Therefore, this value is added twice to the final amount of the limit.

4) This method does not consider the financial capabilities of the creditor company. It is possible to imagine a picture when the enterprise-buyer (borrower) is larger than the enterprise-seller (creditor). Therefore, the loan amount may be small for the borrower and too large for the lender.

5) The method does not consider the principle of temporary value of money [22]. Since a commodity loan is issued for a certain period and at a certain rate, it means that the value of money that will be returned to the lender after the expiration of the loan will not be equal to the value of the same amount of money now.

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The formation of a provision, which mitigates the impact of the risk of non-repayment, means allocating to the company's expenses some share of the existing number of receivables. The share that must be attributed to the costs of the creditor company depends on the probability of non-repayment of the debt. The higher this probability, the higher the proportion. In practice, instead of calculating the probability, use the number of days, how many or there is a debt, or how many days have passed since the date of delay. There is a Resolution of the Board of the National Bank of Ukraine "On approval of the Regulations on the formation and use by banks of the reserve for possible losses from receivables" №505 from 13.12.2002, which approved the method of calculating the provision for receivables [145]. Table 1.6 shows the relationship between the number of days and the percentage of receivables for which it is necessary to form a reserve.

And although this technique applies to banks, it can also be applied to businesses.

Table 1.6.

Provisions ratios according to the number of days receivable

Risk group	Number of days from the time of occurrence on the balance			Number of days overdue	Reservation ratio, %
	receivables arising from capital investments and the acquisition of intangible assets	receivables for the purchase of securities on the open (secondary market)	other receivables		
1	2	3	4	5	6
I	0 - 180	0 - 30	0 - 90	0 - 7	0
II	181 - 270	31 - 60	91 - 180	8 - 90	20
III	271 - 360	61 - 90	181 - 360	91 - 180	50
IV (unprofitable)	361 and more	91 and more	361 and more	181 - 360	100

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Accounts receivable insurance, which avoids the risk of non-repayment.

Accounts receivable insurance provides insurance against the risk of losses from late return of funds by the buyer or his bankruptcy. To do this, the creditor company must enter an insurance contract with the insurance company. According to this agreement, the insured event will be considered the case of non-payment within a certain period by the borrower under a certain agreement. It is possible to insure several contracts at once. "This tool can be effective for trading and manufacturing companies that operate in competitive markets and which do not have the opportunity to dictate to

buyers their terms of sale or who plan to conquer new market niches" [28, p. 65].

Among the advantages of this method of minimizing the risk of default - the financial independence of the creditor [146]. Especially when the lender depends on a small number of buyers (borrowers). Practice shows that the bankruptcy of a large buyer caused the bankruptcy of a few its suppliers.

Among the disadvantages is the significant cost of this type of insurance.

Diversification of borrowers, which reduces the risk of default, means that the creditor company should avoid concentrations that are related to its borrowers and which can be expressed in:

- large share of transactions of one or a small number of borrowers in the total volume of transactions;

- belonging of many borrowers to one branch of economy;

- belonging of many borrowers to one geographical region;

- the large share of transactions of many borrowers, which are related to each other or the general beneficiary, or, for example, the general supplier or buyer.

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- etc.

Therefore, diversification is to avoid such concentrations. If the lending company depends on one borrower, then you need to look for more borrowers, so that the share of the first borrower is not so great.

A comprehensive analysis of the borrower, which reduces the risk of default, is part of credit policy - credit standards (see p. 2.2.). This method is used to rank and group potential borrowers in order to realize which of the potential borrowers have an increased probability of default on the loan, in order to further avoid credit relationships with them.

1.3. Features of commodity lending in agriculture

Lending in agriculture is like lending in other sectors of the economy. And as in every industry, the expansion of production for the company is impossible without the provision of additional financial resources, and for farmers, credit is one of the most important external sources of investment. That is, due to lending, agricultural enterprises (as well as enterprises of any industry) will be able to both renew their fixed assets, get additional working capital to cover the gaps, and so on.

And at the expense of commodity crediting the agricultural enterprises will be able to receive the advantages which were listed in item 1.1 which structure includes increase in turnover of commodity stocks. The problem of turnover of inventories for agricultural enterprises is extremely acute. After all, agricultural products have not so long shelf life.

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But at the same time lending to agricultural enterprises has its own specific properties. In the scientific literature there are the following main features of lending to agricultural enterprises [178, 179, 180, 181, 182]:

1. Seasonality of agricultural production;
2. Dependence on climatic conditions;
3. Continuity of reproduction processes in agricultural production, which cannot be stopped and therefore require constant and timely investment and timely lending
4. The use of a significant share of products as raw materials to continue the production process, which requires specific credit security both in form and in time.
5. The need to keep in circulation a significant stock of raw materials, which slows down the flow of funds and requires appropriate forms of credit security of the required amount of working capital

6. The need for rapid processing or sale of manufactured products that cannot be stored for a long time, which requires guaranteed types of payment.
7. Significant lag of agricultural production from other sectors of the economy in the level of labor capital, which requires a significant amount of investment support of the industry, including credit
8. Outpacing the growth rate of production costs over the growth rate of selling prices, resulting in a price disparity, the elimination of which requires significant financial support from the state
9. Refusal of processors of agricultural products to participate in the formation of financial resources of agricultural enterprises, which causes the need for financial support of credit and gratuitous nature
10. Specificity of collateral and changes in its price (land, property)
11. Inconsistency of the degree of risk and profitability in agriculture compared to other sectors of the economy.

In the scientific literature of Ukraine [for example, [179, 178, 183] there is an opinion that the withdrawal of the agricultural sector of the market economy from the crisis and its development is impossible without financial assistance to agricultural producers from sources of financing and investment. To ensure the agricultural sector of the economy, it is necessary to intensify the development of new forms of lending in agriculture, which would make it possible to obtain loans without state participation, including factoring operations, loans secured by manufactured products, etc.

These properties need to be addressed from the perspective of both the borrower and the lender. When deciding, it is important to set objective interest rates, as well as the term of loans. This requirement is related to the peculiarities of agricultural production, when most technological operations must be performed on time. Seasonality of production and slow turnover of advance funds require an extension of the period of use of credit resources.

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An important condition for ensuring the repayment of bank loans - credit risk insurance. Because agricultural production is most vulnerable to the natural forces of nature, the impact of which in some years is so strong that farms alone cannot overcome them to ensure the continuity of the reproductive process. Therefore, insurance becomes an important tool to replenish lost funds.

Commodity lending in agriculture has all these above-mentioned properties, except for those that contradict the very essence of commodity lending (see p. 1.1.), For example, the specificity of collateral. After all, commodity lending is usually without the use of collateral. Also, the properties of cash lending do not include properties that are related to cash. After all, the object of commodity lending is goods or services.

In agriculture, enterprises can attract commodity credit for the following large groups of purposes:

1) replenishment of fixed assets, which can be divided by types of fixed assets that can be purchased through commodity lending

- purchase of equipment needed in agriculture (sowers, conveyors, etc.).
- purchase of machines and units needed in agriculture (combines, tractors, seeders, motorized harrows, etc.).
- purchase of vehicles (car, truck, etc.).
- purchase of air conditioning equipment (ventilation systems, heating and cooling systems).
- purchase of veterinary instruments.

2) replenishment of working capital, which can be divided by types of working capital.

- purchase of fuels and lubricants
- purchase of fertilizers
- purchase of feed
- purchase of spare parts for machines and equipment
- purchase of construction materials

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- purchase of seed material

- purchase of veterinary drugs

- purchase of young animals (daily poultry, forgiving pigs, cattle, sheep).

3) obtaining services necessary for the implementation of the main activity:

In agriculture, enterprises can provide commodity credit for the following purposes:

- on the sale of its products;

- for the provision of agricultural services (for example, harvesting with motorized machinery);

Thus, at the intersection of the objectives for attracting commodity credit by agricultural enterprises and the provision of commodity credit by these enterprises and is a list of objectives of commodity credit in agriculture. That is, such credit relations, when both the lender and the borrower are agricultural enterprises.

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As you can see, this list coincides with the list of goals for the loan:

- purchase of feed;

- purchase of seed material;

- purchase of young animals (daily poultry, forgiven pigs, cattle, sheep);

- receiving agricultural services.

Chapter 2.
Substantiation of criteria and factors for calculating the limit of commodity lending for agricultural enterprises

2.1. Criteria for choosing a limiting technique.

The existing list of criteria to be met by the calculation of the commodity lending limit, which is given in paragraph 1.2. does not include such a concept as a criterion of the principle of temporary value of money, which is that over time, money loses its value due to inflationary processes [AA]. An important indicator for calculating the limit of commodity lending should be the term of such a loan, because its size depends on the degree of depreciation of money, so this indicator should be included in the list of criteria for calculating the limit of commodity lending.

Since money depreciates over time, it is the rate on the loan that should prevent this process. The borrower must repay a larger amount of money than he received (in the case of commodity lending, a system of discounts is applied to pay immediately, as described in more detail in paragraph 1.1). Also, the presence of a loan rate requires one of the basic principles of lending - payment (see p. 1.1). According to this principle, the payment on the loan is expressed in the rate, which is agreed in advance by both parties to the loan: the lender and the borrower. The size of the rate will affect the amount that in the future (after the expiration of the commodity loan) the borrower must pay to the lender. The higher the rate – the greater the amount the borrower must pay to the lender. Thus, the loan rate should also be included in the list of criteria for calculating the commodity lending limit.

As already described in clause 1.2, limiting is used by creditor companies as one of the ways to reduce the impact of the risk of non-repayment of commodity credit and to improve the quality of the portfolio of commodity loans (receivables). Therefore, in view of this, the

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precautionary principle should be used when calculating the commodity lending limit and using the indicators of both the lending company and the borrower company. The precautionary principle is one of the principles of international accounting standards, which means "the rule that an accountant must exercise caution and prudence in making his or her economic decision" [EC]. According to this principle, in a disputed case, assets should be underestimated, and liabilities should be overestimated. When it comes time to pay on external liabilities, firms will have slightly undervalued assets and the company will avoid bankruptcy. It is much more dangerous to underestimate liabilities and overestimate assets. As a result, profits decrease, and losses increase. According to the Handbook of Legal Terms, "the precautionary principle provides for the protection of the interests of partners and creditors, as well as preserving the value of the company's capital" [GJ], which creates an opportunity to apply this principle in limitation as a way to reduce the risk of default.

The precautionary principle should also be included in the full list of criteria for calculating the commodity credit limit.

Therefore, the full list of criteria should include the following criteria:

- the share of capital of the creditor company, which it is willing to risk;
- financial condition of the creditor company;
- industry affiliation of the borrower;
- the size of the borrower's assets;
- financial stability of the borrower;
- quality of management of a potential borrower;
- prospects for the borrower's development;
- the relationship of the creditor company with the borrower;
- expected profitability considering the risks of transactions with the borrower;
- general state of the economy;
- regulatory requirements;

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• type of credit policy implemented (level of acceptable risk),

• the planned volume of sales by the creditor on terms of deferred payments;

• the average volume of transactions for the sale of finished products by the lender;

• the principle of temporary value of money;

• term of the loan provided;

• rate on the loan provided.

• the precautionary principle.

As described in paragraph 1.2. there are several methods for determining the amount of the limit in commodity lending. Let's analyze these techniques to choose the best:

1. Limit as a percentage of equity. The methodology meets two criteria and has three shortcomings.

2. Limit depending on the international rating. The methodology meets four criteria and has seven shortcomings.

3. The total amount of trade credit. The methodology meets one criterion and has four shortcomings.

4. Limit as the average quarterly revenue with adjustment factors. The methodology meets four criteria and has six shortcomings.

5. Residual value method. The methodology meets four criteria and has five shortcomings.

As a result of the analysis of existing methods of determination of limits it is possible to draw the following conclusions:

1. Best methods 2, 4 and 5. Because each method meets four criteria, which are included in the full list of criteria for calculating the limit of commodity lending.

2. Method 2 is not viable in practical use in Ukraine, as only a few companies in Ukraine have international ratings (as of July 1, 2009, only 8

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companies had international ratings [EB]). In addition, this technique has more than other disadvantages - seven (see section 1.2).

3. Methods 4 and 5 are more practical to use. But there are certain shortcomings of these methods, which do not allow to unconditionally accept them "into service" of the enterprise.

4. Method 1 - the only method that considers the performance of the creditor.

5. None of the methods considers the financial performance of both the lender and the borrower, as required by a complete list of criteria, which carries additional risk for the entire financial transaction.

Since the calculated value of the limit should take into account both the indicators of the borrower and the indicators of the lender, in the future it is advisable to develop method 1 as a calculation of the lender's limit and method 4 or 5 as a calculation of the borrower's limit.

We will choose from methods 4 and 5 the best for further refinement. Method 4, considering the same criteria for calculating the commodity credit limit as Method 5, at the same time has more shortcomings (six against five). Therefore, method 5 was further selected for further refinement.

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We briefly present the main shortcomings of the selected methods 1 and 5 (see section 1.2).

Method 1:

a. unreasonable value of the correction factor K.

b. the financial indicators of the borrower are not considered.

c. the principle of temporary value of money is not considered

Method 5:

1. unreasonable value of specific weight for financial ratios;

2. the given specific weight in calculation is defined expertly (the expert chooses one of three values of specific weight);

3. two different indicators of *VP* and *KZ* are used, which are essentially the same;

4. the method does not consider the financial performance of the creditor.

5. the principle of temporary value of money is not considered

Having got rid of the above-stated shortcomings of methods 1 and 5, it is possible to pass to calculation of a limit of commodity crediting. In addition, these techniques need to be adapted for use by agricultural enterprises. And also the found improved technique of calculation of the limit of the commodity crediting should correspond as much as possible to the greatest number of criteria from the full list of criteria for calculation of the limit of the commodity crediting.

In order to calculate the adequate value of the limit, it should be borne in mind that a commodity lending transaction is a transaction conducted by at least two parties: the lender on the one hand and the borrower on the other. Therefore, it is necessary to consider both the financial performance of the borrower and the financial performance of the lender.

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Almost all methods of calculating the limit consider the financial performance of the borrower, some – the financial performance of the lender. However, none of them considers both the indicators of the borrower and the indicators of the lender, but these indicators together are included in the full list of criteria for the commodity lending limit, which was described above.

For the borrower, the loan is essentially a liability, so (according to the rule of double entry in accounting) it must provide assets. For the lender, the loan is an asset, so it must provide liabilities.

The creditor company has two major liabilities: equity and liabilities. Therefore, one of these articles (or both together) must provide credit. But the creditors of this company accept only business risk and are unlikely to agree to accept additional credit risk of a third debtor company. Thus, the creditor company can only risk its own capital without harming its creditors.

Here is an example, the provision of trade credit. Let the company have goods for only 100 gr. from and 80 gr. from obligations to creditors, the loan

company can give the goods only for 20 gr. units, because the product is 80 gr. from serves to secure its own accounts payable. This statement is true if creditors accept only business risk and do not accept credit risk of the enterprise.

We summarize the data of the example in table 2.1.

Table 2.1. Balance sheet of the enterprise before (left part) and after (right part) granting a trade credit

Assets		Liabilities	
		Equity	20
Inventories	100	Obligation	80
Balance	**100**	Balance	**100**

Assets		Liabilities	
Inventories	80	Equity	20
Accounts receivable (trade credit)	20	Obligation	80
Balance	**100**	Balance	**100**

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As can be seen from table 2.1, the balance of the enterprise is as follows: goods = 80 gr. units, receivables = 20 gr. units from Total asset is equal to 100 gr. from Liabilities include liabilities = 80 gr. units from There is a difference between the value of assets and liabilities, equal to 100 - 80 = 20 gr. units, which is the value of equity. That is, the maximum value of goods that an enterprise can lend without harming the interests of creditors is the value of equity.

To calculate the creditor's limit, method 1 was chosen, which is expressed by formula (1.5). For the practical application of this technique, it is necessary to determine the calculation of the coefficient K so that it is determined based on objective data and not subjective factors (expert opinions), as required by method 1.

To calculate the borrower's limit, a method was chosen based on adding the borrower's assets and subtracting its liabilities (method 5), which is

expressed by formula (1.6). For practical application of this technique requires:

1) Add debt service payments on existing loans of the borrower for the period of the planned loan. This indicator in the calculation of the borrower's limit should be used with the sign "-", as the amount of payments on loans must still be paid by the borrower.

2) Replace net income with EBITDA.

This indicator shows how profitable the company's core business is. In addition, it is not affected by the credit load, the difference in depreciation methods and the revaluation of assets. The indicator is calculated by the following formula:

$$EBITDA = SE + PPR - PPRP + NV - ND + GSP - \\ -VOTR + AMR - PA,$$

where *SE* – net profit; P_{PR} - income tax; P_{PRP} - refunded income tax; *NV* – extraordinary expenses; *ND* – extraordinary income; *GSP* – interest paid by the company; *VOTR* - interest received by the enterprise; *AMR* - depreciation; *PA* - revaluation of assets.

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3) Replace the amount of revenue-net in the indicator of deferred payments with the value of the cost of goods sold, because the indicator of deferred payments should assess the relationship with suppliers, the value of which is reflected in the indicator "cost";

4) Add to the indicator of deferred payments - *SC1* - a plus sign or a minus sign depending on the conditions of suppliers (for example, in the case of prepayment in the formula you need to use a minus sign);

5) Leave only one indicator out of two indicators: the indicator of accounts payable and the indicator of deferred payments. After all, in fact, they evaluate the same thing: an increase in the amount of accounts payable. So in the model should remain only one of them - the cost of goods sold.

After all, the rate of accounts payable shows the amount of debt of the company to creditors now. And the indicator of the cost of goods sold shows how possible an increase in the amount of accounts payable;

6) All indicators of "flow": EBITDA and payments on loans - should be taken not on an annualized basis, but for a period equal to the term of the loan;

7) Forecast EBITDA for the period of the loan.

Then the formula (1.6) will take the following form:

$$\begin{aligned} Л = \pm C \cdot K_1 + EB + ТЗ \cdot K_2 + ДЗ \cdot K_3 + \\ + ФВ \cdot K_4 + ГК - ПП - ПК \end{aligned}, \qquad (2.1)$$

where $Л$ – borrower limit; C – average daily cost; K_1 – 21, 14 or 7 days depending on the relationship with suppliers; EB – EBITDA for the loan period; $ТЗ$ – the value of inventories; K_2 – 70%, 40% or 10% depending on the liquidity of stocks; $ДЗ$ – Receivables; K_3 – 30%, 20% or 10% depending on the quality of receivables; $ФВ$ – Financial investments; K_4 – 40%, 25% or 10% depending on the liquidity of financial investments; $ГК$ – Cash; $ПП$ – Tax payments; $ПК$ – debt service payments on already received loans for the period of the planned loan.

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Liquidity of assets is determined depending on:

- speed of implementation;
- potential level of consumer value;
- additional factors (for example, in the case of goods, the factor may be whether the product is perishable, or how the product is stored, etc.).

To determine the total amount of the limit, which would include indicators of both the borrower and the lender, you need to combine both the calculation of the lender's limit (1.5) and the calculation of the borrower's limit (2.1). These two calculations are different views on the same - the

maximum amount of trade credit. This amount serves to reduce the impact of the risk of non-repayment of the commodity loan, thus, according to the precautionary principle, the total limit will be the minimum of the creditor's limit and the borrower's limit:

$$Л = MIN(Л_{п}; Л_{к}) , \quad (2.2)$$

where $Л$ – the total amount of the limit; $Л_{п}$ – borrower limit calculated by formula (2.1); $Л_{к}$ – creditor limit calculated by formula (1.5).

Formula (2.2) uses the creditor limit ($Л_{к}$), which according to formula (1.5) is defined as the equity of the creditor company, which is multiplied by the adjustment factor. According to the precautionary principle, losses must be inflated, so equity will decrease.

Formula (2.2) uses the borrower's limit ($Л_{п}$), which according to formula (2.1) is defined as the sum of certain assets of the borrower. Assets, according to the precautionary principle, should be understated.

Hence, the calculation of the total limit of the trade credit at least from the calculation of the limit of the lender and the borrower is justified on the basis of the precautionary principle.

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2.2. Determining the limit and coefficients for calculating the borrower's limit

In formula (2.1) the coefficients K_1 - K_4 are used, which, firstly, have no justification for their values, and secondly, the choice of a specific value is made subjectively only at the discretion of the expert who calculates the limit. Therefore, if the calculation of the limit will be done by another expert

for the same company, he may receive a different value of the limit. Such a technique cannot be considered acceptable.

Let us try to determine such a method of calculating the coefficients K_1 – K_4 from formula (2.1), which would reasonably participate in the calculation of the limit and completely eliminate the calculation of the subjective influence of the expert who makes this calculation.

Coefficient K_1

The coefficient K_1 determines the period for which payments to suppliers can be delayed as much as possible without receiving penalties in return. To determine it, it is proposed to choose 1 of three options: 7, 14 or 21 days [38]. The most discrete values are not explained in any way, and their choice is determined by the subjective assessment of the borrower's relationship with its suppliers at the discretion of the expert who makes this calculation.

But in the scientific literature there is already an indicator that characterizes the delay of payments to suppliers. This is the period of turnover of accounts payable (for example [124, p. 383]):

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$$П_{К3} = \frac{\bar{К3}}{СВ} T, \tag{2.3}$$

where $П_{К3}$ – period of turnover of accounts payable; $СВ$ – cost of goods sold for a certain period; $\overline{ЕС}$ – the average value of receivables for the same period, $Т$ – the number of days in the period.

Obviously, on average, the borrower will be able to maximize it to a level that characterizes the market situation. For enterprises in different sectors of the economy, this level is the average industry period of accounts payable for each industry.

That is, for a more accurate definition of K_1 it is necessary to find it as the difference between the average industry period of turnover of accounts payable and the period of turnover of accounts payable of the borrower:

$$K_1 = \overline{П}_{КЗ} - П_{КЗ} \ , \qquad (2.4)$$

where $\overline{П}_{КЗ}$ – average industry period of accounts payable turnover; $П_{КЗ}$ – the period of turnover of accounts payable of the borrower. Accounts payable turnover periods are calculated based on formula (2.3).

If the period of turnover of the borrower's accounts payable is longer than the industry average, it means that the borrower already enjoys the maximum delay in payments, and suppliers are unlikely to give an additional deferral of payment. In this case, it must be accepted $K_1 = 0$.

In formula (2.1) before the product of the cost with a factor of K1 is a sign "±", which is explained by the conditions of suppliers. If a trade credit is used in settlements with suppliers, it is necessary to use the sign "+" in the calculation of the limit, if the prepayment, then - the sign "-". But after the concept of the period of turnover of accounts payable (2.4) was introduced in calculation (2.1), it became clear that prepayment in this case can not be, because the prepayment is characterized by another balance sheet item - receivables. Therefore, to use this product in the calculation of the borrower's limit is required only with the sign "+".

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Coefficient K_2

The coefficient K_2 determines the amount of inventory of the borrower can be sold over a period equal to the term of the commodity loan. To determine it, it is proposed to choose one of three options: 70%, 40% or 10% [36].

