Modeling Foreign Exchange Risk Management In International Outsourcing

E.V. Khlynin¹, S.M. Komarov²

Professor of the Department of Finance and Management of the Institute of Law and Management of the Tula State University, Doctor of Economics, Professor. Russian Federation, 300012, Tula region, Tula, Lenin Avenue, 92

Abstract. The paper examines the impact of foreign exchange risk on economic systems based on international outsourcing and a model for choosing a method for managing foreign exchange risk in international outsourcing. The theoretical basis for building a model of an economic system based on international outsourcing, as well as economic speculative currency risk is presented. The authors have proposed and described a model of the impact of currency risk on economic systems based on international outsourcing. Mathematical modeling, as well as mathematical and graphic analysis of indicators characterizing the impact of currency risk have been carried out. The results are presented that reflect the impact of currency risk, both on a specific participant in the economic system, and on the system as a whole under various particular conditions. The authors point out that the foreign exchange risk in economic systems based on international outsourcing is expressed, not only explicitly, but also hidden through changes in the volume of production, cost and price of the final value. On the basis of modeling, general and particular criteria for the qualitative assessment of foreign exchange risk in international outsourcing are proposed. A model is proposed for choosing a method for managing currency risk in the economic system based on the Monge-Kantorovich problem. The research results can be used by organizations that are part of economic systems based on international outsourcing, regardless of the management approach and the mechanism for forming the economic system based on international outsourcing.

Keywords: currency risk, currency rate, operational risk, economic risk, risk zone.

INTRODUCTION
The development of large companies of the 20th century and their desire to increase profits led the world economy to a new state characterized by the development of transnational trade and investment, the international division of labor, and the presence of many large multinational companies. The rapid change in the global economy is forcing companies to look for new management methods in order to improve the efficiency of their activities.

Over the past decades, a new approach to organizing the activities of companies, called outsourcing, has developed significantly in world practice. It is in the conditions of economic globalization that the division of labor and industrial cooperation on a global scale open up completely
new perspectives for the application of the long-known principles of organizing production management (9, p. 76).

Many of the new industrial strategies that have been adopted in recent years - in both developing and developed countries - almost all rely heavily on attracting investment. At the same time, we are seeing a downward trend in cross-border manufacturing investment (26, p. IV).

The use of an international outsourcing strategy has led to the emergence of risks associated with the distinctive features of the countries where the participants in the production process are based. Firms' decisions to outsource the production of intermediate inputs abroad depend on the macroeconomic environment, driven by the government's monetary and foreign exchange policies.

The crisis in Russia in 2011-2012 showed that organizations with foreign capital, operating in Russia and coping with the high accounting and/or economic currency risk caused by currency fluctuations in 2011-2012, occupied the market niche of their former competitors.

The collapse of the ruble exchange rate in 2014 was one of the reasons for the decline in Russia's attractiveness for foreign direct investment. Despite the recent decline in demand for global trade in intermediate demand, a slight recovery in world trade is expected in the future (25, p. 25).

In these conditions, the problems associated with the impact of currency risk both on an individual organization participating in international outsourcing and on the entire economic system of international outsourcing as a whole are relevant.

Each participant in international outsourcing has its own objectives for managing foreign exchange risk raises the problem of choosing methods for managing foreign exchange risk. The increase in the number of agents of the economic system exposed to foreign exchange risk also increases the number of methods that can be used to manage foreign exchange risk, making it difficult to choose the most optimal one from the available ones.

The aims of this work are to establish the influence of the currency risk of international outsourcing participants on other participants in the economic system in particular and on the economic system as a whole, to search for new methods of currency risk management and to establish criteria for a qualitative assessment of currency risk, both for an individual participant in the economic system and for the entire economic system on the basis of international outsourcing as a whole, as well as the construction of the problem of choosing a method for managing currency risk.

The main part of the work consists of three parts. The first part provides a theoretical basis for constructing a model of the impact of foreign exchange risk on international outsourcing based on an analysis of approaches to managing economic systems using the outsourcing method, as well as an analysis of the current approaches to determining foreign exchange risk. In the second part, a mathematical model of the impact of foreign exchange risk on international outsourcing and a model for choosing a method for managing foreign exchange risk are built. The third part describes the methods of empirical research and the main results of the study of the model.

1. MATERIALS AND METHODS

To write the article, the results of theoretical research by Russian and foreign researchers, as well as previously published results of research by the authors, were used. The methodological part consists of mathematical modeling of the impact of currency risk on the economic system based on international outsourcing and solving the problem of optimizing currency risk management.

For the economic and mathematical description of the impact of currency risk, the article uses a mathematical apparatus based on differential calculus. This allows you to reflect the nature of the
behavior of the economic system and establish the possible results of the impact of currency risk on the economic system.

To build a model of the impact of currency risk on the economic system, the following elements were identified in this work:

- common goal for the entire economic system;
- strong cooperative link between participants in the final value chain;
- structural coordination between participants in the final value chain;
- individual goal of the participant in the final value chain.

For a mathematical description of the model of the economic system proposed in the work "Economic system based on international outsourcing", identification of the elements should be made.

The element "individual goal of a participant in the ultimate value chain" reflects the performance of a particular function by a participant in the ultimate value chain. This element can be decomposed into two constituent elements:

- TC - total cost;
- SP - selling price;

Thus, the first element of the model will itself be a subsystem of two elements.

“Structural coordination between participants in the ultimate value chain” reflects the ability to profit and incur losses in the performance and implementation of its function. Thus, this element can be represented as the sum of the profits of all participants in the ultimate value chain, derived from the change in the cost and implementation price of the process. Therefore, this element can be identified as the economic effect of the participants in the economic system, obtained by changing the cost and/or the selling price.

ΔP - the economic effect of the participant of the economic system.

“A strong cooperative connection between the participants in the ultimate value chain” reflects the share of each participant in the process of creating the final value and can be identified as the coefficient of cooperation.

CC - coefficient of cooperation.

\[
CC_i = \frac{(TC_i + P_i)}{((TC_i + P_i) + (TC_j + P_j))}
\]

\[
CC_j = \frac{(TC_j + P_j)}{((TC_i + P_i) + (TC_j + P_j))}
\]

i and j - participants in the ultimate value chain.

