

**Kyiv National University of Trade and Economics**  
**Banking Department**

**FINAL QUALIFYING PAPER**  
**on the topic:**

**Financial institutions currency risk management**

Student of the 2<sup>nd</sup> year, group 10am,  
specialty 072 «Finance, banking and  
insurance»  
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**Kyiv, 2021**

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## **Task for a final qualifying paper**

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1. Topic of a final qualifying paper

“Financial institutions currency risk management” \_\_\_\_\_

Approved by the Rector's order from November \_\_\_\_ 2020, No. \_\_\_\_\_.

2. Term of submitting by a student his/her terminated paper (project) to 21.11.2021

3. Initial data of the final qualifying paper (project)

*Purpose of the paper (project)* - analysis of scientific and methodological approaches and development of practical recommendations for currency risk management of a financial institution \_\_\_\_\_

*Object of the research* - the process of currency risk management of a financial institution \_\_\_\_\_

*Subject of the research* - scientific-methodical and applied aspects of currency risk management in a financial institution taking into account the principles of the modern concept of risk management



## 6. Time schedule of the paper

No.	Stages of a final qualifying paper	Terms of a final qualifying paper	
		de jure	de facto
1	2	3	4
1.	Approval of the Task of the FQP (Ukrainian)	02.11.2020	
	Approval of the Task of the FQP (English)	23.11.2020	
2.	Submission of an <b>article</b> to the Banking department (English), paper and electronic versions	29.03.2021	
3.	Part I. List of sources used (references)	19.04.2021	
4.	Part II. List of sources used (references)	21.06.2021	
5.	Part III, Introduction, Conclusions, References	01.10.2021	
6.	Submission of the FQP to the Banking department (all Parts, appendices), <b>resume</b> of a scientific adviser	22.10.2021	
7.	Preliminary FQP' protection at the Banking department, <b>review</b> (KNUTE, Ukraine), <b>review</b> (KNUTE, English)	02.11.2021	
8.	Submission of completed (intertwined) the FQP to the Banking department, supporting documents (summary, supporting data, three reviews)	22.11.2021	
9.	Public FQP' protection in the examination commission		

7. Date of receiving the task \_\_\_\_\_, \_\_\_\_\_, 20\_\_\_\_.

8. Scientific adviser of the final qualifying paper

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10. The task received by the student

Zhylych Tetiana A. \_\_\_\_\_

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## 11. Resume of a scientific adviser of a final qualifying paper

Student ZHYLYCH TETIANA ANDRIIVNA completed the final qualifying paper on a topic on Financial institutions currency risk management.

While working on the research, the student used all the knowledge and practical skills acquired during her studies in the English-speaking master's program in "Financial Intermediation".

Advantages of the final qualifying paper are results that made possible to formulate the scientific novelty that the successful operation of the financial institutions as a whole largely depends on the chosen tactics of currency risk management. The purpose of the financial risk management process is to limit or minimize them, as it has happened that it is impossible to completely avoid risks.

According to the results of the final qualifying work, some parts were presented in scientific work at the VIII International competition of student research papers: Credit and banking system: history, modernity and prospects by Kyiv National Economic University, which got the prize place (diploma of the II degree).

In general, the submitted work achieves the goal, content and design meets the conditions for writing such work. This qualifying work can be admitted to the defense and deserves a high score.

Scientific adviser of a final qualifying paper \_\_\_\_\_

(last name, initials, signature)

Note about preliminary paper defence \_\_\_\_\_

(last name, initials, signature)

## 12. Resume about a final qualifying paper

A final qualifying paper of the student Zhylych Tetiana A. \_\_\_\_\_

(last name, initials)

can be admitted to defence in the Examination Board.

Head of the project team

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\_\_\_\_\_ . 2021

## Contents

INTRODUCTION .....	3
PART I THEORETICAL FUNDAMENTALS OF CURRENCY RISK MANAGEMENT OF A FINANCIAL INSTITUTION .....	6
PART II ANALYSIS OF CURRENCY RISK MANAGEMENT OF A FINANCIAL INSTITUTION .....	15
2.1 Analysis of currency risk indicators in Ukraine and the studied financial institution .....	15
2.2 Features of currency risk management in foreign countries and Ukraine .....	22
PART III WAYS TO IMPROVE CURRENCY RISK MANAGEMENT OF FINANCIAL INSTITUTIONS .....	32
3.1 The main directions of improving currency risk management in Ukraine .....	32
3.2. Forecasting the currency risk of financial institutions .....	38
CONCLUSIONS AND RECCOMENDATIONS .....	46
REFERENCES .....	49
APPENDICES .....	54

## INTRODUCTION

**Relevance of research.** Stable development of the financial system and its competitiveness directly depend on effective currency risk management, as the foreign exchange market is one of the largest segments of the financial market, and foreign exchange transactions are among the most complex and risky banking operations.

**Analysis of recent research and publications.** Many domestic and foreign scientists, economists, researchers, such as: T.A Vasilieva [1], N.G Volyk [2], A.O Epifanova [1], S.M Kozmenko [1], K.T Sveshnikova, [3] M.A Rebryk [4], L.A Push [5], I.V Popova [6], L.O Primoska [7], and others, has paid attention to the issue of currency risk management, its study. Nevertheless, today the scientific and methodological principles of creating a mechanism for currency risk management in Ukrainian institutions are still insufficiently researched and developed.

**The aim of the research** is the analysis of scientific and methodological approaches and development of practical recommendations for currency risk management of a financial institution. Achieving this goal is realized through the achievement of the following objectives:

- to consider the essence of currency risk and systematize its types;
- to explore methodological approaches to the analysis of currency risk of financial institutions;
- to describe the information management of currency risk;
- to analyze indicators of currency risk in Ukraine
- to identify ways to optimize the management of currency risk of the financial institution.

**The object of research** is the process of currency risk management of a financial institution.

**The subject of research** is theoretical, methodological and practical aspects of currency risk management of a financial institution.

**Research methods.** During the consideration of the tasks were used general theoretical and economic-statistical methods. The study was conducted using meth-

ods of analysis (economic and regression; systemic and comparative) and synthesis (to reveal the nature of currency risk, classification and typology (to determine the criteria for classification of currency risk of a financial institution), a systematic approach.

**Information base work:** normative-legal acts and methodical recommendations of state authorities of Ukraine, international organizations; official statistical materials of the National Bank of Ukraine; scientific and analytical publications of domestic and foreign researchers on currency risk management.

**The scientific novelty** of the obtained results lies in the deepening of theoretical provisions and substantiation of a set of measures aimed at the practical solution of problems of currency risk management of financial institutions.

- different approaches to the definition of "currency risk" *are analyzed*;
- *received further development*: analysis of the main indicators of currency risk of a financial institution, features of currency risk management of financial institutions in Ukraine, study of currency risk management strategies of financial institutions;
- *improvement* of methodological bases of selection and application of methods of assessment, regulation and control of all types of currency risk taking into account the specifics of their manifestation in the financial sphere.

**The practical significance of the obtained results.** The obtained results can be used by the management staff of financial institutions to improve the management of foreign exchange, as well as risk managers. In particular, practical recommendations have been developed to improve the algorithm for making management decisions regarding the management and hedging of currency risk of financial assets, namely: improving the technical support for the correct calculation of risk and its indicators, testing to determine sensitivity to risk.

**Personal contribution of the master.** The final qualifying work is an independent completed research of the author.

**Publications.** According to the results of the final qualifying work, an article was published: Zhylych T.A. Theoretical fundamentals of currency risk management



of a financial institutions. *Financial institutions in the context of global imbalances: a collection of scientific articles by students / resp. ed. N. Shulga.* - Kyiv: Kyiv National University of Trade and Economics, 2021. - 386 p. Also, some results were presented in scientific work at the VIII International competition of student research papers: *Credit and banking system: history, modernity and prospects / resp. ed. L. Prymostka.* - Kyiv: Kyiv National Economic University, 3 June 2021.

**The structure of scientific research.** The work consists of an introduction, three sections, a conclusion and a list of sources used from 56 titles and 6 appendices. The volume of the work is 48 pages. The work contains 11 tables, 12 figures.

## **PART I**

### **THEORETICAL FUNDAMENTALS OF CURRENCY RISK MANAGEMENT OF A FINANCIAL INSTITUTION**

All participants in the international foreign exchange market are exposed to currency risks, namely the risk of losses in carrying out certain operations. Currency risks are associated with inflation and exchange rate fluctuations. If exchange rates were fixed, there would be no currency risks [8, p. 385].

The issue of risk and return is one of the key issues in financial and production activities of economic entities, including financial institutions. Stable development of the financial system and its competitiveness directly depend on effective currency risk management. Analysis of the opinions of different economists on the nature, specifics and structure of currency risks revealed their diversity. That is why it is important to study certain types of currency risk of banks and institutions that provide financial services because, although there are already some scientific publications in this area, today it is still insufficiently researched and developed scientific and methodological principles for creating a mechanism for currency risk management in Ukrainian financial institutions .

Issues related to currency risk are covered in the studies of foreign scholars: M. Adler, A. Gassem [9], D. Murphy, M. Papayoanu, K. Redhead [10], A. Shapiro [11], A. Stonehill and others. In the domestic literature, studies of the nature and types of currency risk are reflected in the works of famous Ukrainian scientists and practitioners: O. Butuk [12], V. Vitlinsky [13], A. Galchinsky [14], O. Krykliy [15], L. Pri-mostki, I. Sala and others. Their publications highlight different views on the typology of currency risks, but due to the complexity and multifaceted nature of the category today there is no single approach to defining the concept of "currency risk", distinguishing its varieties.

Currency risk is the existing or potential risk to income flow and capital that arises due to adverse fluctuations in foreign exchange rates and prices for bank metals [16]. In Accounting Regulation (Standard) 13 "Financial Instruments" [17] the na-

ture of currency risk is disclosed from an accounting point of view as the probability that the value of a financial instrument will change due to changes in exchange rates.

In the scientific literature there are different approaches to determining the category of currency risk. (App. A) Other authors argue that currency risk is the possibility of losses from changes in the value of foreign currency relative to national [18, 183], the possibility of mismatch of exchange rates to the values expected by decision-makers under market factors [19], the amount of opportunity costs for the chosen strategy of currency risk management, and at the final stage of management it is a measure of qualitative and quantitative assessment of unforeseen changes in the exchange rate "[20, 73].

Such interpretations of the category of currency risk do not reflect all its specifics, as it may deviate in different directions from the expected value, ie to have both unforeseen losses and profits. Thus, MA Rebryk [21] after a thorough study of economic categories "risk" and "currency risk" proposed the author's definitions, highlighting the main areas of currency risk: as the probability of loss, as uncertainty about the consequences of actions, as events, as exposure, holding positions. Based on this, he provides the following interpretation of the category of currency risk: a combination of risk source (which is short-term and long-term fluctuations in exchange rates), currency exposure (which characterizes the degree of loss or income) and consequences (which are ultimately expressed) in the scale of losses or additional benefits for the bank) "[21, 139–140]. But currency risk is not a purely banking risk, it is subject to all owners of both foreign and national currencies (government, organizations, individuals).

The economic essence of currency risk of a financial institution is that it is a consequence of imbalance of assets and liabilities in each of the currencies in terms and amounts and is associated with the internationalization of the banking market, the operation of transnational banks and companies, capital migration between countries and speculative growth of currency transactions. [22].

For a bank that buys one currency and sells another, the possibility of risk depends on its currency position, ie on the ratio of claims and liabilities of the bank in

foreign currency. If the requirements and obligations for a particular currency are equal, the currency position is considered closed, and in case of mismatch - open. An open currency position can be short if the liabilities and liabilities on the sold currency exceed the assets and claims on it, and long if the assets and claims on the purchased currency exceed the liabilities and liabilities. An open position, both long and short, is always associated with the risk of loss, if by the time of purchase of previously sold currency and sale of previously purchased currency of these currencies will change in an unfavorable direction for the bank.

Currency risk is difficult to classify on clear universal grounds due to:

- the presence of a variety of currency risks that are constantly faced by financial institutions in their activities;
- the impossibility of drawing clear boundaries between them due to their close ties with each other;
- the rapid development of the currency sector, which gives rise to their new types and types;
- the difference in the intensity and dynamics of currency risks.

Appendix B provides a classification of types of currency risk according to various classification criteria.

Exchange rates depend on a large number of factors that cause currency risks. The structure of currency risks is heterogeneous: they are divided into groups depending on the factors of their occurrence. There are three groups of currency risks in table 1.1.

Economic currency risk is the most common type of risk associated with exchange rates. It includes both operational and settlement risks. The consequences of economic currency risk caused by unexpected exchange rate fluctuations can be faced not only by international firms, but also by firms that are not related to foreign agreements.

Table 1.1

**TYPES OF CURRENCY RISK\***

settlement (translation, balance)	the source is a possible discrepancy between assets and liabilities denominated in currencies of different countries
economic currency risks (economic exposure)	are defined as the probability of adverse effects of the exchange rate on the economic situation of the company (bank)
operational (conversion) currency risks (transaction exposure)	represent the possibility of losing profits or incurring losses due to exchange rate fluctuations on the expected cash flows

*\*compiled by the author based on the source[23]*

The factors that influence the financial institutions exposure to currency risk are:

- ♣ Structural factors regarding the nature and extent of the bank's currency operations.
- ♣ Strategic factors targeting the efficiency of hedging activities, volume and term matching between currencies and national currency, vulnerability to the real economic value of hedging instruments.
- ♣ External factors including economic, market conditions, competition, technological and legislative changes.

The basic factors that determine the currency risk are:

- ♣ At the microeconomic level: interest rate fluctuations; the economic situation of the trading partner; the level of development of the foreign exchange market in sight and in time; the level of the modernization of the external settlements; the level of operational information on the evolution of the exchange rate; subjective factors.
- ♣ At the macroeconomic level: the pace of economic growth; inflation level; the state of public finances; the balance of payments and trade situation; capital migration.

The exchange rate risk includes other risks that may arise from: the specific volatility of the respective currencies, the correlations between the currencies held in

the portfolio or the devaluation of the currencies and may occur in the following environments:

- ♣ In a pure floating-rate environment, the value of the currency is free to be appreciated or impaired, depending on market movements. Such an example Euro/American Dollar.

- ♣ In a fixed-rate environment, the value of the currency is anchored or linked to another currency, such as the Hong Kong Dollar against the US dollar. This leads to the elimination of risk, which may occur as a result of changes in the parity value of the currency, by devaluation or valuation

- ♣ In case of a change in the currency regime, a fixed rate becomes floating or vice versa.

The essence of the currency risk management system of a financial institution should be considered in the context of the overall risk management system. Thus, the use of a systematic approach to defining the essence of risk management allows to identify and characterize its elements taking into account the peculiarities of their interaction with each other [24]. The mechanism is a system of interrelated organizational, economic and managerial methods that ensure the implementation of strategic objectives of the financial institution.

In addition, there is a legal framework governing foreign exchange transactions and the risks associated with them are: Law of Ukraine "About Currency and Foreign Exchange Transactions"[25], Resolution of the NBU Board of 02.01.2019 № 1" About approval of the Regulations on the structure of the foreign exchange market of Ukraine, conditions and procedure for trading in foreign currency and bank metals on the foreign exchange market of Ukraine "[26], Resolution of the Board of the NBU dated 02.01.2019 № 5 " About approval of the Regulations on protection measures and determination of the procedure for certain operations in foreign currency.[27]

The subjects of currency management are the following functional and structural units: the supervisory board, the board of the financial institution, the risk management unit, internal audit services, back offices, front offices.

The object of management in the system of currency risk management is currency risk, which can be represented as a system of certain types of currency risk, each of which, in turn, consists of the source of risk, exposure to it and the consequences of its implementation. Thus, currency risk management involves the influence of the entity on certain elements of currency risk.

For the proper functioning of the currency risk management mechanism in a financial institution, its provision should be established, which consists of:

- methodological support;
- logistics;
- information support;
- regulatory support;
- staffing.

The primary task in the process of currency risk management is its detection[5]. At this stage, is determining the size of the open currency position and the degree of its risk. Detailed monitoring of changes in the size of the open position and compliance of current indicators with the established standards is the key to stable operation of the financial institution.

An equally important stage of currency risk management is the assessment of its magnitude. Correct quantification of currency risk is a very complex and important task.