The problem of selling inventories is the answer to the question of how much money the company will receive for this product, if it sells it after a period equal to the term of the commodity loan. That is, the coefficient K_2 is also an attempt to discount the inventory in a certain way in the event of a fall in the value of goods. For example, if a given commodity is wheat, then

its prices fluctuate from a certain average up and down with a certain period. It is theoretically possible to sell wheat when its prices are the highest and get more, but to calculate the credit limit due to the precautionary principle, it is necessary to consider only the smallest value in price fluctuations. Thus, this ratio will be lowering. The greater the volatility (price volatility), the higher the probability of price change, so the lower this ratio will be. Volatility is expressed by the standard deviation [124]:

$$\sigma = \sqrt{\frac{1}{n}\sum_{i=1}^{n}(x_i - \bar{x})^2} ,$$

where σ – standard deviation; x_i – random variable; $\bar{x}$ – average value for a set of random variables x_i; n – the number of observations of a random variable.

The indicator that shows the measure of the relative scatter of a random variable is the coefficient of variation, which is calculated by the following formula (for example, [208]):

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$$CV = \frac{\sigma}{\bar{x}} , \qquad (2.5)$$

where CV – coefficient of variation; σ – standard deviation of the price of the product; $\bar{x}$ – the average price of this product.

Formula (2.5) shows what proportion of the average value of a random variable (commodity price) is its average variance. In contrast to the standard deviation, it measures not the absolute but the relative measure of the scatter of the values of the feature in the statistical population.

Since to calculate the commodity credit limit you need to know what value of inventories can be sold at the end of the commodity credit, and the coefficient of variation shows the degree of scatter of the random variable to

be discarded, as described above, then the coefficient K_2 will be calculated as the difference between unit and coefficient of variation:

$$K_2 = 1 - CV_{T3}, \tag{2.6}$$

where CV_{T3} – coefficient of variation of the price of inventories.

But an indicator CV_{T3}, which is calculated by formula (2.5), characterizes the fluctuations of only one type of inventory. And in practice it is possible that inventories are more than one type. To address this issue you need to use for the indicator CV_{T3} weighted average value:

$$CV_{T3} = \frac{\sum_{i=1}^{m} CV_i \cdot T3_i}{\sum_{i=1}^{m} T3_i}, \tag{2.7}$$

where CV_i – coefficient of price variation for the *i*-th type of inventory; $T3_i$ – the amount of the *i*-th type of inventory; *m* – the number of types of inventory.

That is the sum of *m* species $T3_i$ will add up *T3* and, if (2.6) we add (2.7), then formula (2.6) will look like this:

$$K_2 = 1 - \frac{\sum_{i=1}^{m} CV_i \cdot T3_i}{\sum_{i=1}^{m} T3_i}, \tag{2.8}$$

However, in theory, the coefficient of variation can be greater than 1. This indicates an extremely high risk of price fluctuations. Hence, in this case we should take $K_2 = 0$.

There is also the question of what period to take a sample of prices, because when you take a sample for several years, price fluctuations can be very significant, and hence the standard deviation will be very large, and therefore the coefficient K_2 will always be zero. This situation will lead to

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unjustified understatement of the allowable amount of trade credit. Therefore, the sample of prices for the selected type of goods must be taken for a period equal to the loan term. This assumes that price fluctuations over the last n months will be the same as price fluctuations over the next n months. That is, if the loan is for 12 months, you need to take statistics for the previous 12 months.

Coefficient K_3

The coefficient K_3 shows what part of the receivables can be sold at the end of the commodity loan. To determine it, method 5 suggests choosing one of three options: 30%, 20% or 10% [DJ].

Accounts receivable in the calculation of the commodity credit limit means how much money from this receivable will be returned before the end of the loan. Hence, in calculating the limit of commodity lending, you need to consider only such receivables, the repayment period of which is less than the term of the commodity loan.

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There is also a receivable that for several reasons is not repaid on time (overdue receivables). This means that the receivables that will be repaid by the end of the trade credit will be less by the number of overdue receivables. There is an indicator of the same name for calculating the share of overdue receivables $ПВ_{ДЗПР}$ (1.3).

To calculate the coefficient K3 you need to take the share of receivables, the term of which is less than the term of the trade credit, and the inverse to $ПВ_{ДЗПР}$, which shows the share of non-overdue share of receivables:

$$K_3 = \frac{ДЗ_М}{ДЗ}\left(1 - ПВ_{ПДЗ}\right) = \frac{ДЗ_М}{ДЗ}\left(1 - \frac{ДЗ_{ПР}}{ДЗ}\right), \quad (2.9)$$

where $ПВ_{ДЗПР}$ – share of overdue receivables; $ДЗ_М$ – receivables with a maturity of less than the term of the trade credit; $ДЗ$ – the total amount of

receivables; $ДЗ_{ПР}$ – overdue receivables. If we take from the formula (2.1) the product of receivables with a coefficient of K3 and substitute in (2.9), we obtain its third component in the form:

$$ДЗ \cdot K_3 = ДЗ \cdot \left(\frac{ДЗ_M}{ДЗ} \right) \left(1 - \frac{ДЗ_{ПР}}{ДЗ} \right) = ДЗ_M \left(1 - \frac{ДЗ_{ПР}}{ДЗ} \right), \quad (2.10)$$

Coefficient K_4

The coefficient K_4 shows how much investment can be sold at the end of the commodity loan. To determine it, it is proposed to choose one of three options: 45%, 25% or 10% [22].

This coefficient is similar to the coefficient K_2 in essence, so its calculation should be done similarly. A random variable that needs to be characterized is the value of financial investments, the indicator of which is the stock market index (in Ukraine, such an index can be, for example, the PFTS index). Since the random variable that characterizes the financial investment is one (stock market index), when calculating K_4 should be used (2.6):

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$$K_4 = 1 - CV_{ФР}, \quad (2.11)$$

where $CV_{ФР}$ – the coefficient of variation of the stock market index, which is calculated based on a set of daily data of the stock market index.

Similarly, to the calculation of K_2, if K_4 is less than 0 (coefficient of variation greater than 1), it indicates excessive variability of the stock index relative to its average value, which indicates an increased probability of change of this index. Therefore, in this case K_4 should be equal to 0.

Therefore, after additions (2.4), (2.8), (2.10) and (2.11), formula (2.1) will look like this:

$$Л_П = C(\bar{П}_{КЗ} - П_{КЗ}) + EB + ТЗ\left(1 - \frac{\sum_{i=1}^{m} CV_i \cdot ТЗ_i}{ТЗ}\right) +$$

$$+ДЗ_M\left(1 - \frac{ДЗ_{ПР}}{ДЗ}\right) + ФВ(1 - CV_{ФР}) + ГК - ПП - ПК, \qquad (2.12)$$

where $Л_П$ – borrower limit; C – average daily cost; $\bar{Г}_{ЕС}$ – average industry period of accounts payable turnover; $П_{КЗ}$ – the period of turnover of accounts payable of the borrower; EB – EBITDA for the loan period; $ТЗ$ – the value of inventories; CV_i – coefficient of price variation for the i-th type of inventory; $ТЗ_i$ – the value of the i-th type of inventory; m – the number of types of inventories; $ДЗ$ – the total amount of receivables; $ДЗ_М$ – receivables with a maturity of less than the term of the trade credit; $ДЗ_{ПР}$ – overdue receivables; $ФВ$ – financial investments; $CV_{ФР}$ – the coefficient of variation of the stock market index; $ГК$ – cash; $ПП$ – tax payments; $ПК$ – debt service payments on loans already received for the period of the planned loan.

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2.3. Determining the limit and coefficients for calculating the creditor's limit

The credit limit calculated by formula (1.5) is suitable for calculating the creditor's limit. But it is necessary to determine the coefficient K, because different sources indicate different coefficients K. Sometimes it is said that the limit should be 10-20% [168], and in some countries it reaches 30-40% [55]. In this case, the coefficient K is a measure of risk that the creditor company agrees to accept.

The advantage of this method is the simplicity of calculation. And in practical application there is a complication that there is no clear justification

for the value of the correction factor *K*. The range of values from 10% to 40% does not determine a specific value when calculating the limit for a case. Although it is obvious that all authors understand this ratio as a measure of risk.

Therefore, it is necessary to develop a convenient method of calculating the adjustment factor K, which would take into account the risk of the transaction as a risk introduced by the decision-maker in determining the amount of trade credit provided by the creditor company.

The risk appetite of the decision maker (hereinafter ESD) is determined by the utility function [64]. To this end, such a person is offered a game where you can win a large sum of S_2 and a small amount of S_1. Determined utility (U) of the winnings by assigning arbitrary values of utility gain for the worst and the best way, and the worst out of play (S_1) is associated with a smaller number of $U(S_1)$, and greater S_2 - more than the number of $U(S_2)$. The player is offered a choice: get some guaranteed cash sum of m, located between the best and worst values S_2 and S_1, or participate in a game that is obtained from the probability p largest amount of money S_2 and with probability (1 - p) - the smallest amount S_1. This chance to change (raise or lower) until the ESD will become indifferent with regard to the choice between a guaranteed amount and game. Let the stated value equal probability p_0. Then usefulness guaranteed amount m is defined as the mean value (expectation) utility lowest and highest amounts that

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$$U(m) = p_0U(S_2) + (1-p_0)U(S_1) \tag{2.13}$$

In general, the graph of the utility can be of three types (Fig. 2.1):

• for ESD are not at risk - strictly concave function, in which each arc curve lies above its chord AB - curve AEB;

• for ESD, indifferent to the risk - a straight line AB;

• for ESD at risk - strictly convex function, in which each arc of the curve is below its chord AB – curve ADB;

These provisions can be concluded that the higher of AB is the point of indifference $E[m, U(m)]$ curve utility function of ESD, the person is less prone to risk, or the lower of AB is the point of indifference $D[m, U(m)]$ the more risk-averse individual utility function is measured. S_o, if a person is quite cautious, the proposed game it will always choose the probability of winning the largest amount of close to 100%, it will then order that the calculation of the usefulness of the guaranteed amount m will value close to $U(S_2)$ - a point C, - that those responsible sum S_2, and if absolutely risky - it will always choose the probability of winning the largest amount of close to 0%. This result is that the calculation of the guaranteed amount m usefulness will value close to $U(S_1)$, ie, the amount of which correspond to S_1. This point D.

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Then, for quite cautious individual utility function curve pass through the point of DIA, and for quite risky person - in terms ADB. The length of the line CD will determine the maximum possible range between absolute risk and absolute caution. Line length CD can be found by rule calculation of distances between two points $C[m, U(S_2)]$ and $D[m, U(S_1)]$, which is parallel to the y-axis [119, 120], the formula

$$\rho(C,D) = U(S_2) - U(S_1). \qquad (2.14)$$

Distance can be the absolute maximum extent possible range 'riskiness and their riskiness "for specific ESD. After finding the third point on the graph utility function - $E[m, U(m)]$ - which also lies on the line CD, you can draw the following conclusion. The closer this point to t. C, the ESD is less risky, and therefore the greater the amount of equity it can afford to pay in trade credit. Then, with the adjustment coefficient $K(1)$ can be defined as the ratio of ED to the length CD

$$K = \frac{\rho(E,D)}{\rho(C,D)}. \qquad (4)$$

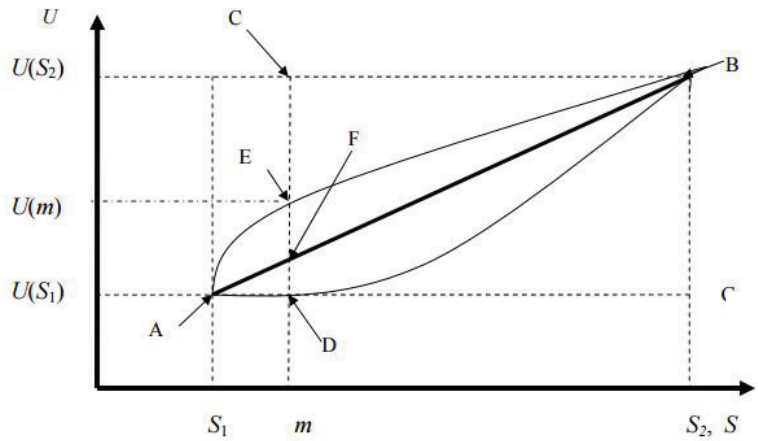

Fig. 2.1. Definition of the utility function of the person who makes decisions (ESD)

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Factor will always vary [0.1] or [0%, 100%], because $\rho(E,D) \le \rho(C,D)$. What it is - the less risky is the ESD and the greater the amount of capital you can afford to give it in trade credit.

Distance $\rho(E,D)$ similarly (3) is as

$$\rho(E,D) = U(m) - U(S_1). \qquad (2.15)$$

Substituting (2.14) - (2.15) obtain numerical values of risk that was found by measuring the utility function specific ESD

$$K = \frac{U(m) - U(S_1)}{U(S_2) - U(S_1)}. \qquad (2.16)$$

Substituting (2.15) to (2.16)

$$K = \frac{p_0 U(S_2) + (1 - p_0) U(S_1) - U(S_1)}{U(S_2) - U(S_1)} = \frac{p_0 U(S_2) + U(S_1) - p_0 U(S_1) - U(S_1)}{U(S_2) - U(S_1)} =$$

$$= \frac{p_0 U(S_2) - p_0 U(S_1)}{U(S_2) - U(S_1)} = \frac{p_0 [U(S_2) - U(S_1)]}{U(S_2) - U(S_1)} = p_0$$

Thus, the ratio of risks is likely to win the largest amount, at which point there comes indifference - or take the guaranteed amount m or take part in the game and pay that amount.

In addition to the two characteristic parameter values P0 - absolutely zero risk for individuals and one for absolutely no risk - interest is the probability value for a person interested in the risk line utility function is represented by a straight AB. This probability is characterized by point *F*, which lies at the intersection of straight *AB* and *CD*.

The magnitude of value which corresponds to *t*. *F* consists of $U(S_1)$ and *DF*. You can find the latest rule similarities *ABG* and *AFD*, both of which have three equal angles [69] $\frac{DF}{BG} = \frac{AD}{AG}$ from

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$$DF = \frac{AD}{AG} BG = \frac{m - S_1}{S_2 - S_1} [U(S_2) - U(S_1)]. \qquad (2.18)$$

Then ordinate t. *F* is $DF + U(S_1)$. By marking probability p_0 to a person indifferent to risk, as *RB*, substitute ordinate value in (2.15)

$$\frac{m - S_1}{S_2 - S_1} [U(S_2) - U(S_1)] + U(S_1) = p_B U(S_2) + (1\text{-}p_B) U(S_1). \qquad (2.19)$$

After transformations, we obtain a probability value for a person indifferent to risk $p_B = \frac{m - S_1}{S_2 - S_1}$. (2.20)

Now p_0 parameter can be used as adjusting factor in (2.13) the calculation of commercial credit limit.

To calculate the coefficient *K*, based on the precautionary principle, it is impossible to allow a person at risk to conduct lending. Therefore, the coefficient K should include the probability values either for the person not at risk or for the person who is indifferent to the risk. Then the correction factor K can be found based on the following expression:

$$K = \begin{cases} p_0, if \;\; p_0 \geq p_B \\ 0, if \;\; p_0 < p_B \end{cases}, \tag{2.21}$$

Now the parameter *K* can be used as a correction factor in formula (1.5) when calculating the commodity credit limit for the lender.

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2.4. Justification of discounting of indicators of calculation of limit

Formula (2.12) is used to calculate the limit of commodity lending for the borrower, but in this formula the indicators are used without taking into account the principle of temporary value of money [15], which is included in the full list of criteria for calculating the limit of commodity lending (see 2.1).

In (2.12) 8 indicators are used:

1. Cost;
2. EBITDA;
3. The value of inventories;
4. Accounts receivable;
5. The amount of financial investments;
6. The amount of cash;
7. The amount of tax payments for the period of the loan;

8. The amount of debt service payments on loans already received for the period of the planned loan.

You need to determine their value over a period equal to the term of the commodity loan. Given the principle of the temporary value of money, to calculate the future value of the financial indicator should use the formula of accrual at a certain percentage [112, p. 16]:

$$FV = PV \cdot (1 + r)^n, \tag{2.22}$$

where FV – future value; PV – present value; r – interest rate (annual); n – terms in years.

And to calculate the present value of the financial indicator, having its future value, you should use the discount formula at a certain percentage [145, p. 17]:

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$$PV = \frac{FV}{(1 + r)^n}, \tag{2.23}$$

Cost and inventories. You need to calculate the future value of these indicators. So, you need to use the formula (2.22). Due to inflation, the cost of production increases over time. Hence, the indicators of cost and inventories should be increased under the consumer price index. For the cost indicator, the calculation of the following type, considering (2.22):

$$C' = C \cdot (1 + i_{СЦ})^n, \tag{2.24}$$

where C` – increased cost; C – cost; $i_{СЦ}$ – consumer price index on an annualized basis; n is the term of the commodity credit in years.

For the indicator of inventories, the calculation of the following type, considering (2.22):

$$ТЗ' = ТЗ \cdot (1 + i_{СЦ})^n, \quad (2.25)$$

where *ТЗ`* – increased value of inventories; *ТЗ* – the value of inventories; $i_{СЦ}$ – consumer price index on an annualized basis; *n* is the term of the commodity credit in years.

EBITDA. You need to calculate the future value of this indicator. In order to use formula (2.22) when calculating the future value of this indicator, there are several obstacles:

1) Formula (2.22) assumes that the indicator will always grow (process) of building, but from practice it is known that such indicators as profit (and EBITDA) including do not always grow. It is possible to reduce or find this indicator at the same level for a long time.
2) It is difficult to find the interest rate at which this indicator will be increased, because the indicator that characterizes the interest rate should affect the EBITDA. As, for example, the rate of inflation on the cost or inventories. But EBITDA is not affected by inflation or, for example, the KIBOR rate, so that they can be used unconditionally to increase this indicator.

Therefore, this figure can be predicted using a periodic function. Economic cycles, seasonality of sales, life cycle of goods or services and other factors can significantly affect the economic performance of an individual enterprise. The periodicity of economic processes is caused by changes in the vital activity of people during the day, week, month and year (there are larger periods of cyclicality).

Therefore, researchers are faced with the task of selecting this type of function, which would correspond in form to the basic forms of periodic and

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non-periodic dependences of economic processes. The second task is to determine the coefficients of the selected function from a sample of statistics. Existing dependencies in the economy should have not only periodic functions, but also exponential and power. Therefore, the following formula was chosen:

$$y = Ax^B + C(1 - e^{Dx})Sin(Ex^F + G) + H\ , \qquad (2.26)$$

where x – argument, y – function, A - H – constants, e – the basis of the natural logarithm. Depending on the numerical values of the constants, this formula gives the set of curves presented in Fig. 2.2

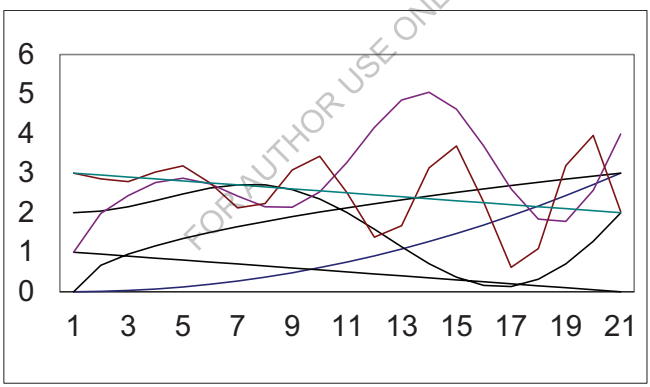

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Fig. 2.2 Types of curves that can be created using the formula (2.26)

The solution of the second problem is complicated by the fact that there are no such mathematical transformations that would allow linearizing (2.26) to then obtain the values of constants A - H by regression or least squares [96]. Therefore, an optimization approach was applied, which is as follows:

1. Arbitrary values are set for model constants.

2. For all values of the argument to calculate the value of y_p, using arbitrary values of constants.
3. For each value of the function find $(y_p - y_\phi)^2$, where y_ϕ is the actual value of the function obtained from statistics.
4. Solve the optimal problem with the functionality of the form:

$$\sum_{i=1}^{n} \frac{(y_{pi} - y_{\hat{o}i})^2}{y_{pi}} \to 0, \tag{2.27}$$

where n is the size of the statistical sample. The changing parameters will search for constants.

Therefore, we use the proposed approach to find the constants *A* - *H*:

1. Set arbitrary values of constants *A* - *H*.

2. Calculate y_p by formula (2.26).

3. Find $(y_p - y_\phi)^2$, where y_ϕ – the actual value of the function obtained from statistics.

4. Solve the optimal problem with the functional of the form (2.27). Parameters - constants *A* - *H*.

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Already the first calculations using the "Solution Search" function of Excel spreadsheets showed that the constants *E* and *G* in (2.26) are defined as zeros in the case when the amplitude of the sine wave is 3-10 times less than the average value of the function. Therefore, to increase the accuracy of the calculation, it is recommended to set limits on the value of constants according to the following rule:

1. 1. On the graph, which was built on statistical data, an element of the curve resembling a sine wave is highlighted and there is a range of values of the argument on which this sine wave performs a complete oscillation. – Δx. Then, for the constant E it is necessary to establish the following restriction:

$$E \leq (0{,}5 - 1{,}5)\ 2\pi/\Delta x_1. \qquad (2.28)$$

2. The initial values of the constants B and F are recommended to be equal to one; constants H - the arithmetic mean of the statistical value of the function; constant $D = -0.05$; $A = 0$.
3. The constant C is determined from the maximum amplitude Δy that part of the graph, which is defined as sinusoidal, and has the following restrictions:

$$C \leq (0{,}4 - 0{,}6)\ \Delta y. \qquad (2.29)$$

In addition to applying constraints 1-3 in the forecasting model, we use the so-called autoregressive model [45], i.e. the dependence of the indicator on its previous values. Since formula (2.26) does not give the desired result if a number from the statistical sample has a negative value (constants B and F can be fractional, and therefore no value of the argument can be negative, because it is through logarithm) , and EBITDA may be negative. Therefore, a number that is greater than the largest modulus of the negative value of the argument must be added to the values of the statistical sample. From the results of the research we can draw the following conclusions:

1. The proposed optimization algorithm allows you to build a model of cyclical economic processes according to any pre-selected formula.

2. The proposed formula allows you to build models of different in nature economic processes.

Therefore, for EBITDA, formula (2.26) for forecasting values will look like this:

$$EB' = A \cdot EB^B + C(1 - e^{D \cdot EB}) Sin(E \cdot EB^F + G) + H \qquad (2.30)$$

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where EB – EBITDA values for previous periods, $EB`$ – EBITDA is forecast, A - H – constants, e – the basis of the natural logarithm.

Cash. You need to calculate the future value of this indicator. So, we use formula (2.22). Cash is usually on the current account of the company, on which the company receives payment from the bank. It can also be deposits in banks. Thus, this indicator can be increased both at the average rate on deposits of legal entities and at the average interest rate on the current account. But as a precaution, this figure should be increased at a lower rate, which is the average interest on the current account for legal entities. Taking into account (2.22) the formula for cash will look like this:

$$ГК' = ГК \cdot (1 + i_{БВ})^n, \tag{2.31}$$

where $ГК`$ – increased amount of cash; $ГК$ – the amount of cash; $i_{БВ}$ – average bank interest on the current account on an annualized basis; n is the term of the commodity credit in years.