"A common goal for the entire economic system" reflects the creation of ultimate value capable of maintaining the integrity of the organization, its stability and balance. "A common goal for the entire economic system" reflects the totality of all stages of creating the final value under the condition of achieving the efficiency of the entire networked economic system. This element of the system can be identified as the profit of the economic system.

ESP - economic system profit.

The profit of the economic system completes the mathematical description of the outsourcing model built on the basis of goals and needs.

Since international outsourcing implies the conduct of international activities associated with the emergence of foreign exchange risk, the external element in relation to the system that has an impact on it is the exchange rate. The set of participants from different countries implies the summation of indicators expressed in different currencies, which leads to the introduction of
additional operations that generate redundancy in the model. In order to avoid model redundancy, all indicators are set in the currency of realization of the final value created by the economic system.

ER - (exchange rate) final value realized price exchange rate.

Thus, we get a model with direct and reverse linkages, which perceives the impact from the external environment in the form of a change in the exchange rate (Figure 1).

![Model Diagram]

Depending on the need, this model can be supplemented by any number of participants in the economic system, regardless of their functional characteristics. Since all indicators of the model are indicated in the currency of realization of the final value, the country of performance of the production function will be determined exclusively by the exchange rate, which affects the elements of the individual goal. Based on the study of this model, the sequential implementation of the following stages of currency risk management can be carried out both for an individual participant in the economic system in particular, and for the entire economic system as a whole:

- identification;
- analysis;
- grade.

The use of the proposed model, regardless of the number of agents in the economic system, makes it possible to identify for each participant and for the entire economic system as a whole: both operational and indirect in terms of impact; both accounting and economic in terms of the consequences of the impact; both explicit and latent by the nature of the manifestation of currency risks.

Having built a model of the impact of currency risk on international outsourcing, one can carry out an economic and mathematical description of the process described in the figure.

The model of the impact of currency risk on the economic system includes the following analytical ratios:

\[ ESP = P_i + P_j \]

\[ CC_{ch_i} = \frac{(TC_i + P_i + \Delta P_i - \Delta TC_i) + (TC_j + P_j - \Delta P_j - \Delta TC_j)}{(TC_i + P_i + \Delta P_i - \Delta TC_i) + (TC_j + P_j - \Delta P_j - \Delta TC_j)} \]

\[ CC_{ch_j} = \frac{(TC_j + P_j - \Delta P_j - \Delta TC_j) + (TC_i + P_i + \Delta P_i - \Delta TC_i)}{(TC_j + P_j - \Delta P_j - \Delta TC_j) + (TC_i + P_i + \Delta P_i - \Delta TC_i)} \]

\[ \Delta P_i = \Delta TC_i + \Delta SP_i \]

\[ \Delta P_j = \Delta TC_j + \Delta SP_j \]

SP, process implementation price

TC, process cost

ER, Exchange rate

P, price

ΔP, change in price

ΔTC, change in process cost

ΔSP, change in process implementation price
- change in profit / loss of an organization entering the economic system under the influence of currency risk on the full cost of the process;
- change in the profit / loss of an organization entering the economic system under the influence of currency risk for the implementation of the final goal (process);
- change in the profit of the economic system as a result of changes in the profit / loss of organizations included in the economic system under the influence of currency risk.

A change in profit and / or economic effect is caused by a change in the current exchange rate in relation to the base one inherent in the cost and price of each process and the entire chain of creation of final value. The size of the effect changes in proportion to the magnitude of the change in the exchange rate. The change in the economic effect under the influence of foreign exchange risk on the total cost of the process is described by the following equation:
- for the first organization of the economic system
  \[ \frac{TC_i}{ER} \times \Delta ER + P_i; \]
- for the second organization of the economic system
  \[ \frac{TC_j}{ER} \times \Delta ER + P_j; \]

The change in the economic effect under the influence of foreign exchange risk on the full realization of the final goal (process) is described by the following equation:
- for the first organization of the economic system
  \[ \frac{SP_i}{ER} \times \Delta ER - SP_i + P_i; \]
- for the second organization of the economic system
  \[ \frac{SP_j}{ER} \times \Delta ER - SP_j + P_j. \]

Change in the economic effect of the economic system as a result of changes in the amount of profit and/or the economic effect of an organization included in the economic system under the influence of currency risk:
\[
\begin{cases}
    \left( \frac{TC_i}{ER} \times \Delta ER + \frac{SP_i}{ER} \times \Delta ER + P_i ight) \times \frac{P_j}{TC_j}; \\
    \left( \frac{TC_j}{ER} \times \Delta ER + \frac{SP_j}{ER} \times \Delta ER + P_j \right) \times \frac{P_i}{TC_i}; 
\end{cases}
\]

The impact of the exchange rate on the total cost of the process of any of the organizations included in the economic system can lead to a negative result or loss. This means that this organization did not fulfill its function in this system and did not carry out the process in full. Consequently, the entire chain of ultimate value creation has not been fully implemented. This influence will be the result of a latent, indirect impact of foreign exchange risk on an organization through the impact of an explicit, operational foreign exchange risk on another organization and is described by the following equation:
- for the first organization of the economic system
  \[ \frac{P_i + \Delta TC_i}{TC_j} \times \frac{P_j}{TC_i}; \]
- for the second organization of the economic system
  \[ \frac{P_j + \Delta TC_j}{TC_i} \times \frac{P_i}{TC_j}. \]
These equations express the inverse relationship between the “common goal for the entire economic system” and the “individual goal of a participant in the final value chain”, which is the indirect impact of foreign exchange risk on one of the participants in the economic system arising from the operational impact of foreign exchange risk on another participant in foreign exchange risk.

The impact of foreign exchange risk on the process price affects the price of the final value. If a change in the price of the final value is not possible, a change in the profit from the realization of the final value affects the organization carrying out the process of realizing the final value, changing the profit it receives from the realization of the process, and is described by the following equation:

$$SP \times \Delta ER \times \frac{TC}{SP}$$

It is calculated for the organization in relation to which the given currency risk arises.

The occurrence of such situations will indicate negative structural coordination within the economic system, with asymmetry in favor of one of the participants in the economic system.