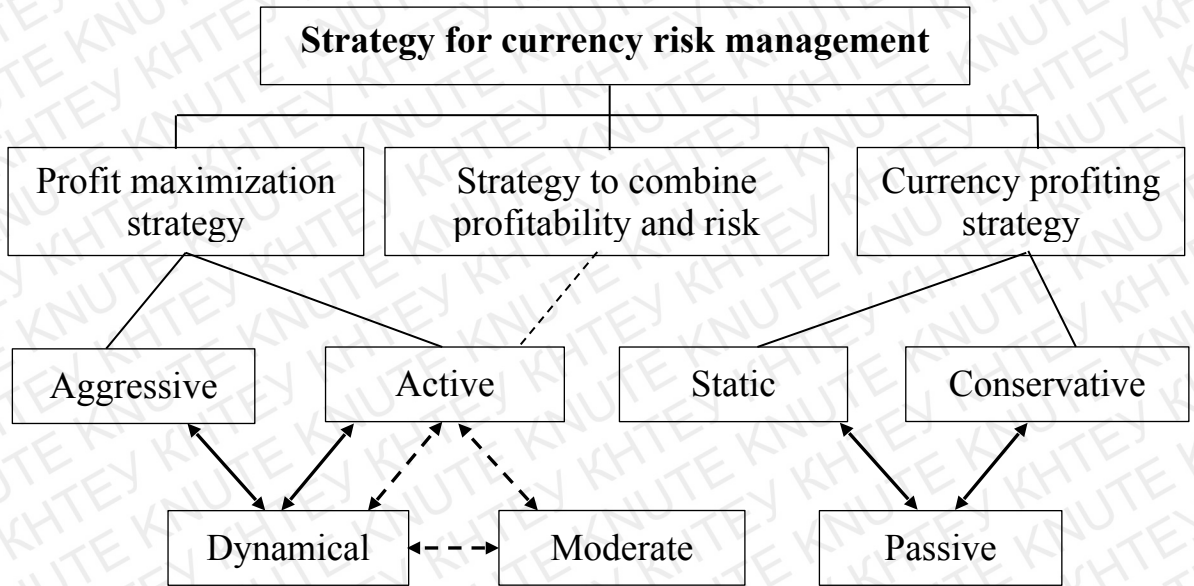
The next step is to choose a method of currency risk management, so in order to fully cover this issue, we grouped the methods on [16,22]:

- external: structural balancing of currency flows by terms and amounts; forward currency agreements;
- internal: limitation; conducting current conversion operations; method of advance and lag (change in terms of foreign currency payments); discounting of payment claims in foreign currency.

It is substantiated that the control and monitoring of selected methods of currency risk management and assessment of their effectiveness will improve the existing management system in the bank as a whole.

At the last stage of currency risk management, the risk is constantly monitored with a feedback mechanism to determine whether the strategic goal of the financial institution has been achieved. In order to identify in time the deviations of the actual results of currency risk management from the planned indicators and to take appropriate corrective measures to achieve the goals of the financial institution, monitoring, control and audit procedures are developed and implemented.

Also, the choice of currency risk management methods depends on the strategy guided by the financial institution during the currency risk management process. In the process of currency risk management, the bank can apply two alternative strategies, keeping the currency position closed (currency matching strategy) or open (profit maximization strategy). There is also a combined strategy, which involves alternating the other two strategies. (Fig 1.1) An asset and liability management strategy that balances the currency structure of the balance sheet is called currency matching. The application of this strategy allows the bank to avoid a significant part of currency risk.



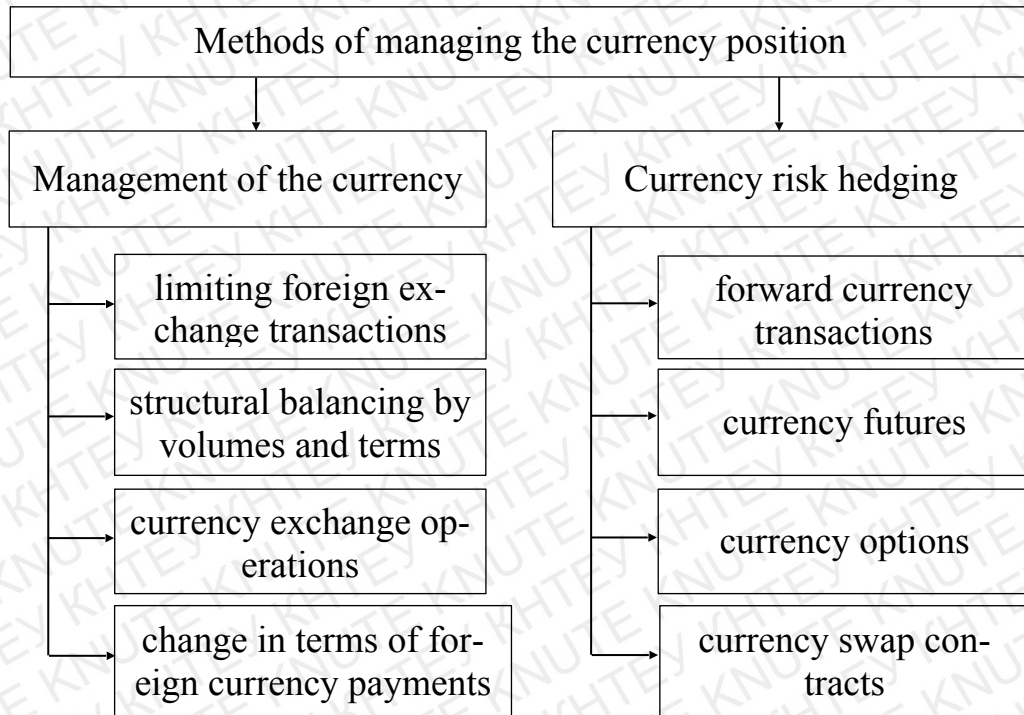
*Fig. 1.1 Classification of the bank's strategies for currency risk management\**  
 \* Compiled by the author based on the source[22]



However, this strategy does not completely eliminate it, as there is a risk associated with the repatriation of profits from international activities or the payment of dividends in foreign currency.[22]

There is also an alternative strategy - profit maximization. Its essence is that market participants "play" on exchange rates to make profits of a speculative nature, leaving the currency position open and deliberately exposing themselves to increased risk.[16]

Due to the fact that the rates of absolutely all currencies, including the reserve currency - the US dollar, are subject to periodic fluctuations due to various objective and subjective reasons, the practice of international economic relations has developed approaches to choosing a strategy for protection from currency risks ( Fig. 1.2).



*Fig. 1.2 Methods of managing the currency position\**

*\* compiled by the author based on the source[38]*

The application of the first group of methods affects the currency structure of the balance sheet and limits the negative consequences associated with the revaluation of foreign exchange financial instruments, which are traditional methods of currency position management, the implementation of which is fully covered in econom-

ic, scientific and practical literature. [38]But the management of the currency position through the implementation of balance sheet transactions does not always correspond to the strategic and tactical plans of financial and economic activities of the banking institution, and is sometimes unprofitable in terms of costs. However, Ukrainian banks are forced to use such operations due to the lack of necessary conditions for the application of modern methods of currency position management, in particular, such as concluding foreign exchange agreements with derivative financial instruments.

In this regard, it should be noted that the hedging method provides for a certain level of protection against the effects of currency risks by concluding additional futures agreements on foreign currency, which aim to compensate for possible financial losses due to exchange rate changes, and activities related to currency risk hedging. , has a certain specificity and requires relevant knowledge about the mechanisms of its implementation.

Therefore, currency risks are an integral part of the activities of financial institutions, so the effective organization of the risk management mechanism should be one of the key competitive advantages of the institution. Banks should pay considerable attention to both the functional component of the mechanism and the component of formation, adhere to all stages of the currency risk management process, use different risk assessment techniques to be able to more effectively manage risks, reduce the risk of their occurrence and, if necessary, minimize them. ensure the stability of revenues and increase financial stability.

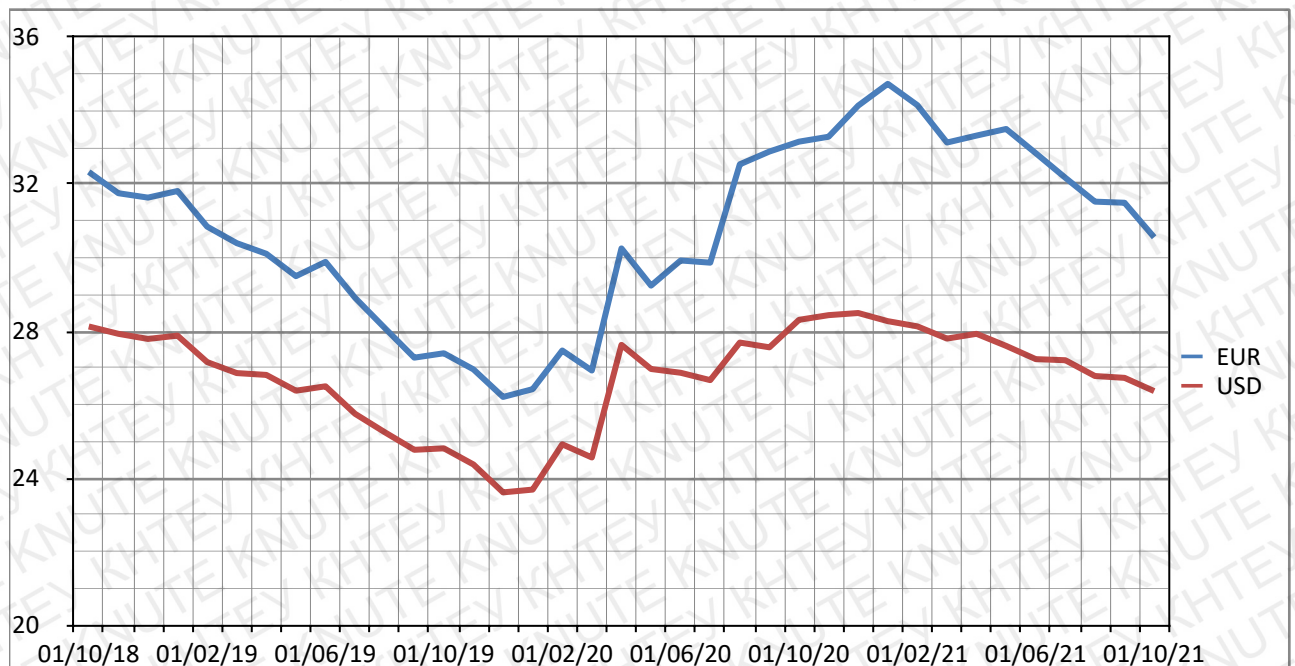
## PART II

### ANALYSIS OF CURRENCY RISK MANAGEMENT OF A FINANCIAL INSTITUTION

#### 2.1 Analysis of currency risk indicators in Ukraine and the studied financial institution

In almost all developed countries there is a regime of flexible exchange rate formation, in which the exchange rate of the national currency is determined by the market. The National Bank of Ukraine abandoned the fixed one and introduced flexible exchange rate formation in 2015. Since then, the flexible exchange rate regime has been an important element of inflation targeting policy and has been a major safeguard against the accumulation of imbalances in the economy.

Since, in the last period, there have often been cases in which the exchange rate of the major international currencies has varied greatly (fig.2.1), hedging currency risk becomes a necessity for any bank or another financial institution.



*Fig.2.1 Change in the exchange rate of the Euro and the Dollar against the Hryvnia for 2018 – 2021\**

*\* compiled by the author based on the source[28]*

In Ukraine, currency risk is quite important because most banks are licensed for such operations that they offer to customers and that they use and as a way of protecting capital and assets under high inflation conditions.

The main indicator of currency risk of a financial institution is its currency position. Currency position (foreign exchange position) - the ratio of assets and liabilities of the bank in each foreign currency and in each bank metal. With their equality it is considered closed, and in case of inequality - open.[29]

For each currency, assets are compared with liabilities, resulting in two distinct positions: Short currency position, when the total of liabilities exceeds the total of the assets; long currency position (Long), when the total of the assets exceeds the total of the liabilities. A certain currency position may become favorable or unfavorable for the banking company, depending on the evolution of the exchange rate of the national currency against the respective currency (table 2.1).

The common currency position is the sum of on-balance sheet and off-balance sheet currency positions. This position is calculated for the purpose of evaluation and analysis the total volume of foreign exchange transactions of the bank.

*Table 2.1.*

**THE INFLUENCE OF THE EXCHANGE RATE VARIATIONS ON THE BANK'S RESULTS\***

<b>Currency position</b>	<b>Depreciation of the national currency</b>	<b>Appreciation of the national currency</b>
Short currency position	unfavorable	favorable
Long currency position	favorable	unfavourable

*\*compiled by the author based on the source[29]*

In order to control the stability of the financial institution, the National Bank of Ukraine introduced certain restrictions. That is limits on the open foreign exchange position - a quantitative restriction (as a percentage) set by the National Bank of Ukraine on the daily value of currency positions opened by the bank, namely.[30] The purpose of setting such limits is to ensure stability in the foreign exchange market and limit the negative impact on its condition of transactions for the purchase and sale of foreign currencies and bank metals carried out by authorized banks.

The National Bank of Ukraine establishes:

1. The limit of the total open currency position of the bank (L13) - the ratio of the total value of the open currency position of the bank for all foreign currencies and bank metals in hryvnia equivalent to the regulatory capital of the bank.
2. The limit of the total long open currency position of the bank (L13-1) - the ratio of the amount of excess of claims on foreign currency and bank metals over the amount of liabilities in hryvnia equivalent to the regulatory capital of the bank.
3. The limit of the total short open currency position of the bank (L13-2) - the ratio of the amount of excess of liabilities in foreign currency and bank metals over the amount of claims in hryvnia equivalent to the regulatory capital of the bank[30].

Thus, the currency position of the bank is a traditional indicator of currency risk - an integral part of modern banking. Therefore methods currency risk insurance, methods of managing assets and liabilities in foreign currency earned by participants in the international foreign exchange market during its operation, and especially by banks, have an object of their own influence is the currency position.

To analyze the currency risk in Ukraine, we decided to consider the performance of systemically important financial institution – banks, in Ukraine according to the NBU. Figure 2.2 shows the analysis of the long open currency position.

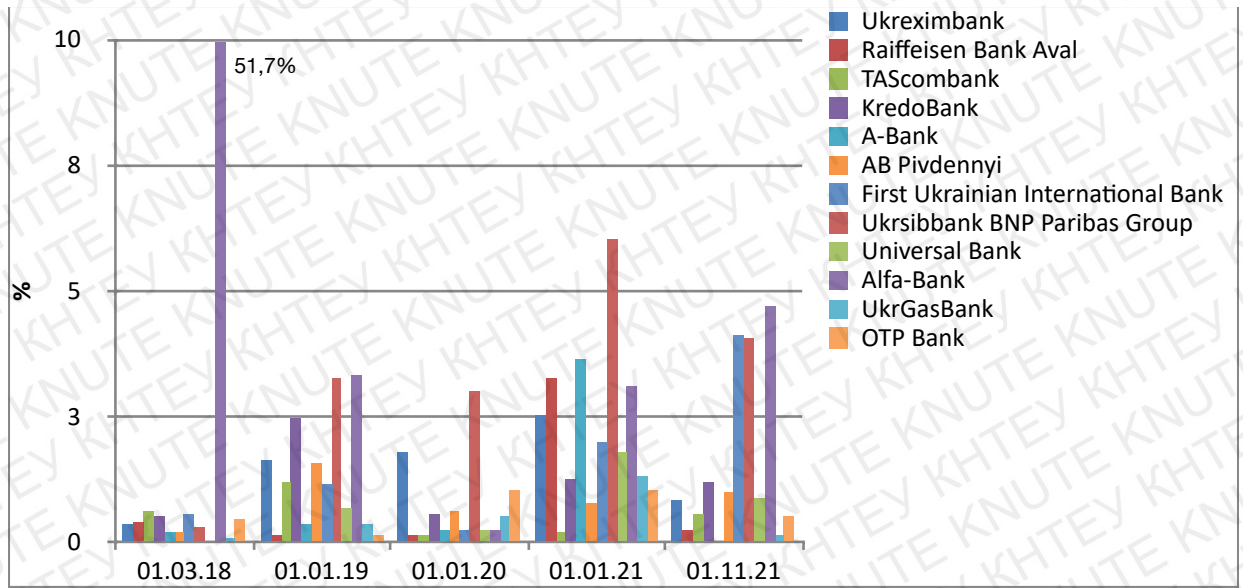


Fig. 2.2 Dynamics of the indicator L13-1 for 01.03.2018-01.11.2021\*

\* compiled by the author based on the source[31]

This indicator should be no more than 10% since January 2020 (no more than 5% in 2018-2019) , and as we see, in systemically important banks shown in the figure, this figure is normal. However, if we consider the two largest and most significant banks for Ukraine, we can see a completely different picture (fig. 2.3).

