where: $Loan_t$ – the current year's loan portfolio, Dep_t – the current year's deposit volume, FL_{t-1} – the gross external debt (foreign liabilities) of the previous year, DL_{t-1} – the amount of distressed loans of the previous year.

After taking the logarithm, the model acquired the following form (form. 2):

$$\ln Loan_t = c_1 + c_2 \ln Dep_t + c_3 \ln FL_{t-1} +$$
$$+ c_4 \ln DL_{t-1} + e_1, \qquad (2)$$

where: $c_1 = \ln b_1$, $c_i = b_i, i = 2,3,4$ – regression coefficients, $e_1 = \ln e$ – error of regression.

The data for regression analysis are taken from CEE Banking Sector Reports [5-11]. The regression analysis was made using econometric application package E-views v.4.0.

For Polish banks the model acquired the following form (form.3):

$$Loan_t = 0,271 Dep_t^{0,547} FL_{t-1}^{0,797} DL_{t-1}^{-0,222}. \qquad (3)$$

The coefficient of determination of the logarithmic linear model is $R^2 = 0,996$, all regression coefficients are statistically significant ($p_i < 0,01$).

The chart of the residuals of the logarithmic linear model is shown in Fig. 1.

The analysis of the model for the evaluation of bank crediting volume provides grounds to believe that the deposits of the current year and external funds loaned

the previous year have a significant direct impact on the growth of the loan portfolios of the banks in Poland. The distressed loans of the previous year reduce the amount of credit in the current year.

The regression analysis of bank crediting in Poland has found that the gross external debt has a more significant impact on the loan portfolio formation than the money deposited in the banks (Fig. 2), as evidenced by the higher value of the corresponding regression coefficient (P (2)> C (3)).

For the banks in Slovakia, the model is as follows (form. 4):

$$Loan_t = 0,184 Dep_t^{0,856} FL_{t-1}^{0,564} DL_{t-1}^{-0,087}. \qquad (4)$$

The coefficient of determination of the logarithmic linear model is $R^2 = 0,991$, all regression coefficients are statistically significant ($p_i < 0,05$). The chart of the residuals of the logarithmic linear model is shown in Fig. 3.

The analysis of the constructed model has found that the deposits of the current year and loan financial resources from foreign markets involved the previous year have a significant direct impact on the growth of the volumes of bank crediting in Slovakia (Fig. 4). Similarly to the situation in Poland, the amounts of distressed loans of the previous year reduce the volume of bank crediting in the current year, but this effect is relatively weaker, as evidenced by the lower value of the corresponding regression coefficient.
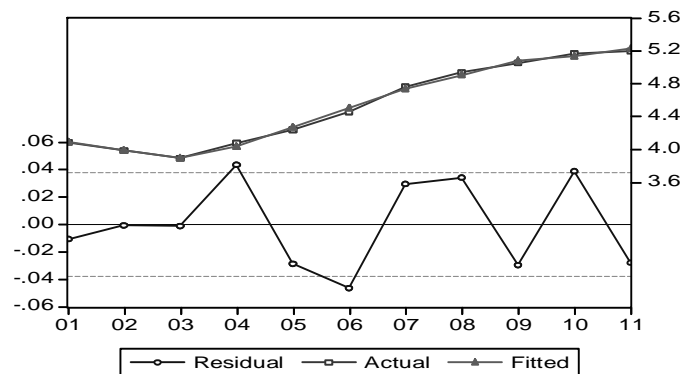

Fig. 1. Residuals of the regression model for the logarithms of the loan portfolios of the banks in Poland
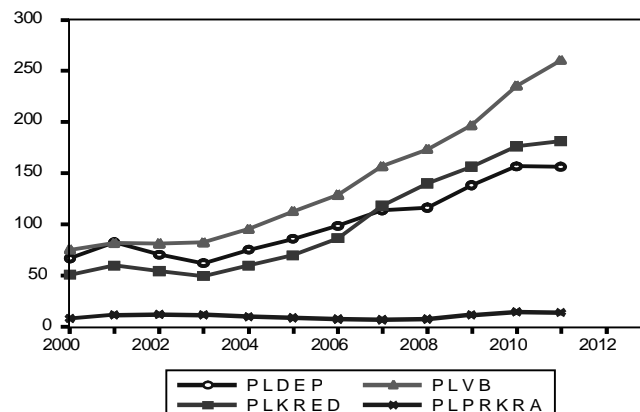