It is proposed to solve the problem of choosing the most optimal method of currency risk management by solving the Monge Kantorovich problem.

$$\sum_{i=1}^{m} a_i = \sum_{j=1}^{n} b_j$$

$$\sum_{j=1}^{n} x_{ij} = a_i, i = 1, 2, \ldots, m$$

$$\sum_{i=1}^{m} x_{ij} = b_j, j = 1, 2, \ldots, n$$

$$\sum_{i=1}^{m} \sum_{j=1}^{n} c_{ij} x_{ij} \rightarrow \text{min}$$

Where: m methods of currency risk management; n elements of the economic system (elements of the individual goal subsystem), which are affected by currency risk;

- $a_i$ the sum of the result of foreign exchange risk management in the risk management method $i$;
- $b_j$ the amount of risk in an element of the system (elements of the subsystem individual goal) $j$;
- $c_{ij}$ - costs of managing one unit of currency risk by method $i$ in element $j$;
- $x_{ij}$ sum of risk covered by control method $i$ in element $j$.

In this case, fixed marginal distributions can be interpreted as distributions of the asset value at certain points in time, and the optimal transport plan as a joint distribution of the model process (2, p. 7).

The type of optimization problem is determined by general conditions that depend on the conditions for managing currency risk, set by relational features between participants in international outsourcing, as well as between the elements of the system (elements of the subsystem - individual goal). In order to manage currency risk, the following relational relationships can be distinguished:

- sharing the costs of managing foreign exchange risk between participants in the economic system;
- division of management methods by a participant in the economic system according to the elements of risk exposure.

Thus, the following general conditions for the formulation of the problem of optimizing currency risk management can be distinguished:

- division by the participants of the economic system of expenses for the management of the arisen foreign exchange risk among themselves;
- division of foreign exchange risk management by a participant in the economic system by elements.

In the work "On some formulations of multi-product transport problems" it is proved that the properties of the "transport problem" depend not only on the number of transported goods, but also on the nature of the relationships between them (5, p. 91). Based on the results of the research carried out in this work, in order to comply with the second general condition in the work "The problems of optimizing the choice of a method for managing foreign exchange risk" (3, p. 18), the author identifies the following risk categories:
- independent risks;
- interchangeable risks.

Independent risks, for each element of the subsystem, an individual goal sets its own parameters that characterize the method of currency risk management.

Interchangeable risks set the parameters common for the elements of the subsystem, which characterize the method of managing currency risk. In turn, interchangeable risks can be both interchangeable for the entire system, and interchangeable only for its individual participants.

Interchangeable risks for the entire system imply the coverage of risk through the use of methods in any element of the individual goal of the entire economic system.

Interchangeable risks for its participants imply coverage of the participant's risk through the use of methods in any of its elements of the emergence of foreign exchange risk.

Thus, the first of the general conditions for setting the problem will affect the form of the problem. The second condition will supplement the first condition and affect both the form of the problem statement and the risk categories used in the formulation of the problem (Table 1).

<table>
<thead>
<tr>
<th>Condition</th>
<th>Optimization problem type</th>
<th>Risk category</th>
</tr>
</thead>
<tbody>
<tr>
<td>The participants in the economic system share the costs of the resulting currency risk. Currency risk management is carried out jointly by elements.</td>
<td>Classic problem</td>
<td>Interchangeable risks</td>
</tr>
<tr>
<td>The participants in the economic system share the costs of the resulting currency risk. Currency risk management is carried out separately by elements</td>
<td>Multi-element task</td>
<td>Independent risks</td>
</tr>
<tr>
<td>The participants in the economic system do not share the costs of the resulting currency risk. Currency risk management of a participant in the economic system is carried out jointly by elements</td>
<td>Multi-element task</td>
<td>Interchangeable risks</td>
</tr>
<tr>
<td>The participants in the economic system do not share the costs of the resulting currency risk. Foreign exchange risk management of a participant in the</td>
<td>Multi-element task</td>
<td>Independent risks</td>
</tr>
</tbody>
</table>
**Table 1. The type of the problem and the risk category depending on the general conditions of the problem statement.**

Despite the fact that the solution of the problem is aimed at optimizing the choice of methods for managing currency risk, the choice of one method or another can also be influenced by additional factors such as:

- **foreign exchange risk management costs.**
  \[ L \leq \sum TC_{crm} \]

  Where: \( L \) - total costs

  \[ \sum_{i=1}^{m} \sum_{j=1}^{n} < c_{ij} x_{ij} > ; \]

  - **TC\(_{crm}\)** foreign exchange risk management costs;
  - **elasticity of demand for the final product depending on the exchange rate.**
  \[ \sum TC_{crm} < SP \]

  Where:
  - \( \sum TC_{crm} \) it is the sum of the costs of managing foreign exchange risk by including foreign exchange risk in the price of the process;
  - **SP** is the amount of profit from the implementation of the process by the participant implementing the final value;
  - **dynamics of exchange rates.**

  Fluctuations in foreign exchange risk lead to an increase in the cost of managing one unit of foreign exchange risk when setting the problem. Consequently, fluctuations in the exchange rate is an external factor that is not regulated by organizations, which influences the management of foreign exchange risk. If the amount of the costs of managing the currency risk is higher than the currency risk, then the use of the control influence will lead to an increase in the negative effect of the influence. Consequently, if the fluctuation of the exchange rate is not enough for the occurrence of a risk that exceeds the costs of its management and does not entail the agent's failure to perform its function, then the currency risk should be ignored. This condition is expressed as follows:

  \[ (\Delta ER \times TC + \Delta ER \times SP) < TC_{crm} \text{ provided that } 0 > \sum \Delta P \leq P \]
In the case when the currency risk entails the failure of the agent to perform the function assigned to it, but at the same time does not exceed the management costs, the costs of its management should be revised. This condition will be expressed as follows:

\[(\Delta ER \times TC + \Delta ER \times SP) < TC_{crm}\] provided that \[0 > \sum \Delta P > P\]

The need to make a profit through currency risk management modifies this condition by removing the constraints \[0 > \sum \Delta P \leq P\] and \[0 > \sum \Delta P > P\] from it.

These factors set additional particular conditions of restrictions, the problem of optimizing the choice of a method for managing foreign exchange risk.

The construction and subsequent solution of this problem allows you to select one or several optimal methods of currency risk management for each participant in international outsourcing in particular and for the entire production chain as a whole, depending on the factors influencing the management of currency risk.