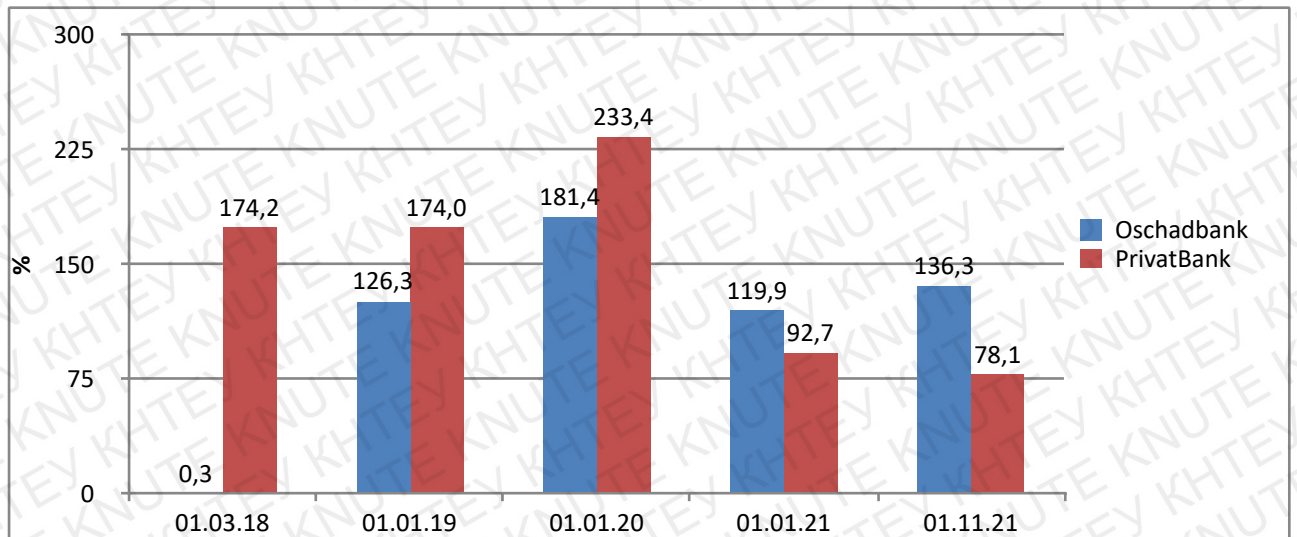


Fig.2.3 Dynamics of the indicator L13-1 for 01.03.2018-01.11.2021\*

\* compiled by the author based on the source[31]

It is possible to notice that values on a scale of percent are much bigger, and considerably exceed norm. However, you should not worry, because this is due to the

fact that these banks may be subject to special requirements, as they are the largest banks of national importance. It also indicates that banks have significantly more foreign currency claims than liabilities, and therefore, if properly managed currency risk, can receive additional income. It is much more dangerous for a bank, when on the contrary, it has a significant open short currency position, because it indicates that the bank has a significant amount of liabilities in foreign currency, which at an unfavorable exchange rate can be dangerous. In Figure 2.4. the dynamics of the indicator L13-2 is shown - the risk ratio of a short open currency position.

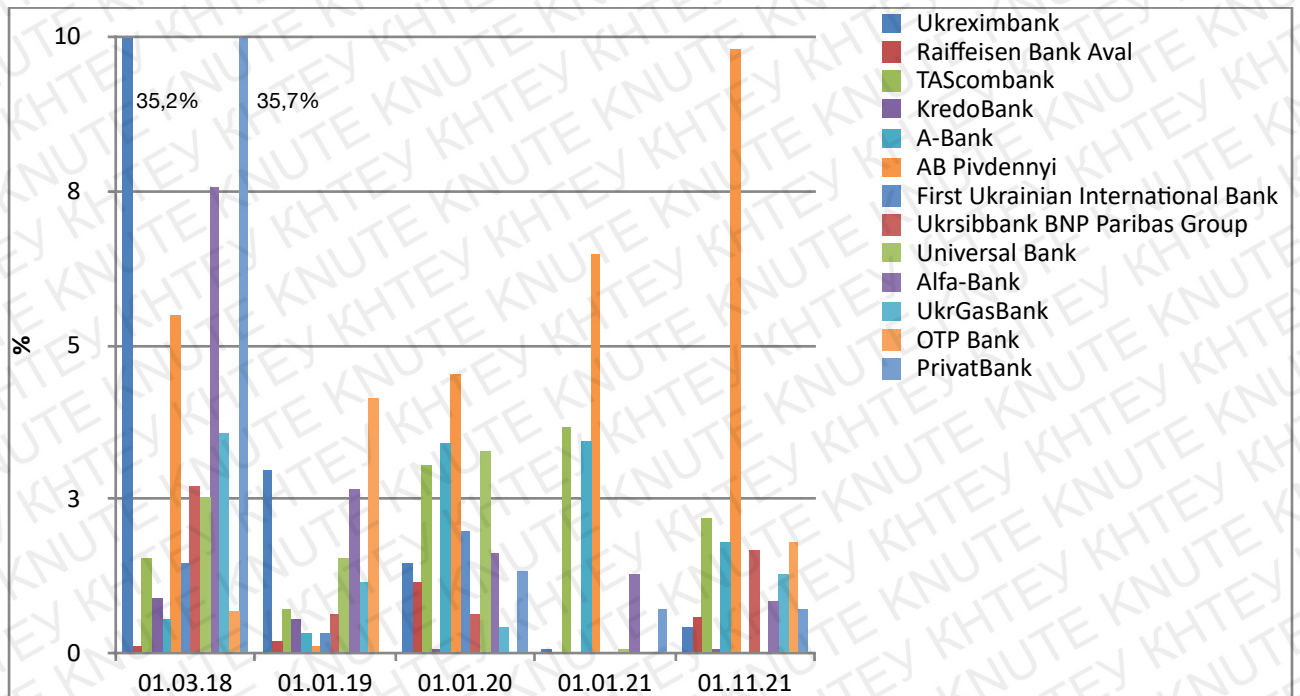


Fig. 2.4 Dynamics of the indicator L13-2 for 01.03.2018-01.11.2021\*

\* compiled by the author based on the source[31]

As we can see since 2019 and up to date, the indicators of all banks are normalized and do not exceed the allowable threshold.

Regarding JSC Oschadbank (fig. 2.4), we can see that only in 2018 the indicators significantly exceeded the norm, but next year and to this day the indicators have stabilized, which can be assessed as a positive trend in the bank.

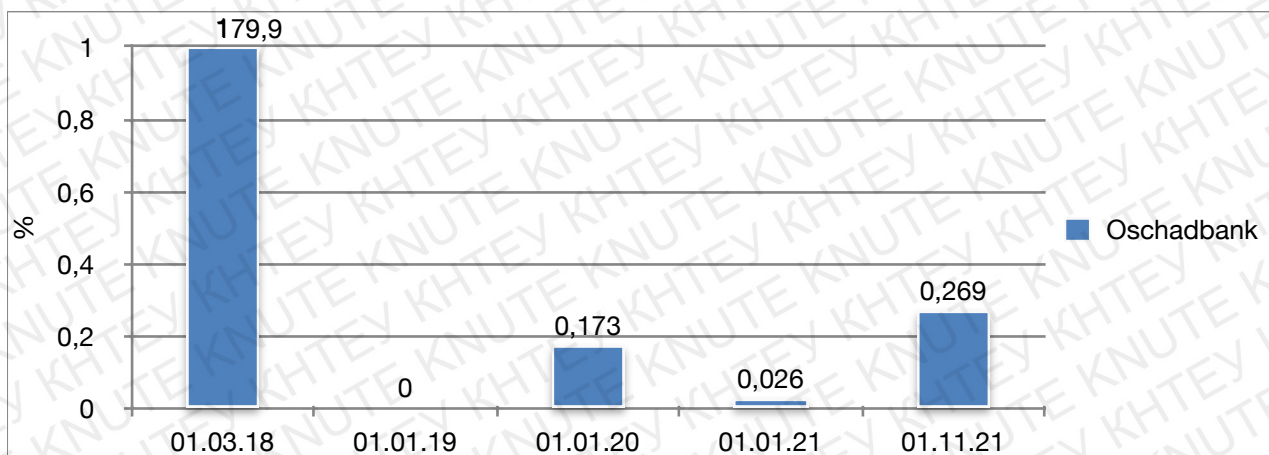


Fig. 2.5 Dynamics of the indicator L13-2 for 01.03.2018-01.11.2021\*

\* compiled by the author based on the source[31]

Also from December 1, 2021, the National Bank increased the limits of the open long and short currency position of banks from 10% to 15% of their regulatory capital. According to NBU estimates, the increase in limits will expand the ability of banks to conduct their own operations in the interbank foreign exchange market within the currency position in the amount of about \$ 400 million. USA. This will help increase the role of banks in smoothing excessive exchange rate fluctuations in the foreign exchange market and increase liquidity and market depth in general.

Looking at the reporting of the researched financial institution JSC "Oschadbank", namely the analysis of the impact of currency risk on the activities of the Bank (table 2.2), we can once again see that the Bank has a long open currency position.

Table 2.2

### DYNAMICS OF OSCHADBANK'S OPEN CURRENCY POSITION\*

(million UAH)

	US dollars		Euro		Deviation	
	2019	2020	2019	2020	in USD	in EUR
<b>Financial assets</b>						
Cash and equivalents	40 932	11 954	2 957	3 432	-28 977	475
Funds in banks	0	0	44	0	0	-44
Loans to customers	17 304	1 392	8 768	11 046	-3 382	2 278
Investments	65 320	50 214	0	2 781	-15 106	2 781
Other financial assets	40	30	24	41	-9	16



continuation of table 2.2

	US dollars		Euro		Deviation	
	2019	2020	2019	2020	in USD	in EUR
<b>Total financial assets</b>	<b>123 598</b>	<b>76 121</b>	<b>11 794</b>	<b>17 302</b>	<b>-47 476</b>	<b>5 507</b>
<b>Financial liabilities</b>						
Bank funds	18	252	13	70	234	56
Customer accounts	90 824	53 168	7 244	12 384	-37 655	5 139
Loans received	18 303	11 744	0	0	-6 558	0
Other borrowed funds	1 076	772	3 301	3 629	-303	327
Other financial liabilities	177	212	0	0	34	0
Subordinated debt	2 462	1 276	0	0	-1 186	0
<b>Total financial liabilities</b>	<b>112 862</b>	<b>67 427</b>	<b>10 560</b>	<b>16 083</b>	<b>-45 435</b>	<b>5 523</b>
<b>Currency position</b>	<b>10 736</b>	<b>8 694</b>	<b>1 234</b>	<b>1 219</b>	<b>-2 041</b>	<b>-16</b>

*\*compiled by the author based on the source (App. C)[32]*

In terms of dynamics, we see that the open currency position has decreased significantly in US dollars, and there is a slight change in the Euro. You can also see that the change in the currency position of the bank in US dollars was affected by a decrease in both assets and liabilities. As for the Euro, on the contrary, there was a significant increase in assets and liabilities, but by almost the same amount, so the currency position has not decreased significantly.

An equally important stage of currency risk management is the assessment of its magnitude. Correct quantification of currency risk is a very complex and important task. Having data on currency positions in terms of currencies, you can calculate this value using VaR (Value at Risk) - methodology for assessing currency risks.

VaR is a probabilistic-statistical approach to determine the ratio of price indicators and risk, the main concept in it is the distribution of probabilities, which connects all possible magnitudes of changes in market factors with their probabilities [33]. VaR is a cost measure of banking risk. This is an estimate in monetary terms of the value that will not exceed the expected losses for a given period of time with a given probability. More details about the calculation are given in section 3.2.

In that calculation, we are able to predict the amount using the exchange rates of previous periods, which in 99% will not exceed the costs of the next day. Usually the forecasting period does not exceed 10 days. In the same way VaR is calculated by other non-bank financial institutions.

In banking practice 99% VaR is used more often when other institutions can use 95% VaR. Accordingly, 99% VaR tells us that exchange rates with a probability of 99% are not able to change so much that the losses exceed the calculated value.

In addition, banks are required to perform analysis to changes in exchange rates (sensitivity analysis). The app. D provides an analysis of the sensitivity of Oschadbank Group to the increase and decrease of the US dollar and euro against the hryvnia as a result of possible changes in exchange rates. [32] The level of sensitivity is used by the Group in compiling currency risk reports for the Group's senior management and is an assessment by the Group's management of possible changes in exchange rates [32].

Currency risk is inherent in almost all financial institutions, as Ukraine has a floating exchange rate regime. The main indicators that allow you to analyze and track the possibility of currency risk is an open currency position, so its management should pay close attention.

## **2.2 Features of currency risk management in foreign countries and Ukraine**

Taking into account the modern-time practice, it can be argued that excessive openness and integration into global processes of national economies, reduction of regulatory measures and currency restrictions in international and domestic financial markets is accompanied by hypersensitivity and vulnerability to global crisis effects, even for countries with high economic development.

Ukraine, as a country with a transforming economy, cannot level the negative effects of liberalization, protect domestic interests, curb destabilizing foreign capital flows, expansion of dollarization of the domestic economy without the use of certain currency restrictions. Moreover with the internationalization and globalization of

economic life, currency market mechanism gives opportunity to create conditions for significant currency speculation, which leads to the spontaneous movement of hot money, changes in exchange rates, deterioration of monetary and economic stability of the country. With a small capacity of the domestic foreign exchange market, which daily turnover averages \$ 600 million. US, while in the world 6.6 trillion. dol. USA, the lack of currency restrictions makes it highly volatile, and the national currency - unstable and attractive for speculative games.[34]

According to the legislation, the National Bank of Ukraine is tasked with regulating the foreign exchange market in Ukraine. In Art. 45 of the Law of Ukraine "On the National Bank of Ukraine" it is stated that the National Bank determines the structure of the foreign exchange market of Ukraine and organizes trade in currency values in accordance to the legislation of Ukraine on foreign exchange regulation. The National Bank has the authority to determine the official exchange rate of the national currency against foreign currencies and to carry out foreign exchange interventions in order to stabilize the foreign exchange market and reduce foreign exchange risk for banks. The activity in the foreign exchange market is regulated by the National Bank through licensing of foreign exchange operations and establishment of obligatory norms. In particular, the norms of open currency position have been introduced [30].

Currency risk management in Oschadbank JSC is carried out with the help of The Currency Control Department, the Treasury and the Strategic Risk Management and Forecasting Department. They are monitoring the Bank's open currency position on a daily basis. Based on the information prepared by the Currency Control Department, the Treasury and the Strategic Risk Management and Forecasting Department, the Assets and Liabilities Management Committee controls currency risk by managing an open currency position based on the forecast level of hryvnia depreciation and other macroeconomic indicators from significant fluctuations in exchange rates against the national currency. The long open currency position significantly exceeds the norm, which can be seen in the table 2.3.

Table 2.3

**DYNAMICS OF THE LEVEL OF ECONOMIC STANDARDS OF THE  
CURRENCY POSITION OF OSCHADBANK JSC DURING 2017-2021\***

Indicators (%)	2017	2018	2019	2020	2021	Absolute deviation, +/-	
						2020	2021
L13-1	0,299	126,3	181,4	119,9	136,3	-61,5	16,4
L13-2	179,9	0,0	0,173	0,026	0,268	-0,147	0,242

\* compiled by the author based on the source[31]

The currency position of Oschadbank JSC is determined daily, separately for each foreign currency. The size of the open currency position of the authorized bank is affected by:

- purchase (sale) of cash and non-cash foreign currency, current and forward transactions (on the terms of "swap", "forward", "option", etc.), for which there are claims and obligations in foreign currencies, regardless of the methods and forms of payment for them;
- receipt (payment) of foreign currency in the form of income or expenses and accrual of income and expenses that are accounted for in the relevant accounts;
- purchase (sale) of fixed assets and inventory for foreign currency;
- receipt of funds in foreign currency to the authorized capital;
- repayment by the bank of bad debts in foreign currency (which is written off from the relevant expense account);
- other foreign exchange transactions (the emergence of claims in one currency when paying for them in another currency, including national, which lead to a change in the structure of assets with unchanged liabilities, and vice versa).

The state of the currency position of Oschadbank JSC is assessed in terms of the total size, long and short currency position.

One of the main elements of risk management of foreign banks is stress testing, the methodology of which has a high level of standardization, and the development of

generally accepted approaches to not only calculation technologies, but also the formation of scenarios.

Consideration of recent research allows us to conclude that it is widespread use of stress testing, in particular, recent studies by the International Monetary Fund show that in most countries, regulators of financial credit markets set requirements for stress testing [39]. In Ukraine, such requirements are set out in the Resolution “On Approval of Methodological Recommendations on the Procedure for Conducting Stress Testing in Ukrainian Banks”, which was approved by the Resolution of the NBU Board of August 6, 2009 No 460 [40].