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Financial investments. You need to calculate the future value of this indicator. So you can use formula (2.22). This indicator over time depends on the fluctuations of the stock market index. But in formula (2.12) it is already multiplied by the coefficient that characterizes the stock market index. Therefore, this figure does not need to increase.

Receivables. You need to calculate the future value of this indicator. So you can use formula (2.22). Accounts receivable must be increased by the interest rate at which the trade credit was issued. Taking into account (2.22) the formula for receivables will look like this:

$$ДЗ' = ДЗ \cdot (1 + i_{вДЗ})^n, \tag{2.32}$$

where *ДЗ`* – the amount of receivables increased; *ДЗ* – the amount of receivables; $i_{ВДЗ}$ – interest on receivables on an annualized basis (if the trade credit was issued without interest, then $i_{ВДЗ}$=0); *n* – terms of commodity credit in years.

Tax payments and debt service payments**.** They do not need to be increased, as they reflect the same amount that will need to be paid in a certain period. To calculate the limit, these 2 indicators should reflect the amounts that need to be paid to the borrower in a period equal to the term of the commodity loan.

Therefore, after making changes (2.24), (2.25) and (2.30) - (2.32), formula (2.12) will look like this:

$$Л = C'(\bar{П}_{КЗ} - П_{КЗ}) + EB' + ТЗ'\left(1 - \frac{\sum_{i=1}^{m} CV_i \cdot ТЗ_i}{ТЗ}\right) + ДЗ'_М\left(1 - \frac{ДЗ_{ПР}}{ДЗ}\right) + \\ + ФВ \cdot (1 - CV_{ФР}) + ГК' - ПП - ПК, \qquad (2.33)$$

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where *Л* – borrower limit; *C'* – average daily increased cost; $\bar{П}_{КЗ}$ – average industry period of accounts payable turnover; $П_{кз}$ – the period of turnover of accounts payable of the borrower; *EB'* – projected EBITDA for the loan period; *ТЗ'* – increased value of inventories; CV_i – coefficient of price variation for the *i*-th type of inventory; $ТЗ_i$ – the value of the i-th type of inventory; *m* – the number of types of inventories; *ДЗ* – the total amount of receivables; $ДЗ'_М$ – accrued receivables with a maturity less than the term of the trade credit; $ДЗ_{ПР}$ – overdue receivables; *ФВ* – financial investments; $CV_{ФР}$ – the coefficient of variation of the stock market index; *ГК'* – increased cash; *ПП* – tax payments; *ПК* – debt service payments on loans already received for the period of the planned loan.

After determining the total amount of the borrower's limit, this amount shows how much money can be obtained in the future (after the expiration of the commodity loan). To find the current amount, you need to discount at the rate at which the lender issues a commodity loan in accordance with formula (2.23). Thus, you will receive an amount that can be issued now so that the borrower repays it after a certain period and pays interest on this loan at a certain rate:

$$Л_{П}^{'} = \frac{Л_{П}}{(1+r)^{n}}, \quad (2.34)$$

where $Л_{П}$` – the discounted amount of the borrower's credit limit; $Л_{П}$ – the amount of the borrower's credit limit; r – interest rate on commodity credit; n is the term of the commodity credit in years.

One of the features of commodity lending in agriculture, as already mentioned in paragraph 1.3, is the need for rapid processing or sale of manufactured products, which cannot be stored for a long time. Thus, the limited shelf life of agricultural should be considered in calculating the amount of the credit limit in the form of certain discount factors for the value of inventories depending on the storage conditions of the product.

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The problem of discounting the cost of agricultural products is to determine the numerical values of the coefficient of reduction of production costs. The application of the known dependence with a constant discount rate is almost impossible, because the dependence of the shelf life has a pronounced exponential dependence.

In the scientific literature, the terms of storage of products depending on storage conditions (temperature, humidity, method of storage) are known. Let's try to consider in turn the following dependencies for the main types of agricultural products. Terms of storage of meat and meat products are given in [170, p. 207]:

Table 2.2. Shelf life of meat and meat products

Type and category of product	Shelf life (months) at temperature, degrees C				
	-12	-15	-18	-21	-25
1	**2**	**3**	**4**	**5**	**6**
Beef and lamb of the first category	6	9	12	18	18
Beef and lamb of the second category	5	7	10	15	15
Pork in the skin	5	7	10	15	15
Pork without skins	4	6	8	12	12
Chickens, turkeys, guinea fowl	5	7	10	10	12
Egg chickens, broiler chickens, turkeys, caesareans	4	6	8	8	11
Geese, ducks	4	5	7	7	11
The geese, the kittens	3	4	6	6	10
By-products	4	4	6	6	6

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Graphically, the dependence of the shelf life of meat products on the temperature (Fig. 2.3), constructed according to Table 2.2., Looks like an exponential function.

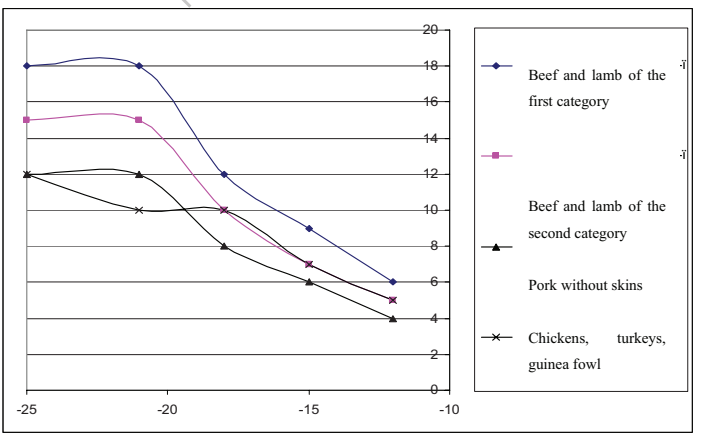

Fig. 2.3. Dependence of the shelf life of meat products on the storage temperature

The expression to describe this dependence is as follows:

$$T = \begin{cases} a_1, if\ t \le t_{min} \\ b_1 \cdot e^{-c_1 \cdot t}, if\ \ t > t_{min} \end{cases}, \quad (2.35)$$

where T – shelf life of meat products, t - storage temperature, t_{min} - lowest storage temperature, a_1, b_1, c_1 – model coefficients.

Obviously, a_1 is equal to the largest value of the shelf life. The coefficients b_1 and c_1 can be found using the optimization approach described above:

1. Set arbitrary values of constants b_1 and c_1.
2. Solve T_p by formula (2.35).
3. Find $(T_p - T_\phi)^2$, where T_ϕ – the actual value of the shelf life according to table. 2.2.
4. Solve the optimal problem with a functional of the form (2.27), where n is the size of the statistical sample (in our case $n = 5$), and the parameters are the required constants b_1 and c_1.

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Calculations using the "Search Solution" function of Excel spreadsheets are presented in table 2.3. There is also a confidence probability of the quality of the approximation by Pearson's criterion. For this purpose, the function XI2 was used with the parameters of the value x, taken from the calculated functional in item 4 of the optimization approach, and the number of degrees of freedom $r = n - 1 = 4$.

Table 2.3. Numerical values of model coefficients (2.35)

Type and category of product	a_1	b_1	c_1	**Confidence probability, β**
Beef and lamb of the first category	18	1,417951	0,12062	0,999
Beef and lamb of the second category	15	1,109004	0,123465	1,000

Type and category of product	a_1	b_1	c_1	Confidence probability, β
Pork in the skin	15	1,109004	0,123465	1,000
Pork without skins	12	0,961803	0,119697	0,999
Chickens, turkeys, guinea fowl	12	2,916381	0,059003	0,976
Egg chickens, broiler chickens, turkeys, caesareans	11	2,09323	0,067051	0,990
Geese, ducks	11	1,652357	0,074718	0,996
The geese, the kittens	10	1,085699	0,087902	0,994
By-products	6	2,742753	0,034777	0,990

As can be seen from Table 2.3, the confidence probability is extremely high: at least 97.6% for meat products "chickens, turkeys and guinea fowl", and other products - not less than 99.0%.

Consider now the products of crop production. First, determine which models can describe the shelf life of potatoes, vegetables and fruits. To do this, use the data from [44, p. 404-405], which are summarized in table. 2.4. These data record the loss of vegetable products relative to the mass measured in the previous month. Therefore, to determine the absolute value of losses relative to the initial mass of products laid in storage, you need to use the formula:

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$$B_M = \prod_{t=1}^{M} (100\% - B_t), \tag{2.36}$$

where B_M – absolute losses in the final month M, B_t – relative losses in the current month t.

Table 2.4. Norms of natural losses (in% to weight) of potatoes, vegetables and fruits at long storage in storages and warehouses of various type

Product	Storage method	September	October	November	December	January	February	March	April	May	June	June	August
Potato Beets, radishes, turnips, horseradish, kohlrabi, parsnips Carrots, parsley, celery, turnips	1	1	0,6	0,5	0,5	0,5	0,5	0,5	0,8	0,8	0,8	0,8	0,8
	2	1,3	0,9	0,7	0,5	0,5	0,5	0,5	0,9	1,1	1,8	2	2,5
	3	1,4	1	0,7	0,4	0,4	0,4	0,7	0,9	1,5			
Cabbage (white and red cabbage, Savoy, Brussels) medium-ripe varieties Potato Beets, radishes, turnips, horseradish, kohlrabi, parsnips	1	1,5	0,8	0,8	0,7	0,6	0,6	0,6	0,8	0,9	0,9		
	2	1,7	0,9	0,8	0,7	0,6	0,6	0,6	0,8	1,1	1,9		
	3	1,5	1	0,7	0,6	0,3	0,3	0,6	0,9	2			
Carrots, parsley, celery,	1	2,2	1,3	1,2	0,8	0,7	0,7	0,7	1	1	1		
	2	2,3	2	1,3	0,8	0,7	0,8	1	1,2	2,4			
	3	1,5	1,3	1,2	0,6	0,6	0,6	0,8	0,9	2			

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Product	Storage method	September	October	November	December	January	February	March	April	May	June	June	August
turnips Potato													
Beets, radishes, turnips, horseradish, kohlrabi, parsnips	2		3,3	2,4	1,1	2,5	2,7						
	3		3,3	1,8	1	2	2,5						
Cabbage (white and red cabbage, Savoy, Brussels sprouts), late varieties Onions (onions and samples) Garlic	1		2,3	1,3	1	1	1	1,3	1,3	1,8	1,8		
	2		2,8	2,1	1	1	1,2	1,3	1,5				
	3		2,8	1,8	0,8	0,8	0,8	1,1	1,3				
Pumpkin	1	0,8	0,7	0,6	0,5	0,5	0,5	0,6	0,8	1,1	1,2	1,5	1,5
Apples (autumn varieties)	2	1,7	1,2	1,1	0,6	0,6	0,6	0,6	1	1,7	0	0	2,5
Apples (winter varieties) Pears	1	1,6	1	0,9	0,9	0,9	0,9	0,9	0,9	1,5	1,5	1,5	1,7
	2	3	2	1,2	1,1	1,1	1,2	1,3	1,5				
Grape	2	1,5	1,2	0,7	0,5	0,3							
Cabbage (white and red cabba	1	1,2	0,8	0,6	0,5	0,5	0,4						
	2	2	1,2	1,2	1	1							

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Product	Storage method	September	October	November	December	January	February	March	April	May	June	June	August
ge, Savoy, Brussels sprouts), late varieties Onions (onions and samples)													
Garlic Pumpkin	1	1	0,4	0,3	0,3	0,25	0,25	0,3	0,3	0,5	0,5		
	2	1,8	0,8	0,6	0,5	0,5	0,5	0,5					
Apples (autumn varieties)	1	1	0,8	0,6	0,6	0,5	0,4	0,4	0,4	0,5			
Apples (winter varieties)	2	2	1,6	1,4	0,7	0,6	0,6	0,6					
Pears	1	0,8	0,7	0,7	0,6	0,4	0,4	0,4					

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Symbols of the storage method: 1. With artificial cooling. 2. Without artificial cooling. 3. Burts, trenches.

Relative values of losses from table 2.4. were listed in absolute terms by formula (2.36) and are presented in table. 2.5.

Table 2.5. Rates of the balance of potatoes, vegetables and fruits (in% to weight at the time of laying on storage) at long storage in storages and warehouses of various type

Product	Storage method	September	October	November	December	January	February	March	April	May	June	June	August
Potato Beets, radishes,	1	0,99	0,98	0,98	0,97	0,97	0,96	0,96	0,95	0,94	0,94	0,93	0,92
	2	0,99	0,98	0,97	0,97	0,96	0,96	0,95	0,94	0,93	0,92	0,90	0,88

Product	Storage method	September	October	November	December	January	February	March	April	May	June	June	August
turnips, horseradish, kohlrabi, parsnips Carrots, parsley, celery, turnips	3	0,99	0,98	0,97	0,97	0,96	0,96	0,95	0,94	0,93	-	-	-
Cabbage (white and red cabbage, Savoy, Brussels) medium-ripe varieties Potato Beets, radishes, turnips, horseradish, kohlrabi, parsnips	1	0,99	0,98	0,97	0,96	0,96	0,95	0,95	0,94	0,93	0,92	-	-
	2	0,98	0,97	0,97	0,96	0,95	0,95	0,94	0,93	0,92	0,91	-	-
	3	0,99	0,98	0,97	0,96	0,96	0,96	0,95	0,94	0,92	-	-	-
Carrots, parsley, celery, turnips Potato	1	0,98	0,97	0,95	0,95	0,94	0,93	0,93	0,92	0,91	0,90	-	-
	2	0,98	0,96	0,95	0,94	0,93	0,92	0,91	0,90	0,88	-	-	-
	3	0,99	0,97	0,96	0,95	0,95	0,94	0,94	0,93	0,91	-	-	-
Beets, radishes, turnips, horseradish, kohlrabi, parsnips	2	-	0,97	0,94	0,93	0,91	0,89	-	-	-	-	-	-
	3	-	0,97	0,95	0,94	0,92	0,90	-	-	-	-	-	-
	2	0,98	0,97	0,96	0,95	0,95	0,94	0,94	0,93	0,91	0,91	0,91	0,89
Cabbage	1	0,98	0,97	0,97	0,96	0,95	0,94	0,93	0,92	0,91	0,90	0,88	0,87

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Product	Storage method	September	October	November	December	January	February	March	April	May	June	June	August
(white and red cabbage, Savoy, Brussels sprouts), late varieties Onions (onions and samples)	2	0,97	0,95	0,94	0,93	0,92	0,91	0,90	0,88	-	-	-	-
Garlic Pumpkin	2	0,99	0,97	0,97	0,96	0,96	-	-	-	-	-	-	-
Apples (autumn varieties) Apples (winter varieties)	1	0,99	0,98	0,97	0,97	0,96	0,96	-	-	-	-	-	-
	2	0,98	0,97	0,96	0,95	0,94	-	-	-	-	-	-	-
	1	0,99	0,99	0,98	0,98	0,98	0,98	0,97	0,97	0,96	0,96	-	-
	2	0,98	0,97	0,97	0,96	0,96	0,95	0,95	-	-	-	-	-
Cabbage (white and red cabbage, Savoy, Brussels sprouts), late varieties Onions (onions and samples)	1	0,99	0,98	0,98	0,97	0,97	0,96	0,96	0,95	0,95	-	-	-
	2	0,98	0,96	0,95	0,94	0,94	0,93	0,93	-	-	-	-	-
Garlic Pumpkin	1	0,99	0,99	0,98	0,97	0,97	0,96	0,96	-	-	-	-	-

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Symbols of the storage method: 1. With artificial cooling. 2. Without artificial cooling. 3. Burts, trenches.

In fig. 2.4 presents graphs of the dependence of the level of preservation of products from the month of storage. Despite the almost linear shape of the curves, the quality of data approximation from table was checked. 2.5 model type (2.35), instead of t storage temperature was used M – month number.

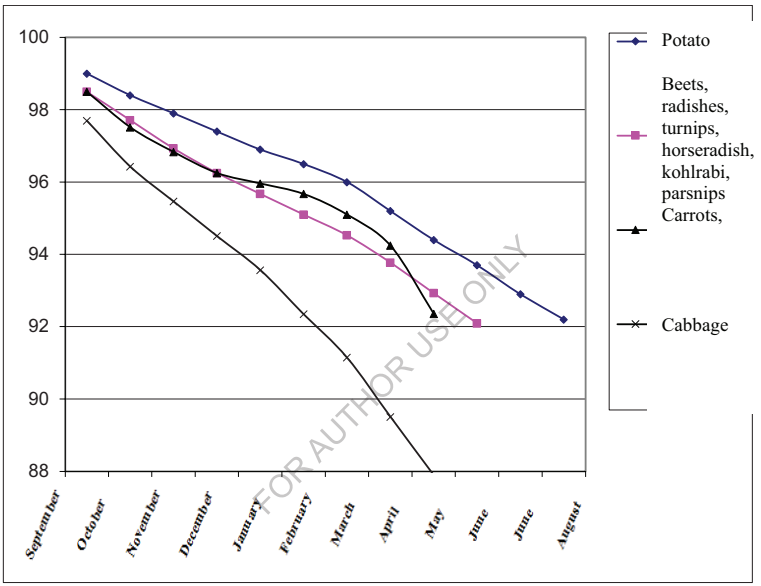

Fig. 2.4. Dependence of the mass of potatoes, vegetables and fruits during storage on time

For this purpose, the previous procedure of the optimization approach was used. The following numbers were assigned to the months: 1 – September, 2 - October, 3 - November, 4 - December, 5 - January, 6 - February, 7 - March, 8 - April, 9 - May, 10 - June, 11 - July, August 12. a_1 is equal to the largest value of the month of possible storage. T_p calculated by the formula (2.35). T_ϕ – the actual value of the balance of

products according to table. 2.5. Functional of the optimal problem of the form (2.27).

The results of calculations of the coefficients of the models are summarized in table. 2.6.

Table 2.6. Calculations of model coefficients (2.35) for potatoes, vegetables and fruits

Product	Storage method	a_1	b_1	c_1	Confidence probability, β
1	2	3	4	5	6
Potato	1	12	0,999013	0,006357	1,000
	2	12	1,004401	0,009462	1,000
	3	9	0,991486	0,006529	1,000
Beets, radishes, turnips, horseradish, kohlrabi, parsnips	1	10	0,99159	0,007162	1,000
	2	10	0,99156	0,007946	1,000
	3	9	0,990664	0,006677	1,000
Carrots, parsley, celery, turnips	1	10	0,982803	0,008822	1,000
	2	9	0,98277	0,011112	1,000
	3	9	0,990887	0,008785	1,000
Cabbage (white and red cabbage, Savoy, Brussels) medium-ripe varieties	2	6	1,009638	0,021201	1,000
	3	6	1,003658	0,017725	1,000
Cabbage (white and red cabbage, Savoy, Brussels sprouts), late varieties	1	10	1,004756	0,01266	1,000
	2	8	0,993308	0,012773	1,000
	3	8	0,988334	0,010205	1,000
Onions (onions and samples)	1	12	1,006011	0,008046	1,000
	2	12	0,988165	0,008086	1,000
Garlic	1	12	0,999647	0,01102	1,000
	2	8	0,978444	0,012783	1,000
Pumpkin	2	5	0,988403	0,00664	1,000
Apples (autumn varieties)	1	6	0,991786	0,005536	1,000
	2	5	0,990118	0,011067	1,000
Apples (winter varieties)	1	10	1,215998	0,052512	1,000
	2	7	0,985674	0,005519	1,000
Pears	1	9	0,992065	0,005053	1,000
	2	7	0,982081	0,008793	1,000
Grape	1	7	0,995293	0,005307	1,000

Symbols of the storage method: 1. With artificial cooling. 2. Without artificial cooling. 3. Burts, trenches.

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The calculation of the confidence probability by Pearson's test showed that its value for all models was not less than $\beta = 0{,}99$.

Next, the storage parameters of the main legumes and oilseeds were determined. These crops can be stored safely without ventilation for some time. From work [56, p. 253-255] was taken the data summarized in table. 2.7.

Table 2.7. Approximate terms of safe storage of grain, days

Grain	Grain moisture, %	Grain temperature, °C							
		30	**25**	**20**	**15**	**10**	**5**	**0**	**-5**
Wheat, rye, barley	13	95	130	180	180	180	180	-	-
	14	30	37	78	170	180	180	-	-
	15	13	18	33	75	180	180	-	-
	16	6	9	18	35	135	180	-	-
	17	1	3	12	20	75	180	-	-
	18	-	-	8	12	32	127	-	-
	19	-	-	4	8	18	70	-	-
	20	-	-	2	5	13	36	-	-
	21	-	-	-	3	10	26	-	-
	22	-	-	-	2	8	22	-	-
	23	-	-	-	1	6	20	-	-
	24	-	-	-	-	5	18	-	-
	25	-	-	-	-	3	17	-	-
	26	-	-	-	-	2	15	-	-
	27	-	-	-	-	1	13	-	-
	28	-	-	-	-	-	12	-	-
	29	-	-	-	-	-	11	-	-
	30	-	-	-	-	-	10	-	-
Rice	14	-	110	120	120	120	120	120	120
	15	-	50	94	120	120	120	120	120
	16	-	24	46	88	114	120	120	120
	17	-	12	20	37	84	104	120	120
	18	-	7	12	21	45	85	120	120
	19	-	4	7	14	21	45	95	120
	20	-	2	4	8	12	23	63	120
	21	-	1	2	4	8	14	32	86
	22	-	-	1	2	4	8	18	35
	23	-	-	-	1	3	5	10	20

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Grain	Grain moisture, %	Grain temperature, °C							
		30	**25**	**20**	**15**	**10**	**5**	**0**	**-5**
Buckwheat	14	-	140	140	140	140	140	140	140
	15	-	115	140	140	140	140	140	140
	16	-	55	105	140	140	140	140	140
	17	-	30	52	125	140	140	140	140
	18	-	20	30	76	140	140	140	140
	19	-	12	21	48	95	140	140	140
	20	-	8	15	26	57	123	140	140
	21	-	5	9	14	40	80	140	140
	22	-	4	6	10	26	53	120	140
	23	-	3	5	8	17	35	72	130
	24	-	2	3	6	12	25	50	82
	25		1	2	4	9	20	39	60
Millet	14	11	25	45	90	120	120	120	120
	15	6	10	20	58	113	120	120	120
	16	3	9	10	28	65	120	120	120
	17	2	4	7	12	27	80	110	120
	18	1	3	4	7	16	40	83	120
	19	-	2	3	5	9	16	52	105
	20	-	1	2	4	7	10	22	70
	21	-	-	1	3	5	8	13	35
	22	-	-	-	2	4	6	10	18
	23	-	-	-	1	3	4	7	5
	24	-	-	-	-	2	3	5	10
Oat	14	14	26	57	75	90	90	90	90
	15	4	10	30	50	90	90	90	90
	16	2	4	11	20	70	90	90	90
	17	1	3	7	14	35	90	90	90
	18	-	1	4	8	20	70	-	-
	19	-	-	2	6	15	46	-	-
	20	-	-	1	3	10	26	-	-
	22	-	-	-	1	6	20	-	-
	24	-	-	-	-	4	16	-	-
	26	-	-	-	-	1	14	-	-
	28	-	-	-	-	-	11	-	-
	30	-	-	-	-	-	8	—	—
Corn in the grain	15	-	42	54	70	85	100	120	120
	16	-	33	42	54	68	80	100	120
	17	-	23	30	40	50	60	77	100
	18	-	16	22	30	38	45	58	75
	19	-	10	14	20	28	33	44	53
	20	-	6	9	14	17	23	32	40
	21	-	4	7	10	13	18	26	33

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Grain	Grain moisture, %	Grain temperature, °C							
		30	**25**	**20**	**15**	**10**	**5**	**0**	**-5**
	22	-	2	4	7	10	14	20	26
	23	-	1	3	5	8	12	17	20
	24	-	-	2	4	7	10	15	17
	25	-	-	1	3	6	9	13	16
	26	-	-	-	2	5	8	12	15
	28	-	-	-	1	4	7	11	14
	30	-	-	-	-	3	6	10	13
Corn is not shelled	15	-	72	93	145	180	180	180	180
	16	-	61	80	118	177	180	180	180
	17	-	50	68	94	142	180	180	180
	18	-	39	53	75	110	180	180	180
	19	-	30	42	60	81	120	180	180
	20	-	20	32	45	60	80	180	180
	21	-	14	25	36	48	64	120	180
	22	-	9	18	30	39	54	74	-
	23	-	4	14	24	31	46	61	-
	24	-	3	11	20	28	40	54	-
	25	-	2	9	17	25	37	47	-
	26	-	1	8	15	22	34	43	-
	28	-	-	6	10	17	27	38	-
	30	-	-	3	5	10	20	28	-
Soybean seeds	12	-	-	93	140	140	140	140	140
	13	-	-	53	114	140	140	140	140
	14	-	-	29	65	122	140	140	140
	15	-	-	16	38	84	128	140	140
	16	-	-	12	21	58	104	129	140
	17	-	-	9	15	40	82	102	140
	18	-	-	8	12	28	63	83	129
	19	-	-	7	9	19	48	68	111
	20	-	-	6	8	15	36	58	95
	21	-	-	5	7	13	28	49	83
	23	-	-	3	5	9	17	36	64
	25	-	-	2	4	7	10	27	53
Sorghum seeds	15	-	-	4	9	20	70	-	-
	17	-	-	3	6	12	28	-	-
	20	-	-	2	3	5	10	-	-
	22	-	-	1	2	4	6	-	-
	25	-	-	-	1	2	3	-	-
Sunflower seeds	8	20	30	50	90	90	90	90	90
	9	6	9	19	34	90	90	90	90
	10	-	2	7	14	37	90	90	90
	11	-	-	3	7	15	43	-	-

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Grain	Grain moisture, %	Grain temperature, °C							
		30	**25**	**20**	**15**	**10**	**5**	**0**	**-5**
	12	-	-	-	3	9	25	-	-
	13	-	-	-	1	6	21	-	-
	14	-	-	-	-	5	18	-	-

Graphs of dependence of shelf life of some grain crops on storage temperature were constructed, which are presented in fig. 2.5.