To model the management of foreign exchange risk in international outsourcing, the following initial data were used (Table 2):

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basic rate of the national currency (Russian ruble) against the reserve currency (USD)</td>
<td>64.03 RUB</td>
</tr>
<tr>
<td>The range of the change in the exchange rate of the Russian ruble against the US dollar</td>
<td>From -20% to +20%</td>
</tr>
<tr>
<td>Planned cost of the process of the 1st participant in the final value chain in the currency of the planned selling price of the final value (USD)</td>
<td>1000 000</td>
</tr>
<tr>
<td>Planned cost of the process of the 2nd participant in the final value chain in the currency of the planned selling price of the final value (USD)</td>
<td>125 000</td>
</tr>
<tr>
<td>Planned price of realization of the final goal of the 1st participant in the chain of creation of final value in the currency of the planned price of realization of the final value (USD)</td>
<td>1 250 000</td>
</tr>
<tr>
<td>The planned price of the final goal of the 2nd participant in the final value chain in the currency of the planned price of the final value (USD)</td>
<td>140 000</td>
</tr>
<tr>
<td>The sum of the costs of managing the currency risk of the 2nd participant in the final value chain (USD)</td>
<td>5000</td>
</tr>
<tr>
<td>The amount of expenses of the 2nd participant for the management of currency risk using method 1 (USD)</td>
<td>3200</td>
</tr>
<tr>
<td>The amount of realizable risk by the 2nd participant per USD 1 of costs by 1 method. (Amount shown after deducting the cost of using the method)</td>
<td>1.5</td>
</tr>
<tr>
<td>The amount of expenses of the 2nd participant for the management of currency risk using the 2nd method (USD)</td>
<td>2400</td>
</tr>
</tbody>
</table>
The amount of realizable risk by the 2nd participant per USD 1 of the costs by the 2nd method. (Amount shown after deducting the cost of using the method) | 2
---|---
The amount of expenses of the 2nd participant for the management of currency risk using method 3 (USD) | 1600
The amount of realizable risk by the 2nd participant per USD 1 of expenses by the 3rd method. (Amount shown after deducting the cost of using the method) | 2,2
The amount of expenses of the 2nd participant for the management of currency risk using method 4 (USD) | 4500
The amount of realizable risk by the 2nd participant per USD 1 of costs by the 4th method. (Amount shown after deducting the cost of using the method) | 1,4

Table 2. Input data for modeling the impact of foreign exchange risk on international outsourcing.

General conditions for describing the impact of foreign exchange risk on international outsourcing:
1) Currencies for private conditions:
   1- USD;
   2- RUB.
2) The target currency of the target selling price of the final value is set in the US dollar in the simulation. The amounts of foreign exchange risk in the event of a change in the exchange rate will be measured in USD.
3) The first organization will both produce and implement its part of the final value chain in USD.

It can be seen from the general conditions that only the second participant of this system will be exposed to operational currency risk. Also, according to the initial data, the costs of managing the currency risk are also imposed on only the 2nd participant.

The study of modeling the impact of currency risk on the economic system will be carried out separately for four different particular conditions.

2. REFERENCES REVIEW
The problem of constructing mathematical models of the economic system on the basis of international outsourcing, as well as outsourcing in general, lies in the vagueness of the concept of outsourcing associated with the evolutionary development of this management method, which divided the very use of outsourcing into two fundamentally different approaches. The evolutionary development of outsourcing is indicated by Glauco De Vita and Catherine L. Wang in their joint work "Development of Outsourcing Theory and Practice: a taxonomy of Outsourcing generations" (13, p. 13). This paper analyzes the evolution of the theory and practice of outsourcing over time. As a result of their research, they generalize the theory and practice of outsourcing, dividing its development into three successive evolutionary stages (Table 3).
## The elements

<table>
<thead>
<tr>
<th>The first stage of evolutionary development</th>
<th>The second stage of evolutionary development</th>
<th>The third stage of evolutionary development</th>
</tr>
</thead>
</table>
| **Key factors to the transition to outsourcing** | **Efficiency, cost saving.** | **Efficiency;**  
- Focusing on basic professional qualities;  
- Search for additional features. | **Efficiency, innovation and adaptation;**  
- Flexible solutions for clients;  
- Transformation of business processes. |

<table>
<thead>
<tr>
<th><strong>Outsourcing activities</strong></th>
<th><strong>Peripheral activity.</strong></th>
<th><strong>Almost the main activities.</strong></th>
<th><strong>Traditionally defined core activities.</strong></th>
</tr>
</thead>
</table>
| **Relational features (relationship features)** | - Small integration;  
- The only supplier;  
- The asymmetry of size and power favors the outsourcing firm;  
- Separation of outsourcing activities from the outsourcing firm. There is only one point of responsibility between the outsourcing firm and the supplier. | - Extended integration;  
- Asymmetry of the size and capacity of the outsourcing company;  
- More than one partner on the side, but still gravitates towards one partner;  
- The outsourcing firm maintains the necessary resources to manage relationships with external suppliers. | - Virtual integration;  
- The asymmetry is undefined;  
- Establishing close relationships with several but major partners;  
- Outsourcing firm expands its boundaries, exchange information in real time with external partners to create a virtual chain;  
- Outsourcing as core competence. |

| **Basic success factor** | - The supplier is more efficient than the outsourcing firm;  
- Strong dependence primarily on the choice of the right partner;  
- Revealing hidden costs and clearly defining the cost structure in the original contract | Built-in contract flexibility for technological evolution and capital investment;  
- Standardization of contracts and technological platform;  
- Protection of knowledge from leakage in the outsourcing process. | - Flexible and responsive customer solutions to provide added value;  
- Clear definition of core competencies;  
- Standardization of outsourcing processes;  
- The outsourcing firm provides centralized control over business operations, while ensuring the decentralization of business processes. |

| **Measuring efficiency** | Cost reduction | Impact of outsourcing on overall business performance. | Transformation of business processes and achievement of common goals |