Fig. 2. The dynamics of the volumes "deposits – loans – foreign debt –distressed loans" for the banks in Poland, billion euros
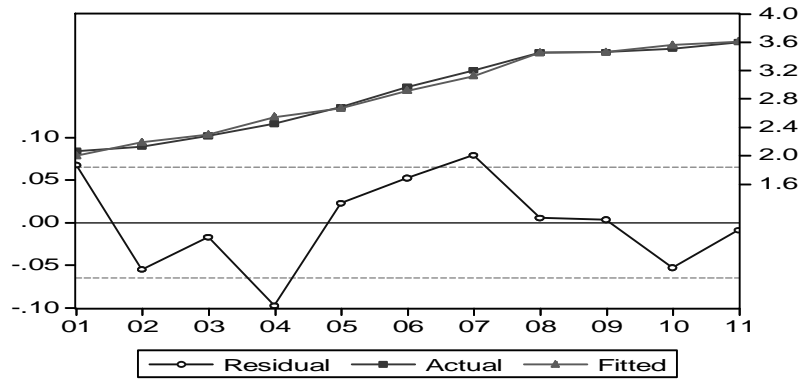
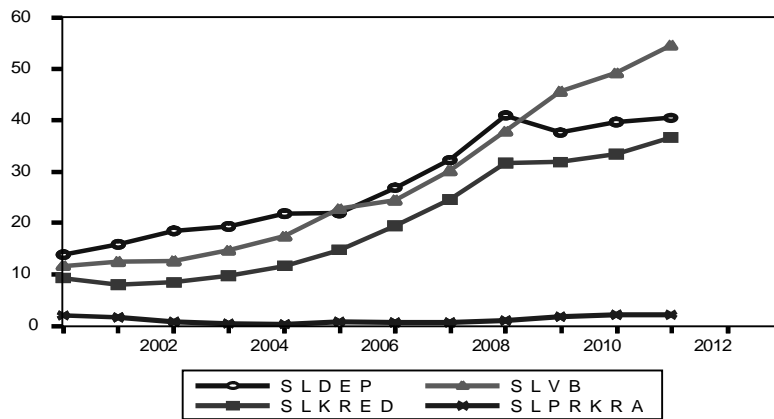**Fig. 3.** Residuals of the regression model for the logarithms of the loan portfolios of the banks in Slovakia

Fig. 4. The dynamics of the volumes "deposits – loans – foreign debt – distressed loans" for the banks in Slovakia, billion euros
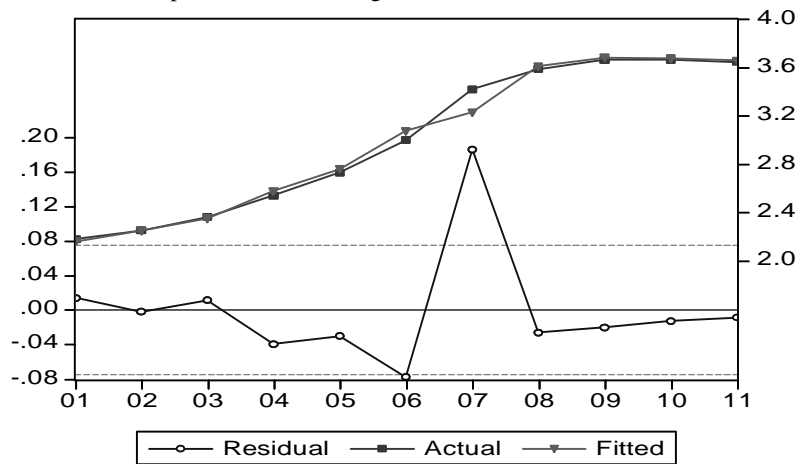

Fig. 5. Residuals of the regression model for the logarithms of the loan portfolio volumes of the banks in Slovenia

The analysis of the evaluation model of bank crediting in Slovenia showed a statistically insignificant value of the regression coefficient in the volume of deposits of the banking system of the country. After removal of this variable, the model acquired the following form (form. 5):

$$Loan_t = 0,693 FL_{t-1}^{1,103} DL_{t-1}^{-0,078} . \qquad (5)$$

The coefficient of determination of the logarithmic linear model is $R^2 = 0,988$, and, similar to the previous models, all regression coefficients are statistically significant ($p_i < 0,05$). The chart of residuals of the logarithmic linear model is shown in Fig. 5.