During this period, stress testing is one of the necessary components of the risk management system, although at first glance it seems that it plays a secondary role (the reason for this is the probable nature of the indicators used in risk assessment and analysis). In 1996, in the Amendments to the Basel Accord on capital adequacy, which is necessary to cover risks, the amount of capital was set depending on the presence of a stress testing system, which also serves as an effective incentive for the dissemination of this tool [41]. An example is the United Kingdom, where the regulator of financial credit markets proposes to use functional-cost analysis (from the English. - Activity Based Costing) in the review of financial risks, in the analysis of risks and threats to financial stability.

In the table 2.4 shows a comparison of stress testing methods that can be used to control the level of currency risk of the bank in conditions of exchange rate volatility. The NBU conducts stress testing using the scenario analysis method and the VaR method, but notes that each bank has the right to develop its own system of currency risk stress testing.

*Table 2.4*

#### **STRESS TESTING METHOD\***

<b>In Ukraine</b>	<b>According to the recommendations of the World Bank and the IMF</b>	<b>According to the European approach</b>
Scenario analysis	Analysis of probabilistic events	The method of elasticities
Sensitivity analysis	Analysis of the most probable events	Loss estimation method

*continuation of table 2.4*

<b>In Ukraine</b>	<b>According to the recommendations of the World Bank and the IMF</b>	<b>According to the European approach</b>
-	Analysis of moderately adverse events	Scenario analysis
-	Emergency analysis	Index method

*\*compiled by the author based on the source[42]*

The IMF and the World Bank for Reconstruction and Development propose to use "stress testing" techniques, which in some way depend on risk assessment methods and can be developed according to a hierarchy of the following probabilities:

- analysis of probabilistic events;
- analysis of the most probable events;
- analysis of moderately adverse events;
- analysis of extraordinary events "exceptional, but at the same time possible".

The purpose of stress testing in the EU, which is carried out on the recommendation of the EU Ministers of Economy and Finance and coordinated by the European Committee of Banking Supervisors and the European Central Bank, together with national supervisors and the European Commission, is to ensure economic shock

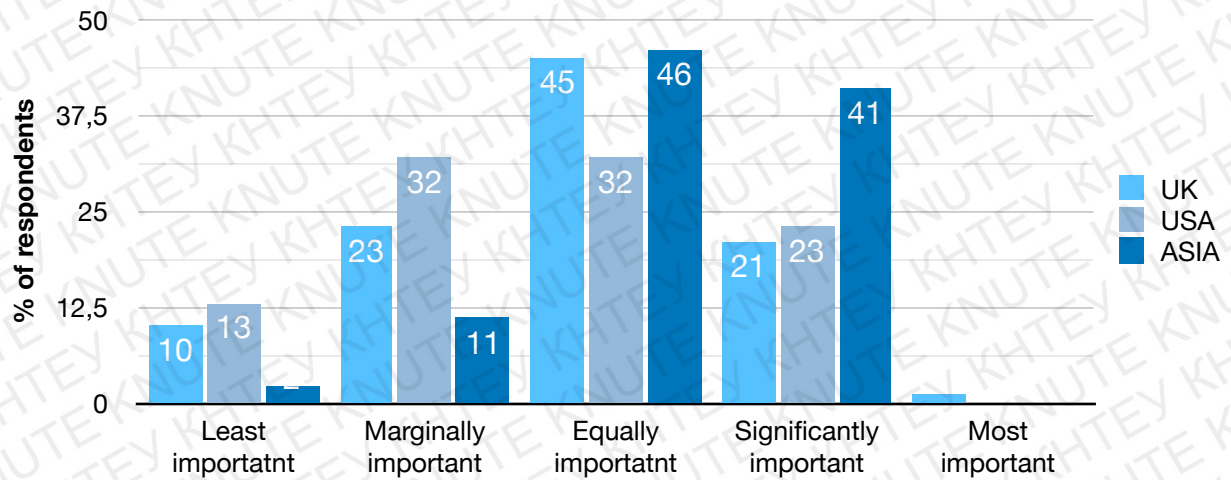
Considering the world experience [43; 44; 45], there are four main methods of stress testing: The method of elasticities; Method of estimating losses; Scenario method; Index method.

In Ukraine, namely in JSC Oschadbank, the identification and assessment of currency risks of a financial institution is usually carried out on the basis of:

- analysis of the Group's open currency positions;
- VAR-methodologies for currency risk assessment;
- concentration analysis;
- analysis of possible scenarios and modeling;
- stress testing [32].

To analyze the methods of currency risk management in the world, three regions were studied, namely North America (USA), Europe (UK) and Asia.

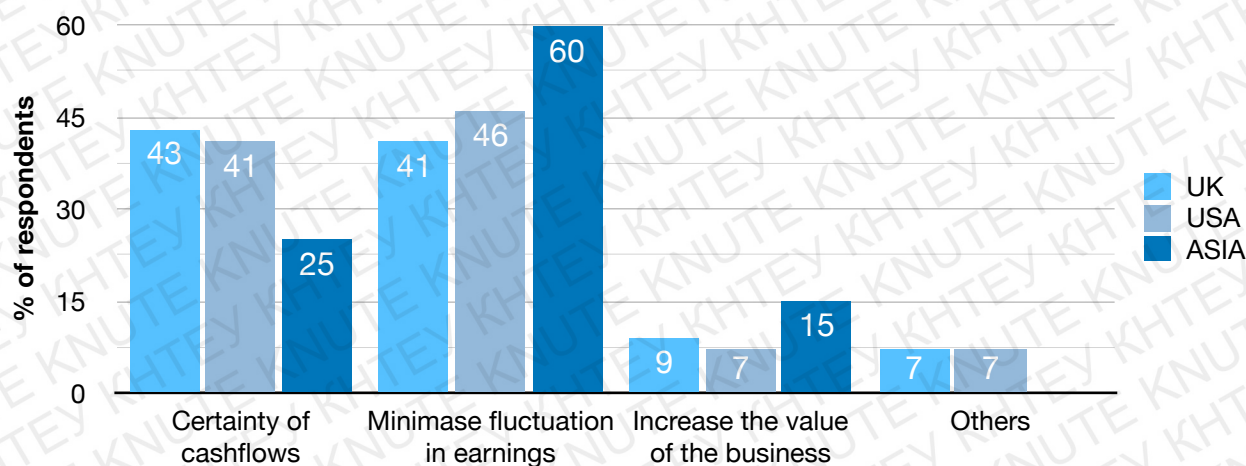
Fig. 2.6 shows the importance of foreign exchange risk management in relation to business risk management for each region. The majority of the respondents stated that foreign exchange risk management is equally or significantly important in relation to business risk management, however, Fig. 2.6 shows a significant difference between the regions.



*Fig. 2.6 A comparison of the importance of foreign exchange risk management to business risk management\**

*\* compiled by the author based on the source[35]*

There was no statistically significant difference between UK and USA financial institutions, but there was a significant difference with both regions and Asia Pacific when considered on a paired basis . In Asia Pacific, a total of 87% of respondent companies rank foreign exchange risk management as equally or significantly important. The Asian crisis, which caused Asian currencies to depreciate by as much as 70% clearly influences this result. It can be seen from Fig. 2.7 there was a significant difference between the objective of managing foreign exchange risk management and the respondent region. Again, this difference is driven by the Asian Pacific as the responses for the UK and USA are very similar with 85% of UK and USA respondents seeking to achieve certainty of cashflow and to minimise the fluctuations of earnings.



*Fig. 2.7 Objectives of managing foreign exchange risk\**

*\*compiled by the author based on the source[35]*

Depending on the object, different methods of currency risk management are chosen. Various methods are used to manage the currency risks of a financial institution. The first step to managing foreign exchange risks within the structure is to set limits on foreign exchange transactions. Thus, for example, the following types of limits are very common:

- limits on foreign countries;
- limits on transactions with counterparties and clients;
- limit of instruments;
- setting limits for each day and each dealer;
- limit of losses.[36]

In addition to the limits according to the world practice the following methods of currency risk management are used:

- mutual offset of purchase and sale of currency by assets and liabilities, the so-called method of "matching", where with the help of deducting the receipt of currency from the amount of its outflow, the bank has the opportunity to influence their size;
- the use of the "netting" method, the meaning of which is in the maximum reduction of the number of currency transactions with the help of their consolidation.



For this purpose, financial institutions create subdivisions that coordinate the receipt of applications for the purchase and sale of foreign currency;

- acquisition of additional information by purchasing information products, specialized firms in real time exchange rates reflecting the movement and the latest information;

- careful study and analysis of foreign exchange markets on a daily basis.[36]

In order to measure currency risk and estimate the amount of possible losses, such techniques as scenario analysis, simulation methods, stress testing, and statistical methods are used, the most common of which is VaR-methodology. [37] Due to the fact that the possibility of accurately determining future changes in exchange rates does not always exist, currency position is considered to be the indicator of the level of currency risk to which the financial institution is exposed due to the imbalance of the structure and volume of assets and liabilities. That is why in the process of currency risk analysis the main attention is paid to the methods of assessment and regulation of the bank's currency position. This approach is based on the fact that the financial business provides services to customers and should not include risk that is not associated with the need to conduct these operations. In fact, a financial institution is an intermediary between the client and the foreign exchange market, so the currency position of such an institution must be set at a level that meets the requirements for the normal conduct of client transactions.

Regarding world practice, the app. E presents a survey of financial institutions, located in USA, UK and Asia, whether the respondents manage translation and transaction exposure and whether they use internal or external methods. The vast majority of respondents' use hedging instruments, only seven of them do not use internal hedging instruments and five do not use external hedging instruments.

Fig. 2.8 (a) shows no significant difference between the regions in the internal methods to manage transaction exposure. Broadly, netting seems to be the most popular technique amid the UK and USA respondents, although matching and pricing policies are also fashionable and many financial institutions are using at least two of

these methods. This is understandable given the similarities in the process of implementing internal methods.

Fig. 2.8 (b) shows that for those financial institutions who manage translation risk balance sheet hedging is the most common method. Many of the financial institutions were only using this method. However, it is less popular in Asia Pacific than the other two regions. This is understandable given the link between the Asian Pacific financial institutions and the smallest size quartile and their lack of investments overseas.

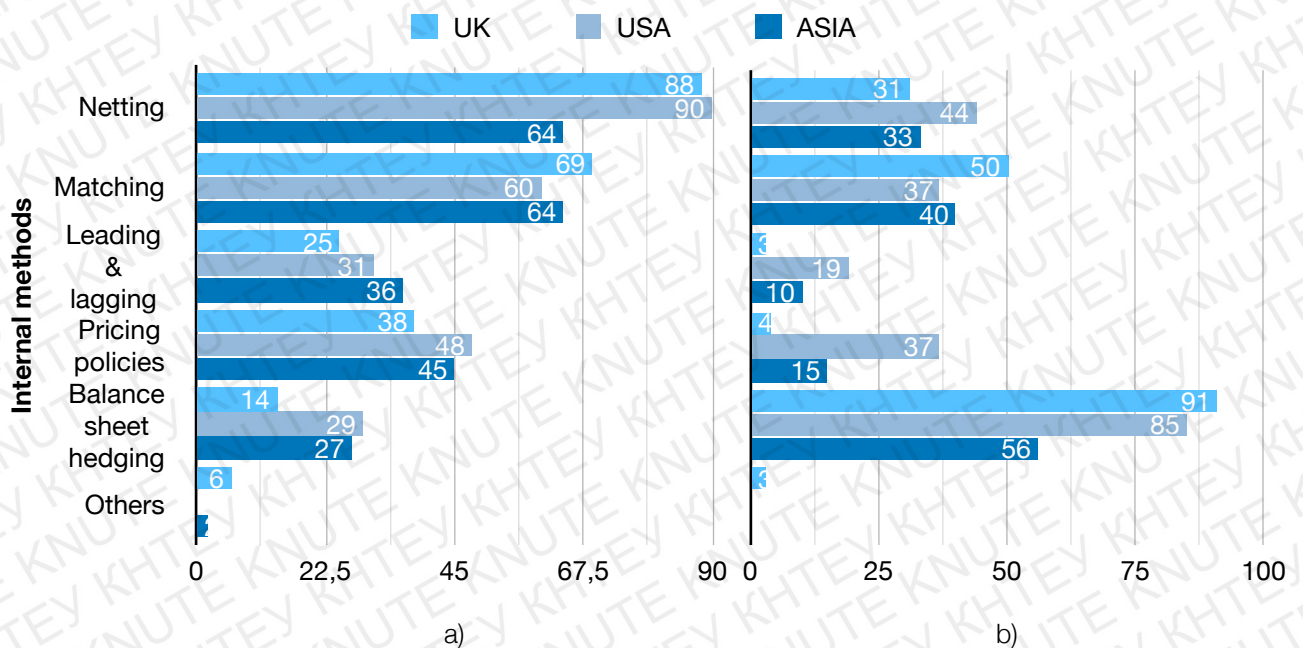


Fig. 2.8 Internal methods used for managing a) transaction and b) translation risk. Respondents could choose more than one method.\*

\*compiled by the author based on the source[35]

In fig. 2.9 (a) we can see three main methods of currency risk management used in all three regions. These methods include forward contracts, options and swaps. With a slight difference, Asia also uses futures as opposed to the USA and the UK. Consequently, fig. 2.9 (b) shows a statistically significant difference between the regions and the use of external methods for managing translation exposure, especially between UK and the other two regions. It is worth noting, despite the small numbers of Asia Pacific and USA financial institutions who manage this exposure, they do so

in a comparatively sophisticated manner as currency options are popular with about half of the respondents in Asia Pacific and the USA. Currency futures are not popular in the UK and USA, but one in five Asia Pacific financial institutions use these derivatives. The Asian Pacific MNCs seem to be the more sophisticated derivative users and have moved on from the simple forward contract.

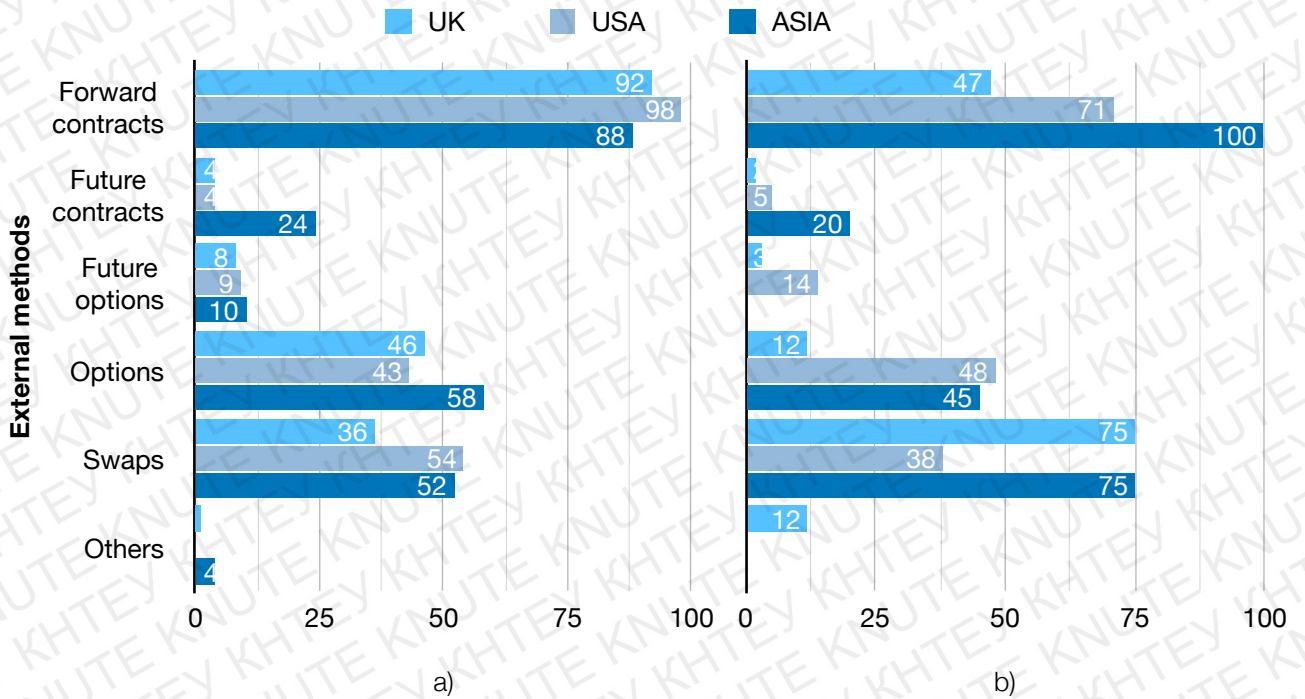


Fig. 2.9 External methods used for managing a) transaction and b) translation risk. Respondents could choose more than one method.\*

\*compiled by the author based on the source[35]

Summing up, we can say that there are two main approaches to currency risk management. This is a method of managing the balance sheet structure and risk hedging. In Ukraine, hedging through futures is not yet widespread enough, but it has great prospects. Also, in Oschadbank JSC one of the main elements of currency risk management is stress testing, which, depending on the approaches, may differ in the method of execution. Like all other banks, Oschadbank is obliged to adhere to limits as methods of risk minimization. In terms of indicators, the short open currency position is normal, and the long open currency position significantly exceeds the allowed level. Therefore, the bank's management should pay attention to this to minimize the risks.