### Table 3. Evolutionary change in the theory and practice of outsourcing over time.
The evolutionary development of outsourcing has given rise to two approaches to the use of outsourcing. The first approach is based on a systematic approach to management strategy. The second approach is based on an integrated management strategy approach. The difference in approaches makes it possible to build various options for models of economic systems based on outsourcing. Among foreign researchers, the systems approach is followed by Quentin Comine (22, p. 47, 101), Brenton A. (10, p. 6). This is expressed in the fact that the modeling of the economic system is carried out taking into account the priority of the customer over the contractor, highlighting such an element of the system as an integrator. As can be seen from the work presented by Glauco De Vita and Catherine L. Wang, the priority of the customer's interests over the interests of the contractor is present only in the first two stages of outsourcing development. This is expressed through: factors for the transition to outsourcing, namely in efficiency and cost savings; relational features, namely the asymmetry in favor of the outsourcing firm; performance measurement, namely cost savings and the impact of outsourcing on overall business performance. The third stage of outsourcing development based on an integrated management approach includes in the key factors for the transition to outsourcing not only efficiency and cost savings, but also customer orientation, as well as the need for innovation, adaptation and transformation of business processes. At the same time, cost reduction is excluded from the factors determining the transition to outsourcing already at the second stage of the evolutionary development of outsourcing. Relational features eliminate the asymmetry of size and power in favor of the outsourcing firm, and efficiency is measured through the achievement of common goals and the transformation of business processes. This approach helps to remove any restrictions on volumes and synergies, using technology to use the appropriate level of efficiency and effectiveness even at relatively low levels of transaction volumes (17, p. 8). Among Russian researchers, an integrated approach in making a managerial decision to switch to outsourcing suggests using I.V. Truschenko. (7, p. 94). Among foreign researchers, Prabir Ch.P. (18, p. 132), Fletcher R. (11, p. 11), Fay Son Khan Pham (21, p. 25) adhere to an integrated approach.

Based on the analysis of the stages of development of international outsourcing in the article "Economic system based on international outsourcing" (15, p. 28), the author proposed the following structure of the economic system based on international outsourcing (Figure 2).
Thus, the evolutionary development of outsourcing poses the problem of finding a new approach to mathematical modeling of economic systems based on outsourcing.

Modeling the relationship between the customer and the contractor within the structure of the economic system based on international outsourcing is complicated by such an external factor as foreign exchange risk.

The influence of foreign exchange risk on international outsourcing is considered in the work of the authors "RESEARCH OF THE RELATIONSHIP OF INTERNATIONAL OUTSOURCING WITH INTERMEDIATE IMPORT INDICATORS AND CURRENCY RATE VARIATIONS" (8, p. 124), where the results of correlation and regression analysis of the relationship between international outsourcing and currency fluctuations are presented. The paper concludes that the activity of international outsourcing companies in the Russian Federation in the period from 2006 to 2016 is due to the dynamics of the dollar against the ruble. Also, the impact of foreign exchange risk on outsourcing is discussed in the work of Wai Min Ho.

Today, there are two approaches to the theoretical definition of foreign exchange risk, on the basis of which two fundamentally different approaches to managing foreign exchange risk are built. The first approach defines foreign exchange risk as the risk of incurring losses as a result of changes in the exchange rate. The second approach defines foreign exchange risk as a risk that has the ability to reap both profit and loss. However, the impact of foreign exchange risk can have not only accounting consequences, expressed in direct profit or loss, but also economic ones.

Assessing the economic impact of foreign exchange risk refers to a qualitative assessment of foreign exchange risk. To date, the most widespread are two fundamentally different approaches to determining the economic currency risk. The first approach focuses on the impact of exchange rate
changes on future cash flows. Economic foreign exchange risk is the change in the company's value (PV) as a result of the impact of changes in exchange rates and is expressed as $\Delta PV / \Delta e$, where $\Delta PV$ is the change in the present value of the company associated with a change in the exchange rate, $\Delta e$. "Thus, foreign exchange risk is considered as the possibility that fluctuations in exchange rates can change the expected amount or the volatility of future cash flows" (20, p. 380). The second approach is well illustrated by the definition given by K. Redhead and S. Hughes. They define the economic foreign exchange risk as "The likelihood of an adverse impact of exchange rate changes on the economic position of the company, for example, the likelihood of a decrease in the volume of trade or a change in the company's prices for factors of production and finished products in comparison with other prices in the domestic market" (6, p. 17).

The economic impact of currency risk is considered by the author in the work "ECONOMIC CURRENCY RISK IN INTERNATIONAL OUTSOURCING ON THE EXAMPLE OF COMPANIES IN THE MACHINE CLUSTER OF THE KALUGA REGION FOR THE PERIOD FROM 2012 TO 2016" (4, p. 25). This paper shows that $\Delta PV / \Delta e$ does not reflect the degree of economic consequences of the negative result of the indirect impact of foreign exchange risk.

Doctor of Economics Kiseleva I.A., Professor of the Russian University of Economics named after G.V. Plekhanov, summarizing the materials of Russian and foreign researchers, divides the currency risk into zones with different degrees of risk, highlighting the following groups of qualitative assessment of currency risk:

- risk-free zone;
- area of acceptable risk;
- area of critical risk;
- area of catastrophic risk.

The risk zones highlighted by her detail the qualitative assessment of the currency risk.

Since in international outsourcing, the participants in the final value chain are in a strong cooperative relationship, the failure of one of the participants to achieve their individual goal as a result of the impact of currency risk may lead to failure to achieve a goal common to all participants. Thus, a qualitative assessment of currency risk should take into account the indirect impact of currency risk on participants in the economic system in particular and on the economic system as a whole.

Thus, in order to establish criteria for a qualitative assessment of currency risk, both for an individual participant in the economic system and for the entire economic system on the basis of international outsourcing as a whole, it is necessary to build a model that satisfies the following conditions:

- the model should not be focused on the outsourcing company (customer), as this reflects only a systematic approach to management;
- the model should take into account the possibilities of speculative currency risk, as well as reflect the indirect impact of currency risk.

Since the majority of Russian and foreign researchers create mathematical models of economic systems on the basis of outsourcing using a systematic approach as a basis, therefore, they single out the participant to whom the model will be focused, for the purposes of this study, the model proposed by the author in the work "Economic system based on international outsourcing" was used.
3. RESULTS

Research results of modeling the impact of currency risk on the economic system:

<table>
<thead>
<tr>
<th>Condition</th>
<th>1 Organization (participant) of the ultimate value chain</th>
<th>2 Organization (participant) of the ultimate value chain</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full cost currency</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Process implementation currency</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

Table 4. First particular condition.

Condition 1 shows that the customer and the contractor incur the costs of the process, and also directly implement their processes in USD.

The simulation results are presented in the form of a diagram, which graphically depicts the change in the amount of profit of each participant and the economic system as a whole when the exchange rate fluctuates by 20% with the total volume of negative and positive effects from the implementation and implementation of the process 40% under various, particular, previously specified conditions.