Therefore, the crucial factor for the growth of loan portfolios of the banks in Slovenia in the current year is the increase in the gross external debt in the previous year (Fig. 6). The distressed loans of the previous year slightly reduce the volume of crediting in the current year.

A similar situation exists in the Czech banking system. After the removal of the volume of deposits, the model acquired the following form (form. 6):

$$Loan_t = 0,620 FL_{t-1}^{1,228} DL_{t-1}^{-0,122} . \qquad (6)$$

The coefficient of determination of the logarithmic linear model is $R^2 = 0,980$, all regression coefficients are statistically significant ($p_i < 0,05$).The chart of the residuals of the logarithmic linear model is shown in Fig. 7.

The growth of bank crediting in the Czech Republic in the current year is due to the increase in the gross external debt in the previous period, while the distressed loans of the previous year insignificantly reduce the amount of crediting in the current period.

During the last two periods, the growth of distressed debt was accompanied by a decrease in the volumes of deposits and loan portfolio of the Czech banks (Fig. 8). However, the long-term stable value of distressed debt in the previous analyzed periods makes it impossible to assess the impact of this factor on the dynamics of the loan portfolio of the banks in the Czech Republic. The increase in the distressed bank loans during the crisis

was accompanied by a slight decline in the gross external debt.

The analysis of the regression model for the evaluation of bank crediting in Hungary has made it possible to determine that there is no connection between the gross external debt and distressed loans. After the removal of the above mentioned variables the model is as follows (form. 7):

$$Loan_t = 0,079 Dep_t^{1,747} . \qquad (7)$$

The coefficient of the determination of the model is $R^2 = 0,985$, all regression coefficients are statistically significant ($p_i < 0,01$). The chart of the residuals of the logarithmic linear model is shown in Fig. 9.

The dynamics of loan portfolio volumes of the banks in Hungary is directly and closely related only to the dynamics of deposits of the population and business entities in the country.