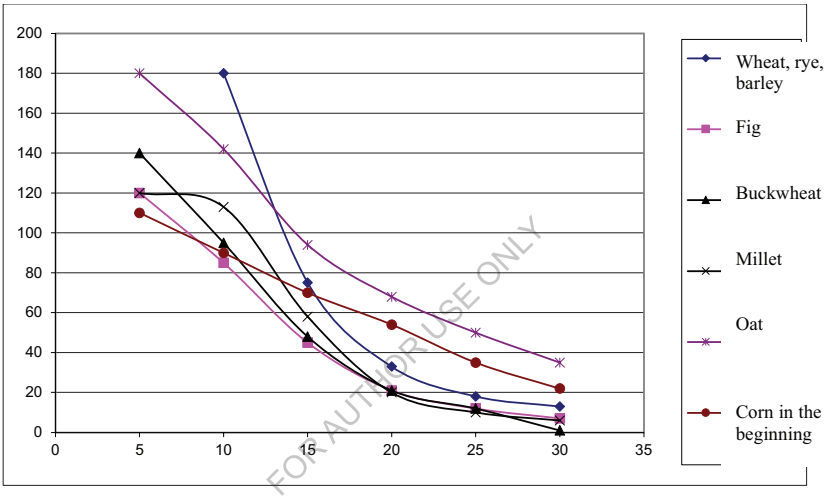

Fig. 2.5. Graphs of grain storage life depending on storage temperature

As can be seen from Fig. 2.5, the shape of the curves corresponds to model (2.35). Let us now construct the dependence of the shelf life on the moisture content of the grain (Fig. 2.6).

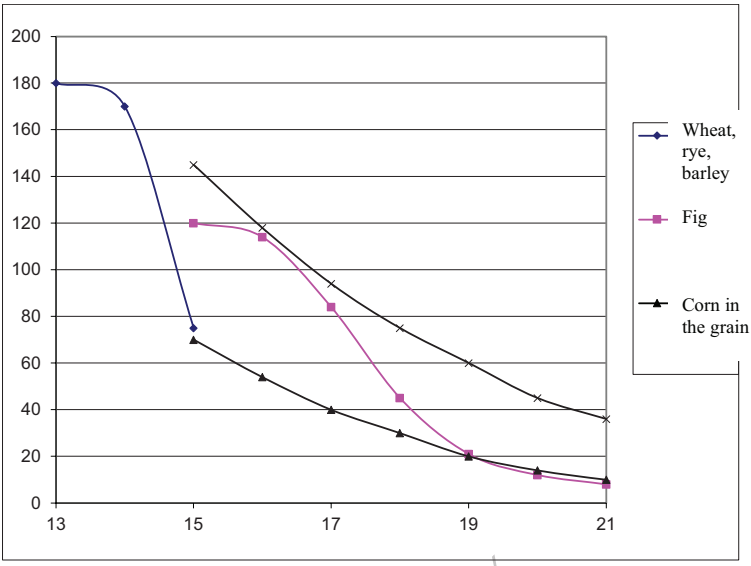

Fig. 2.6. Dependence of grain storage life on grain moisture at temperature 15° C

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The curves in Fig. 2.6 also correspond to model (2.35), but considering fig. 2.5, it can be concluded that this model needs to be complicated because it already has two variables – grain moisture and storage temperature. Therefore, the following form of exponential model is proposed for legumes and oilseeds:

$$T = \begin{cases} a_2, & \text{if} \quad t,\theta \le t_{\min},\theta_{\min} \\ b_2 \cdot e^{-c_2 \cdot t} \cdot e^{-d_2 \cdot \theta}, & \text{if} \quad t,\theta > t_{\min},\theta_{\min} \end{cases}, \tag{2.37}$$

where T – shelf life of the culture, $a_2 \ldots d_2$ – model coefficients, t – grain temperature, θ – grain moisture, $t_{\min},\theta_{\min}$ – the smallest values of grain temperature and humidity, respectively.

We apply the optimization approach described above to find the coefficients of the model (2.37). a_1 is equal to the largest value of the shelf life. T_p calculated by the formula (2.37). T_ϕ – the actual value of the shelf life according to table 2.7. Functional of the optimal problem of the form (2.27).

The results of the calculations are given in table. 2.8.

Table 2.8. Model coefficients (2.37) for legumes and oilseeds

Corn	a_2	b_2	c_2	d_2	Confidence probability, β
Wheat, rye, barley	180	61408	0,0973	0,3297	1,000
Fig	120	524453	0,0969	0,4638	1,000
Buckwheat	140	55000	0,0897	0,2915	1,000
Millet	120	290226	0,1193	0,4625	1,000
Oat	90	15368,3	0,1198	0,2721	1,000
Corn in the grain	120	4214,07	0,05	0,2357	1,000
Corn is not shelled	180	9465,92	0,0741	0,2089	1,000
Soybean seeds	140	5805,01	0,0844	0,2322	1,000
Sorghum seeds	70	11496,1	0,1688	0,2954	1,000
Sunflower seeds	90	76773,1	0,129	0,613	1,000

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The confidence probability according to Pearson's criterion was at least 0.99 for each model, so they are all adequate. In addition, legumes and oilseeds during storage also lose their weight as products that are described in table 2.4. This is confirmed by the following data [99, p. 402-403], which are presented in table 2.9.

Table 2.9. Norms of natural weight loss of grain (%)

Product	Storage method	Shelf life, months		
		3	6	12
Wheat, rye, barley, spelled	1	0,07	0,09	0,12
	2	0,04	0,06	0,09
	3	0,12	0,16	–
Oat	1	0,09	0,13	0,17
	2	0,05	0,07	0,09
	3	0,15	0,2	–

Product	Storage method	Shelf life, months		
		3	6	12
Buckwheat, rice-grain	1	0,08	0,11	0,15
	2	0,05	0,07	0,1
Millet, chumiza, sorghum	1	0,11	0,15	0,19
	2	0,06	0,08	0,1
	3	0,14	0,19	–
Corn in the grain	1	0,13	0,17	0,21
	2	0,07	0,11	0,13
	3	0,18	0,22	–
Corn is not shelled	1	0,25	0,3	0,45
	3	0,45	0,55	0,7
Soy	1	0,07	0,09	0,12
	2	0,04	0,06	0,08
Sunflower (seeds)	1	0,19	0,25	0,3
	2	0,11	0,15	0,2

Symbols of the method of storage: 1. In warehouses in bulk. 2. In warehouses in containers. 3. On the adapted platforms and in bugs.

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In order to develop a model (2.35) for the data in table 2.9 they need to be converted from the norms of natural loss to the norms of the balance by subtracting one from each value. These data are presented in table. 2.10.

Table 2.10. Grain residue rates (%)

Product	Storage method	Shelf life, months		
		3	6	12
Wheat, rye, barley, spelled	1	0,93	0,91	0,88
	2	0,96	0,94	0,91
	3	0,88	0,84	–
Oat	1	0,91	0,87	0,83
	2	0,95	0,93	0,91
	3	0,85	0,8	–

Product	Storage method	Shelf life, months		
		3	6	12
Buckwheat, rice-grain	1	0,92	0,89	0,85
	2	0,95	0,93	0,9
Millet, chumiza, sorghum	1	0,89	0,85	0,81
	2	0,94	0,92	0,9
	3	0,86	0,81	–
Corn in the grain	1	0,87	0,83	0,79
	2	0,93	0,89	0,87
	3	0,82	0,78	–
Corn is not shelled	1	0,75	0,7	0,55
	3	0,55	0,45	0,3
Soy	1	0,93	0,91	0,88
	2	0,96	0,94	0,92
Sunflower (seeds)	1	0,81	0,75	0,7
	2	0,89	0,85	0,8

Symbols of the method of storage: 1. In warehouses in bulk. 2. In warehouses in containers. 3. On the adapted platforms and in bugs.

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Graphically, the data from table. 2.10, which are presented in Fig. 2.7, look like exponential functions, and therefore can be described by model (2.35).

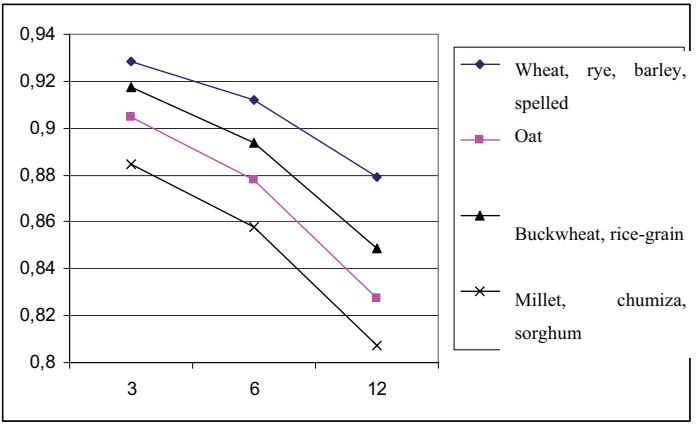

Fig. 2.7. Dependence of grain weight during storage on time

We apply the optimization approach described above to find the coefficients of the model (2.35). a_1 is equal to the largest rate of product balance, ie 100%. T_p calculated by formula (2.35), where instead of t is used n – shelf life in months. T_ϕ – the actual value of the grain residue rate according to table. 2.10. Functional of the optimal problem of the form (2.27). The results of the calculations are given in table. 2.11.

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Table 2.11. Model coefficients (2.35) for grain

Product	**Storage method**	a_1	b_1	c_1	**Confidence probability, β**
Wheat, rye, barley, spelled	1	1,000	0,945759	0,006067	1,000
	2	1,000	0,975735	0,005872	1,000
	3	1,000	0,922012	0,01551	1,000
Oat	1	1,000	0,931991	0,009928	1,000
	2	1,000	0,960458	0,004624	1,000
	3	1,000	0,901894	0,019801	0,999
Buckwheat, rice-grain	1	1,000	0,94152	0,008649	1,000
	2	1,000	0,965741	0,005935	1,000
	1	1,000	0,912037	0,010163	1,000

Product	Storage method	a_1	b_1	c_1	Confidence probability, β
Millet, chumiza, sorghum	2	1,000	0,950461	0,004674	1,000
	3	1,000	0,912508	0,019747	1,000
Corn in the grain	1	1,000	0,892088	0,01041	1,000
	2	1,000	0,94106	0,006944	1,000
	3	1,000	0,860371	0,016197	0,999
Corn is not shelled	1	1,000	0,844433	0,034948	1,000
	3	1,000	0,673769	0,067408	1,000
Soy	1	1,000	0,945759	0,006067	1,000
	2	1,000	0,970454	0,004575	1,000
Sunflower (seeds)	1	1,000	0,839379	0,015682	1,000
	2	1,000	0,917639	0,011633	1,000

Symbols of the method of storage: 1. In warehouses in bulk. 2. In warehouses in containers. 3. On the adapted platforms and in bugs.

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From [28, 134] it is known that some types of grain can be stored on the current after harvest for some time without loss. The data were entered in table 2.12.

Table 2.12. Safe shelf life of grain.

Grain	Term of stay on a current after collecting without losses, days
Wheat	14-21
Corn	21-28
Sunflower	14-21

Let us now use the research done in [48] that for every 2 months of storage of wheat and corn remains 95% of the 3rd class, 4% - the 6th and 1% of waste. Moreover, the sixth class can be sold at a price about twice cheaper than the third. The data were summarized in table 2.13.

Table 2.13. Grain residue rates of a certain class for a period of 6 months.

Grain classes	Number of months of storage		
	2	4	6
3-th	0,95	0,90	0,86
6-th	0,04	0,08	0,11
Waste	0,01	0,02	0,03

Such a system of losses for the third class of grain is described by the dependence of the species (2.35). Construct, taking into account the shelf life, the change in grain weight of the third class over time and present them in Fig. 2.8.

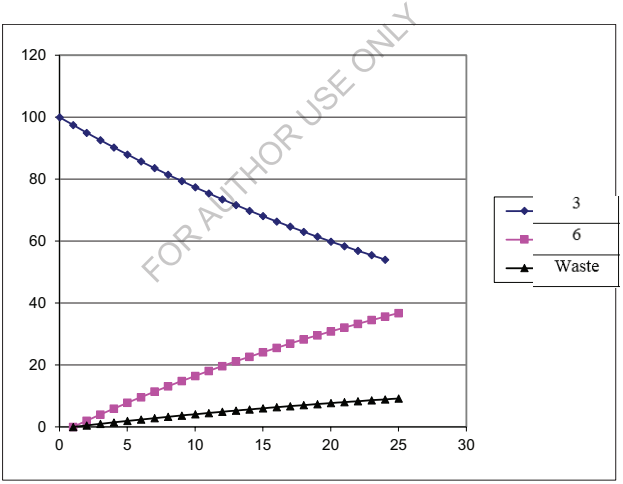

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Fig. 2.8. Construct, considering the shelf life, the change in grain weight of the third class over time

$$T = \begin{cases} a_3, if \ \ n = 0 \\ b_3 \cdot (1 - e^{-c_3 \cdot n}), if \ \ n > 0 \end{cases}, \tag{2.38}$$

where $a_3 = 0$, b_3, c_3 – model constants n – number of months of storage.

According to the optimization approach described above, the values of the coefficients of model (2.35) for grain of the third class and model (2.38) for grain of the sixth class and waste were found. a1 for grain of the third class is equal to the largest rate of the balance of production, ie 100%. T_p calculated according to the class: by formula (2.35) for grain of the third class, where instead of t n - storage period in months is used, and by formula (2.38) for grain of the sixth class and waste. T_ϕ – the actual value of the grain residue rate according to table 2.13. Functional of the optimal problem of the form (2.27). The results of the calculations are given in table. 2.14.

Table 2.14. Exponential model coefficients (2.35) and (2.38)

Grain classes	a_3	b_3	c_3	**Confidence probability, β**
3-th	1,000	1,000084	0,025651	1,000
6-th	0,000	0,725843	0,028442	1,000
Waste	0,000	0,166623	0,031147	1,000

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The confidence probability according to Pearson's criterion was not less than 0.99 for each model, so they are all adequate. Based on the research, it can be concluded that the shelf life of all types of crop products is well described by exponential models. The obtained models of the form (2.35), (2.37) and (2.38) allow to create discount rates of agricultural products. These standards depend on the type of product. If they are meat products, the following discount rate should be used, because these products are described by the dependencies of the species (2.35):

$$НД_M = \frac{b_1 \cdot e^{-c_1 \cdot t} - (n \cdot 12 + n_{M3})}{a_1}, \quad (2.39)$$

where a_1, b_1, c_1 – coefficients for the corresponding type of meat products from table 2.3; n – term for which it is planned to lend goods, years; n_{M3} – time elapsed since the slaughter of meat products, months. But if the shelf life of the product is exceeded, the discount rate should be 0. So, if $НД_М < 0$, then $НД_М = 0$.

For potatoes, vegetables and fruits, the discount rate directly depends on the number of the month in which the trade credit is issued and on the maximum possible number of months of storage.

$$НД_O = \begin{cases} b_1 \cdot e^{-c_1(n \cdot 12 + M)}, if\ (n \cdot 12 + M) \leq a_1 \\ 0, if\ (n \cdot 12 + M) > a_1 \end{cases}, \tag{2.40}$$

where a_1, b_1, c_1 – coefficients for the corresponding type of product from table 2.6; n – term for which it is planned to lend goods, years; M – the number of the current month according to table 2.5.

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For the discount rate of legumes and oilseeds, it is necessary to consider both the storage conditions of the product (temperature and humidity) and the rate of product residue during storage. Therefore, we need to consider 2 models: (2.35) and (2.37). Then the discount rate of legumes and oilseeds took the following form:

$$НД_{З\_1} = \left(\frac{b_2 \cdot e^{-c_2 \cdot t} \cdot e^{-d_2 \cdot \theta} - (n \cdot 365 + n_{M3} \cdot 30) + Б_T}{a_2}\right) \cdot b_1 \cdot e^{-c_1 \cdot (n \cdot 12 + n_{M3})}, \tag{2.41}$$

where a_1, b_1, c_1 – coefficients for the corresponding type of grain from table.2.11; a_2, b_2, c_2, d_2 – coefficients for the corresponding type of grain from table 2.8; t – grain storage temperature; θ – grain storage humidity; n – term for which it is planned to lend goods, years; n_{M3} – time elapsed since the collection of products, months; $Б_T$ – safe shelf life of some types

of products from the moment of its receipt in the commodity form from tab.2.12 (for types of products which are not specified in tab.2.12, $Б_Т = 0$).

If the shelf life of the product is exceeded, the discount rate should be 0. Therefore, if $НД_{З\_1} < 0$, then $НД_{З\_1} = 0$.

However, for cereals such as wheat and maize, in addition to the shelf life described in model (2.37) and the residual rates described in model (2.35), some fraction of spoiled products may be sold at a certain price. . This particle is described by the model (2.38). But when using models (2.35), (2.37) and (2.38) at the same time we need to calculate that each of them, when forming a coefficient of type (2.39) - (2.41) will give a number whose value will vary from 0 to 1. Moreover, if the coefficients for the model (2.35) and (2.37) should reduce the share of marketable products that will be credited, the coefficient for the model (2.38) should increase this share. Then the discount rate for wheat and corn will be as follows:

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$$НД_{З\_2} = \left(\frac{b_2 \cdot e^{-c_2 \cdot t} \cdot e^{-d_2 \cdot \theta} - (n \cdot 365 + n_{МЗ} \cdot 30) + Б_Т}{a_2}\right) \times$$

$$\times\, b_1 \cdot e^{-c_1 \cdot (n \cdot 12 + n_{МЗ})} \left(1 - \frac{Ц_{6кл} \cdot b_{36} \cdot (1 - e^{-c_{36} \cdot (n \cdot 12 + n_{МЗ})})}{Ц_{1кл} \cdot a_{31}}\right), \qquad (2.42)$$

Where a_1, b_1, c_1 – coefficients for the corresponding type of grain from table 2.11; a_2, b_2, c_2, d_2 – coefficients for the corresponding type of grain from table 2.8; n – term for which it is planned to lend goods, years; $n_{МЗ}$ – time elapsed since the grain was harvested, months; $Б_Т$ – safe shelf life of some types of products from the moment of its receipt in the commodity form from table 2.12; a_{31}, b_{31} та c_{31} – coefficients of the model from table 2.14 for the highest class of grain; a_{36}, b_{36} та c_{36} – coefficients of the model from table 2.14 for the lowest class of grain; $Ц_{1кл}$, $Ц_{6кл}$ – the cost of grain, respectively, the highest and lowest class; n – term for which

it is planned to lend goods, years; t – grain storage temperature; θ – grain storage humidity.

If the shelf life of the product is exceeded, the discount rate should be 0. Therefore, if $НД_{З\_2} < 0$, then $НД_{З\_2} = 0$.

All four discount rates will vary from one to zero and will be smaller the longer the commodity loan will be taken. They will also depend on the storage conditions of agricultural products, and for crop products, as well as on what time from the collection of these products, a commodity loan was obtained. For the norm (2.42), it will decrease due to the first factor and increase due to the second factor.

In addition to finding the limit amount when limiting for a commodity loan, as already mentioned in paragraph 1.2, you must also find the deadline for which a commodity credit can be issued.

The term of a trade credit can be calculated using an optimization model, the general task of which is to find the extremum (maximum or minimum) of the objective function in the presence of constraints on n variables in the form of m linear inequalities or equations [CU].

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Thus, the term of commodity lending - this will be a variable of the objective function of this optimization model.

For the term of the commodity loan as well as the loan amount, a complete list of criteria for calculating the commodity credit limit is also relevant (see item 2.1). And models that meet such conditions were found in Section 2. This is the creditor's limit ($Л_К$) and the borrower's limit ($Л`_П$).

From these functions, the borrower's limit depends on the term, because its components are increased over the term of the loan and then $Л`_П$ is also discounted for the term of commodity lending. So, $Л`_П$ will be the target function.

But to solve the problem of the optimization model you need to find the extremum of the objective function. That is, specify the value to which

this model goes. As mentioned above - this can be a maximum or minimum of the objective function.

From an economic point of view, for $Л`_{П}$ minimum and zero are one and the same, because the sum of the limit cannot be less than zero. But zero, as the value to which the objective function goes, is not desirable on the grounds that in this case the creditor company should not start commodity lending at all, if before the issuance of loans the company decides to limit the loan amount to zero. Therefore, it contradicts the goals of the creditor company.