Line 1 reflects the change in the profit of the second participant in the economic system from changes in the amount of the cost of the process and the amount of the implementation of the process, which are subject to currency risk. It can be seen from the diagram that as the range of fluctuations in the exchange rate, expressed in %, increases, the amount of profit decreases in proportion to the increase in foreign exchange risk. Line 1 also shows an increase in profits as the range of fluctuations in the exchange rate, expressed in %, increases. This change for the second participant will be the...
result of an explicit operational, accounting, foreign exchange risk and will be expressed through profit or loss. An increase in the range of negative foreign exchange risk of the second participant over 12% leads to a decrease in production volumes. This impact will be expressed in the form of a decrease in the volume of the process performed, both for the second and for the first participant in an amount from 1000 units for each percentage of the negative impact of foreign exchange risk over the designated 12%. Based on the data specified in Table 3, an increase in the range between an increase in the foreign exchange rate during the implementation of the process and a decrease in the foreign exchange rate during its implementation by less than 4% makes the management of foreign exchange risk not economical, since the costs of managing foreign exchange risk exceed the amount of foreign exchange risk. Also, foreign exchange risk arising outside the range of more than 8.5% cannot be realized by the provided methods, since the maximum amount of realizable risk by one of the methods is equal to USD 7,500

Curve 2 shows the change in the amount of profit / loss from the change in the cost of the process and the implementation of the process of the first participant in the economic system. According to the general conditions, this participant cannot bear obvious operational, accounting, currency risks. However, the receipt of losses by the second participant from the negative impact of foreign exchange risk has an impact on the first participant, for whom this impact will be indirect. Curve 3 shows the change in the amount of profit / loss of the entire economic system from a change in the range between exchange rates during the implementation of the process and its implementation, being a hidden, indirect, economic, currency risk for the economic system, entailing a decrease in the volume of production of the final value.

The amount of foreign exchange risk, taking into account the hidden indirect economic effect, depending on the fluctuations in the exchange rate, ranges from -73,000 to 53,000 USD. The coordination range is -73,000 to 53,000 USD. The range of coordination due to the foreign exchange risk of the second participant ranged from -53,000 to 53,000, of which due to the influence of foreign exchange risk on the cost of the process from -25,000 to 25,000 USD and from -28,000 to 28,000 due to the influence of foreign exchange risk on the selling price. The range of coordination due to the foreign exchange risk of the first participant was from -20,000 to 0. However, the first participant can only avoid the hidden, indirect, economic, foreign exchange risk in the range from -15,000 to 53,000 USD.

<table>
<thead>
<tr>
<th>The currency of the actual payment for the process</th>
<th>1 Organization (participant) of the ultimate value chain</th>
<th>1 Organization (participant) of the ultimate value chain</th>
</tr>
</thead>
<tbody>
<tr>
<td>Process implementation currency</td>
<td>1</td>
<td>2</td>
</tr>
</tbody>
</table>

Table 5. The second particular condition.
According to 2 conditions, the customer carries out and implements his processes in US dollars, while the outsourcer carries out the costs of the process in Russian rubles, and implements his process in USD.

Line 1 reflects the change in the amount of profit of the second participant in the economic system from the change in the amount of expenses for the process and the amount of its implementation, which are subject to currency risk. Positive effects from the realization of foreign exchange risk by the second participant:

1) making a profit from explicit, operational, accounting, currency risk due to the implementation of the process with an increase in the USD against the RUB;
2) reduction in the cost of the final value, due to the growth of the USD against the RUB, which is a hidden, indirect, economic impact of currency risk.

Negative effects from the realization of foreign exchange risk by the second participant:
1) reducing profits and receiving losses;
2) an increase in the cost of the final value.

Based on the data specified in Table 3, an increase in the range between an increase in the foreign exchange rate during the implementation of the process and a decrease in the foreign exchange rate during its implementation by less than 4% makes the management of foreign exchange risk not economical, since the costs of managing foreign exchange risk exceed the amount of foreign exchange risk. Also, foreign exchange risk arising outside the range of more than 8.5% cannot be realized by the provided methods, since the maximum amount of realizable risk by one of the methods is equal to USD 7,500.

According to the general conditions, the first participant in the economic system is not exposed to an explicit operational accounting currency risk. Since the foreign exchange risk of the second participant did not entail the emergence of an indirect foreign exchange risk for the first participant, line 2, reflecting the change in the profit of the first participant, remains unchanged.
Line 3 does not reflect the change in the positive and/or negative effect of the entire economic system from the impact of currency risk on its participants. Since the currency risk affected only the second participant, this line will be proportional to line 1.

The amount of currency risk ranges from 53,000 to 53,000 USD. The range of coordination due to the foreign exchange risk of the second participant ranged from -53,000 to 53,000, of which due to the influence of foreign exchange risk on the cost of the process from -25,000 to 25,000 USD and from -28,000 to 28,000 USD due to the influence of foreign exchange risk on the selling price.

<table>
<thead>
<tr>
<th>The currency of the actual payment for the process</th>
<th>1 Organization (participant) of the ultimate value chain</th>
<th>2 Organization (participant) of the ultimate value chain</th>
</tr>
</thead>
<tbody>
<tr>
<td>Process implementation currency</td>
<td>1</td>
<td>2</td>
</tr>
</tbody>
</table>

**Table 6. The third particular condition.**

According to 3 conditions, the customer carries out and implements his processes in USD, while the outsourcer carries out the actual costs of the process in US dollars, and implements it in RUB.

Line 1 shows the change in the amount of profit/loss of the second participant in the economic system, from the change in the amount of expenses for the process and its amount of its...
implementation, which are subject to currency risk. Positive effect from the realization of foreign exchange risk by the second participant:

1) making a profit from an explicit operational accounting currency risk, due to the implementation of costs for the process when the USD depreciates against the RUB.

Negative effect of the realization of the foreign exchange risk of the second participant:

1) decrease in profit and subsequent loss.

An increase in the range of negative foreign exchange risk of the second participant over 12% leads to a decrease in production volumes. This impact will be expressed in the form of a decrease in the volume of the process performed, both for the second and for the first participant in an amount of 1000 units for each percentage of the negative impact of foreign exchange risk over the designated 12%.