As shown in Fig. 10, when deposits of legal entities and individuals begin to decline in volume, the volumes of crediting sharply decrease. This is the reaction of the Hungarian banking system to the challenges of the crisis phenomena in the world economic system.
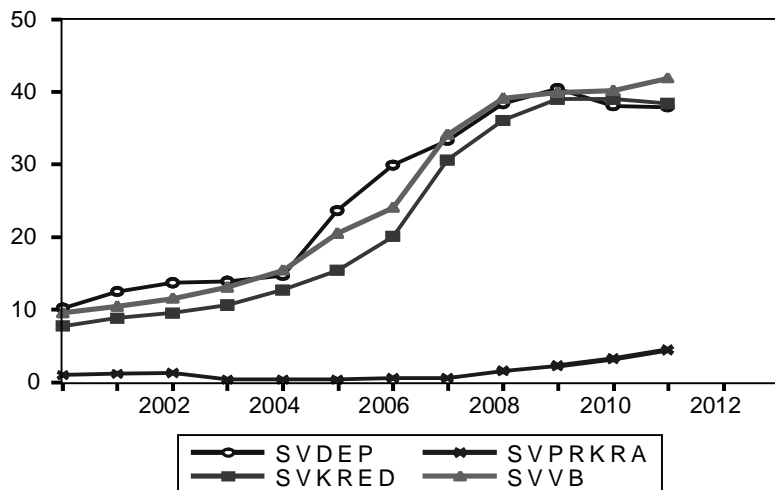
Fig. 6. The dynamics of "deposits – loans – foreign debt – distressed loans" for the banks in Slovenia, billion euros
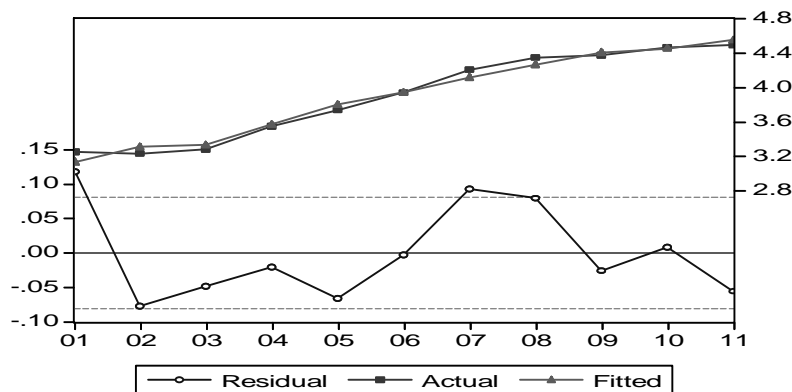
Fig. 7. Residuals of the regression model for the logarithms of the loan portfolio volumes of the banks in the Czech Republic
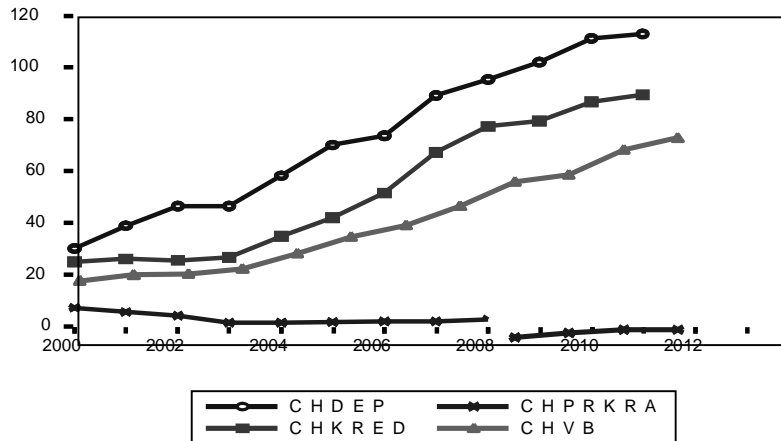
Fig. 8. The dynamics of "deposits – loans – foreign debt – distressed loans" for the banks in the Czech Republic, billion euros
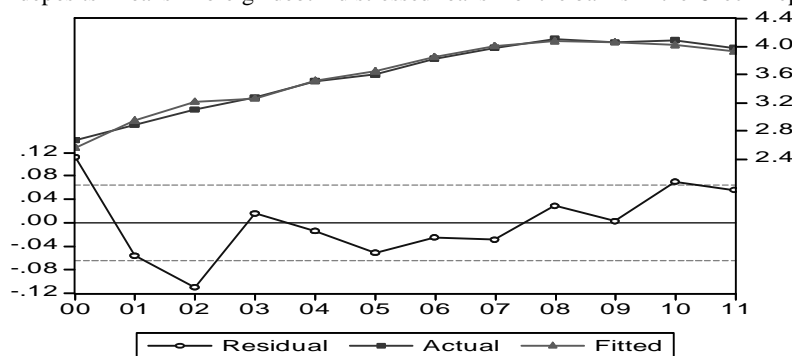

Fig. 9. Residuals of the regression model for the logarithms of the loan portfolio volumes of the banks in Hungary
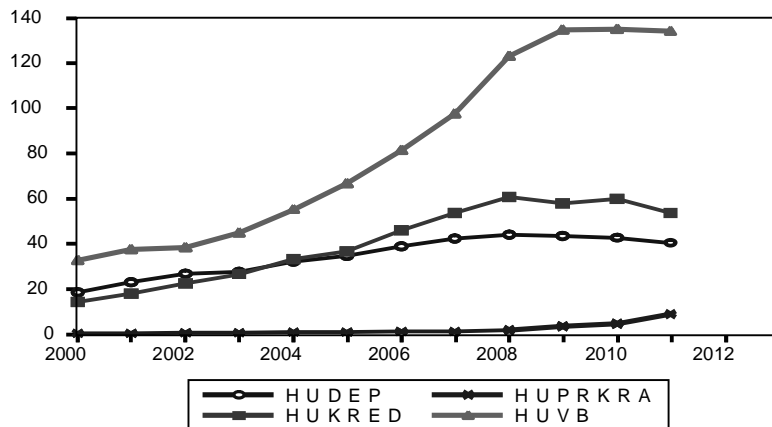

Fig. 10. The dynamics of "deposits – loans – foreign debt – distressed loans" for the banks in Hungary, billion euros

The study of the banking system of Ukraine has found that there is statistically insignificant connection between the crediting volumes of the current year and the amount of the distressed debts of the banks in the previous period. After removal of the specified variable, the model acquired the following form (form. 8) [16, 17]:

$$Loan_t = 0,55 Dep_t^{0,828} FL_{t-1}^{0,428} . \qquad (8)$$

The coefficient of the determination of the model is $R^2 = 0,986$, all regression coefficients are statistically significant ($p_i < 0,01$).The chart of the residuals of the logarithmic linear model is shown in Fig. 11.