### **PART III**

## **WAYS TO IMPROVE CURRENCY RISK MANAGEMENT OF FINANCIAL INSTITUTIONS**

### **3.1 The main directions of improving currency risk management in Ukraine**

The presence of significant systemic contradictions in the economy of Ukraine increases the threat of destabilization of the situation in the foreign exchange market and complicates the forecasting of exchange rate dynamics. Under such circumstances, the constant increase in the volume of operations of domestic banks with foreign currency causes an increase in their currency risk. The problem is exacerbated by the low efficiency of existing methods and tools for assessing and managing currency risk in banks, as well as the presence of legal restrictions on their operations with foreign exchange derivatives. That is why the improvement of scientific-methodical and practical principles of currency risk management, which will ensure the creation of conditions for its stable and effective functioning, is becoming increasingly important.

Of course, any risk requires clear management by the governing bodies. In the theoretical sense, the concept of management involves the transformation of information about the state of the object in the command information from the subject. This is a purposeful programmed or arbitrary influence on objects in order to achieve the ultimate goal through phenomena, processes, when there is interaction with them in the mode of deterministic or arbitrary program / regulation. The effectiveness of management is determined by the adequacy of management actions on the object of management

Improving currency risk management should start with a correct assessment of the magnitude of this risk, as mentioned earlier, there are a huge number of mathematical ways to identify the size of the risk. Therefore, it is necessary to analyze their advantages and disadvantages.

The table 3.1 shows the most common methods.

*Table 3.1*

### METHODS OF CURRENCY RISK ASSESSMENT

Methods	Advantages of the method	Disadvantages of the method
1. VaR method	Quite a high definition of the size of the damage and the probability of their occurrence in the future in ordinary conditions	The need to process a large amount of statistical information. Low efficiency of assessment in a crisis
2.1. Methods of expert evaluation: Delphi method	Effective in the absence of reliable information or its insufficiency. High efficiency of assessment in a crisis	Subjective nature
2.2. Decision tree method		
3. Stress testing	Contains the possibilities of factor analysis of parameters. High efficiency of assessment in a crisis	Laborious
4. The method of analogies	When other methods of analysis cannot be used. High efficiency in ordinary conditions	It is difficult to create conditions in which past experience would be repeated
5. Combined method	Synergetic effect. High efficiency in ordinary conditions and in crisis conditions	Labor-intensive, requires processing a large amount of statistical, accounting and management information

*\*compiled by the author based on the source[46]*

The most common method is Stress testing which includes the use of the VaR method. As a result of global financial instability, there have been shortcomings in the use of stress testing, which regulators in developed countries are trying to overcome. The development of stress testing in Ukraine is complicated by a number of factors, overcoming which will contribute to more intensive use of this tool in the regulatory system of the financial system. Developers of new stress testing programs draw atten-

tion to the insufficient level of use of complex econometric tools in the process of economic policy coordination. The main reasons are that economic models do not reflect the reality of the economies of developing countries, there are no sufficient and reliable statistics, a high share is occupied by the shadow sector and accounting manipulation of financial statements. However, the need to use stress tests does not disappear [47].

Second, the complex process of calculations requires a high professional level management of commercial banks, which becomes critical in the implementation of stress testing, insufficient experience in stress testing leads to significant errors in assumptions, results and conclusions.

Third, there is also the problem of the quality of financial data for testing and the availability of the appropriate level of analytical IT systems. Stress testing is accompanied by a high level of information collection costs, which is often insufficient because only part of the required data is available to researchers, because official macroeconomic statistics in Ukraine do not accurately reflect the real situation in the economy due to the high share of the shadow sector.

Fourth, the lack of transparency in stress testing makes the risk assessment process a formal, mechanistic procedure that is mandatory for supervisors. If the heads of the financial institution cannot understand the arguments on the main assumptions on which the stress scenario is based, they will not trust the results of stress tests and will be interested only in the formal replenishment of reserves, only the required amount required by the regulator. It should be noted that the use of stress tests in the current level of financial literacy in Ukraine - is a complex and responsible process, because the negative results of financially weak banks can cause panic among depositors, which can spread to other financial institutions.

Overcoming these problems on the way to the implementation of full-fledged stress testing programs of financial institutions is an extremely difficult but unalterable task for the National Bank of Ukraine in the context of the development of a modern and effective system of regulation.

The method of limitation is often used to manage currency risk and therefore it is important to properly analyze the indicators and their volume. According to the results of monitoring the currency risk limits by observing their actual values on the basis of the generated control information obtained from the reports, deviations are revealed, therefore adequate measures should be taken in case the actual values of currency risk limits approach critical and / or limit values. Depending on the profile of currency risk, appropriate measures of its control are introduced (Fig. 3.1).

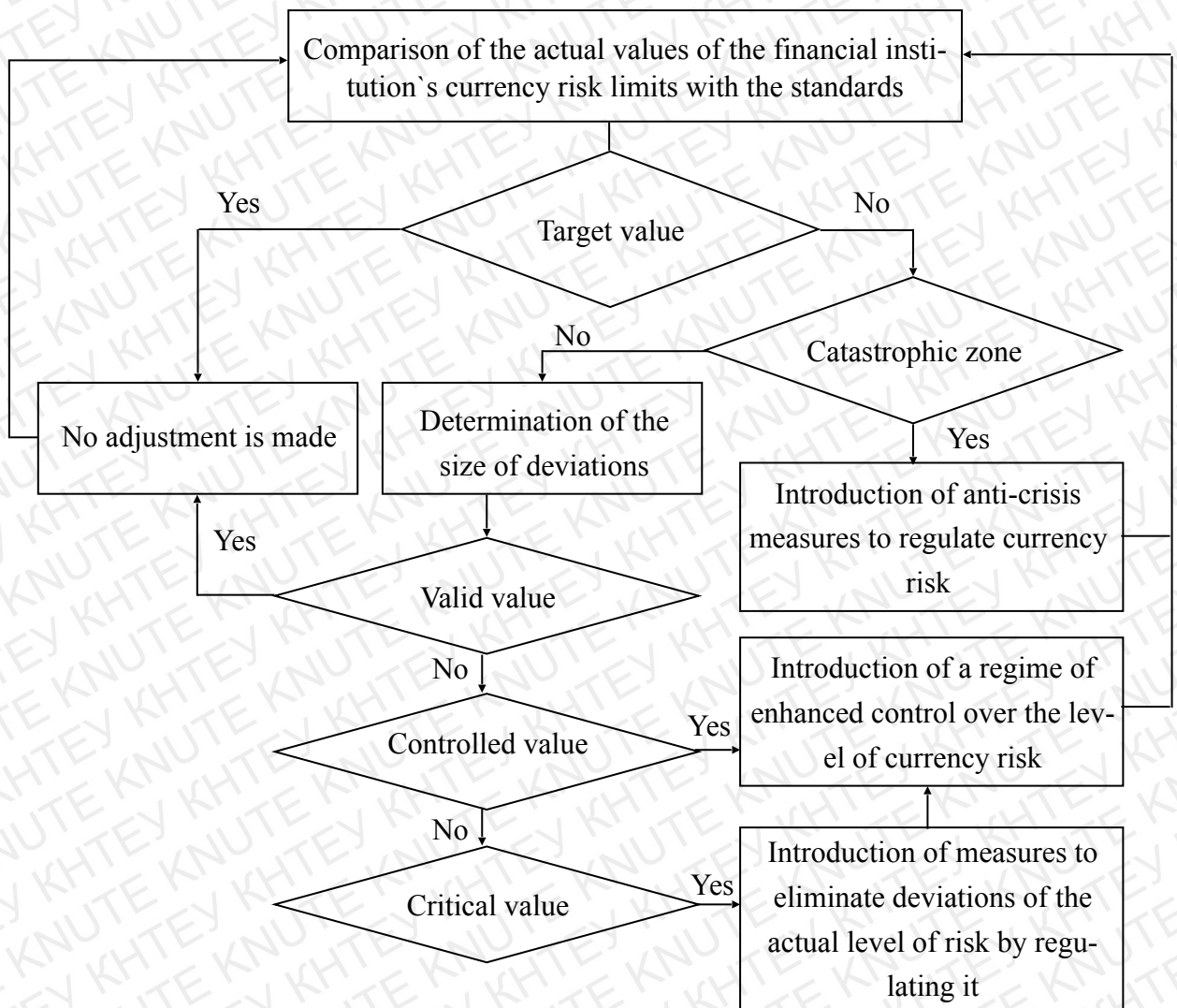


Fig. 3.1 The procedure for choosing control measures\*

\* compiled by the author based on the source [48]

Exchange rate fluctuations can affect the financial results of enterprises, so the usual world practice of minimizing currency risks is to hedge them using special financial instruments - forwards, futures, swaps, etc.

Leading companies in different countries, concluding foreign trade agreements with deferred payments, be sure to use such tools to protect themselves from unwanted movements in the exchange rate of a currency in the future (and this can be both a movement towards revaluation and devaluation).

Thanks to currency liberalization carried out by the National Bank, Ukrainian companies also have the opportunity to use modern instruments to hedge currency risks.

In 2019, the law "On currency and currency transactions" was adopted. Since 2019, more than 30 restrictions have been lifted and most of the current ones have been relaxed. The business was finally able to hedge its risks, transfer dividends abroad without restrictions, buy foreign currency on credit, and not sell part of the foreign exchange earnings - previously there was a rule of mandatory sale from 30% to 100% (in different periods).

The removal of currency restrictions may provoke volatility in the foreign exchange market. To avoid this, the National Bank made two important decisions in the context of this easing. First, he decided to gradually allow businesses to buy currency without obligations - the first limit is 100 thousand euros per day. Secondly, this step was taken in the summer - during a period of low economic activity.

The study of the problems and prospects of the formation of the market of financial derivatives in Ukraine has shown that this segment should be considered as an integral part of the modern financial market, and the lack of such increases ]. Therefore, the transition from administrative methods of regulating the currency positions of banks to economic methods of currency risk management through the introduction of operations with foreign exchange derivatives is a promising direction for the formation of foreign exchange.

In particular, businesses already have the opportunity to enter into forward contracts with fixing the exchange rate in the future to hedge risks on transactions of export and import of goods (products, works, services, intellectual property rights and other non-property rights), as well as loan agreements to attract funds from nonresidents or banks.



Active use of modern tools for hedging currency risks is another step that brings Ukrainian business closer to the best world standards.

This practice guarantees the real sector a fixed level of profit and the possibility of long-term business planning.

The easiest way to hedge over derivatives is to fix the exchange rate, so the financial instrument is FORWARD. It makes it possible to record the future price (rate) of purchase or sale. And as a result, you can plan your activities based on a predetermined course.[49]

FORWARD (in simple language) - an agreement that provides for settlements later than SPOT (3 days), you can buy / sell currency either now or later - in a week, month, six months, etc.

Types of forward contracts:

- forward with delivery of the underlying asset - one party at some point in the future must sell foreign currency at a predetermined rate to the other party, which is obliged to pay for the currency and receive it;
- forward without delivery of the underlying asset - settlements between the parties to the agreement are based on the difference between the forward rate and the spot rate on the agreed day [50].

The main conditions for concluding forward contracts with and without delivery (currency regulation, calculation of the forward rate, guarantee coverage) are identical. However, the advantages of a forward without delivery are a wider base of counterparties and lower settlement risk [50].

With greater financial capacity to raise and place funds than other market participants, financial institutions, namely banks, can avoid real losses under forward contracts even when market prices are not in their favor. By concluding two forward contracts for opposite operations (one - for the purchase, the other - for sale) of the same type of assets in the same amount, the bank has the opportunity to compensate for losses on one operation with income on the opposite. Sometimes the bank acts as an intermediary, looking for parties with opposing interests and helping to draw up a deal. The underdevelopment of organized trade in forward contracts, and hence low

competition in this market, allows banks to dictate their terms when concluding a forward contract with a client. Forward contracts have certain advantages over other financial instruments. First, the individual nature of the contract allows you to accurately hedge the risk by determining the amount of the agreement and the terms that meet the needs of the parties. Secondly, forward contracts do not charge an additional fee (commission). For banks, the advantage of forward agreements is that due to their OTC nature, they are able to dictate the terms of the agreement (in particular, the pricing of the underlying instrument).

For Ukrainian banks, hedging is a relatively new and most promising area of currency risk management, but domestic banking institutions do not enjoy its advantages due to the lack of a market for foreign exchange derivatives in Ukraine. However, international experience shows that the creation of a market for derivative financial instruments will make it possible to control the situation with changes in exchange rates and will introduce the use of modern methods of reducing currency risk in domestic banking practice. Therefore, the transition to non-traditional methods of managing the currency position of Ukrainian banks through the gradual introduction and effective use of operations with foreign exchange derivatives is one of the promising areas for improving the management of financial and economic activities of domestic banks.

Therefore, the main directions of further development of management of foreign exchange operations of a financial institution should be both the improvement of technical capabilities of existing management methods and the development of the use of new ones, namely hedging. It should be noted that the National Bank of Ukraine is already taking measures for currency liberalization.

### **3.2. Forecasting the currency risk of financial institutions**

Modern foreign exchange markets are characterized by increased volatility of exchange rates, which are increasingly difficult to predict. This is due to the integration processes in the world, the growing number of subjects of currency relations, the

emergence of new financial and banking products. The development of the domestic financial market and currency relations increases the impact of currency risks on the activities of the Ukrainian banking system. Traditionally, the bank's propensity to currency risk is characterized by the size of its open currency positions. The result of foreign exchange trading operations is an important component of the financial result of domestic banks and averages about 2% of the income of the banking system of Ukraine [51]. Therefore, an important task of risk management of Ukrainian banks is to forecast possible losses from foreign exchange transactions in order to effectively manage the currency position. Banks as active participants in the foreign exchange market have a risk of changes in foreign exchange rates. An internal component of a bank's currency risk is an open currency position, defined as the difference between assets and liabilities denominated in a particular foreign currency.

To assess the currency risk of a financial institution, the VaR methodology is used as an effective integrated approach to forecasting market risk. From an economic point of view, the VaR indicator characterizes the value that will not exceed the expected losses for a certain period with a given probability. The advantages of the VaR methodology over other methods of currency risk assessment give grounds to conclude that its large-scale application in the practice of risk management of banks and non-bank financial institutions. The increased volatility of exchange rates in the crisis increasingly motivates to improve methods of assessing the currency risk of the bank on the basis of VaR-methodology. The concept of VaR is inextricably linked with the covariance method of calculating this indicator [52]. The method is based on the apparatus of modern portfolio theory and the assumption of a normal law of distribution of yields of financial instruments. However, due to the peculiarities of currency regulation and the influence of various factors on financial markets, the effectiveness of the parametric approach to calculating VaR is perceived ambiguously. Although the parametric method of calculating VaR is a classic, it needs to be adapted to modern conditions in the financial market of Ukraine. In addition, analysts are increasingly preferring non-parametric methods for calculating VaR, arguing for higher accuracy of their prediction and better back-testing results.

Consider the main stages of the parametric method of estimating VaR currency position of the bank. The initial stage is the preparation and initial processing of the original data. VaR assessment in the practice of risk management in the bank is most often used to set daily limits on open currency positions. Thus, the input parameters of such models are the history of daily dynamics of exchange rates over the past 6-9 months. The main disadvantage of this approach, which significantly reduces the accuracy of the model, is the lack of coverage of historical data. The depth of the retrospective (6-9 months) does not cover the entire economic cycle. As practice shows, on the eve of the economic crisis, which is usually accompanied by inflation and the depreciation of the national currency in Ukraine, there is a minimum volatility of the exchange rate. Under such conditions, the VaR estimate based on historical data is much lower than the bank's actual losses as a result of an unexpected change in exchange rate.

To improve the accuracy of VaR estimates, historical data should include the dynamics of market indicators during the crisis period.

The calculation of VaR includes the largest open currency positions of the studied bank - in US dollars, euros.