Based on the data specified in Table 3, an increase in the range between an increase in the foreign exchange rate during the implementation of the process and a decrease in the foreign exchange rate during its implementation by less than 4% makes the management of foreign exchange risk not economical, since the costs of managing foreign exchange risk exceed the amount of foreign exchange risk. Also, foreign exchange risk arising outside the range of more than 8.5% cannot be realized by the provided methods, since the maximum amount of realizable risk by one of the methods is equal to USD 7,500.

Curve 2 shows the change in the amount of profit / loss of the first participant in the economic system. According to the general conditions, this participant cannot bear clear operational accounting currency risks. However, this model demonstrates the change in the financial result of the first participant.

Positive effect from the realization of currency risk by the first participant:

1) Growth in profits from the implementation of the process of realizing the final value;

Negative effect from the realization of currency risk by the first participant:

1) a decrease in profits from the implementation of the process of realizing the final value;

2) a decrease in profits due to changes in production volumes as a result of the impact of latent indirect economic currency risk.

Curve 3 shows the change in the amount of profit / loss from changes in the cost of the process and the implementation of the process of the entire economic system.

The amount of foreign exchange risk, taking into account the hidden indirect economic effect, depending on the fluctuations in the exchange rate, ranges from - 70,000 to 53,000 USD. The range of coordination due to the currency risk of the second participant ranged from - 25,000 to 25,000 due to the influence of currency risk on the cost of the process. The range of coordination due to the currency risk of the first participant ranged from - 48,000 to 28,000 due to the influence of currency risk on the cost of the process. Of these, from - 28,000 to 28,000 due to changes in the purchasing power of the currency and from - 20,000 to 0 due to latent, indirect, economic impact.

<table>
<thead>
<tr>
<th>The currency of the actual payment for the process</th>
<th>1 Organization (participant) of the ultimate value chain</th>
<th>2 Organization (participant) of the ultimate value chain</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>2</td>
</tr>
</tbody>
</table>

7601  http://www.webology.org
Table 7. The fourth particular condition.

According to 4 conditions, the customer carries out and implements his processes in USD, while the outsourcer incurs expenses, and also implements his process in RUB.

<table>
<thead>
<tr>
<th>Process implementation currency</th>
<th>1</th>
<th>2</th>
</tr>
</thead>
</table>

Line 1 reflects the change in the amount of profit / loss of the second participant in the economic system, from the change in the amount of expenses for the process and its amount of its implementation, which are subject to currency risk. The positive effect of the realization of the currency risk by the second participant is the reduction in the cost of the process of the second participant of the economic system in the chain of creation of final value.

The negative effect of the realization of the foreign exchange risk by the second participant is an increase in the cost of the process carried out by the participant in the chain of creating the final value.

An increase in the negative range over 12% leads to a decrease in production volumes. This impact will be expressed in the form of a decrease in the volume of the process performed, both for the second and for the first participant in an amount of 1000 units for each percentage of the negative impact of foreign exchange risk over the designated 12%.

Based on the data specified in Table 3, an increase in the range between an increase in the foreign exchange rate during the implementation of the process and a decrease in the foreign exchange rate during its implementation by less than 4% makes the management of foreign exchange risk not economical, since the costs of managing foreign exchange risk exceed the amount of foreign exchange risk. Also, foreign exchange risk arising outside the range of more than 8.5% cannot be
realized by the provided methods, since the maximum amount of realizable risk by one of the methods is equal to USD 7,500

Curve 2 in Diagram 4 shows the change in the amount of profit / loss from the change in the cost of the process and the implementation of the process of the first participant in the economic system. The positive effect of the realization of the foreign exchange risk by the first participant is the growth of profits from the implementation of the process of realizing the final value.

Negative effects from the realization of foreign exchange risk by the first participant:
1) a decrease in profits from the implementation of the process of realizing the final value;
2) a decrease in profits due to a decrease in production volumes.

Curve 3 in Diagram 4 shows the change in the amount of profit / loss from changes in the cost of the process and the implementation of the process of the entire economic system.

The amount of foreign exchange risk, taking into account the hidden indirect economic effect, depending on currency fluctuations, ranges from - 53,000 to 53,000 USD. The sum of the possible range of structural coordination is 50,000 to 50,000 USD. The range of structural coordination due to the foreign exchange risk of the second participant ranged from - 25,000 to 25,000 due to the influence of foreign exchange risk on the cost of the process. The range of coordination due to the foreign exchange risk of the first participant ranged from - 28000 to 28000 due to the influence of foreign exchange risk on the cost of the process. Of these, from - 28,000 to 28,000 due to changes in the purchasing power of the currency.

To solve the problem, to optimize the choice of the currency risk management method, it is necessary to set additional restrictions, such as:
- costs of managing foreign exchange risk in the specified amount of 5000 (US dollars);
- fluctuation in the exchange rate, which is indicated in the range from -20 to + 20%;
- the elasticity of demand for the final product depending on the fluctuation of the exchange rate is not specified.

It is also necessary to indicate the general conditions for the formulation of the problem, which determine the risk category.

Condition 1 - participants in the economic system do not share the costs of managing foreign exchange risk.
Condition 2 - foreign exchange risk management is carried out jointly by cost elements.

These general conditions make it possible to define the problem as a multi-element optimization problem with interchangeable risks.

Having solved the optimization problem, we get the following results:
The most effective method for managing foreign exchange risk for the second participant is method 3. With this method, it covers USD 3520 foreign exchange risk. Method 2 is the next most effective, it covers USD 4800 foreign exchange risk. Method 1 covers only USD 1,500 from the remaining currency risk management costs. The total realizable risk was 9820 USD. The combination of these methods makes it possible to neutralize the negative impact of exchange rate fluctuations in the range of 7%.

With a negative exchange rate fluctuation of more than 19%, the selected methods of currency risk management are not able to keep the second participant of international outsourcing in the zone of acceptable risk, which will lead to the termination of his function and a decrease in production volumes. Therefore, when predicting currency rate fluctuations with a negative amplitude of more than 19%, it is ineffective to use foreign exchange risk management methods and one should predict
losses as a result of a decrease in production volumes and consider changes in production volumes as a method of managing foreign exchange risk under given conditions.

4. DISCUSSION
Having received the results of modeling the impact of foreign exchange risk on international outsourcing, it becomes possible to establish criteria for a qualitative assessment of foreign exchange risk.