It is also not desirable to choose the maximum for this target function out of the precautionary principle: it is not desirable for the creditor company to maximize the amount of the limit, because then the probability of non-repayment of the trade credit increases significantly. If directing an objective function neither to the maximum nor to its minimum does not seem possible for economic reasons, it means that the function must be directed to a certain value, which does not depend on the objective function or on the variable of this function. This indicator should serve as a value $Л_{К}$, after all, firstly, this value meets the above conditions, and secondly, this indicator meets the full list of criteria for the limit of commodity lending.

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The objective function of the optimization model for finding the value of the term of the trade credit will take the form:

$$Л'_{П} \rightarrow Л_{К}, \tag{2.43}$$

The value of the term of the trade credit n, which will be obtained as a result of solving the optimization problem, will reflect, depending on whether the borrower's limit was greater or less relative to the creditor's limit before solving the problem of the optimization model:

1) If $Л_{П}^{'} > Л_{К}$, which means that the financial capabilities of the borrower are more powerful than the financial capabilities of the lender, n will show the minimum possible loan term for the borrower.

2) If $Л_{П}^{'} < Л_{К}$, which means that the financial capabilities of the borrower are less powerful than the financial capabilities of the lender for the maximum possible loan term for the borrower.

As mentioned above, to solve the optimization problem on the objective function (2.43) and its variables need to impose some restrictions, which consist of the economic essence of this function, its components and variables. Since the function (2.43) is a credit limit, ie the amount of money, it must be a positive number. In addition, the term of the trade credit may not be less than 1 calendar day. Therefore, the limitations of the rock are the following system:

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$$\begin{cases} n \geq {}^{1}/_{365}, \\ Л_{П}^{'} \geq 0 \end{cases} \tag{2.44}$$

where $Л`_{П}$ – borrower's limit; n - term of the commodity credit, years. The solution of the optimal problem with the objective function (2.43) and the system of constraints (2.44) can be carried out using the simplex method, which is an analytical method of finding solutions to the problems of optimization models [CU]. This method is implemented in the MS Excel spreadsheet environment in the " Search Solution" function.

Chapter 3.
Implementation of research results on the calculation of the limit of commodity lending for agricultural enterprises

3.1. Determining the general method of calculating the limit of commodity lending for agricultural enterprises

In order to depict in the method of calculating the total limit of the commodity credit we add to the formula (2.2) the value of the discounted amount of the limit of the commodity credit of the borrower from (2.34):

$$Л = MIN(Л_{П}^{'}; Л_{K}), \quad (3.1)$$

where $Л$ – the total amount of the limit; $Л_n$ – borrower limit calculated by formula (2.1); $Л_к$ – creditor limit calculated by formula (1.5).

The creditor's limit is calculated by the formula:

$$Л_к = K \cdot \text{В}K,$$

where L is the sum of the limit; K – correction factor; VK – equity of the creditor company.

The adjustment factor K is the probability of winning an economic game when ESD does not care whether to participate in the game or leave the game with a certain guaranteed amount of money. In the case of an ESD creditor agricultural enterprise, it is the manager who makes the decision to grant a commodity loan.

The correction factor K is calculated by the formula (2.21):

$$K = \begin{cases} p_0, if\ p_0 \geq p_Б \\ 0,\ if\ \ p_0 < p_Б \end{cases},$$

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where p_0 – probability for ESD, which was found as a result of the economic game; $p_Б$ – probability for a person indifferent to risk, calculated by the formula (2.20):

$$p_Б = \frac{m - S_1}{S_2 - S_1},$$

where S_2 and S_1 – the amounts of winnings and losses in the economic game, respectively; m - the amount of the guaranteed reward for leaving the game. The relationship between these indicators is as follows: $S_2 > m > S_1$.

The borrower's limit is calculated by the formula (2.34):

$$ЛИ_П' = \frac{ЛИ_П}{(1+r)^n},$$

where $ЛИ_П$` – discounted amount of the borrower's trade credit limit; $ЛИ_П$ – the amount of the borrower's credit limit; r - interest rate on commodity credit on an annualized basis; n – term of commodity credit, years.

The interest rate on a commodity loan is determined by the borrower based on the conditions described in clause 1.1: the rate on a commodity loan must be higher than the inflation rate and lower than the rate on bank loans, which can be written as follows:

$$i_{СЦ} < r < i_К, \tag{3.2}$$

where r – interest rate on a commodity loan; $i_{СЦ}$ – consumer price index on an annualized basis; $i_К$ – the average interest rate on loans to the real sector of the economy.

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The limit of commodity crediting of the borrower is calculated based on the formula (2.33) and taking into account norms of a discount of an indicator of commodity production (2.39) - (2.42) depending on kinds of the given commodity production:

$$ЛП = C'K_1 + EB' + ТЗ'_Д + ДЗ'_M K_3 + ФВ \cdot K_4 + ГК' - ИПП - ИПК, \quad (3.3)$$

where $Л$ – borrower limit; C' – average daily increased cost; $\bar{П}_{КЗ}$ – average industry period of accounts payable turnover; $П_{КЗ}$ – the period of turnover of accounts payable of the borrower; EB' – projected EBITDA for the loan period; $ТЗ'$ – increased value of inventories; CV_i – coefficient of price variation for the i-th type of inventory; $ТЗ_i$ – the value of the i-th type of inventory; m – the number of types of inventories; $ДЗ$ – the total amount of receivables; $ДЗ'_M$ – accrued receivables with a maturity less than the term of the trade credit; $ДЗ_{ПР}$ – overdue receivables; $ФВ$ – financial investments; $CV_{ФР}$ – the coefficient of variation of the stock market index; $ГК'$ – increased cash; $ИПП$ – tax payments; $ИПК$ – debt service payments on loans already received for the period of the planned loan.

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The average daily incremental cost is calculated by the formula (2.24):

$$C' = C \cdot (1 + i_{СЦ})^n \ ,$$

where C' – average daily increased cost; C – average daily cost; $i_{СЦ}$ – consumer price index on an annualized basis; n – term of commodity credit, years.

The correction factor K1 is calculated by formula (2.4):

$$K_1 = \bar{П}_{КЗ} - П_{КЗ} \ ,$$

where K_1 – correction factor; $\overline{П}_{КЗ}$ – average industry period of accounts payable turnover; $П_{кз}$ – the period of turnover of accounts payable of the borrower. If $K_1<0$, then $K_1=0$.

The projected EBITDA is calculated by the formula (2.30):

$$EB' = A \cdot EB^B + C(1 - e^{D \cdot EB})Sin(E \cdot EB^F + G) + H,$$

where EB – EBITDA values for previous periods, $EB`$ – *EBITDA* predicted, A - H – constants, e – the basis of the natural logarithm. The accrued discounted value of inventories is calculated according to (2.25) and (2.22):

$$ТЗ'_Д = ТЗ_Д(1 + i_{СЦ})^n, \quad (3.4)$$

where $ТЗ_Д`$ – increased discounted value of inventories; $ТЗ_Д$ – discounted value of inventories; $i_{СЦ}$ – consumer price index on an annualized basis; n is the term of the commodity credit in years.

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The discounted value of inventories is calculated according to formulas (2.8) and (2.39) - (2.42):

$$ТЗ_Д = \sum_{i=1}^{m} K_{2_i} \cdot ТЗ_i \cdot НД_i, \quad (3.5)$$

where $ТЗ_Д$ – discounted value of inventories; m – the number of types of inventories; $ТЗ_i$ – the value of the i-th type of inventory; K_{2i} – adjustment factor of the i-th type of inventory, which shows what share of inventory can be sold over the period of the commodity loan; $НД_i$ – discount rates of the i-th type of inventory, which depend on the conditions and terms of storage of products.

The adjustment factor K_2 was calculated by formula (2.8), which gave the overall result for all types of inventories, but taking into account the influence of discount rates (2.39) - (2.42) on the calculation of the discounted value of inventories (3.5) adjustment factor K_{2i} should be calculated as follows:

$$K_{2i} = 1 - CV_{T3i}, \tag{3.6}$$

where K_{2i} – adjustment factor of the i-th type of inventory; CV_{T3i} – coefficient of variation of the price of the i-th type of inventory. If $K_{2i}<0$, then $K_{2i}=0$.

Inventory discount rates are calculated by formulas (2.39) - (2.42) for: 1 - meat and meat products; 2 - potatoes, vegetables and fruits; 3 - cereals, legumes and oilseeds, except wheat and corn; 4 - wheat and corn. That is, for inventories with a shelf life. For other inventories that do not have a shelf life, this rate is 1. This can be denoted by the following expression:

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$$НД_i = \begin{cases} НД_j (j = 1..4), T3_i \in S \\ 1, T3_i \notin S \end{cases}, \tag{3.7}$$

where $НД_i$ – discount rates of the *i*-th type of inventory; $НД_j$ – discount rates for inventories that are included in the set *S*; $T3_i$ – the value of the *i*-th type of inventory; *S* is a set consisting of the following types of inventories: meat, meat products, potatoes, vegetables, fruits, grains, legumes and oilseeds.

Discount rates for inventories with a shelf life are described by the following formulas depending on the type of inventory. For meat and meat products according to formula (2.39):

$$НД_M = \frac{b_1 \cdot e^{-c_1 \cdot t} - (n \cdot 12 + n_{M3})}{a_1},$$

where $НД_M$ – discount rate for meat and meat products; a_1, b_1, c_1 – coefficients for the corresponding type of meat products from table 2.3; t – storage temperature of products; n – term of commodity credit, years; n_{M3} – time elapsed since the slaughter of meat products, months. If $НД_M < 0$, then $НД_M = 0$.

For potatoes, vegetables and fruits according to the formula (2.40):

$$НД_O = \begin{cases} b_1 \cdot e^{-c_1(n \cdot 12 + M)}, & if \ \ (n \cdot 12 + M) \le a_1 \\ 0, & if \ \ (n \cdot 12 + M) > a_1 \end{cases},$$

where $НД_O$ – discount rate for potatoes, vegetables and fruits; a_1, b_1, c_1 – coefficients for the corresponding type of product from table 2.6; n – term of commodity credit, years; M – the number of the current month according to table 2.5.

For cereals, legumes and oilseeds, except wheat and maize by the formula (2.41):

$$НД_{3\_1} = \left(\frac{b_2 \cdot e^{-c_2 \cdot t} \cdot e^{-d_2 \cdot \theta} - (n \cdot 365 + n_{M3} \cdot 30) + E_T}{a_2}\right) \cdot b_1 \cdot e^{-c_1 \cdot (n \cdot 12 + n_{M3})},$$

where $НД_{3\_1}$ – discount rate for cereals, legumes and oilseeds, except wheat and corn; a_1, b_1, c_1 – coefficients for the corresponding type of grain from table. 2.11; a_2, b_2, c_2, d_2 – coefficients for the corresponding type of grain from table 2.8; t – grain storage temperature; θ – grain storage humidity; n – term of commodity credit, years; n_{M3} – time elapsed since the collection of products, months; E_T – safe shelf life of some types of products from the moment of its receipt in the commodity form from table 2.12 (for

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types of products which are not specified in table 2.12, $Б_T = 0$). If $НД_{З\_1} < 0$, then $НД_{З\_1} = 0$

For wheat and corn according to the formula (2.42):

$$НД_{З\_2} = \left(\frac{b_2 \cdot e^{-c_2 \cdot t} \cdot e^{-d_2 \cdot \theta} - (n \cdot 365 + n_{МЗ} \cdot 30) + Б_T}{a_2}\right) \times$$
$$\times\, b_1 \cdot e^{-c_1 \cdot (n \cdot 12 + n_{МЗ})} \left(1 - \frac{Ц_{6кл} \cdot b_{36} \cdot (1 - e^{-c_{36} \cdot (n \cdot 12 + n_{МЗ})})}{Ц_{1кл} \cdot a_{31}}\right),$$

where $НД_{З\_2}$ – discount rate for wheat and corn; a_1, b_1, c_1 – coefficients for the corresponding type of grain from table 2.11; a_2, b_2, c_2, d_2 – coefficients for the corresponding type of grain from table 2.8; n – term of commodity credit, years; $n_{МЗ}$ – time elapsed since the grain was harvested, months; $Б_T$ – safe shelf life of some types of products from the moment of its receipt in the commodity form from table 2.12; a_{31}, b_{31} and c_{31} – coefficients of the model from table 2.14 for the highest class of grain; a_{36}, b_{36} та c_{36} – coefficients of the model from table 2.14 for the lowest class of grain; $Ц_{1кл}$, $Ц_{6кл}$ – the cost of grain, respectively, the highest and lowest class; n – term for which it is planned to lend goods, years; t – grain storage temperature; θ – grain storage humidity.

If $НД_{З\_2} < 0$, then $НД_{З\_2} = 0$.

Accrued receivables with a maturity less than the term of the trade credit is calculated similarly to (2.32) considering (2.22):

$$ДЗ'_M = ДЗ_M(1 + i_{ВДЗ})^n, \qquad (3.8)$$

where $ДЗ`_M$ – increased the amount of receivables with a maturity less than the term of the trade credit; $ДЗ_M$ – the amount of receivables with a maturity less than the term of the trade credit; $i_{ВДЗ}$ – interest rate on

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receivables on an annualized basis; n is the term of the commodity credit in years.

The correction factor K_3 is calculated by the formula (2.9), but considering (2.10) the correction factor K_3 should be presented as follows:

$$K_3 = 1 - \frac{ДЗ_{ПР}}{ДЗ}, \quad (3.9)$$

where K_3 – adjustment factor; $ДЗ$ – the total amount of receivables; $ДЗ_{ПР}$ – overdue receivables.

The correction factor K_4 is calculated by the formula (2.11):

$$K_4 = 1 - CV_{ФР},$$

where K_4 – adjustment factor; $CV_{ФР}$ – the coefficient of variation of the stock market index, which is calculated based on a set of daily data of the stock market index.

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Accrued funds are calculated by the formula (2.31):

$$ГК' = ГК \cdot (1 + i_{БВ})^n,$$

where $ГК$` – increased amount of cash; $ГК$ – he amount of cash; $i_{БВ}$ – average interest rate on attracted deposits on an annualized basis; n is the term of the commodity credit in years.

To find the value of the term of a trade credit, the objective function of the following form (2.43) is used:

$$Л'_П \rightarrow Л_К,$$

where $Л_{П}`$ – the discounted amount of the borrower's limit; $Л_{к}$ – creditor limit.

In addition, the objective function (2.43) has a system of constraints (2.44):

$$\begin{cases} n \geq {}^{1}/_{365}, \\ Л_{П}^{'} \geq 0 \end{cases}$$

where $Л`_{П}$ – borrower's limit; n – term of the commodity credit, years.

The value of n, which will be obtained as a result of optimization, displays in the case:

1) $Л_{П}^{'} > Л_{К}$ the minimum possible loan term for this borrower.

2) $Л_{П}^{'} < Л_{К}$ the maximum possible loan term for this borrower.

The specified method of calculating the total limit of commodity credit meets the following criteria from the full list of criteria for calculating the limit of commodity credit (see p. 2.1):

- the share of capital of the creditor company, which it is willing to risk;
- financial condition of the creditor company;
- industry affiliation of the borrower;
- the size of the borrower's assets;
- financial stability of the borrower;
- prospects for the borrower's development;
- general state of the economy;
- regulatory requirements.
- type of credit policy implemented (level of acceptable risk),
- expected profitability taking into account the risks of transactions with the borrower;
- the principle of temporary value of money.
- term of the loan provided;

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• rate on the loan provided.

• the precautionary principle

Thus, the proposed method among the existing methods of calculating the limit of commodity lending has the largest number of matches to the full list of criteria, namely 14.

This number of criteria that meet the full list of criteria is much larger than the number of criteria that meet the full list of criteria in methods 1 and 5 (see p. 2.2.), Which formed the basis of the developed methodology for determining the total limit of trade credit. Method 1 meets two criteria, and Method 5 meets four criteria from a complete list of criteria for determining the commodity credit limit.

In addition, the proposed method does not have the disadvantages that were inherent in the above methods 1 and 5. Briefly present the main disadvantages of the selected methods 1 and 5 (see section 1.2).

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Method 1:

a. unreasonable value of the correction factor K.

b. the financial indicators of the borrower are not considered.

c. the principle of temporary value of money is not considered

Method 5:

1. unreasonable value of specific weight for financial ratios;

2. the given specific weight in calculation is defined expertly (the expert chooses one of three values of specific weight);

3. two different indicators of *VP* and *KZ* are used, which are essentially the same;

4. the method does not consider the financial performance of the creditor.

5. the principle of temporary value of money is not considered

As you can see, the proposed technique is devoid of these shortcomings, because it:

1. contains an objective calculation of the correction factor K.
2. considers both the financial performance of the borrower and the financial performance of the lender.
3. considers the principle of temporary value of money.
4. contains an objective calculation adjusting the coefficients K_1-K_4.
5. deprived of the method of expert assessments
6. uses indicators that are different in nature (no duplication of indicators).

For practical application, it is necessary to determine the list of necessary input information, based on which it is possible to calculate the limit of commodity lending for agricultural enterprises.

To determine the financial indicators of the enterprise such as: EBITDA, inventories, financial investments, cost, receivables, cash, tax payments, it is necessary to use reporting forms approved by the Orders of the Ministry of Finance of Ukraine "On approval of Accounting Regulations (standards)" №87 of March 31, 1999 and "On approval of the Regulation (standard) of accounting 25" Financial report of a small business entity "" №39 of February 25, 2000. [195, 196] depending on the type of enterprise.

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To determine the indicators of receivables: the amount of overdue receivables and the amount of receivables with a maturity less than the term of the trade credit - it is necessary to decipher the receivables.

To determine the composition of inventories and discount rates, it is necessary to decipher inventories, as well as data on the conditions of storage of inventories.

To determine the amount of payments on loans, you need data on received bank loans, terms, repayment schedules, rates on these loans.

To calculate the accrued indicators from the calculation of the borrower's limit (LP) such as, the average daily accrued cost (C'), increased discounted value of inventories ($ТЗ_Д`$), increased the amount of receivables with a maturity less than the term of the trade credit ($ДЗ`_М$) and the increased

amount of cash ($ГК$`). It is necessary to know the term of the commodity loan (n), consumer price index on an annualized basis ($i_{СЦ}$) and the average interest rate on attracted deposits on an annualized basis ($i_{БВ}$).

To calculate the discounted amount of the borrower's trade credit limit ($ЛП$`) you need to know the interest rate on a commodity loan on an annualized basis (r) and the average interest rate on loans to the real sector of the economy (i_K).

To calculate the adjustment factor K_1 it is necessary to know the industry-wide period of turnover of accounts payable ($\overline{П}_{КЗ}$).

To calculate the adjustment factors K_{2i} necessary data on price fluctuations for all types of inventories.

To calculate the adjustment factor K_4 necessary data on stock market index fluctuations.

To calculate the creditor's limit ($ЛК$) necessary data from the creditor company on its own capital and on the results of the economic game with ESD to determine the adjustment factor K.

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Therefore, all the necessary input data for calculating the total limit of commodity lending can be divided into 4 major groups according to information sources:

1) Terms of trade credit
2) General economic information;
3) Reporting from the borrower;
4) Data of the creditor company.

Terms of a commodity loan are determined by the creditor company independently and consist of:

- Interest rate on a commodity loan;
- Loan term.

General economic information consists of:

- Consumer price index (inflation rate) at the time of calculation;

• Coefficient of variation of the stock market;

• The average interest rate on loans to the real sector of the economy on the relevant date;

• Average interest rate on attracted deposits on the relevant date;

• The average industry period of accounts payable;

• Coefficient of variation of prices of inventories of the borrower.

The list of reporting forms from the borrower should be as follows:

• Financial Statements. Balance sheet (form №1) according to the appendix to the Regulation (standard) of accounting 2 "Balance sheet", which is approved by the Order of the Ministry of Finance of Ukraine "On approval of the Regulations (standards) of accounting" from of March 31, 1999. and the Report on financial results (form № ») according to the appendix to the Regulation (standard) of accounting 3" Report on financial results "which is approved by the Order of the Ministry of Finance of Ukraine" About the statement of Regulations (standards) of accounting "№87 from March 31, 1999. [195]. If the enterprise is a small business entity, instead of form №1 and form №2 - Financial report according to the appendix to Regulation (standard) of accounting 25 "Financial report of small business entity", which is approved by the Order of the Ministry of Finance of Ukraine. On approval of the Regulation (standard) of accounting 25 "Financial report of a small business entity" »№39 dated February 25, 2000. [196].

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• Deciphering receivables by maturity and return as of the last reporting date.

• Deciphering inventories by type.

• Information on storage conditions of inventories (temperature, grain moisture, type of storage facility, dates of harvesting each type of crop products, etc.).

• Information on current bank loans (terms, repayment schedules, rates on these loans).

The data of the creditor company consists of:

• The amount of equity at the time of calculating the limit.

• Determining the probability p_0 for the decision maker (ESD) by conducting an economic game.

3.2. Calculation of the general limit on the example of agricultural enterprises

In order to calculate the total limit of commodity credit for several enterprises, it is necessary to first determine the general economic indicators and terms of commodity lending, which will be the same for all enterprises:

• Consumer price index (inflation rate);

• Average interest rate on loans to the real sector of the economy;

• Interest rate on a commodity loan;

• Loan term;

• Stock market variation ratio;

• Average interest rate on attracted deposits;

• Average industry turnover of accounts payable in days.

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The consumer price index is regularly published on the official website of the State Statistics Committee of Ukraine [197]. According to the site for 2009. the consumer price index (CPI) was 12.3%.

The interest rate on the loan should be set based on inequality (3.2). To do this, in addition to the value of the consumer price index, to determine the average interest rate on loans to the real sector of the economy. This interest rate can be found in the data on the official website of the National Bank of Ukraine, which are listed in Table 3.1 [198].

Table 3.1. Interest rates on loans to the real sector of the economy and on borrowed deposits according to the statistical reporting of banks of Ukraine for December 2009, % per annum

Date	For loans *			For deposits			
	in the national currency	in foreign currency	integral	in the national currency	including by term in national currency	in foreign currency	integral
1	2	3	4	5	6	7	8
01	17.1	12.8	16.5	13.7	16.4	9.9	11.9
02	21.6	9.6	18.9	14.8	16.2	9.8	12.4
03	22.5	11.3	20.4	15.0	17.0	10.0	12.3
04	21.7	10.1	17.7	14.1	15.9	9.8	12.3
07	19.9	9.7	17.7	14.6	16.9	9.7	12.3
08	19.8	9.6	17.9	12.9	14.9	8.9	11.2
09	19.8	8.3	17.7	13.9	15.6	9.5	11.7
10	19.9	10.1	17.0	14.3	16.0	9.5	12.0
11	20.6	10.2	18.2	13.3	15.1	10.0	11.8
14	20.9	10.9	18.7	15.1	17.4	9.9	12.1
15	20.7	9.9	16.0	13.3	15.8	10.0	11.6
16	21.6	11.2	18.6	12.2	14.6	9.2	10.8
17	23.1	10.5	21.3	12.3	15.0	9.5	11.0
18	20.0	8.9	16.6	13.5	15.4	9.4	11.7
21	22.4	12.0	19.7	14.3	15.9	9.4	12.1
22	21.9	11.4	19.7	14.3	15.9	9.4	12.1
23	22.9	10.2	19.5	13.8	15.9	10.1	11.9
24	21.8	8.4	17.6	14.3	16.3	10.3	12.4

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Date	For loans *			For deposits			
	in the national currency	in foreign currency	integral	in the national currency	including by term in national currency	in foreign currency	integral
25	22.2	8.3	18.3	14.3	16.3	9.0	11.5
28	20.0	9.3	17.5	14.9	17.2	9.6	12.2
29	17.7	9.9	15.6	14.6	16.8	9.7	12.2
30	16.5	11.0	15.7	14.8	16.0	9.2	12.7
31	16.6	19.2	17.0	11.5	14.5	6.6	9.3

* excluding the cost of overdraft loans.