The analysis of the constructed model has found that the deposits in the current year and gross external funds in the previous year have a significant direct impact on the growth of the loan portfolio of Ukrainian banks (Fig. 12).

Ukrainian banks are characterized by a leveling of the risks related to the distressed loans of the previous periods [1, 13].

Comparison of the regression models of the loan portfolios of banks in CEE causes us to recognize four types of strategies of the formation of loan portfolios of banks (Table 1).
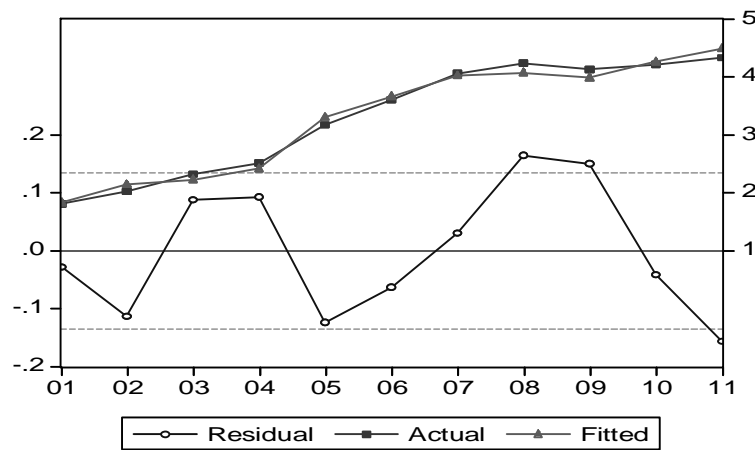
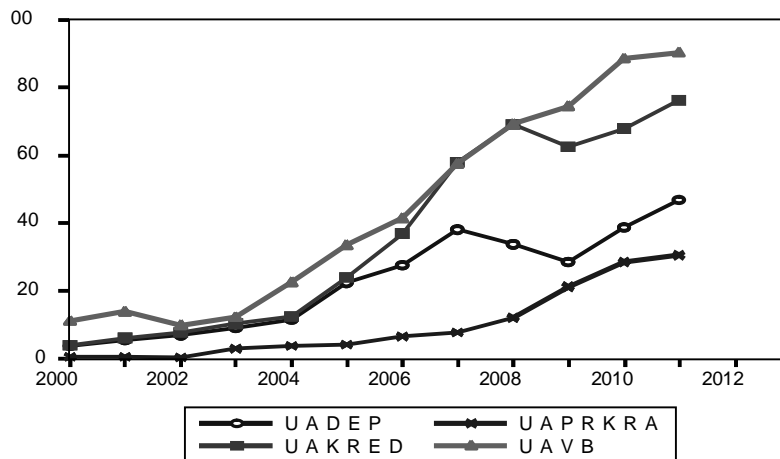**Fig.11.** Residuals of the regression model for the logarithms of the loan portfolios of the banks in Ukraine

Fig. 12. The dynamics "deposits – loans – foreign debt – distressed debts" for the banks in Ukraine, billion euros

Table 1. Matrix of strategies of the formation of the loan portfolios of banks in CEE

Types of loan strategies of the banks in CEE	Deposits of individuals and businesses	External debts of banks	Distressed debts of banks (risk)
Moderate (risk-conscious) deposit and debt strategy	+	+	+
Moderate (risk-conscious) debt strategy	–	+	+
Risk deposit strategy	+	–	–
Risk deposit and debt strategy	+	+	–

The first type of strategies is a moderate (risk-conscious) deposit and debt strategy. It is characterized by the formation of the loan volumes by banks both as deposits of individuals and legal entities and debt financing in foreign financial markets, with consideration given to the risks caused by distressed debts of the previous periods. This type of the loan portfolio formation strategy is inherent in the banks in Poland and Slovakia.

The second type of strategies is a moderate (risk-conscious) debt strategy. It is characterized by the formation of the loan volumes mainly by external loans. Thus, when planning the bank crediting volumes more

consideration is given to the assessment of risks related to the amount of distressed loans of banks in the previous periods. This type of strategy is inherent in the banks in the Czech Republic and Slovenia.