*Table 3.2*

**SIGNIFICANCE OF OPEN FOREIGN CURRENCY POSITIONS OF OSCHADBANK IN NOMINAL AS OF 31.12.2020\***

	<i>USD</i>	<i>EUR</i>
<b>Currency position, face value</b>	<b>307 498</b>	<b>35 066</b>

*\* compiled by the author based on the source [32]*

Next, calculate the logarithms of the daily growth rate of exchange rates according to the formula:

$$X_t^i = \ln(R_t^i / R_{t-1}^i), t = 1, 2, 3, \dots, T, i = 1, 2, \dots, n, \quad (3.1)$$

Where  $R_t^i$  - the value of the  $i$ -th currency in  $t$  dimension;

$R_{t-1}^i$  - the value of the exchange rate of the  $i$ -th currency  $t - 1$  dimension;  
 $T$  - the total number of measurements of logarithms of exchange rate growth rates;  
 $i$  - currency index;  
 $n$  - number of currencies.

The logarithm of the growth rate of the exchange rate characterizes the intensity of exchange rate changes and is a random variable, the distribution of which in this method is assumed to be close to normal (table. 3.3).

Table 3.3

**FRAGMENT OF THE TABLE OF A NUMBER OF FOREIGN EXCHANGE RATES FROM 01.09.2020 TO 31.08.2021 (COMPLETE TABLE CAN BE FOUND IN APPENDIX F)\***

DATA	840	USD		978	EUR	
	BID	%BID	lnBID	BID	%BID	lnBID
01.09.2020 0:00	27,5618			32,895		
02.09.2020 0:00	27,6049	0,16%	0,16%	33,0721	0,54%	0,54%
03.09.2020 0:00	27,6428	0,14%	0,14%	32,7996	-0,82%	-0,83%
04.09.2020 0:00	27,6908	0,17%	0,17%	32,7319	-0,21%	-0,21%
07.09.2020 0:00	27,7325	0,15%	0,15%	32,8589	0,39%	0,39%
08.09.2020 0:00	27,7509	0,07%	0,07%	32,8099	-0,15%	-0,15%
...	...	...	...	...	...	...
31.08.2021 0:00	26,8601	-0,26%	-0,26%	31,6963	0,10%	0,10%

*\*compiled by the author based on the source [28]*

In order to take into account the correlations between exchange rates, we calculate the correlation matrix for random variables  $X_i$  (logarithms of the growth rate of the  $i$ -th currency), and  $i = 1, 2, \dots, n$ .

The correlation coefficient characterizes the strength and nature of the relationship between two random variables: the closer it is to one in absolute value, the stronger the relationship, the closer to zero - the weaker the relationship (table 3.4).

Table 3.4

**CORRELATION MATRIX\***

<i>Currency</i>	<i>USD</i>	<i>EUR</i>
<i>USD</i>	1	0,466983
<i>EUR</i>	0,466983	1

*\*compiled by the author based on the source [32]*

The correlation matrix characterizes the direct relationship between foreign exchange rates against the hryvnia. The correlation between the exchange rates of the US dollar and the euro is 0.47. The positive correlation between foreign exchange rates indicates that trends in exchange rate dynamics are mainly due to fluctuations in the purchasing power of the national currency. In this model, it is assumed that the economic value of open currency positions coincides with their value in the accounts. If open currency positions are characterized by risks other than currency, in particular credit risks, their economic value may be lower than the book value. The value of the economic value of an open currency position is determined from the initial data for each currency as the product of the position in foreign currency and the exchange rate in UAH per unit of currency (table 3.5):

$$V_i = Position_i * Rate^i, i = 1, 2, \dots, n. \quad (3.2)$$

Table 3.5

**VECTOR-RANGE OF ECONOMIC VALUES OF OPEN FOREIGN CURRENCY POSITIONS OF BANKS AS OF THE REPORTING DATE\***

	<i>USD</i>	<i>EUR</i>	<i>TOTAL</i>
<b>Currency position, face value</b>	307 498	35 066	
<b>Exchange rate</b>	26,86	31,70	
<b>Currency position, equivalent (UAH)</b>	8 259 429,93	1 111 451,68	<b>9 370 881,60</b>

*\*compiled by the author based on the source [32]*

Using the standard deviation of the logarithm of the growth rate of the exchange rate, we calculate the quantile, which corresponds to a confidence level of 99% by multiplying the standard deviation by a coefficient of 2.33 (App. G).

The next step is to calculate the VAR without correlation by simply multiplying the economic position by the quantile equivalent (table 3.6).

*Table 3.6*

**A NUMBER OF ESTIMATES OF POSSIBLE LOSSES ON OPEN FOREIGN CURRENCY POSITIONS IN EACH CURRENCY VAR ON THE REPORTING DATE\***

	<i>USD</i>	<i>EUR</i>	<i>Total</i>
Currency position, face value	<b>307 498</b>	<b>35 066</b>	
Exchange rate	26,86	31,70	
Currency position, equivalent (UAH)	8 259 429,93	1 111 451,68	<b>9 370 881,60</b>
<b>VaR, UAH (no correlation)</b>	49 533,85	10 345,95	<b>59 879,80</b>
VaR, %	0,60%	0,93%	<b>0,64%</b>
VaR with correlation	54 365,23	33 477,41	
<b>VaR with correlation</b>			<b>55 129,62</b>

*\*compiled by the author based on the source [28, 32]*

Next, we calculate the correlated VaR by multiplying the non-correlated VaR matrices by the matrix of the exchange rate correlation itself. And the total amount of risk is calculated as the square root of the multiplication of the matrices Var without correlation and with correlation.

Depending on the strategy and objectives of valuation at risk, the risk manager chooses the optimal level of confidence interval. The Basel Committee on Banking Regulation and Supervision recommends a maximum confidence level of 99%. The higher the level of confidence, the greater the value of VaR and the limitation of the bank's operations in the financial market. In order to find a compromise between the accuracy of currency risk assessment and the prospect of income from foreign ex-

change transactions in practice, the level of trust is often reduced to 95%. The 95% confidence level is optimal for determining the risk of changes in exchange rates, because, on the one hand, it is quite high because it allows only 5% error, and on the other - does not overestimate the risk, which is typical for a maximum confidence level of 99%. When considering the VaR estimate for each currency without reference to the valuations of positions in other currencies, the plus or minus sign is not significant and indicates only whether the position is short or long. [53].

One of the disadvantages of the VaR estimation model described above is the use of uniformly weighted volatility, which takes into account all historical data to the same extent. This is impractical, because the future dynamics of exchange rates is mainly determined by recent trends. The older the data, the less they are able to determine future trends [54]. Therefore, exponentially weighted volatility should be used to calculate the VaR of the foreign exchange portfolio, which responds more quickly to shock changes in yields and is generally a good forecast of the standard deviation.

As an alternative to the classical RiskMetrics method, it is increasingly proposed to use full evaluation methods, in particular the Monte Carlo method.

In general, the Monte Carlo method is a group of quantitative methods based on obtaining a large number of variants of the stochastic (random) process, which is formed in such a way that its probabilistic characteristics coincide with similar values of the problem to be solved [55].

The world practice of banking risk management confirms the successful use of the Monte Carlo method in the process of valuation at risk (VaR) and shows its many advantages. First, the Monte Carlo method involves modeling a large number of scenarios of changes in asset prices and a complete revaluation of the bank's open positions. Therefore, compared to local valuation methods based on the existing value of the position and the linear function, the Monte Carlo method is characterized by higher accuracy of results and allows the calculation of risks for financial instruments with nonlinear price characteristics. Second, the Monte Carlo method involves the use of any probability distribution in contrast to parametric methods based on the



normal distribution. The probability distribution of most financial assets is characterized by the so-called "thick tails" - the deviation of the edges of the distribution from normal. As a result, VaR estimates based on normal distribution are often overestimated or underestimated. Third, due to the possibility of modeling a large number of price trajectories, the Monte Carlo method makes it possible to model the unexpected behavior of markets - trends, clusters of high or low volatility, changing correlations between risk factors, scenarios and more. This increases the accuracy of VaR estimation compared to the historical modeling method and parametric methods. Fourth, the use of complex software complexes contributes to the further improvement of the Monte Carlo method in the direction of increasing the number of scenarios and the use of "artificial intelligence". These advantages determine the feasibility of using the Monte Carlo method to assess market risks in domestic financial institutions[56]

Based on a complex mathematical basis and assumptions of efficient market theory, the implementation of the Monte Carlo method can be difficult. The difficulty of understanding it by top management prevents effective risk minimization decisions. In models based on historical data and small sample sizes, there is a risk of error in a regulated financial market in transition economies. The Monte Carlo method gives higher indicators of VaR risk, which does not always correspond to the development strategy of Ukrainian banks.

The introduction of the Monte Carlo method helps to increase the accuracy and adequacy of VaR estimates in the Ukrainian financial market. Based on a complete revaluation of the value of a financial instrument and the generation of a large number of scenarios, the application of the Monte Carlo method eliminates the errors of parametric methods associated with assumptions about the normal probability distribution and linear characteristics of financial asset prices.

Improvement of the parametric approach to valuation of currency risk of the bank was carried out through the use of exponentially weighted.

## CONCLUSIONS AND RECCOMENDATIONS

Summing up this work, it should be noted that finance activity in a market economy is inevitably associated with risk, and therefore one of the prerequisites for the successful operation of any financial institution is its ability to manage its own risks in certain macroeconomic conditions. In countries with economies in transition, which are mostly characterized by instability of the macroeconomic situation and high variability of financial market parameters, market risk management is of particular importance.

The study of currency risk of financial institutions and methods of its minimization made it possible to draw the following conclusions:

1. Under the currency risk of the financial institutions in the work it is proposed to understand the cost measure of the consequences of the threat or chance, the probability of which is due to the impact of short-term, medium-term and long-term unexpected fluctuations in exchange rates at exchange rates.

2. Taking into account the specifics of structural elements of currency risk in the financial sector, its classification is specified due to the deepening of the following classification features "by way of implementation" (by substantiating the feasibility of risk-based allocation and risk-taking). In the first section of the work the theoretical bases of currency risk management were considered. In the process, it was found that economic currency risk is the most common type of risk associated with exchange rates. It includes both operational and restatement risks.

3. Problems related to currency risk for commercial banks of Ukraine are becoming more and more relevant and consist in the fact that the risk category is associated primarily with possible financial losses, and therefore only logically. In Ukraine, the activity on the foreign exchange market is regulated by the National Bank of Ukraine through licensing of foreign exchange operations and establishment of obligatory norms, in particular, norms of open currency position have been introduced. In the second section, it was investigated that almost all systemically important banks in the country adhere to the limit of long open currency position (up to

10%). However, the two largest banks, PrivatBank and OschadBank, significantly exceed this figure - 104% and 127%, respectively. However it may be due to the fact that these banks may be subject to special requirements, as they are the largest banks of national importance.

4. The results of the research obtained in the work allow to make proposals in order to improve the management of currency risk of the bank. The main tasks that should underlie the development of national monetary policy include reducing the level of "dollarization" of the country, ensuring the stability of the national currency, increasing and efficient use of existing gold and foreign exchange reserves and improving the perfection of foreign exchange legislation of Ukraine.

5. An important stage of currency risk management of the institution is hedging, with the help of derivatives, the safest and easiest to implement is the conclusion of agreements on a forward basis. The most common method of hedging is forward contracts. It is used by 94% of surveyed financial institutions in the world. For Ukrainian banks, hedging is a relatively new and most promising area of currency risk management, but domestic financial institutions do not enjoy its advantages due to the lack of a market for foreign exchange derivatives in Ukraine.

6. In order to effectively manage currency risk, it must first be properly measured. The most common method is Stress testing which includes the use of the VaR method. As a result of global financial instability, there have been shortcomings in the use of stress testing, which regulators in developed countries are trying to overcome. The first reason is that economic models do not reflect the reality of the economies of developing countries, because a high share of them is occupied by the shadow sector and accounting manipulation of financial statements. Secondly, insufficient experience in stress testing may lead to significant errors in assumptions, results and conclusions, since it is a very complex process of calculations. Third, due to the fact that stress testing is accompanied by a high level of information collection and software costs there is also the problem of the quality of financial data for testing and the availability of the appropriate level of analytical IT systems. Last but not least, the lack of transparency in stress testing makes the risk assessment process a formal,

mechanistic procedure that is mandatory for supervisors, which may not lead to expected results. This is why overcoming these problems on the way to the implementation of full-fledged stress testing programs of financial institutions is an extremely difficult but unalterable task for the National Bank of Ukraine in the context of the development of a modern and effective system of regulation.

Currency risks are one of the key problems in financial activities, because by their nature the set of transactions carried out by a financial institution is risky. The main factors influencing currency risk are exchange rate fluctuations, as well as the bank's internal propensity to currency risk. The main purpose of an effective currency risk management system is to protect the profits and capital of a financial institution, which are implemented during the five stages. For the functioning of the bank's currency risk management tactics it is necessary to form organizational and information support, adequate to the goals and objectives of the bank's currency risk management. Thus, the successful operation of the bank as a whole largely depends on the chosen tactics of currency risk management. The purpose of the financial risk management process is to limit or minimize them, as it has happened that it is impossible to completely avoid risks.

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## APPENDICES

### *Appendix A*

#### **Comparative characteristics of scientists' statements on the interpretation of currency risk \***

<b>Author</b>	<b>Definition of "currency risk"</b>
V. Yushchenko, V. Mishchenko	the possibility of losses of foreign exchange market participants due to exchange rate fluctuations
O. Dziubliuk	the possibility of monetary losses of foreign exchange market participants due to exchange rate fluctuations
Hughes C.	the risk of potential losses from changes in exchange rates
M. Krupka, E. Andrushchak, N. Paitra	the risk of losses due to possible changes in exchange rates
L. Primostka	the probability of financial losses due to the fact that the exchange rate of one currency against another will change over time
O. Lavrushin	probability of monetary losses due to exchange rate fluctuations
N. Bozhidarnik, T. Bozhidarnik	the likelihood that events, expected or unexpected, may have a negative impact on the bank's capital and / or income
L. Donets	the probability of financial losses as a result of changes in exchange rates in the period between changes in exchange rates, the period between changes in the contract with individuals and production and settlements on it
A. Shikhverdiev	the risk of currency losses associated with changes in the exchange rate of one foreign currency against another, when conducting foreign economic, credit and other foreign exchange transactions
I. Larionov	the risk of losses associated with changes in the exchange rate of foreign currency against the national currency during foreign trade, credit, currency transactions, operations on stock and currency exchanges
T. Struchenkova	currency risk arises when conducting transactions in foreign currency and is an opportunity to reduce the value of assets (losses), loss of planned income due to adverse changes in exchange rates
Basel Committee on Banking Supervision	the risk of holding or accepting positions in foreign currencies, including gold
Resolution of the NBU dated 02.08.2004 № 361	existing or potential risk to revenues and capital arising from adverse fluctuations in foreign exchange rates and bank metal prices

\*Developed by the author according to sources [2 - 8]

<b>Types of currency risk</b>	
By types of currency transactions:	<ul style="list-style-type: none"> <li>- operating;</li> <li>- commercial;</li> <li>- trade.</li> </ul>
By the nature of the consequences:	<ul style="list-style-type: none"> <li>- economic;</li> <li>- accounting.</li> </ul>
By period of occurrence:	<ul style="list-style-type: none"> <li>- available;</li> <li>- potential.</li> </ul>
By level of aggregation:	<ul style="list-style-type: none"> <li>- individual currency risk of the bank;</li> <li>- portfolio currency risk of the bank.</li> </ul>
By time horizon of impact:	<ul style="list-style-type: none"> <li>- strategic;</li> <li>- tactical;</li> <li>- operative.</li> </ul>
By method of implementation:	<ul style="list-style-type: none"> <li>- transactional;</li> <li>- translational;</li> <li>- risk of revaluation.</li> </ul>
By the scale of the consequences:	<ul style="list-style-type: none"> <li>- acceptable;</li> <li>- allowable;</li> <li>- critical;</li> <li>- disastrous.</li> </ul>
By forms:	<ul style="list-style-type: none"> <li>- direct currency risk of the bank;</li> <li>- indirect currency risk of the bank.</li> </ul>

\*Developed by the author according to sources [2 - 8]

## Appendix C

**NOTES TO THE SEPARATE FINANCIAL STATEMENTS OF OSCHADBANK JSC  
FOR THE YEAR ENDED 31 DECEMBER 2020**

(thousand UAH)