Table 3.1 shows that at the end of 2009 the average interest rate on hryvnia (IC) loans was 16.6% per annum. Therefore, according to inequality (3.2):

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$$12{,}3\% < r < 16{,}6\%$$

The rate on commodity credit (r) will be equal to 14% per annum. The term of the commodity credit (n) will be equal to 90 days, ie 0.25 years.

To calculate the coefficient of variation of the stock market ($CV_{ФР}$) use the data on the PFTS index, which are on the official website of the PFTS [199]. Since the term of the commodity loan of 90 days has already been determined, data on the PFTS index should also be taken for the same period (see table 3.2).

From table 3.2. it is easy to calculate the coefficient of variation for the PFTS index using formula (2.5).

Table 3.2. PFTS index for the period from 01.11.09 to 31.12.09

date	Index PFTS	date	Index PFTS	date	Index PFTS
1	2	3	4	5	6
30.10.09	591,82	01.12.09	603,97	31.12.09	572,91
29.10.09	587,9	30.11.09	594,56	30.12.09	573,79
28.10.09	585,88	27.11.09	598,89	29.12.09	573,36
27.10.09		26.11.09	611,53	28.12.09	569,49
26.10.09	606,55	25.11.09	617,68	25.12.09	571,59
23.10.09	612,83	24.11.09	624,2	24.12.09	573,46
22.10.09	615,69	23.11.09	628	23.12.09	572,17
21.10.09	634,11	20.11.09	624,66	22.12.09	573,36
20.10.09	647,5	19.11.09	634,81	21.12.09	578,7
19.10.09	648,99	18.11.09	639,44	18.12.09	586,58
16.10.09	649,85	17.11.09	637,29	17.12.09	590,98
15.10.09	646,05	16.11.09	638,53	16.12.09	597,69
14.10.09	661,1	13.11.09	636,9	15.12.09	596,7
13.10.09	651,14	12.11.09	641,17	14.12.09	
12.10.09	649,54	11.11.09	647,77	11.12.09	602,91
09.10.09	617,27	10.11.09	640,5	10.12.09	604,67
08.10.09	604,78	09.11.09	628,25	09.12.09	603,51
07.10.09	592,66	06.11.09	619,69	08.12.09	603,83
06.10.09	596,91	05.11.09	619,44	07.12.09	607,32
05.10.09	580,1	04.11.09	607,79	04.12.09	
02.10.09	570,34	03.11.09	588,74	03.12.09	612,79
01.10.09	573,2	02.11.09	588,2	02.12.09	605,4

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The average value of the PFTS index in table 3.2 is equal to 609,007. The standard deviation of the PFTS index is 25,646.

$$CV_{ÓÐ} = \frac{25,646}{609,007} = 0,042\,, \tag{3.10}$$

Data on the rate for the balance on the current account of enterprises can be taken from the official website of the National Bank of Ukraine, which are given in table 3.1 [197].

Table 3.1 shows that at the end of 2009 the average rate for enterprises in hryvnia on deposits (term and demand) was 11.5%.

The average period of turnover of accounts payable for agricultural enterprises ($\bar{П}_{К3}$) it is possible to calculate from the data of the official site of the State Statistics Committee of Ukraine [197]. Data on the structure of the balance sheet of enterprises by type of economic activity as of September 30, 2009 and data on the formation of net profit (loss) of enterprises by type of economic activity for January-September 2009 for agricultural, hunting and forestry enterprises are summarized in Table 3.3.

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Table 3.3. Data for calculating the turnover of accounts payable

Indicator	Amount, UAH million
Current liabilities as of 01.01.09	1527,4
Current liabilities as of October 1, 2009	1751,5
Operating costs	3858,7

Using the formula (2.3) from the data of table 3.3. it is easy to calculate the number of days of turnover of accounts payable on average in the field of agriculture, hunting and forestry:

$$\bar{П}_{К3} = \frac{\frac{1527,4+1751,5}{2}}{3858,7} 270 = 115, \qquad (3.11)$$

Formula (3.11) shows that the average industry period of accounts payable is 115 days.

We summarize the data on general economic indicators, which were obtained including from formulas (3.10), (3.11) and table 3.1, to table 3.4.

Table 3.4. General economic indicators and conditions of commodity crediting

Indicator	**Value**
1	**2**
Consumer price index, IC, annual $i_{СЦ}$, annual	12,3%
The average interest rate on loans to the real sector of the economy,, $i_К$, annual	16,6%
Commodity loan fee, *r*, per annum	14,0%
Commodity loan term, *n*, years	0,25
The coefficient of variation of the stock market index, $CV_{ФР}$	0,042
Average interest rate on attracted deposits, $i_{ББ}$, per annum	11,5%
The average industry period of turnover of accounts payable, $\overline{П}_{КЗ}$, day	115

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In addition, to calculate the limit of the borrower's trade credit, you need to determine the coefficients of variation of prices for different types of inventories ($CV_{ТЗі}$). Data on price dynamics can be found on the official website of the State Statistics Committee of Ukraine. Average sales prices of agricultural products are presented in table 3.5. [197].

Table 3.5. Average sales prices of agricultural products in 20091 (agricultural enterprises (except small ones); UAH per ton)

Period	**Cereals and legumes**	**Sunflower seeds**	**Sugar beets**	**Potatoes**	**Vegetables**		**Livestock and poultry (live weight)**	**Milk and dairy products**	**Eggs, thousand**
					Total	**including indoor vegetables**			
January	601,4	1224,6	150,0	1607,1	1180,8	11714,4	9744,5	1906,4	396,2
January-February	664,5	1467,6	150,0	1408,7	1654,4	13164,4	9830,7	1905,2	374,7
January-March	712,8	1599,3	...	1541,6	2471,4	11095,7	10123,6	1909,5	381,3

Period	Cereals and legumes	Sunflower seeds	Sugar beets	Potatoes	Vegetables		Livestock and poultry (live weight)	Milk and dairy products	Eggs, thousand
					Total	including indoor vegetables			
January-April	730,0	1718,2	...	1652,3	3486,8	10831,6	10296,5	1902,1	369,6
January-May	749,1	1775,0	...	1628,2	3867,0	9234,4	10426,7	1858,8	346,9
January-June	754,5	1801,9	...	1636,6	3720,8	7864,7	10524,0	1825,1	344,0
January-July	753,9	1807,2	...	1607,0	3496,0	7203,3	10478,4	1799,4	348,6
January-August	756,1	1808,8	...	1556,1	2725,7	6702,7	10457,4	1779,0	356,7
January-September	764,3	1784,9	292,0	1372,1	1914,8	6179,4	10462,2	1777,4	365,3
January-October	776,9	1778,7	327,1	1300,6	1777,1	6031,6	10445,0	1787,8	374,4
January-November	789,2	1823,5	383,7	1271,6	1786,7	6012,8	10394,2	1814,7	388,0
For 2009	799,0	1897,0	409,9	1298,6	1790,0	6055,0	10362,9	1888,8	403,9

[1] Excluding VAT, transport, forwarding and overhead costs, but including subsidies.

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The data given in table 3.5 are presented as average values for the period from the beginning of the year to the current month. But to calculate the coefficient of variation requires prices for each month. To find such prices, we convert the formula for calculating the arithmetic mean.

The arithmetic mean is calculated by the following formula [200]:

$$\overline{x} = \frac{\sum_{i=1}^{n} x_i}{n}, \qquad (3.12)$$

where $\overline{x}$ – average; x_i – value; n is the number of values x_i.

Each column of table 3.5 contains the average price for a certain number of months: January - the average price for 1 month; January-February - the average price for 2 months; January-March - the average price for 3 months

and so on. Therefore, formula (3.12), which calculates the arithmetic mean for n cases For a particular case at $n = 2$, the formula will look like:

$$\bar{x}_2 = \frac{x_1 + x_2}{2}, \tag{3.13}$$

From (3.13) it is easy to find x_2:

$$x_2 = 2\bar{x}_2 - x_1 \tag{3.14}$$

For n=3:

$$\bar{x}_3 = \frac{x_1 + x_2 + x_3}{3} \Rightarrow x_3 = 3\bar{x}_3 - x_2 - x_1, \tag{3.15}$$

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If we substitute (3.14) in (3.15), we obtain:

$$x_3 = 3\bar{x}_3 - (2\bar{x}_2 - x_1) - x_1 = 3\bar{x}_3 - 2\bar{x}_2, \tag{3.16}$$

If we substitute in formula (3.12) the values (3.14) and (3.15) for $n = 4$ we obtain:

$$x_4 = 4\bar{x}_4 - x_3 - x_2 - x_1 = 4\bar{x}_4 - 3\bar{x}_3 + 2\bar{x}_2 - 2\bar{x}_2 + x_1 - x_1 = 4\bar{x}_4 - 3\bar{x}_3, \tag{3.17}$$

Given (3.14) - (3.17), it is possible to obtain the definition of x_n in General form, which will be:

$$x_n = n\bar{x}_n - (n-1)\bar{x}_{n-1}, \tag{3.18}$$

Processed using the formula (3.18) data table. 3.5 is summarized in table. 3.6, and add to this table the coefficients of variation calculated by means of (2.5) for the prices of agricultural products for the last quarter of 2009 (after all according to tab. 3.5 n = 0,25 years, ie 3 months).

Table 3.6.

Coefficients of variation of prices of agricultural products

for the 4th quarter of 2009[1]

(agricultural enterprises (except small ones); UAH per ton)

Period	Cereals and legumes	Sunflower seeds	Sugar beets	Potatoes	Vegetables		Livestock and poultry (live weight)	Milk and dairy products	Eggs, thousand
					Total	including indoor vegetables			
1	2	3	4	5	6	7	8	9	10
October	890,3	1 722,9	432,4	657,1	537,8	4 701,4	10 290,2	1 881,4	456,3
November	912,2	2 271,5	610,1	981,6	1 882	5 824,8	9 886,2	2 083,7	524,0
December	906,8	2 705,5	540,9	1 595,6	1 826	6 519,2	10 018,6	2 703,9	578,8
Coefficient of variation, *CV*	0,010	0,180	0,139	0,361	0,439	0,132	0,017	0,157	0,096

[1] Excluding VAT, transport, forwarding and overhead costs, but including subsidies.

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Find the coefficients of variation for the prices of industrial products. Industrial producer price indices are given in Annex P [197], ie the values are presented as the ratio of the current month's price to its value in the previous month, which complicates the calculation of coefficients of variation, because according to formula (2.5) absolute price values are required for calculation.

From (2.5) it is known that to calculate the coefficient of variation it is necessary to know the value of the arithmetic mean (3.12) and the standard deviation, which is calculated by the following formula [201]:

$$\sigma = \sqrt{\frac{1}{n}\sum_{i=1}^{n}(\overline{x} - x_i)^2}\ , \qquad (3.19)$$

where σ – standard deviation of the value x_i; x_i – value; $\overline{x}$ – arithmetic mean of x_i; n – number of value x_i.

First, we present the price index for the nth month and for the first month, respectively, in fractions:

$$i_n = \frac{x_n}{x_{n-1}} \text{ та } i_1 = \frac{x_1}{x_0}, \qquad (3.20)$$

where i_n, i_1 – the value of the price index, respectively, the nth month and the 1st month; x_n – price value in the month n; x_0 – the value of the price in the base month.

Next, we give all the indices, which according to (3.20) are fractions, to a single denominator, which will be x_0, simply by multiplying all the indices sequentially. Then

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$$i_1 i_2 i_3 \ldots i_n = \frac{x_1}{x_0}\frac{x_2}{x_1}\ldots\frac{x_n}{x_{n-1}} = \frac{x_n}{x_0} = \prod_{i=1}^{n} i_i\ , \qquad (3.21)$$

Also, for further calculation of the arithmetic mean you need to know the sum of xi. If you add the products of the indices that have already been obtained from formula (3.21), you can get the sum of prices for n months. Let's illustrate this:

$$\frac{x_1}{x_0}+\frac{x_1}{x_0}\frac{x_2}{x_1}+\frac{x_1}{x_0}\frac{x_2}{x_1}\frac{x_3}{x_2}+\ldots+\frac{x_1}{x_0}\frac{x_2}{x_1}\ldots\frac{x_n}{x_{n-1}}=\frac{\sum_{i=1}^{n}x_i}{x_0}=$$

$$=i_1+i_1i_2+\ldots+i_1i_2\ldots i_n=\sum_{i=1}^{n}\prod_{j=1}^{i}i_j \Rightarrow \frac{\sum_{i=1}^{n}x_i}{x_0}=\sum_{i=1}^{n}\prod_{j=1}^{i}i_j, \quad (3.22)$$

Having the sum of the values of x_i, you can easily obtain the value of the arithmetic mean by dividing the right and left parts of equation (3.22) by n:

$$\frac{\sum_{i=1}^{n}x_i}{x_0 n}=\frac{\sum_{i=1}^{n}\prod_{j=1}^{i}i_j}{n} \Rightarrow \frac{\bar{x}}{x_0}=\frac{\sum_{i=1}^{n}\prod_{j=1}^{i}i_j}{n}, \quad (3.23)$$

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Next, we substitute formulas (3.12) and (3.19) in formula (2.5), in addition, we divide in the obtained formula x_i and $\bar{x}$ on x_0:

$$CV=\frac{\sqrt{\frac{1}{n}\sum_{i=1}^{n}\left(\bar{x}-x_i\right)^2}}{\bar{x}}=\frac{\sqrt{\frac{1}{n}\sum_{i=1}^{n}\left(\frac{\bar{x}}{x_0}-\frac{x_i}{x_0}\right)^2}}{\frac{\bar{x}}{x_0}}, \quad (3.24)$$

The obtained equation (3.24) proves that formulas (3.21) and (3.23) can be used to calculate the coefficient of variation of prices. And, therefore, it will be correct to take price indices, instead of the prices. To calculate the coefficients of variation based on price indices must be replaced in the formula (3.24) x_i and $\bar{x}$ values from formulas (3.21) and (3.23). Then

$$CV = \frac{\sqrt{\frac{1}{n}\sum_{k=1}^{n}\left(\frac{\sum_{i=1}^{n}\prod_{j=1}^{i} i_j}{n} - \prod_{j=1}^{k} i_j\right)^2}}{\frac{\sum_{i=1}^{n}\prod_{j=1}^{i} i_j}{n}}, \qquad (3.25)$$

Formula (3.25) allows you to calculate the coefficients of variation for industrial prices. We calculate the required coefficients of variation using formula (3.25). We reduce the calculated data to table 3.7.

Table 3.7. Coefficients of variation of industrial producer prices for the 4th quarter of 2009

Economic industry	**Coefficient of variatio, *CV***
Industry	0,006
Mining industry	0,003
Extraction of fuel and energy minerals	0,004
Extraction of minerals, except fuel and energy	0,003
Processing industry	0,004
from it:	
Manufacture of food products, beverages and tobacco	0,019
production of meat and meat products	0,009
production of dairy products and ice cream	0,064
production of bread and bakery products	0,005
sugar production	0,067
beverage production	0,002
Light industry	0,011
textile production; manufacture of wearing apparel, fur and fur products	0,006
manufacture of leather, leather products and other materials	0,024

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Economic industry	Coefficient of variatio, *CV*
Wood processing and manufacture of wood products, except furniture	0,008
Pulp and paper production; publishing activity	0,009
Production of coke, refined petroleum products	0,023
coke production	0,012
production of refined products	0,029
Chemical and petrochemical industry	0,014
chemical production	0,018
production of rubber and plastic products	0,003
Manufacture of other non-metallic mineral products	0,003
Metallurgical production and production of finished metal products	0,001
Engineering	0,003
manufacture of machinery and equipment	0,003
production of electrical, electronic and optical equipment	0,005
production of vehicles and equipment	0,003
Production and distribution of electricity, gas and water	0,015

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We find the coefficients of variation for prices for light petroleum products using data on sales of light petroleum products on the official website of the State Statistics Committee of Ukraine [197], which are presented in table 3.8.

Table 3.8. Retail sale of light petroleum products through gas stations for the 4th quarter of 2010.

	October 2009	November 2009	December 2009
In kind, thousand tons	476,4	429,9	442,8
In cash, UAH million.	4 223,0	3 871,9	3 694,1

From table 3.8 we find the average selling price of light petroleum products, dividing the value of sales in cash by the value of sales in kind. Let's calculate the coefficient of variation (2.5) according to the calculated data. The data are summarized in table 3.9.

Table 3.9. Coefficient of variation of prices of light oil products for the 4th quarter of 2009

	October 2009	**November 2009**	**December 2009**	**Coefficient of variation, *CV***
Average price of light oil products, UAH / t.	8 864,4	9 006,5	8 342,6	0,033

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Having calculated the general economic indicators, terms of commodity lending (Table 3.4) and coefficients of variation of different types of inventories (Table 3.6, Table 3.7 and Table 3.9), we proceed to the calculation of indicators for specific enterprises. The calculation of the total limit of commodity credit was carried out on the example of three enterprises of Dnipropetrovsk region:

1. LLC "Gospodar" (Dnipropetrovsk region, Magdalinivka district, Magdalinivka township).

2. SFG "Merry Valley" (Dnipropetrovsk region, Tomakiv district, Semenivka village)

3. Lan LLC (Dnipropetrovsk region, Tomakivskyi district, Kirove village).

LLC " Gospodar "

To calculate the borrower's limit (LP) and the creditor's limit (LK), the values of financial indicators from the financial statements of the enterprise are required. The required financial indicators are summarized in table 3.10

Table 3.10. Financial indicators of LLC "Master"

Item	Value
Average daily cost, thousand UAH	17,2
Average accounts payable, thousand UAH	1 351,4
Inventories, vehicles, thousand UAH	4 352,8
Accounts receivable, thousand UAH	452,8
Overdue receivables, thousand UAH	0,0
Accounts receivable with a maturity of less than the term of the loan,	436,8
thousand UAH	0,0%
Interest rate on receivables on an annualized basis	0,0
Financial investments, PV, thousand UAH	3,6
Cash, Civil Code, thousand UAH	2,3
Tax payments, PE, thousand UAH	5 269,2

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To calculate the adjustment factor K_1 it is necessary to calculate the period of turnover of accounts payable of the enterprise, which can be found by formula (2.3), substituting the necessary data from table 3.10:

$$П_{К3} = \frac{1351,4}{17,2} = 79, \quad (3.26)$$

Calculate K_1 using the formula (2.4) based on data from the calculation (3.26) and table. 3.4:

$$K_1 = 115 - 79 = 36, \quad (3.27)$$

To calculate the average daily accrued cost, use the formula (2.24), in which we substitute the data from table 3.4 and table. 3.10:

$$C' = 17{,}2 \cdot (1 + 12{,}3\%)^{0{,}25} = 17{,}7 \quad , \tag{3.28}$$

To calculate the projected EBITDA for the period of the loan, we will make calculations in accordance with the optimization approach described in paragraph 2.4, based on data on the actual value of this indicator, which are given in table 3.11.

Table 3.11. EBITDA of LLC "Gospodar" by quarters, thousand UAH.

Period	Sum
4 qu 2007	1 098,5
1 qu 2008	482,4
2 qu 2008	887,4
3 qu 2008	935,8
4 qu 2008	-32,5
1 qu 2009	513,3
2 qu 2009	-173,9
3 qu 2009	958,6
4 qu 2009	-1 230,1

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As can be seen from Table 3.11, the actual EBITDA values contain negative values, which makes it impossible to use the optimization model: the functional by formula (2.27) can give a total of 0, but consist of positive and negative values. In addition, the functionality can be negative, which makes it impossible to approximate the model according to Pearson's criterion.

Thus, to continue the calculation, the actual data must be normalized and add 4 according to the following formula:

$$x_н = \frac{x_ф - \bar{x}}{s} + 4, \tag{3.29}$$

where $x_н$ – normalized value; $x_ф$ – actual value; $\overline{x}$ – arithmetic mean $x_ф$ by formula (3.12); s – standard deviation value $x_ф$ 3 and the formula (3.30).

The standard deviation of the value is calculated by the following formula [202]:

$$s = \sqrt{\frac{n}{n-1}\sigma^2}, \tag{3.30}$$

where s – standard deviation of the value; n– the number of values; σ – standard deviation of the value x_i by the formula (3.19). For this purpose, the arithmetic mean and standard deviation for the periods from 1 quartal 2008 were obtained on 4 sq. 2009. 292.6 and 750.0, respectively. This data set contains the actual values of the function. As well as the arithmetic mean and standard deviation for the periods from Sq4 2007 on 3 sq. 2009. 583.7 and 476.7, respectively. This data set contains an argument for the calculated values of the function. After normalization of the data from table 3.11 using the formula (3.29) was obtained value for the calculation of the projected EBITDA, which will depend on its previous values. The data were summarized in table 3.12.

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Table 3.12. Normalized values

Period	**Function**	**Argument**
1qu 2008	4,2530	5,0799

Period	Function	Argument
2 qu 2008	4,7930	3,7875
3 qu 2008	4,8575	4,6371
4 qu 2008	3,5665	4,7386
1 qu 2009	4,2942	2,7073
2 qu 2009	3,3780	3,8523
3 qu 2009	4,8879	2,4107
4 qu 2009	1,9698	4,7865

Thus, based on the data from table. 3.12 it is possible to carry out calculations according to the optimization approach which is described in item 2.4:

1. Arbitrary values of constants were set *A- H*.
2. y_p was calculated by the formula (2.30).
3. Calculated $(y_p - y_\phi)^2$, where y_ϕ – the actual value of the function according to table 3.12.
4. The optimal problem with the functional of the form (2.27) was solved, where n is the size of the statistical sample (in our case $n = 8$), and the parameters are the required constants *A- H*.

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The calculation using the "Solution Search" function of Excel spreadsheets showed a high confidence probability of the approximation quality according to Pearson's criterion (for this purpose the CHIINV function was used), which is equal to 0,981.

If we compare the graph of the actual normalized values with the graph of the calculated values (see Fig. 3.1), we can see significant similarities.