According to the results of the study, individual participants in the economic system may not have exposure to risk, however, the economic system as a whole will always be exposed to currency risk due to the impact of currency risk on at least one of its participants. This impact can be both operational and indirect, both accounting and economic, both explicit and latent. Consequently, the criteria for the qualitative assessment of foreign exchange risk should be divided into specific and general.

The Federation of European Associations of Risk Managers in the "Risk Management Standards" introduces such a concept as "Risk Appetite". Dmitrieva M.A. in her dissertation work also points to such a value as "Risk appetite" or "the maximum amount of possible losses that a company can withstand without significant damage to core activities" (1, p. 110).

Modeling showed that an organization participating in international outsourcing receives significant damage the moment the currency risk exceeds the amount of profit of this organization, which leads to economic risk in the form of a decrease in production volumes. Therefore, for organizations involved in international outsourcing, the value of "risk appetite" can be set as the sum of the organization's profit.

Based on the concept of "risk appetite", as well as the grouping of the qualitative assessment of currency risk proposed by Doctor of Economics Kiseleva, in accordance with the results of modeling the impact of currency risk on international outsourcing for a qualitative assessment of currency risk, the following private grouping of currency risk zones is proposed (Table 8).

<table>
<thead>
<tr>
<th>n</th>
<th>Risk zone name</th>
<th>Risk criterion</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>risk-free zone</td>
<td>All losses are zero or profit is being made.</td>
</tr>
<tr>
<td>2</td>
<td>zone of acceptable risk</td>
<td>Does not exceed the amount of profit of a given participant in the economic system.</td>
</tr>
<tr>
<td>3</td>
<td>critical risk zone</td>
<td>From the amount of profit of a given participant in the economic system to the amount of profit of a participant in the economic system with the largest amount of profit in the economic system.</td>
</tr>
<tr>
<td>4</td>
<td>catastrophic risk zone</td>
<td>More than the amount of profit of the participant in the economic system with the largest amount of profit in the economic system.</td>
</tr>
</tbody>
</table>

Table 8. Currency risk zones depending on the size of possible losses of a participant in the economic system.

Since the economic system based on international outsourcing can consist of an unlimited number of participants and the negative effect of the impact of currency risk on one of the participants
can be covered by the positive effect of the impact of currency risk on another participant, the qualitative criteria of the zone of acceptable and critical risk in the general grouping of currency risk zones will differ from qualitative criteria for a private grouping of currency risk zones.

For a qualitative assessment of the currency risk of the entire economic system on the basis of international outsourcing, the following general grouping of currency risk zones is proposed (Table 9).

<table>
<thead>
<tr>
<th>No.</th>
<th>Risk zone name</th>
<th>Risk criterion</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>risk-free zone</td>
<td>All losses are zero or profit is being made.</td>
</tr>
<tr>
<td>2</td>
<td>zone of acceptable risk</td>
<td>Does not exceed the amount of profit of a participant in the economic system with the smallest amount of profit in the economic system.</td>
</tr>
<tr>
<td>3</td>
<td>critical risk zone</td>
<td>From the amount of profit of a participant in the economic system with the least amount of profit in the economic system to the amount of profit of a participant in the economic system with the largest amount of profit in the economic system.</td>
</tr>
<tr>
<td>4</td>
<td>catastrophic risk zone</td>
<td>More than the amount of profit of the participant in the economic system with the largest amount of profit in the economic system</td>
</tr>
</tbody>
</table>

Table 9. Currency risk zones depending on the size of possible losses of the economic system.

Having received qualitative criteria for assessing currency risk, it becomes possible to identify, analyze and qualitatively assess the currency risk in the economic system.

As can be seen from the results of modeling the impact of foreign exchange risk on participants in international outsourcing in various conditions, the latent and indirect impact of foreign exchange risk on participants in the economic system that are not exposed to explicit operational risk leads to an increase in the impact of foreign exchange risk on the entire economic system. This impact leads to the movement from one risk zone to another not only an individual participant in international outsourcing, but also the economic system as a whole. The positive consequences of the currency risk of one of the participants are able to neutralize the negative effect of the impact of currency risk on the entire economic system by moving it from one currency risk zone to another.

The regulated organization must establish appropriate processes and procedures to continuously monitor the performance of the service provider to ensure that it retains the ability and ability to continue to perform the outsourced task (19, p. 15).

The consequences of the impact of foreign exchange risk in the form of a decrease in production volumes make one think about a deliberate decrease in production volumes as a method of managing foreign exchange risk to reduce the impact of foreign exchange risk on the entire economic system. The inclusion of this method in the task of optimizing foreign exchange risk management is possible at the initial stage when determining the cost of foreign exchange risk management methods. This method can be classified as an internal method for managing foreign exchange risk. To correlate
management methods and currency risk zones, it is necessary to determine the main differences in the formation of costs of methods of currency risk management. The underlying financial instruments (internal methods) do not depend on the amount of the covered risk. Consequently, the costs of internal management methods are constant, have an inverse relationship and will decrease with an increase in foreign exchange risk. Thus, this method will be effective when currency risks are sufficient to move the economic system to a critical or catastrophic zone.

CONCLUSION

Analyzing the results obtained during the simulation, the following conclusions can be drawn:

1. Being in a single economic system with a participant exposed to explicit, operational, accounting, foreign exchange risk, a participant not exposed to the same risk may be exposed to latent, indirect, economic, foreign exchange risk due to the negative effect of foreign exchange risk on the first participant. The economic system based on international outsourcing is exposed to latent, indirect, economic, currency risk in proportion to both explicit and latent, operational, indirect, accounting and economic, currency risk of its participants. Currency risk within the economic system is expressed not only explicitly through a change in the amount of profit received by a specific participant or the system as a whole, but also hidden through a change in production volumes, a change in cost and a change in the price of the final value.

2. The disruption of the function of a participant in the economic system based on international outsourcing as a result of the impact of foreign exchange risk prompts to consider the change in production volumes as an internal method of managing foreign exchange risk.

3. Proposed in the form of a qualitative assessment of the currency risk zones reflect the impact of currency risk, both on an individual participant and on the entire economic system as a whole.

4. The constructed problem of choosing a method for managing currency risk based on the Monge-Kantorovich problem using general and particular conditions shows the most optimal methods for managing currency risk, as well as the exchange rate at which the use of certain methods becomes ineffective and it is possible to include such a method of managing currency risk as decrease in production volumes.

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