The third type (risk deposit strategy) is inherent in the banks in Hungary. It is characterized by planning the volumes of the loan portfolios by internal funds (deposits of legal entities and individuals). This makes it possible to ignore the impact of the risks caused by the increase of the distressed debts of the banks.

The fourth type of strategies is a risk deposit and debt strategy. It is characterized by using both deposits of the population and external funds of banks. This

model does not reveal any impact of distressed loans of the previous periods on planning the volumes of the loan portfolios of banks. This type of loan behavior is inherent in the banking institutions in Ukraine.

CONCLUSIONS

Priorities in the activities of the banks in CEE countries, which form a moderate deposit and debt strategy are currently as follows:

- to resume volumes of crediting for the needs of national economies through internal funds with the aim of reducing the economic system dependence on debt financing;

- to attract temporarily surplus funds of citizens to the programs of economic recovery and growth in the post-crisis period. The restoration of public confidence in the banking system would increase the national source of investment in the economy through the banking institutions, and reduce the amount of non-bank money circulation.

Priorities in the activities of the banks in CEE countries, which form a risk deposit strategy and debt and deposit strategy are currently as follows:

- effective management of distressed debts of the banks arising from the effects of the global financial crisis;

- application of new methodologies to assess the creditworthiness of borrowers with the aim of maintenance of the optimum ratio "yield - risk" when forming the loan portfolios of the banks.

Stable operation of the banking sector is the basic principle of economic development. The global financial crisis has revealed major risks of operation of the banks. In these circumstances, the analysis of the banking risks revealed the most significant factors that affected the efficiency of the loan portfolios of the banks in Central and Eastern Europe. This analysis and experience make it possible to develop the corresponding anti-crisis strategies under conditions of competitive environment and European integration processes.

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Nonlinear regression model of the formation of the loan portfolios of the banks in Central and Eastern Europe

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Abstract. The article examines the impact of significant factors and adaptation of the experience of CEE countries to the current conditions of the banking business development in Ukraine in order to strengthen the competitiveness of domestic banks in the conditions of European financial integration. In order to identify the main sources of risks a regression analysis of formation of the loan portfolio volumes of the banks in CEE has been made.

Key words: bank, loan portfolio, external debt, foreign liabilities, deposits, distressed loans.

INTRODUCTION

The global financial crisis has exposed the basic elements of functional vulnerability of the banks in Central and Eastern Europe and significantly increased the risks of their development. In order to identify the main sources of risks and factors influencing the volume of crediting the economic needs of individuals and businesses by the banks, a regression analysis of formation of the loan portfolio volumes of the banks in CEE has been made [5–8].

The study of the dominant factors affecting the formation of behavioral strategies of the banks in the market will make it possible to develop specific recommendations for improving their credit activity with the aim to increase the competitiveness of the entire banking system and avoid crisis phenomena, as well as to model strategies for the development of the banking sector in the conditions of increased integration of national economies into the European financial system.

The necessity for evaluation of the efficiency of banking systems based on loan portfolio volumes is caused by a special urgency to solve the problem of shortage of bank credit resources, which is experienced by all entities of the economy, and trends in the credit, deposit, and shareholder policy of the banks in the pre-crisis, crisis and post-crisis periods. The basis of the analysis of credit rates in the banking systems in CEE countries is formed by the following indices:

§ volume of deposits in the country as an index used to determine the level of savings and trust of individuals and legal entities in the banking system, which is used for crediting the needs of economic entities of national economies;

§ volume of distressed loans as an index of the riskiness of the credit policy pursued by the banks;

§ volume of the gross external debt (foreign liabilities) as a source of accumulating financial resources by the banks for crediting operations. Typically, this source dominates in the countries with a low level of savings and deposits in the banks, and considerable credit needs of the economy in resources, which encourages the banks to implement the strategies of forming loan funds in foreign financial markets [9–12].

RESULTS AND DISCUSSION

Development and implementation of effective strategies of credit portfolio formation of banks in the present-day conditions of development requires a comprehensive consideration of the impact of significant factors and adaptation of the experience of CEE countries to the current conditions of the banking business development in Ukraine in order to strengthen the competitiveness of domestic banks in the conditions of European financial integration. To assess the impact of the volumes of deposits, gross external debt and distressed loans on the loan portfolios of the banks in CEE, the multiplicative regression model was built (form. 1):

$$Loan_t = b_1 Dep_t^{b_2} FL_{t-1}^{b_3} DL_{t-1}^{b_4} e , \qquad (1)$$