	Hryvnia	US dollars 1 US dollar = 28.2746 hryvnia	Euro 1 euro = 34.7396 hryvnia	Other foreign currency	December 31st 2020 Total
<b>Non-derivative financial assets</b>					
Cash and cash equivalents Cash at bank	10,951,243 100	11,954,390 -	3 432 681 -	176 382 -	26 514 696 100
Loans provided to clients	38 257 014	13 922 249	11,046,814	-	63 226 077
Investments	77 256 256	50 214 166	2 781 119	-	130 251 541
Investments in subsidiaries and associates	24 800	-	-	-	24 800
Other financial assets	357 958	30 786	41,500	3	430 247
<b>Total non-derivative financial assets</b>	<b>126 847 371</b>	<b>76 121 591</b>	<b>17 302 114</b>	<b>176 385</b>	<b>220 447 461</b>
<b>Non-derivative financial liabilities</b>					
Bank funds	5,501,296	252 391	70 186	109	5,823,982
Customer accounts	120 580 356	53 168 925	12 384 352	34 172	186 167 805
Loans received from international and other financial institutions	-	11,744,323	-	-	11,744,323
Other borrowed funds	50 350	772 913	3 629 386	-	4 452 649
Other financial liabilities	893 737	212 413	23	-	1 106 173
Subordinated debt	-	1 276 240	-	-	1 276 240
<b>Total non-derivative financial obligations</b>	<b>127 025 739</b>	<b>67 427 205</b>	<b>16 083 947</b>	<b>34 281</b>	<b>210 571 172</b>
<b>Open position</b>	<b>(178,368)</b>	<b>8,694,386</b>	<b>1,218,167</b>	<b>142 104</b>	

	Hryvnia	US dollars 1 US dollar = 23.6862 hryvnia	Euro 1 euro = 26,422 <sup>th most common</sup> hryvnia	Other foreign currency	December 31st 2019 Total
<b>Non-derivative financial assets</b>					
Cash and cash equivalents Cash at bank	12,751,750 100	40 932 249 -	2,957,255 44 880	161 700 -	56 802 954 44 980
Loans provided to clients	39 095 305	17 304 771	8,768,268	-	65 168 344
Investments	48 295 883	65 320 300	-	-	113 616 183
Investments in subsidiaries and associates	24 800	-	-	-	24 800
Other financial assets	128 202	40 710	24 586	4	193 502
<b>Total non-derivative financial assets</b>	<b>100 296 040</b>	<b>123 598 030</b>	<b>11,794,989</b>	<b>161 704</b>	<b>235 850 763</b>
<b>Non-derivative financial liabilities</b>					
Bank funds	1 860	18 017	13 633	24 530	58 040
Customer accounts	104 040 694	90 824 717	7 244 490	33 139	202 143 040
Loans received from international and other financial institutions	-	18 303 243	-	-	18 303 243
Other borrowed funds	51 540	1,076,593	3 301 950	-	4 430 083
Other financial liabilities	889 619	177 627	7	-	1,067,253
Subordinated debt	-	2 462 640	-	-	2 462 640
<b>Total non-derivative financial obligations</b>	<b>104 983 713</b>	<b>112,862,837</b>	<b>10,560,080</b>	<b>57 669</b>	<b>228 464 299</b>
<b>Open position</b>	<b>(4,687,673)</b>	<b>10,735,193</b>	<b>1 234 909</b>	<b>104 035</b>	

\*\*source[32]

## Appendix D

## CURRENCY RISK SENSITIVITY ANALYSIS\*

	as of December 31, 2020		as of December 31, 2019	
	UAH/US Dol- lar + 10%	UAH/US Dol- lar -5 %	UAH/US Dol- lar + 10%	UAH/US Dol- lar -5 %
	Impact on profit and capital	712 940	(356 470)	880 286

	as of December 31, 2020		as of December 31, 2019	
	UAH/ Euro + 10%	UAH/ Euro -5 %	UAH/ Euro + 10%	UAH/ Euro -5 %
	Impact on profit and capital	99 890	(49 945)	101 263

\*\*source[32]

## Appendix E

	<b>USA No. (%)</b>	<b>UK No. (%)</b>	<b>ASIA No. (%)</b>
Internal methods used to manage transaction exposure			
Yes	42 (89)	65 (82)	45 (86)
No	5 (11)	14 (18)	8 (14)
External methods used to manage transaction exposure			
Yes	46 (98)	76 (96)	51 (97)
No	1 (2)	3 (4)	2 (3)
Internal methods used to manage translation exposure			
Yes	27 (57)	68 (86)	49 (93)
No	20 (43)	11 (14)	4 (7)
External methods used to manage translation exposure			
Yes	21 (45)	59 (75)	20 (37)
No	26 (55)	20 (25)	33 (63)

*\*Developed by the author according to sources [34]*

## Appendix F

TABLE OF A NUMBER OF FOREIGN EXCHANGE RATES FROM  
01.09.2020 TO 31.08.2021\*

DATA	840	USD		978	EUR	
	BID	%BID	lnBID	BID	%BID	lnBID
9/1/20 0:00	27,5618			32,895		
9/2/20 0:00	27,6049	0,16%	0,16%	33,0721	0,54%	0,54%
9/3/20 0:00	27,6428	0,14%	0,14%	32,7996	-0,82%	-0,83%
9/4/20 0:00	27,6908	0,17%	0,17%	32,7319	-0,21%	-0,21%
9/7/20 0:00	27,7325	0,15%	0,15%	32,8589	0,39%	0,39%
9/8/20 0:00	27,7509	0,07%	0,07%	32,8099	-0,15%	-0,15%
9/9/20 0:00	27,8032	0,19%	0,19%	32,798	-0,04%	-0,04%
9/10/20 0:00	27,8296	0,09%	0,09%	32,768	-0,09%	-0,09%
9/11/20 0:00	27,8346	0,02%	0,02%	32,9687	0,61%	0,61%
9/14/20 0:00	27,9003	0,24%	0,24%	33,0674	0,30%	0,30%
9/15/20 0:00	28,0003	0,36%	0,36%	33,2476	0,54%	0,54%
9/16/20 0:00	28,0556	0,20%	0,20%	33,3441	0,29%	0,29%
9/17/20 0:00	28,1195	0,23%	0,23%	33,3877	0,13%	0,13%
9/18/20 0:00	28,1127	-0,02%	-0,02%	33,1744	-0,64%	-0,64%
9/21/20 0:00	28,1718	0,21%	0,21%	33,3456	0,52%	0,51%
9/22/20 0:00	28,2022	0,11%	0,11%	33,1996	-0,44%	-0,44%
9/23/20 0:00	28,2059	0,01%	0,01%	33,1151	-0,25%	-0,25%
9/24/20 0:00	28,1874	-0,07%	-0,07%	32,9609	-0,47%	-0,47%
9/25/20 0:00	28,2487	0,22%	0,22%	32,8942	-0,20%	-0,20%
9/28/20 0:00	28,2673	0,07%	0,07%	32,8763	-0,05%	-0,05%
9/29/20 0:00	28,3062	0,14%	0,14%	33,0376	0,49%	0,49%
9/30/20 0:00	28,2989	-0,03%	-0,03%	33,1309	0,28%	0,28%
10/1/20 0:00	28,3105	0,04%	0,04%	33,1643	0,10%	0,10%
10/2/20 0:00	28,3343	0,08%	0,08%	33,3282	0,49%	0,49%
10/5/20 0:00	28,3408	0,02%	0,02%	33,2324	-0,29%	-0,29%
10/6/20 0:00	28,4009	0,21%	0,21%	33,4037	0,52%	0,51%
10/7/20 0:00	28,3639	-0,13%	-0,13%	33,4822	0,24%	0,23%
10/8/20 0:00	28,324	-0,14%	-0,14%	33,3303	-0,45%	-0,45%
10/9/20 0:00	28,2836	-0,14%	-0,14%	33,2799	-0,15%	-0,15%
10/12/20 0:00	28,2098	-0,26%	-0,26%	33,2791	-0,00%	-0,00%
10/13/20 0:00	28,2481	0,14%	0,14%	33,3398	0,18%	0,18%
10/15/20 0:00	28,3164	0,24%	0,24%	33,3935	0,16%	0,16%
10/16/20 0:00	28,3365	0,07%	0,07%	33,1764	-0,65%	-0,65%
10/19/20 0:00	28,3649	0,10%	0,10%	33,3018	0,38%	0,38%
10/20/20 0:00	28,3762	0,04%	0,04%	33,4343	0,40%	0,40%
10/21/20 0:00	28,3707	-0,02%	-0,02%	33,5044	0,21%	0,21%
10/22/20 0:00	28,2737	-0,34%	-0,34%	33,5312	0,08%	0,08%
10/23/20 0:00	28,265	-0,03%	-0,03%	33,4106	-0,36%	-0,36%
10/26/20 0:00	28,2911	0,09%	0,09%	33,549	0,41%	0,41%
10/27/20 0:00	28,3352	0,16%	0,16%	33,4908	-0,17%	-0,17%
10/28/20 0:00	28,3655	0,11%	0,11%	33,5578	0,20%	0,20%
10/29/20 0:00	28,3989	0,12%	0,12%	33,3133	-0,73%	-0,73%

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<b>10/30/20 0:00</b>	28,4383	0,14%	0,14%	33,2984	-0,04%	-0,04%
<b>11/2/20 0:00</b>	28,4507	0,04%	0,04%	33,2475	-0,15%	-0,15%
<b>11/3/20 0:00</b>	28,5827	0,46%	0,46%	33,2917	0,13%	0,13%
<b>11/4/20 0:00</b>	28,6	0,06%	0,06%	33,4806	0,57%	0,57%
<b>11/5/20 0:00</b>	28,5074	-0,32%	-0,32%	33,4249	-0,17%	-0,17%
<b>11/6/20 0:00</b>	28,3643	-0,50%	-0,50%	33,5819	0,47%	0,47%
<b>11/9/20 0:00</b>	28,1375	-0,80%	-0,80%	33,4245	-0,47%	-0,47%
<b>11/10/20 0:00</b>	28,1116	-0,09%	-0,09%	33,3938	-0,09%	-0,09%
<b>11/11/20 0:00</b>	28,1206	0,03%	0,03%	33,2006	-0,58%	-0,58%
<b>11/12/20 0:00</b>	28,161	0,14%	0,14%	33,1441	-0,17%	-0,17%
<b>11/13/20 0:00</b>	28,1963	0,13%	0,13%	33,266	0,37%	0,37%
<b>11/16/20 0:00</b>	28,1158	-0,29%	-0,29%	33,2118	-0,16%	-0,16%
<b>11/17/20 0:00</b>	28,112	-0,01%	-0,01%	33,241	0,09%	0,09%
<b>11/18/20 0:00</b>	28,1067	-0,02%	-0,02%	33,3964	0,47%	0,47%
<b>11/19/20 0:00</b>	28,13	0,08%	0,08%	33,3608	-0,11%	-0,11%
<b>11/20/20 0:00</b>	28,2572	0,45%	0,45%	33,4353	0,22%	0,22%
<b>11/23/20 0:00</b>	28,3553	0,35%	0,35%	33,6266	0,57%	0,57%
<b>11/24/20 0:00</b>	28,3694	0,05%	0,05%	33,7553	0,38%	0,38%
<b>11/25/20 0:00</b>	28,3741	0,02%	0,02%	33,6801	-0,22%	-0,22%
<b>11/26/20 0:00</b>	28,3816	0,03%	0,03%	33,784	0,31%	0,31%
<b>11/27/20 0:00</b>	28,4428	0,22%	0,22%	33,8455	0,18%	0,18%
<b>11/30/20 0:00</b>	28,4681	0,09%	0,09%	33,9596	0,34%	0,34%
<b>12/1/20 0:00</b>	28,4962	0,10%	0,10%	34,1456	0,55%	0,55%
<b>12/2/20 0:00</b>	28,5583	0,22%	0,22%	34,2157	0,21%	0,21%
<b>12/3/20 0:00</b>	28,4367	-0,43%	-0,43%	34,316	0,29%	0,29%
<b>12/4/20 0:00</b>	28,3038	-0,47%	-0,47%	34,4047	0,26%	0,26%
<b>12/7/20 0:00</b>	28,2913	-0,04%	-0,04%	34,3895	-0,04%	-0,04%
<b>12/8/20 0:00</b>	28,2394	-0,18%	-0,18%	34,2586	-0,38%	-0,38%
<b>12/9/20 0:00</b>	28,0828	-0,55%	-0,56%	34,0546	-0,60%	-0,60%
<b>12/10/20 0:00</b>	28,0406	-0,15%	-0,15%	33,9558	-0,29%	-0,29%
<b>12/11/20 0:00</b>	28,075	0,12%	0,12%	33,9946	0,11%	0,11%
<b>12/14/20 0:00</b>	27,9666	-0,39%	-0,39%	33,8941	-0,30%	-0,30%
<b>12/15/20 0:00</b>	27,8661	-0,36%	-0,36%	33,888	-0,02%	-0,02%
<b>12/16/20 0:00</b>	27,759	-0,38%	-0,39%	33,6897	-0,59%	-0,59%
<b>12/17/20 0:00</b>	27,7373	-0,08%	-0,08%	33,8021	0,33%	0,33%
<b>12/18/20 0:00</b>	27,8184	0,29%	0,29%	34,0789	0,82%	0,82%
<b>12/21/20 0:00</b>	27,828	0,03%	0,03%	34,1018	0,07%	0,07%
<b>12/22/20 0:00</b>	28,0391	0,76%	0,76%	34,1811	0,23%	0,23%
<b>12/23/20 0:00</b>	28,2513	0,76%	0,75%	34,5669	1,13%	1,12%
<b>12/24/20 0:00</b>	28,4551	0,72%	0,72%	34,6156	0,14%	0,14%
<b>12/28/20 0:00</b>	28,3547	-0,35%	-0,35%	34,5601	-0,16%	-0,16%
<b>12/29/20 0:00</b>	28,3668	0,04%	0,04%	34,6458	0,25%	0,25%
<b>12/30/20 0:00</b>	28,2605	-0,37%	-0,38%	34,6375	-0,02%	-0,02%
<b>12/31/20 0:00</b>	28,2746	0,05%	0,05%	34,7396	0,29%	0,29%
<b>1/1/21 0:00</b>	28,2746	0,00%	0,00%	34,7396	0,00%	0,00%
<b>1/4/21 0:00</b>	28,2746	0,00%	0,00%	34,7396	0,00%	0,00%
<b>1/5/21 0:00</b>	28,431	0,55%	0,55%	34,9389	0,57%	0,57%
<b>1/6/21 0:00</b>	28,4028	-0,10%	-0,10%	34,846	-0,27%	-0,27%