After finding the required constants A- H, the formula for calculating the normalized value of the forecast EBITDA (2.30) for the 1st quarter of 2010 will take the following form:

$$y = 4{,}8249\left(\frac{x-583{,}7}{476{,}7}+4\right)^{-0{,}1125} + 1{,}66\cdot 10^{-6}\left(1-e^{3{,}0421\left(\frac{x-583{,}7}{476{,}7}+4\right)}\right)\times$$

$$\times Sin(0{,}3403\left(\frac{x-583{,}7}{476{,}7}+4\right)^{1{,}5059} + 11{,}7432) + 0{,}2665 \qquad (3.31)$$

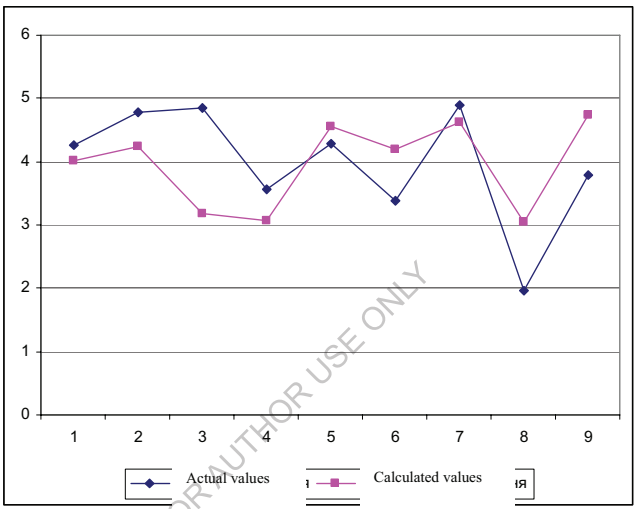

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Fig. 3.1. Comparison of actual values with calculated ones

By formula (3.31) when the value of the argument is 1.9698, the calculated value of the function y will be 4.7269. In order to bring the normalized value of y to the original form, the inverse transformation of formula (3.29) is required:

$$x_ф = (x_н - 4)s + \bar{x}, \qquad (3.32)$$

where $x_н$ – normalized value; $x_ф$ – actual value; $\overline{x}$ – arithmetic mean $x_ф$ according to the formula (3.12); s is the standard deviation of the value $x_ф$ according to the formula (3.30).

Therefore, according to the formula (3.32) it is easy to calculate the projected EBITDA for the next quarter:

$$EB' = (4{,}7269 - 4)750 + 292{,}6 = 837{,}8 \quad (3.33)$$

To calculate the discounted value of inventories ($ТЗ_Д$) according to formula (3.5) it is also necessary to calculate the adjustment factor of each type of inventory (K_{2i}) and discount rates for each type of inventory ($НД_i$).

The adjustment factor of each type of inventory (K_{2i}) will be calculated by formula (3.6) from the data given in table 3.6, table 3.7 and table 3.9. Among the types of inventories that are included in the set *S* according to (3.7) are only cereals, legumes and oilseeds. Hence, the discount rate will be calculated for cereals, legumes and oilseeds, except wheat and corn ($НД_{З\_1}$) according to formula (2.41) and discount rates for wheat and corn ($НД_{З\_2}$) by the formula (2.42). For other types of inventories $НД_i$=1 according (3.7).

To determine $НД_{З\_1}$ and $НД_{З\_2}$ it is necessary to know the conditions of storage of agricultural products. These conditions are given in table. 3.13.

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Table 3.13. Conditions of storage of agricultural products of LLC Gospodar

Corn	**The time that has elapsed since the harvest, $n_{МЗ}$, month.**	**Storage temperature, t , C**	**Humidity, θ, %**
Corn	4	5	15
Oat	4	5	14
Wheat	3,5	5	14
Sunflower	4	5	9
Barley	3,5	5	13

In addition, to calculate $НД_{З\_2}$ it is necessary to know the grain prices of the highest and lowest classes at the time of calculation. This information can be found on the LIGA news website (see Table 3.14) [203].

Table 3.14. Prices for grain of the highest and lowest classes, UAH / ton

Class	**Wheat**	**Corn**
2-th	1 180	1 320
6-th	1 040	1 190

Based on the data from Table 3.13 and Table 3.14, we calculate the discount rates for inventories using formulas (2.41) and (2.42). The obtained data are summarized in table 3.15.

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Table 3.15. Discount rates ($НД_i$)

Corn	**Formula (2.37)**	**Formula (2.35)**	**Formula (2.38)**	$НД_i$
Corn	-0,6938	0,9983	0,8819	-0,6107
Oat	-1,3472	0,9987	-	-1,3454
Wheat	0,0264	0,9991	0,8920	0,0235
Sunflower	-1,1139	0,9975	-	-1,1111
Barley	0,0264	0,9991	-	0,0264

To calculate the discounted value of inventories ($ТЗ_Д$) it is necessary to take the amounts of inventories, as well as discount rates from table 3.15, the calculation of adjustment factors K_{2i} by formula (3.6) and the discounted value of inventories according to formula (3.5). We summarize the data in table 3.16.

Table 3.16. Calculation of the discounted value of inventories ($ТЗ_Д$)

LLC Gospodar

Inventories	***ТЗ_i*, UAH**	***CV_ТЗi***	***К_2i***	***НД_i***	***ТЗ_Дi*, UAH**
Fuel and lubricants	4 301,00	0,033	0,967	1,000	4 160,50
Seed material	106 023,00	0,010	0,990	0,024	2 468,56
Mineral fertilizers and herbicides	1 030 077,00	0,003	0,997	1,000	1 027 117,26
Concentrates	13 959,00	0,003	0,997	1,000	13 918,89
Barley	230 513,00	0,010	0,990	0,026	6 016,78
Wheat	346 608,00	0,010	0,990	0,024	8 070,16
Corn	113 354,00	0,010	0,990	0,000	0,00
Sunflower	304 545,00	0,180	0,820	0,000	0,00
Oat	217 800,00	0,010	0,990	0,000	0,00
Sugar	35 125,00	0,067	0,933	1,000	32 781,88
Total	**2 402 305,00**				**1 094 534,02**

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To calculate the accrued discounted value of inventories, use the formula (3.4), in which we substitute the data from table 3.4 and table 3.16:

$$ТЗ_Д^{'} = 1094{,}5(1 + 12{,}3\%)^{0{,}25} = 1126{,}7 \quad (3.34)$$

To calculate the accrued receivables with a maturity of less than the term of the commodity loan use the formula (3.8), in which we substitute the data from table 3.10:

$$ДЗ_М^{'} = 436{,}8(1 + 0{,}0\%)^{0{,}25} = 436{,}8 \quad (3.35)$$

To calculate the correction factor K_3, use the formula (3.9), in which we substitute the data from table. 3.10:

$$K_3 = 1 - \frac{0{,}0}{452{,}8} = 1 \quad (3.36)$$

To calculate the correction factor K_4 use formula (2.11), in which we substitute the data from table. 3.4:

$$K_4 = 1 - 0{,}042 = 0{,}958 \tag{3.37}$$

To calculate the increased amount of cash use the formula (2.31), in which we substitute the data from table 3.4 and table. 3.10:

$$ГК' = 3{,}6(1 + 11{,}5\%)^{0{,}25} = 3{,}7 \tag{3.38}$$

To calculate the debt service payments on already received loans for the period of the planned commodity loan, information on bank loans already received by the borrower is required. This information is given in table 3.17.

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Table 3.17. Loans obtained by Gospodar LLC

Name of the Lending Bank	Currency	Debt, UAH eq.	Rate,%	Date of issue	Date of repayment
OJSC Raiffeisen Bank Aval	UAH	452 280,00	16,0	14.03.08	13.03.11
CJSC "FUIB"	UAH	326 394,50	22,6	15.08.08	27.12.10
CJSC "FUIB"	USD	318 425,50	14,0	25.06.08	24.12.10
PJSC "AB" RADABANK "	UAH	1 500 000,00	25,0	16.12.09	16.12.11

From the table. 3.17 you can find out that in the 1st quarter of 2010 (the period for which the commodity loan is planned) there is no repayment of any loan. The borrower must pay interest on a monthly basis, so to calculate the required amount you need to multiply column 3 and column 4, add up, and then multiply by the term of the trade credit (n). So

$$ПК = n\sum Col3 \times Col4 = 141{,}4 \quad (3.39)$$

Having calculated all the indicators for calculating the borrower's limit, we substitute in formula (3.3) the values that were obtained from the calculations (3.27), (3.28), (3.33) - (3.39) and from table. 3.10:

$$Л_П = 17{,}7 \cdot 36 + 837{,}8 + 1126{,}7 + 436{,}8 \cdot 1 + 0{,}0 \cdot 0{,}958 + \\ +3{,}7 - 2{,}3 - 141{,}4 = 2898{,}5 \quad (3.40)$$

Where is it easy to get the discounted amount of the borrower's credit limit according to the formula (2.34):

$$Л_П^{'} = \frac{2898{,}5}{(1+14{,}0\%)^{0{,}25}} = 2805{,}1 \quad (3.41)$$

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To calculate the limit of the creditor (LC) LLC "Master" was a measurement of the utility function for the director of the enterprise (ESD) using the economic game, the conditions of which are given in table 3.18.

Table 3.18. Conditions of economic game

Indicator	Value
The amount of loss in the game, S_1, UAH.	100 000
The amount of winnings in the game, S_2, UAH	10 000
Guaranteed amount for withdrawal from the game, m, UAH	40 000
Usefulness of loss, $U(S_1)$	1
The usefulness of the win, $U(S_2)$	10

After the game it turned out that the indifference point of ESD was reached with a probability of winning the amount S_2 – p_0 = 0,686.

Value $p_Б$ was found using the formula (2.20), in which the data of table 3.18 were substituted:

$$p_Б = \frac{40000-10000}{100000-10000} = 0{,}333 \quad (3.42)$$

Therefore, the calculation of the correction factor K can be performed by formula (2.21), in which the value of the calculation (3.42) and the obtained value p_0.

$$K = 0{,}686 \ (0{,}686 > 0{,}333) \quad (3.43)$$

The creditor's limit can be calculated using the formula (1.5), in which we substitute the calculation (3.43) and the data of table 3.10:

$$Л_K = 0{,}686 \cdot 5269{,}2 = 3614{,}7 \quad (3.44)$$

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SFG "Vesela Dolina"

To calculate the borrower's limit and the creditor's limit, the required values of financial indicators are summarized in table. 3.19.

Table 3.19. Financial indicators of SFG "Vesela Dolina"

Indicator	Value
Average daily cost, thousand UAH	1 098,9
Average accounts payable, thousand UAH	1 390,4
Inventories, vehicles, thousand UAH	118,9
Accounts receivable, thousand UAH	0,0
Overdue receivables, thousand UAH	50,0
Accounts receivable with a maturity of less than the term of the loan,	0,0
thousand UAH	0,0

Indicator	Value
Interest rate on receivables on an annualized basis	1,9
Financial investments, PV, thousand UAH	0,0
Cash, Civil Code, thousand UAH	4 425,9

To calculate the adjustment factor K_1 it is necessary to calculate the period of turnover of accounts payable of the enterprise, which can be found by formula (2.3), substituting the necessary data from table 3.19:

$$П_{К3} = \frac{1098,9}{14,6} = 75, \quad (3.45)$$

Calculate K_1 using the formula (2.4) based on data from the calculation (3.26) and table. 3.4:

$$K_1 = 115 - 75 = 40, \quad (3.46)$$

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To calculate the average daily accrued cost, use the formula (2.24), in which we substitute the data from table 3.4 and table. 3.19:

$$C' = 14,6 \cdot (1 + 12,3\%)^{0,25} = 15,1 \quad , \quad (3.47)$$

To calculate the projected EBITDA for the period of the loan, we will make calculations in accordance with the optimization approach described in paragraph 2.4, based on data on the actual value of this indicator, which are given in table 3.20.

Table 3.20. EBITDA of SFG "Vesela Dolina" by quarters, thousand UAH

Period	Sum
4 qu 2007	16,5
1 qu 2008	307,8
2 qu 2008	895,0
3 qu 2008	647,6
4 qu 2008	69,5
1 qu 2009	114,0
2 qu 2009	1 206,5
3 qu 2009	-1 325,1
4 qu 2009	

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As can be seen from Table 3.11, the actual EBITDA values contain negative values, which makes it impossible to use the optimization model: the functional by formula (2.27) can give a total of 0, but consist of positive and negative values. In addition, the functionality can be negative, which makes it impossible to approximate the model according to Pearson's criterion.

Thus, to continue the calculation, the actual data must be normalized and add 4 according to the formula (3.29).

For this purpose, the arithmetic mean and standard deviation for the periods from the 2nd quarter of 2008 to the 4th quarter of 2009 were obtained 273.6 and 818.6, respectively. This data set contains the actual values of the function. As well as the arithmetic mean and standard deviation for the periods from the 1st quarter of 2008 to the 3rd quarter of 2009 465.3 and 460.7, respectively. This data set contains an argument for the calculated values of the function. After normalization of the data from table 3.19 using the formula (3.29) was obtained value for the calculation of the projected

EBITDA, which will depend on its previous values. The data were summarized in table 3.21.

Table 3.21. Normalized values

Period	Function	Argument
1 qu 2008	4,0418	3,0259
2 qu 2008	4,7591	3,6582
3 qu 2008	4,4569	4,9327
4 qu 2008	3,7506	4,3958
1 qu 2009	3,8050	3,1410
2 qu 2009	5,1396	3,2376
3 qu 2009	2,0470	5,6089

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Thus, based on the data from table. 3.21 it is possible to carry out calculations according to the optimization approach which is described in item 2.4:

1. Arbitrary values of constants were set *A- H*.
2. y_p was calculated by the formula (2.27).
3. Calculated $(y_p - y_\phi)^2$, where y_ϕ – the actual value of the function according to table. 3.12.
4. The optimal problem with the functional of the form (2.27) was solved, where n is the size of the statistical sample (in our case $n = 7$), and the parameters are the required constants *A- H*.

The calculation using the "Solution Search" function of Excel spreadsheets showed a high confidence probability of the approximation quality according to Pearson's criterion (for this purpose the CHIINV function was used), which is equal to 0,999.

If we compare the graph of the actual normalized values with the graph of the calculated values (see Fig. 3.2), we can see significant similarities.

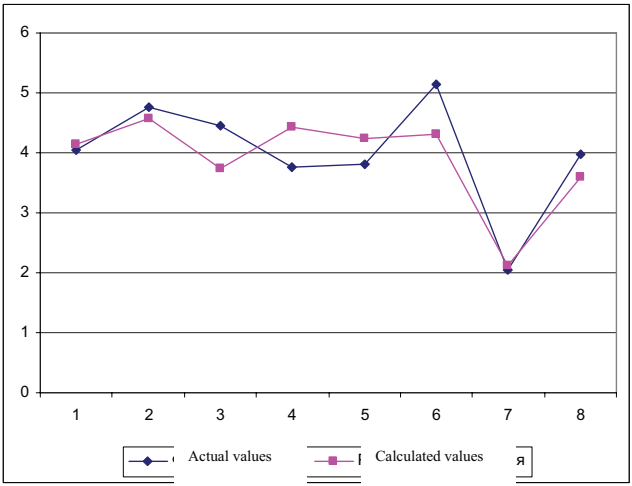

Fig. 3.2. Comparison of actual values with calculated ones

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After finding the required constants A- H, the formula for calculating the normalized value of the forecast EBITDA (2.30) for the 1st quarter of 2010 will take the following form:

$$y = -4{,}8067\left(\frac{x-465{,}3}{460{,}7}+4\right)^{1{,}0122} + 13{,}7386\left(1-e^{-0{,}6537\left(\frac{x-465{,}3}{460{,}7}+4\right)}\right)\times$$

$$\times\, Sin(1{,}6536\left(\frac{x-465{,}3}{460{,}7}+4\right)^{0{,}5030} + 3{,}5378) + 17{,}2265$$

(3.48)

By formula (3.48) when the value of the argument is 2.0470, the calculated value of the function y will be 3.5949. Using formula (3.32) it is easy to calculate the forecast EBITDA for the next quarter:

$$EB' = (3{,}5949 - 4)818{,}6 + 273{,}6 = -58{,}0. \qquad (3.49)$$

Adjustment factor of each type of inventory (K_{2i}) will be calculated by formula (3.6) from the data given in table 3.6, table. 3.7 and table. 3.9. Among the types of inventories that are included in the set S according to (3.7) are only cereals, legumes and oilseeds. Hence, the discount rate will be calculated for cereals, legumes and oilseeds, except wheat and corn ($НД_{З\_1}$) by formula (2.41) and discount rates for wheat ($НД_{З\_2}$) by the formula (2.42). For other types of inventories $НД_i$=1 according (3.7).

For calculate $НД_{З\_1}$ and $НД_{З\_2}$ it is necessary to know the conditions of storage of agricultural products. These conditions are given in table 3.22.

Table 3.22. Storage conditions for agricultural products

SFG "Vesela Dolina"

Corn	**The time that has elapsed since the harvest, $n_{МЗ}$, month.**	**Storage temperature, t , C**	**Humidity, θ, %**
Pea	4	5	13
Buckwheat	4	5	14
Wheat	3,5	5	14
Sunflower	4	5	9
Barley	3,5	5	13

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In addition, to calculate $НД_{З\_2}$ it is necessary to know the grain prices of the highest and lowest classes at the time of calculation. This information is given in table. 3.14.

Based on the data from Table 3.14 and Table 3.22, we calculate the discount rates for inventories using formulas (2.41) and (2.42). The obtained data are summarized in table 3.23.

Table 3.23. Discount rates ($НД_i$)

Corn	Formula (2.37)	Formula (2.35)	Formula (2.38)	$НД_i$
Pea	-0,5089	0,9991	-	-0,5085
Buckwheat	-0,5089	0,9988	-	-0,5083
Wheat	0,0264	0,9991	0,8920	0,0235
Sunflower	-1,1139	0,9975	-	-1,1111
Barley	0,0264	0,9991	-	0,0264

To calculate the discounted value of inventories it is necessary to take the amounts of inventories, as well as discount rates from table. 3.23, calculation of correction factors K_{2i} according to formula (3.6) and discounted value of inventories according to formula (3.5).

We summarize the data in table 3.24.

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Table 3.24. Calculation of the discounted value of inventories SFG "Vesela Dolina"

Inventories	$ТЗ_i$, UAH	$CV_{Т3i}$	K_{2i}	$НД_i$	$ТЗ_{Дi}$, UAH
Fuel and lubricants	84,5	0,033	0,967	1,000	81,7
Plants protecting tools	2,5	0,003	0,997	1,000	2,5
Mineral fertilizers	878,3	0,003	0,997	1,000	875,8
Spare parts	9,2	0,003	0,997	1,000	9,2
Winter wheat	42,8	0,010	0,990	0,024	1,0
Winter barley	249,1	0,010	0,990	0,026	6,5
Waste	7,6	0,010	0,990	0,000	0,0
Pea	72,7	0,010	0,990	0,000	0,0
Buckwheat	43,7	0,010	0,990	0,000	0,0
Total	**1390,4**				**976,7**

To calculate the accrued discounted value of inventories use formula (3.4), in which we substitute the data from table 3.4 and table.34:

$$ТЗ_{Д}^{'} = 976,7(1 + 12,3\%)^{0,25} = 1005,4 \quad (3.50)$$

To calculate the accrued receivables with a maturity of less than the term of the trade credit use the formula (3.8), in which we substitute the data from table 3.19:

$$ДЗ_{М}^{'} = 50,0(1 + 0,0\%)^{0,25} = 50,0 \quad (3.51)$$

To calculate the correction factor K_3 use the formula (3.9), in which we substitute the data from table 3.19:

$$K_3 = 1 - \frac{0,0}{118,9} = 1 \quad (3.52)$$

The correction factor K_4 is determined by calculation (3.37). To calculate the increased amount of cash use the formula (2.31), in which we substitute the data from table 3.4 and table 3.19:

$$ГК^{'} = 1,9(1 + 11,5\%)^{0,25} = 2,0 \quad (3.53)$$

To calculate the debt service payments on already received loans for the period of the planned commodity loan (PC), information on bank loans already received by the borrower is required. This information is given in table 3.25.

Table 3.25. Loans received by SFG "Vesela Dolina"

Name of the Lending Bank	Currency	Debt, UAH eq.	Rate,%	Date of issue	Date of repayment
PrivatBank	UAH	154 000,00	18	13.07.07	13.07.12

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From the data of table 3.25 it is possible to learn that in the 1st quarter of 2010 (the period for which the commodity credit is planned) there is no repayment of any credit (column "Repayment date"). The borrower must pay interest on a monthly basis, so to calculate the required amount you need to multiply the column "% rate" and the column "Debt, UAH..equ.", And then multiply by the term of the trade credit (n). So

$$ПК = 0{,}25 \cdot 154 \cdot 18\% = 6{,}9 \quad (3.54)$$

Having calculated all the indicators for calculating the borrower's limit, we substitute in formula (3.3) the values that were obtained from the calculations (3.37), (3.46), (3.47), (3.49) - (3.54) and from table 3.19:

$$Л_П = 15{,}1 \cdot 40 - 58{,}0 + 1005{,}4 + 50{,}0 \cdot 1 + 0{,}0 \cdot 0{,}958 + 2{,}0 - 0{,}0 - 6{,}9 = 1596{,}5 \quad (3.55)$$

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Where is it easy to get the discounted amount of the borrower's credit limit according to the formula (2.34):

$$Л'_П = \frac{1596{,}5}{(1+14{,}0\%)^{0{,}25}} = 1545{,}0 \quad (3.56)$$

To calculate the creditor limit (LC) of SFG "Vesela Dolyna", the utility function for the head of the enterprise (ESD) was measured using an economic game, the conditions of which are given in Table 3.18. After the game it turned out that the indifference point of ESD was reached with a probability of winning the amount $S_2 – p_0 = 0{,}734$.

Value $p_Б$ was calculated (3.42).

Therefore, the calculation of the correction factor K can be performed by formula (2.21), in which the value of the calculation (3.42) and the obtained value p_0.

$$K = 0{,}734\ (0{,}734 > 0{,}333) \tag{3.57}$$

The limit of the creditor can be calculated using the formula (1.5), in which we substitute the calculation (3.57) and the data of table 3.19:

$$Л_K = 0{,}734 \cdot 4425{,}9 = 3248{,}6 \tag{3.58}$$

LLC "Lan"

To calculate the borrower's limit (LP) and the creditor's limit (LK), the values of financial indicators from the financial statements of the enterprise are required. The required financial indicators are summarized in table. 3.26.

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Table 3.26. Financial indicators of Lan LLC

Indicator	Value
Average daily cost, thousand UAH	868,0
Average accounts payable, thousand UAH	293,0
Inventories, vehicles, thousand UAH	55,0
Accounts receivable, thousand UAH	0,0
Overdue receivables, thousand UAH	38,0
Accounts receivable with a maturity of less than the term of the loan,	0,0
thousand UAH	0,0
Interest rate on receivables on an annualized basis	3,0
Financial investments, PV, thousand UAH	6,0
Cash, Civil Code, thousand UAH	2 608,0

To calculate the adjustment factor K_1 it is necessary to calculate the period of turnover of accounts payable of the enterprise, which can be found by formula (2.3), substituting the necessary data from table 3.26:

$$П_{К3} = \frac{868,0}{22,1} = 39, \quad (3.59)$$

Calculate K_1 using the formula (2.4) based on data from the calculation (3.26) and table. 3.4:

$$K_1 = 115 - 39 = 76, \quad (3.60)$$

Calculate K_1 using the formula (2.4) based on data from the calculation (3.26) and table. 3.4:

$$K_1 = 115 - 75 = 40, \quad (3.46)$$

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To calculate the average daily accrued cost, use the formula (2.24), in which we substitute the data from table 3.4 and table. 3.26:

$$C' = 22,1 \cdot (1 + 12,3\%)^{0,25} = 22,8 \ , \quad (3.61)$$

To calculate the projected EBITDA for the period of the loan, we will make calculations in accordance with the optimization approach described in paragraph 2.4, based on data on the actual value of this indicator, which are given in table 3.27.