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<b>1/11/21 0:00</b>	28,2847	-0,42%	-0,42%	34,909	0,18%	0,18%
<b>1/12/21 0:00</b>	28,2038	-0,29%	-0,29%	34,2817	-1,80%	-1,81%
<b>1/13/21 0:00</b>	28,046	-0,56%	-0,56%	34,0787	-0,59%	-0,59%
<b>1/14/21 0:00</b>	27,9705	-0,27%	-0,27%	34,0373	-0,12%	-0,12%
<b>1/15/21 0:00</b>	28,0609	0,32%	0,32%	33,9888	-0,14%	-0,14%
<b>1/16/21 0:00</b>	28,0524	-0,03%	-0,03%	34,0121	0,07%	0,07%
<b>1/18/21 0:00</b>	28,0524	0,00%	0,00%	34,0121	0,00%	0,00%
<b>1/19/21 0:00</b>	28,1926	0,50%	0,50%	34,0158	0,01%	0,01%
<b>1/20/21 0:00</b>	28,1544	-0,14%	-0,14%	34,1555	0,41%	0,41%
<b>1/21/21 0:00</b>	28,2035	0,17%	0,17%	34,1488	-0,02%	-0,02%
<b>1/22/21 0:00</b>	28,2561	0,19%	0,19%	34,3651	0,63%	0,63%
<b>1/25/21 0:00</b>	28,1648	-0,32%	-0,32%	34,2526	-0,33%	-0,33%
<b>1/26/21 0:00</b>	28,1665	0,01%	0,01%	34,2265	-0,08%	-0,08%
<b>1/27/21 0:00</b>	28,1524	-0,05%	-0,05%	34,1897	-0,11%	-0,11%
<b>1/28/21 0:00</b>	28,1652	0,05%	0,05%	34,1207	-0,20%	-0,20%
<b>1/29/21 0:00</b>	28,1929	0,10%	0,10%	34,1035	-0,05%	-0,05%
<b>2/1/21 0:00</b>	28,1324	-0,21%	-0,21%	34,157	0,16%	0,16%
<b>2/2/21 0:00</b>	28,0603	-0,26%	-0,26%	33,9039	-0,74%	-0,74%
<b>2/3/21 0:00</b>	28,0589	-0,00%	-0,00%	33,7913	-0,33%	-0,33%
<b>2/4/21 0:00</b>	27,995	-0,23%	-0,23%	33,6374	-0,46%	-0,46%
<b>2/5/21 0:00</b>	27,8885	-0,38%	-0,38%	33,4509	-0,55%	-0,56%
<b>2/8/21 0:00</b>	27,7711	-0,42%	-0,42%	33,2823	-0,50%	-0,51%
<b>2/9/21 0:00</b>	27,6651	-0,38%	-0,38%	33,2604	-0,07%	-0,07%
<b>2/10/21 0:00</b>	27,6426	-0,08%	-0,08%	33,4406	0,54%	0,54%
<b>2/11/21 0:00</b>	27,7665	0,45%	0,45%	33,6655	0,67%	0,67%
<b>2/12/21 0:00</b>	27,8384	0,26%	0,26%	33,8111	0,43%	0,43%
<b>2/15/21 0:00</b>	27,844	0,02%	0,02%	33,6801	-0,39%	-0,39%
<b>2/16/21 0:00</b>	27,9671	0,44%	0,44%	33,9297	0,74%	0,74%
<b>2/17/21 0:00</b>	27,8304	-0,49%	-0,49%	33,7708	-0,47%	-0,47%
<b>2/18/21 0:00</b>	27,9038	0,26%	0,26%	33,6422	-0,38%	-0,38%
<b>2/19/21 0:00</b>	27,8461	-0,21%	-0,21%	33,6478	0,02%	0,02%
<b>2/22/21 0:00</b>	27,8468	0,00%	0,00%	33,7768	0,38%	0,38%
<b>2/23/21 0:00</b>	27,9304	0,30%	0,30%	33,8866	0,33%	0,32%
<b>2/24/21 0:00</b>	27,8976	-0,12%	-0,12%	33,883	-0,01%	-0,01%
<b>2/25/21 0:00</b>	27,9492	0,18%	0,18%	33,9289	0,14%	0,14%
<b>2/26/21 0:00</b>	27,9301	-0,07%	-0,07%	34,1459	0,64%	0,64%
<b>3/1/21 0:00</b>	27,9456	0,06%	0,06%	33,8449	-0,88%	-0,89%
<b>3/2/21 0:00</b>	28,0007	0,20%	0,20%	33,717	-0,38%	-0,38%
<b>3/3/21 0:00</b>	27,933	-0,24%	-0,24%	33,6006	-0,35%	-0,35%
<b>3/4/21 0:00</b>	27,8477	-0,31%	-0,31%	33,5565	-0,13%	-0,13%
<b>3/5/21 0:00</b>	27,7564	-0,33%	-0,33%	33,4062	-0,45%	-0,45%
<b>3/9/21 0:00</b>	27,7091	-0,17%	-0,17%	33,075	-0,99%	-1,00%
<b>3/10/21 0:00</b>	27,7431	0,12%	0,12%	32,9741	-0,31%	-0,31%
<b>3/11/21 0:00</b>	27,7016	-0,15%	-0,15%	32,9317	-0,13%	-0,13%
<b>3/12/21 0:00</b>	27,7486	0,17%	0,17%	33,1748	0,74%	0,74%
<b>3/15/21 0:00</b>	27,7305	-0,07%	-0,07%	33,0839	-0,27%	-0,27%
<b>3/16/21 0:00</b>	27,6434	-0,31%	-0,31%	32,9523	-0,40%	-0,40%
<b>3/17/21 0:00</b>	27,6525	0,03%	0,03%	32,9632	0,03%	0,03%

continuation of Appendix F

<b>3/18/21 0:00</b>	27,6978	0,16%	0,16%	32,9853	0,07%	0,07%
<b>3/19/21 0:00</b>	27,6828	-0,05%	-0,05%	32,9785	-0,02%	-0,02%
<b>3/22/21 0:00</b>	27,7184	0,13%	0,13%	32,9502	-0,09%	-0,09%
<b>3/23/21 0:00</b>	27,6871	-0,11%	-0,11%	33,0072	0,17%	0,17%
<b>3/24/21 0:00</b>	27,7295	0,15%	0,15%	32,9329	-0,23%	-0,23%
<b>3/25/21 0:00</b>	27,8706	0,51%	0,51%	32,9389	0,02%	0,02%
<b>3/26/21 0:00</b>	27,9698	0,36%	0,36%	33,0337	0,29%	0,29%
<b>3/29/21 0:00</b>	27,9679	-0,01%	-0,01%	32,9532	-0,24%	-0,24%
<b>3/30/21 0:00</b>	27,9694	0,01%	0,01%	32,9661	0,04%	0,04%
<b>3/31/21 0:00</b>	27,8852	-0,30%	-0,30%	32,7233	-0,74%	-0,74%
<b>4/1/21 0:00</b>	27,8226	-0,22%	-0,22%	32,629	-0,29%	-0,29%
<b>4/2/21 0:00</b>	27,8324	0,04%	0,04%	32,7003	0,22%	0,22%
<b>4/5/21 0:00</b>	27,9555	0,44%	0,44%	32,8365	0,42%	0,42%
<b>4/6/21 0:00</b>	27,939	-0,06%	-0,06%	32,8632	0,08%	0,08%
<b>4/7/21 0:00</b>	27,8384	-0,36%	-0,36%	32,898	0,11%	0,11%
<b>4/8/21 0:00</b>	27,8923	0,19%	0,19%	33,1388	0,73%	0,73%
<b>4/9/21 0:00</b>	27,9768	0,30%	0,30%	33,2266	0,26%	0,26%
<b>4/12/21 0:00</b>	27,9094	-0,24%	-0,24%	33,1522	-0,22%	-0,22%
<b>4/13/21 0:00</b>	27,9335	0,09%	0,09%	33,2758	0,37%	0,37%
<b>4/14/21 0:00</b>	28,0156	0,29%	0,29%	33,3218	0,14%	0,14%
<b>4/15/21 0:00</b>	27,9765	-0,14%	-0,14%	33,4753	0,46%	0,46%
<b>4/16/21 0:00</b>	27,9592	-0,06%	-0,06%	33,4616	-0,04%	-0,04%
<b>4/19/21 0:00</b>	27,9783	0,07%	0,07%	33,525	0,19%	0,19%
<b>4/20/21 0:00</b>	28,0087	0,11%	0,11%	33,7099	0,55%	0,55%
<b>4/21/21 0:00</b>	28,0096	0,00%	0,00%	33,7362	0,08%	0,08%
<b>4/22/21 0:00</b>	28,0576	0,17%	0,17%	33,6986	-0,11%	-0,11%
<b>4/23/21 0:00</b>	28,0642	0,02%	0,02%	33,8103	0,33%	0,33%
<b>4/26/21 0:00</b>	27,9014	-0,58%	-0,58%	33,6714	-0,41%	-0,41%
<b>4/27/21 0:00</b>	27,8558	-0,16%	-0,16%	33,6512	-0,06%	-0,06%
<b>4/28/21 0:00</b>	27,7715	-0,30%	-0,30%	33,5577	-0,28%	-0,28%
<b>4/29/21 0:00</b>	27,7867	0,05%	0,05%	33,526	-0,09%	-0,09%
<b>4/30/21 0:00</b>	27,75	-0,13%	-0,13%	33,6427	0,35%	0,35%
<b>5/5/21 0:00</b>	27,733	-0,06%	-0,06%	33,5112	-0,39%	-0,39%
<b>5/6/21 0:00</b>	27,7339	0,00%	0,00%	33,2751	-0,70%	-0,71%
<b>5/7/21 0:00</b>	27,7205	-0,05%	-0,05%	33,4129	0,41%	0,41%
<b>5/11/21 0:00</b>	27,7641	0,16%	0,16%	33,4904	0,23%	0,23%
<b>5/12/21 0:00</b>	27,6744	-0,32%	-0,32%	33,6728	0,54%	0,54%
<b>5/13/21 0:00</b>	27,6318	-0,15%	-0,15%	33,4953	-0,53%	-0,53%
<b>5/14/21 0:00</b>	27,6273	-0,02%	-0,02%	33,3738	-0,36%	-0,36%
<b>5/17/21 0:00</b>	27,6142	-0,05%	-0,05%	33,4781	0,31%	0,31%
<b>5/18/21 0:00</b>	27,555	-0,21%	-0,21%	33,4449	-0,10%	-0,10%
<b>5/19/21 0:00</b>	27,4368	-0,43%	-0,43%	33,5319	0,26%	0,26%
<b>5/20/21 0:00</b>	27,4166	-0,07%	-0,07%	33,488	-0,13%	-0,13%
<b>5/21/21 0:00</b>	27,4665	0,18%	0,18%	33,5174	0,09%	0,09%
<b>5/24/21 0:00</b>	27,4572	-0,03%	-0,03%	33,4799	-0,11%	-0,11%
<b>5/25/21 0:00</b>	27,4281	-0,11%	-0,11%	33,4911	0,03%	0,03%
<b>5/26/21 0:00</b>	27,4553	0,10%	0,10%	33,6643	0,52%	0,52%
<b>5/27/21 0:00</b>	27,5461	0,33%	0,33%	33,6765	0,04%	0,04%

*continuation of Appendix F*

<b>5/28/21 0:00</b>	27,526	-0,07%	-0,07%	33,5693	-0,32%	-0,32%
<b>5/31/21 0:00</b>	27,5004	-0,09%	-0,09%	33,3896	-0,54%	-0,54%
<b>6/1/21 0:00</b>	27,4674	-0,12%	-0,12%	33,5116	0,37%	0,36%
<b>6/2/21 0:00</b>	27,4381	-0,11%	-0,11%	33,5335	0,07%	0,07%
<b>6/3/21 0:00</b>	27,3449	-0,34%	-0,34%	33,3348	-0,59%	-0,59%
<b>6/4/21 0:00</b>	27,34	-0,02%	-0,02%	33,2577	-0,23%	-0,23%
<b>6/7/21 0:00</b>	27,2914	-0,18%	-0,18%	33,0635	-0,58%	-0,59%
<b>6/8/21 0:00</b>	27,1923	-0,36%	-0,36%	33,0781	0,04%	0,04%
<b>6/9/21 0:00</b>	27,1764	-0,06%	-0,06%	33,1104	0,10%	0,10%
<b>6/10/21 0:00</b>	27,0906	-0,32%	-0,32%	33,0248	-0,26%	-0,26%
<b>6/11/21 0:00</b>	27,1068	0,06%	0,06%	32,989	-0,11%	-0,11%
<b>6/14/21 0:00</b>	27,0404	-0,24%	-0,25%	32,7905	-0,60%	-0,60%
<b>6/15/21 0:00</b>	26,9957	-0,17%	-0,17%	32,7053	-0,26%	-0,26%
<b>6/16/21 0:00</b>	26,9258	-0,26%	-0,26%	32,6166	-0,27%	-0,27%
<b>6/17/21 0:00</b>	27,0275	0,38%	0,38%	32,7722	0,48%	0,48%
<b>6/18/21 0:00</b>	27,1712	0,53%	0,53%	32,4424	-1,01%	-1,01%
<b>6/22/21 0:00</b>	27,1935	0,08%	0,08%	32,2882	-0,48%	-0,48%
<b>6/23/21 0:00</b>	27,305	0,41%	0,41%	32,467	0,55%	0,55%
<b>6/24/21 0:00</b>	27,2737	-0,11%	-0,11%	32,6003	0,41%	0,41%
<b>6/25/21 0:00</b>	27,4589	0,68%	0,68%	32,7928	0,59%	0,59%
<b>6/29/21 0:00</b>	27,3964	-0,23%	-0,23%	32,7401	-0,16%	-0,16%
<b>6/30/21 0:00</b>	27,1763	-0,80%	-0,81%	32,3018	-1,34%	-1,35%
<b>7/1/21 0:00</b>	27,2275	0,19%	0,19%	32,3463	0,14%	0,14%
<b>7/2/21 0:00</b>	27,3841	0,58%	0,57%	32,5227	0,55%	0,54%
<b>7/5/21 0:00</b>	27,4121	0,10%	0,10%	32,4107	-0,34%	-0,34%
<b>7/6/21 0:00</b>	27,2904	-0,44%	-0,44%	32,3732	-0,12%	-0,12%
<b>7/7/21 0:00</b>	27,2497	-0,15%	-0,15%	32,2623	-0,34%	-0,34%
<b>7/8/21 0:00</b>	27,2993	0,18%	0,18%	32,291	0,09%	0,09%
<b>7/9/21 0:00</b>	27,2862	-0,05%	-0,05%	32,3191	0,09%	0,09%
<b>7/12/21 0:00</b>	27,3234	0,14%	0,14%	32,4056	0,27%	0,27%
<b>7/13/21 0:00</b>	27,2904	-0,12%	-0,12%	32,3459	-0,18%	-0,18%
<b>7/14/21 0:00</b>	27,3216	0,11%	0,11%	32,372	0,08%	0,08%
<b>7/15/21 0:00</b>	27,3047	-0,06%	-0,06%	32,2482	-0,38%	-0,38%
<b>7/16/21 0:00</b>	27,2905	-0,05%	-0,05%	32,2369	-0,04%	-0,04%
<b>7/19/21 0:00</b>	27,2301	-0,22%	-0,22%	32,141	-0,30%	-0,30%
<b>7/20/21 0:00</b>	27,2132	-0,06%	-0,06%	32,0313	-0,34%	-0,34%
<b>7/21/21 0:00</b>	27,2205	0,03%	0,03%	32,0344	0,01%	0,01%
<b>7/22/21 0:00</b>	27,2405	0,07%	0,07%	32,0607	0,08%	0,08%
<b>7/23/21 0:00</b>	27,1915	-0,18%	-0,18%	32,0343	-0,08%	-0,08%
<b>7/26/21 0:00</b>	27,048	-0,53%	-0,53%	31,845	-0,59%	-0,59%
<b>7/27/21 0:00</b>	26,9805	-0,25%	-0,25%	31,8087	-0,11%	-0,11%
<b>7/28/21 0:00</b>	26,906	-0,28%	-0,28%	31,7814	-0,09%	-0,09%
<b>7/29/21 0:00</b>	26,8628	-0,16%	-0,16%	31,7021	-0,25%	-0,25%
<b>7/30/21 0:00</b>	26,8867	0,09%	0,09%	31,9239	0,70%	0,70%
<b>8/2/21 0:00</b>	26,8168	-0,26%	-0,26%	31,8946	-0,09%	-0,09%
<b>8/3/21 0:00</b>	26,8444	0,10%	0,10%	31,9032	0,03%	0,03%
<b>8/4/21 0:00</b>	26,8411	-0,01%	-0,01%	31,8913	-0,04%	-0,04%
<b>8/5/21 0:00</b>	26,9094	0,25%	0,25%	31,9482	0,18%	0,18%

*end of Appendix F*

<b>8/6/21 0:00</b>	26,9395	0,11%	0,11%	31,8964	-0,16%	-0,16%
<b>8/9/21 0:00</b>	26,8346	-0,39%	-0,39%	31,6756	-0,69%	-0,69%
<b>8/10/21 0:00</b>	26,8011	-0,12%	-0,12%	31,5302	-0,46%	-0,46%
<b>8/11/21 0:00</b>	26,7557	-0,17%	-0,17%	31,3617	-0,53%	-0,54%
<b>8/12/21 0:00</b>	26,8042	0,18%	0,18%	31,4105	0,16%	0,16%
<b>8/13/21 0:00</b>	26,7686	-0,13%	-0,13%	31,421	0,03%	0,03%
<b>8/16/21 0:00</b>	26,6931	-0,28%	-0,28%	31,3978	-0,07%	-0,07%
<b>8/17/21 0:00</b>	26,6457	-0,18%	-0,18%	31,3633	-0,11%	-0,11%
<b>8/18/21 0:00</b>	26,6752	0,11%	0,11%	31,382	0,06%	0,06%
<b>8/19/21 0:00</b>	26,6455	-0,11%	-0,11%	31,2379	-0,46%	-0,46%
<b>8/20/21 0:00</b>	26,6504	0,02%	0,02%	31,169	-0,22%	-0,22%
<b>8/25/21 0:00</b>	26,6718	0,08%	0,08%	31,1287	-0,13%	-0,13%
<b>8/26/21 0:00</b>	26,7074	0,13%	0,13%	31,3438	0,69%	0,69%
<b>8/27/21 0:00</b>	26,7744	0,25%	0,25%	31,5121	0,54%	0,54%
<b>8/28/21 0:00</b>	26,929	0,58%	0,58%	31,6645	0,48%	0,48%
<b>8/30/21 0:00</b>	26,929	0,00%	0,00%	31,6645	0,00%	0,00%
<b>8/31/21 0:00</b>	26,8601	-0,26%	-0,26%	31,6963	0,10%	0,10%

\*Developed by the author according to source [28]

## Appendix G

	USD ( <i>ln</i> BID)	EUR( <i>ln</i> BID)
<i>Quadratic deviation</i>	0,001656274	0,003990138
<i>Quadratic deviation / n</i>	0,0000066251	0,0000159606
<i>The standard deviation</i>	0,002573926	0,003995066
<i>Quantile, which corresponds to a confidence interval of 99%</i>	0,005997248	0,009308504

\*Developed by the author according to sources [32]