Table 3.27. EBITDA of Lan LLC by quarters, UAH thousand

Period	Sum
4 qu 2007	-628,0
1 qu 2008	-35,0

Period	Sum
2 qu 2008	-13,0
3 qu 2008	1 393,0
4 qu 2008	-942,0
1 qu 2009	321,0
2 qu 2009	92,0
3 qu 2009	845,0
4 qu 2009	-1 531,0

As can be seen from Table 3.11, the actual EBITDA values contain negative values, which makes it impossible to use the optimization model: the functional by formula (2.27) can give a total of 0, but consist of positive and negative values. In addition, the functionality can be negative, which makes it impossible to approximate the model according to Pearson's criterion.

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Thus, to continue the calculation, the actual data must be normalized: each value will be divided by 100 and added 20. To do this, we will select 2 data sets: for the periods from 1 quarter of 2008 to 4 quarter of 2009, which will contain the actual values of the function and for the periods from the 4th quarter of 2007 to the 3rd quarter of 2009, which will contain an argument for the calculated values of the function. After normalization of the data from table 3.27, a value was obtained for the calculation of the projected EBITDA, which will depend on its previous values. The data were summarized in table 3.28.

Table 3.28. Normalized values

Period	Function	Argument
1 qu 2008	19,6500	13,7200
2 qu 2008	19,8700	19,6500
3 qu 2008	33,9300	19,8700

Period	Function	Argument
4 qu 2008	10,5800	33,9300
1 qu 2009	23,2100	10,5800
2 qu 2009	20,9200	23,2100
3 qu 2009	28,4500	20,9200
4 qu 2009	4,6900	28,4500

Thus, based on the data from table. 3.28 it is possible to carry out calculations according to the optimization approach which is described in item 2.4:

1. Arbitrary values of constants were set *A- H*.
2. y_p was calculated by the formula (2.30).
3. Calculated $(y_p - y_\phi)^2$, where y_ϕ – the actual value of the function according to table.3.28.
4. The optimal problem with the functional of the form (2.27) was solved, where n is the size of the statistical sample (in our case $n = 8$), and the parameters are the required constants *A- H*.

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The calculation using the "Solution Search" function of Excel spreadsheets showed a high confidence probability of the approximation quality according to Pearson's criterion (for this purpose the CHIINV function was used), which is equal to 0,999.

If we compare the graph of the actual normalized values with the graph of the calculated values (see Fig. 3.3), we can see significant similarities.

After finding the required constants A- H, the formula for calculating the normalized value of the forecast EBITDA (2.30) for the 1st quarter of 2010 will take the following form:

$$y = -1{,}0426(x/100 + 20)^{0{,}9579} + 8{,}0716\left(1 - e^{-0{,}1092(x/100+20)}\right) \times \\ \times Sin(0{,}1627(x/100 + 20)^{1{,}2153} - 5{,}0783) + 37{,}8352 \qquad .(3.62)$$

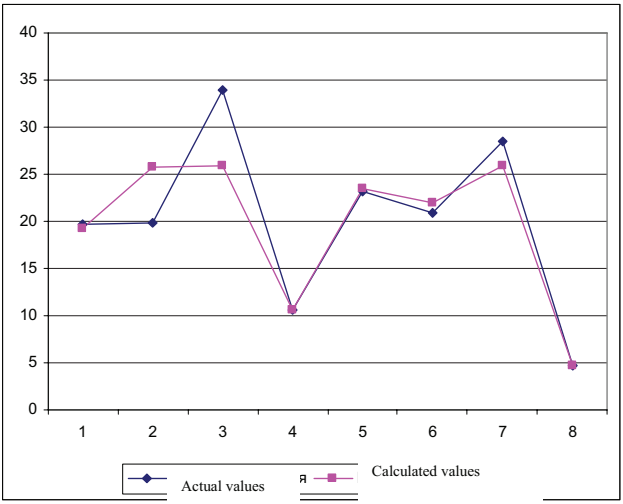

Fig. 3.3. Comparison of actual values with calculated ones

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According to the formula (3.62) with the value of the argument 4.6900, the calculated value of the function y will be 35.7316. Carry out the reverse actions on the obtained value: subtract 20 and multiply by 100

$$EB' = (35{,}7316 - 20)100 = 1573{,}2 \qquad (3.63)$$

To calculate the discounted value of inventories ($ТЗ_Д$) according to formula (3.5) it is also necessary to calculate the adjustment factor of each type of inventory (K_{2i}) and discount rates for each type of inventory ($НД_i$).

Adjustment factor of each type of inventory (K_{2i}) will be calculated by formula (3.6) from the data given in table. 3.6, table. 3.7 and table. 3.9.

Among the types of inventories that are included in the set S according to (3.7) are only cereals, legumes and oilseeds. Hence, the discount rate will be calculated for cereals, legumes and oilseeds, except wheat and corn ($НД_{З\_1}$) according to formula (2.41) and discount rates for wheat and corn

($НД_{3\_2}$) by the formula (2.42). For other types of inventories $НД_i$=1 according (3.7).

For calculate $НД_{3\_1}$ and $НД_{3\_2}$ it is necessary to know the conditions of storage of agricultural products. These conditions are given in table 3.29.

Table 3.29. Conditions of storage of agricultural products of LLC Lan

Corn	The time that has elapsed since the harvest, n_{M3}, month.	Storage temperature, t , C	Humidity, θ, %
Corn	4	5	15
Wheat	3,5	5	14
Sunflower	4	5	9
Sorghum	4	5	15
Barley	3,5	5	13

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Also, for calculation $НД_{3\_2}$ it is necessary to know the prices for grain of the highest and lowest classes at the time of calculation. This information is given in table 3.14.

Based on the data from Table 3.14 and Table 3.29, we calculate the discount rates for inventories using formulas (2.41) and (2.42). The obtained data are summarized in table 3.30.

Table 3.30. Discount rates ($НД_i$)

Corn	Formula (2.37)	Formula (2.35)	Formula (2.38)	$НД_i$
Corn	-0,6938	0,9983	0,8819	-0,6107
Wheat	0,0264	0,9991	0,8920	0,0235
Sunflower	-1,1139	0,9975	-	-1,1111
Sorghum	-2,0179	0,9985	-	-2,0148
Barley	0,0264	0,9991	-	0,0264

To calculate the discounted value of inventories it is necessary to take the amounts of inventories, as well as discount rates from table 3.30, the calculation of adjustment factors by formula (3.6) and the discounted value of inventories according to formula (3.5). We summarize the data in table 3.31.

Table 3.31.

Calculation of the discounted value of inventories (TZD) LLC "Lan"

Inventories	***ТЗ*$_i$, UAH**	***CV*$_{ТЗi}$**	***К*$_{2i}$**	***НД*$_i$**	***ТЗ*$_{Дi}$, UAH**
Organic fertilizers (manure)	127 200,00	0,003	0,997	1,000	126 834,51
Electric lamps	709,33	0,005	0,995	1,000	706,12
Ammunition	41,25	0,005	0,995	1,000	41,06
Other	553,95	0,005	0,995	1,000	551,44
Gasoline A-80	2 494,90	0,033	0,967	1,000	2 413,40
Gasoline A-92	402,76	0,033	0,967	1,000	389,60
Gasoline A-95	50,00	0,033	0,967	1,000	48,37
Diesel fuel	6 350,36	0,033	0,967	1,000	6 142,91
Containers (banks)	158,29	0,001	0,999	1,000	158,09
Twigs, corners	874,09	0,001	0,999	1,000	873,00
Quicklime	2 050,00	0,003	0,997	1,000	2 044,11
Mesh netting	2 898,51	0,001	0,999	1,000	2 894,90
Other	4 852,79	0,001	0,999	1,000	4 846,74
Spare parts	27 987,69	0,003	0,997	1,000	27 907,60
Sliding wardrobe	2 833,33	0,011	0,989	1,000	2 801,70
Chair	1 435,30	0,011	0,989	1,000	1 419,28
Xerox	1 287,86	0,005	0,995	1,000	1 282,03
Phone-fax	966,13	0,005	0,995	1,000	961,75
Mobile phones	1 711,42	0,005	0,995	1,000	1 703,67
Fire extinguishers	3 022,25	0,011	0,989	1,000	2 988,51
Bedspreads	2 369,90	0,006	0,994	1,000	2 355,17
Thermos	3 044,50	0,011	0,989	1,000	3 010,52
Other	43 937,49	0,011	0,989	1,000	43 447,03
Fodder wheat	1 718,84	0,010	0,990	0,024	40,02

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Inventories	$ТЗ_i$, UAH	$CV_{ТЗi}$	$К_{2i}$	$НД_i$	$ТЗ_{Дi}$, UAH
Barley	12 775,84	0,010	0,990	0,026	333,47
Corn	24 083,89	0,010	0,990	0,000	0,00
Grain waste	1 519,40	0,010	0,990	0,000	0,00
Sudan	13 474,63	0,010	0,990	0,000	0,00
Sunflower	1 996,97	0,180	0,820	0,000	0,00
Food	717,97	0,010	0,990	0,000	0,00
Total	**293 519,64**				**236 195,02**

To calculate the accrued discounted value of inventories use the formula (3.4), in which we substitute the data from table 3.4 and table. 3.31:

$$ТЗ_Д^{'} = 236{,}2(1 + 12{,}3\%)^{0{,}25} = 243{,}1 \quad (3.64)$$

To calculate the accrued receivables with a maturity of less than the term of the trade credit use the formula (3.8), in which we substitute the data from table 3.26:

$$ДЗ_M^{'} = 38{,}0(1 + 0{,}0\%)^{0{,}25} = 38{,}0 \quad (3.65)$$

To calculate the correction factor K_3, use the formula (3.9), in which we substitute the data from table 3.26:

$$K_3 = 1 - \frac{0{,}0}{55{,}0} = 1 \quad (3.66)$$

The correction factor K_4 is determined by calculation (3.37).

To calculate the increased amount of cash use the formula (2.31), in which we substitute the data from table 3.4 and table 3.6:

$$ГК^{'} = 3{,}0(1 + 11{,}5\%)^{0{,}25} = 3{,}1 \quad (3.67)$$

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According to the financial statements, Lan LLC has no bank loans, therefore *ПК*=0.

Having calculated all the indicators for calculating the borrower's limit (LP), we substitute in formula (3.3) the values that were obtained from the calculations (3.37), (3.60), (3.61), (3.63) - (3.67) and from table 3.26:

$$Л_{П} = 22{,}8 \cdot 76 + 1573{,}2 + 243{,}1 + 38{,}0 \cdot 1 + 0{,}0 \cdot 0{,}958 + 3{,}1 - 6{,}0 - 0{,}0 = 3584{,}2 \quad (3.68)$$

Where is it easy to get the discounted amount of the borrower's credit limit according to the formula (2.34):

$$Л_{П}^{'} = \frac{3584{,}2}{(1+14{,}0\%)^{0{,}25}} = 3468{,}7 \quad (3.69)$$

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To calculate the limit of the creditor (LC) LLC "Lan" was a measurement of the utility function for the director of the enterprise (ESD) using the economic game, the conditions of which are given in table 3.18.

After the game it turned out that the indifference point of ESD was reached with a probability of winning the amount $S_2 – p_0 = 0{,}817$.

Value of $p_Б$ was determined in the calculation (3.42). Therefore, the calculation of the correction factor K can be performed by formula (2.21), in which the value of the calculation (3.42) and the obtained value p_0.

$$K = 0{,}817 (0{,}817 > 0{,}333) \quad (3.70)$$

The creditor's limit can be calculated using the formula (1.5), in which we substitute the calculation (3.70) and the data of table 3.26:

$$Л_K = 0{,}817 \cdot 2608{,}0 = 2130{,}7 \quad (3.71)$$

The values of the calculations (3.41), (3.44), (3.56), (3.58), (3.69) and (3.71) of the discounted borrower's limit and the creditor's limit for clarity are summarized in Table 3.32.

Table 3.32.

Discounted limits of the borrower and limits of the creditor, thousand UAH

Enterprise	Discount limit of the borrower	Limit of the creditor
LLC "Gospodar"	2 805,1	3 614,7
SFG "Vesela Dolina"	1 545,0	3 248,6
LLC "Lan"	3 468,7	2 130,7

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Thus, it is possible to find a total limit of commodity lending for each pair of agricultural enterprises. To do this, using the formula (3.1) calculate 6 values of the total limit for 6 pairs of lender-borrower in accordance with the data of table 3.32.

The data are summarized in table. 3.33.

The values of table. 3.33 practically show that the total limit of commodity lending will be different in the case for two companies, when they change the roles of lender and borrower. For example, for the pair Gospodar LLC and Vesela Dolyna SFG, the limit is UAH 2,805.1 thousand, while Vesela Dolyna SFG is the creditor and Gospodar LLC is the borrower, and UAH 1,545.0 thousand. ., when SFG "Vesela Dolina" borrower, and LLC "Gospodar" creditor.

Table 3.33. General limits of commodity credit, thousand UAH

Кредитор	Borrower		
	LLC "Gospodar"	SFG "Vesela Dolina"	LLC "Lan"
LLC "Gospodar"	-	1 545,0	3 468,7
SFG "Vesela Dolina"	2 805,1	-	3 248,6
LLC "Lan"	2 130,7	1 545,0	-

To calculate the term of a trade credit, it is necessary to use an optimization model with functionality (2.43) and constraints (2.44). This calculation must be performed for 6 pairs of lender-borrower. The data of calculations using the "Solution Search" function of Excel spreadsheets are summarized in Table 3.34.

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Table 3.34. Optimal terms of a commodity credit, days

Creditor	Borrower		
	LLC "Gospodar"	SFG "Vesela Dolina"	LLC "Lan"
LLC "Gospodar"	-	1	101
SFG "Vesela Dolina"	159	-	78
LLC "Lan"	1	1	-

The optimal terms show (according to item 2.4) the maximum and minimum possible terms of granting a commodity loan, depending on whether the discounted limit of the borrower was greater than the limit of the lender or not.

The value of the term of the trade credit (n), which will be obtained as a result of optimization, reflects in the case of:

1) $Л_{П}^{'} > Л_{К}$ the minimum possible loan term for this borrower.

2) $Л_{П}^{'} < Л_{К}$ the maximum possible loan term for this borrower.

Therefore, when the borrower SFG "Vesela Dolina" in both cases in table. 3.34 presents the maximum loan term. When the borrower of Gospodar LLC and the creditor of SFG Vesela Dolyna are the maximum loan term, and in the case of the creditor of Lan LLC, the minimum loan term. When the borrower of LLC "Lan" and the lender of LLC " Gospodar " – the maximum loan term, and in the case of the creditor of SFG "Vesela Dolina" - the minimum loan term.

For SFG "Vesela Dolina" the result of optimization in both cases decreased to its limit (2.44): $n \geq 1/365$. Which indicates the impossibility of increasing the discounted limit of the borrower for the company by increasing the loan term. Obviously, such low values due to the forecast EBITDA (EB`), which is negative. For the other two companies, the maximum and minimum terms of commodity lending were obtained. The practical calculation of the total limit of commodity credit on the example of three enterprises of Dnipropetrovsk region and the resulting six general limits of commodity lending and six optimal terms of credit for each pair "lender-borrower" prove the possibility of practical application of the proposed method.

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3.3. Evaluation of the effectiveness of the methodology for determining the limits of commodity credit for agricultural enterprises

The calculation of the limit of commodity lending between agricultural enterprises is aimed at finding such an amount of commodity credit that would allow the borrower to settle with the lender in a timely manner and in full. Commodity credit is reflected on the balance of the creditor as receivables (see p.1.2). If borrowers on commodity loans are paid on time, this receivable is term. If the creditor has cases when commodity loans are settled late, this receivable is recorded as overdue.

Therefore, the efficiency of the introduction of the calculation of the limit of commodity lending between agricultural enterprises should be reflected as a decrease in the share of overdue receivables in total receivables. To calculate the effectiveness of the introduction of the calculation of the limit of commodity lending between agricultural enterprises will be used adjustment factor K_3, which shows the share of current receivables in the total receivables of the creditor company (3.9).

The calculation of efficiency involves a change in performance over a period. Therefore, to calculate the effectiveness of the introduction of the calculation of the limit of commodity lending between agricultural enterprises, the indicator K_3 will be taken at the beginning of the observation period and at the end of the period:

$$E = (K_{З\_К} - K_{З\_П})\frac{ДЗ_К + ДЗ_П}{2}, \quad (3.72)$$

where E – economic effect of changes in the share of current receivables; $ДЗ_К$ and $ДЗ_П$ – the total amount of receivables at the end of the period and at the beginning of the period, respectively; $K_{З\_К}$ and $K_{З\_П}$ – the share of current receivables at the end of the period and at the beginning of the period, respectively.

The efficiency indicator E is expressed in monetary units (UAH). The higher it is, the more efficient the introduction of the calculation of the commodity lending limit. May be marked "-", which means a decrease in the share of current receivables in total receivables and represents the economic loss from such a change.

Consider the calculation of efficiency on the example, the data for which are given in table 3.35.

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Table 3.35. Example of efficiency calculation

Indicators	Creditor -1	Creditor -2	Creditor -3
Overdue receivables at the end of the period, thousand UAH	50,0	50,0	85,0
Accounts receivable at the end of the period, thousand UAH	70,0	100,0	120,0
Overdue receivables at the beginning of the period, thousand UAH	80,0	80,0	80,0
Accounts receivable at the beginning of the period, thousand UAH	100,0	100,0	100,0
Correction factor at the end of the period	0,286	0,500	0,292
Adjustment factor at the beginning of the period	0,200	0,200	0,200
Economic effect, E, thousand UAH	7,3	30,0	10,1

In table 3.35 indicators of receivables are taken from the financial statements of creditors and adjusting the coefficients and the economic effect (*E*) was calculated by formulas (3.9) and (3.72), respectively.

Table 3.35 shows that the largest economic effect was received by the company Creditor-2 (30 thousand UAH).

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Conclusions

In the process of analyzing the scientific literature on the chosen research topic was:

1. It is determined that the main feature of a commodity loan is the deferral of payment by the buyer for the goods (services) provided.
2. It is determined that the functions of commodity credit and the advantages and disadvantages are significantly different for the lender and the borrower.
3. The classification of receivables by types has been finalized and the place of trade credit among other types of receivables has been determined.
4. The existing list of advantages of commodity crediting for the creditor to which the following advantages were added and substantiated is finished:
   - commodity credit accelerates the turnover of inventories;
   - commodity lending is an easier way to increase the turnover of inventories

5. The existing list of shortcomings of commodity crediting for the creditor has been finalized, to which such shortcoming as lack of collateral for commodity credit has been added and substantiated.

6. The existing list of advantages and disadvantages of commodity lending for the borrower has been finalized. It was justified to move such a feature as the lack of provision from the list of disadvantages to the list of advantages.

7. Defined conditions under which a commodity loan can bring additional income to the lender: the rate on a commodity loan should be higher than the inflation rate and lower than the rate on bank loans.

8. Commodity lending to creditors has been shown to have more disadvantages than advantages.

9. Identified ways to reduce and minimize the disadvantages of commodity lending for the lender.

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10. The place of limitation among the ways to reduce and minimize the shortcomings of trade credit for the lender, which as a result of application allows to improve the quality of receivables.

As a result of scientific research, the following results were obtained:

1. The list of criteria for calculating the commodity lending limit was supplemented by such important criteria as:

- the principle of temporary value of money;
- term of the loan provided;
- rate on the loan provided.
- the precautionary principle.

2. It is substantiated that when calculating the commodity credit limit, it is necessary to separate the borrower's limit and the lender's limit.

3. The calculation of the general limit of commodity crediting through the choice of the smallest of the limits of the borrower and the lender is substantiated.

4. It is substantiated to determine the amount of commodity credit as a separate value for each individual pair of lender-borrower.

5. It is determined that the commodity credit limit for the creditor is proportional to the probability of indifference of the Neumann-Morgenstern utility function.

6. The composition of indicators when calculating the commodity loan limit for the borrower is substantiated.

7. It is substantiated that when calculating the borrower's limit of a commodity loan, the flow indicators (EBITDA and payments on loans) should be taken for the period equal to the loan term.

8. For the commodity credit limit for the borrower it is determined that:

- the value of the commodity loan limit for the borrower is also proportional to such parameters as EBITDA; debt service payments on already received loans for the period of the planned loan; cost;

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• inventory ratio is proportional to the coefficient of variation of prices for these types of inventories and quantitative parameters of storage conditions of inventory data;

• the receivables ratio is proportional to the share of overdue receivables;

• the indicator of financial investments is proportional to the coefficient of variation of the stock index.

9. The indicators of accrual and discounting for the components of the commodity credit limit for the borrower were substantiated and determined according to the principle of temporary value of money.

10. Discount rates were calculated, which depend on the conditions and terms of storage of agricultural products, to assess the value of inventories of enterprises.

11. It is proved that the exponential reproduction of microorganisms in agricultural products with a high probability (β not less than 0.6) is the cause of the exponential relationship between the conditions and shelf life of this product.

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12. The term of granting the commodity credit by means of the decision of a problem of optimization model is calculated. Within this optimization model, the choice is justified:

- target function;
- the extremum to which this function goes;
- systems of constraints for the objective function and variable of this function.

As a result of generalization of the offered technique and carrying out practical calculations there were:

1. It is proved that the proposed method of calculating the total limit of the trade credit meets 14 criteria from the full list of criteria for calculating the limit of the trade credit:

• the share of capital of the creditor company, which it is willing to risk;

• financial condition of the creditor company;

• industry affiliation of the borrower;

• the size of the borrower's assets;

• financial stability of the borrower;

• prospects for the borrower's development;

• general state of the economy;

• regulatory requirements.

• type of credit policy implemented (level of acceptable risk),

• expected profitability taking into account the risks of transactions with the borrower;

• the principle of temporary value of money.

• term of the loan provided;

• rate on the loan provided.

• the precautionary principle

1. It is proved that the proposed method is devoid of the shortcomings of previous methods. After all, this technique:

   • Contains an objective calculation of the correction factor K.

   • Considers both the financial performance of the borrower and the financial performance of the lender.

   • Considers the principle of temporary value of money.

   • Contains an objective calculation adjusting the coefficients K_1-K_4.

   • Deprived of the method of expert assessments

   • Uses indicators that are different in nature (no duplication of indicators).

2. The classification of all information necessary for calculation of the general limit of commodity crediting on sources of origin is carried out. The sources were divided into 4 large groups.

   • Terms of trade credit

   • General economic information;

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• Reporting from the borrower;

• Data of the creditor company.

4. The list of reporting forms of the enterprise-borrower for possibility of practical calculation of the general limit of the commodity credit is defined and substantiated.

5. A practical calculation was performed on the example of three enterprises of Dnipropetrovsk region and six general limits of commodity crediting for each pair "creditor-borrower" were obtained, which proves the possibility of practical application of the proposed method.

6. A practical calculation of the optimal term of a trade credit using the optimization model calculation on the example of three enterprises of Dnepropetrovsk region for each pair "lender-borrower" and obtained six optimal terms of trade credit, which proves the practical application of the proposed approach to determining the term of trade credit.

7. The calculation of efficiency from application of the offered technique is developed and substantiated.

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