Отримано: 30 жовтня 2013 р.

Прорецензовано: 2 грудня 2013 р.

Прийнято до друку: 20 грудня 2013 р.

Ambarchyan V. S. The linear model of dependence of the amount of bank financial investments on the cost of resources accomodated and the revenues on their allocation building / V. S. Ambarchyan // Наукові записки Національного університету «Острозька академія». Серія «Економіка» : збірник наукових праць / ред. кол. : І. Д. Пасічник, О. І. Дем'янчук. – Острог : Видавництво Національного університету «Острозька академія», 2013. – Випуск 24. – С. 251–256.

UDK: 33.021:330.322

JEL Classification: G20

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THE LINEAR MODEL OF DEPENDENCE OF THE AMOUNT OF BANK FINANCIAL INVESTMENTS ON THE COST OF RESOURCES ACCOMODATED AND THE REVENUES ON THEIR ALLOCATION BUILDING

The article focuses on the research of the dependence of the amount of financial investments on the expenses on resources accommodation and revenues on securities acquired. Two-factor linear model, which determines the strength of impact of each factor on independent variable, is built. The adequacy of the model and the statistical significance of the parameters and regressors are verified. Is determined as appropriate to apply the built linear regression model to the process of managerial decisions performance, that refer to the amount of the financial investments.

Key words: *bank financial investments, linear regression model, correlation, securities rate of return, price for financial resources, statistical significance.*

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ПОБУДОВА ЛІНІЙНОЇ МОДЕЛІ ЗАЛЕЖНОСТІ ОБСЯГІВ ФІНАНСОВОГО ІНВЕСТУВАННЯ БАНКУ ВІД ВАРТОСТІ ЗАЛУЧЕННЯ РЕСУРСІВ ТА ДОХОДІВ ВІД ЇХ РОЗМІЩЕННЯ

У статті проведено дослідження залежності обсягів фінансового інвестування банку від витрат на залучення ресурсів та доходів за придбаними цінними паперами. Побудовано двофакторну лінійну модель, що визначає силу впливу кожного чинника на незалежну змінну. Проведено перевірку адекватності побудованої моделі та статистичної значущості параметрів і регресорів моделі. Визнано за доцільне застосовувати побудовану лінійну регресійну модель у процесі прийняття управлінських рішень щодо обсягів фінансового інвестування установи.

Ключові слова: *фінансові інвестиції банку, лінійна регресійна модель, кореляційна залежність, дохідність цінних паперів, вартість фінансових ресурсів, статистична значущість.*

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ПОСТРОЕНИЕ ЛИНЕЙНОЙ МОДЕЛИ ЗАВИСИМОСТИ ОБЪЕМОВ ФИНАНСОВОГО ИНВЕСТИРОВАНИЯ БАНКА ОТ СТОИМОСТИ ПРИВЛЕЧЕНИЯ РЕСУРСОВ И ДОХОДОВ ОТ ИХ РАЗМЕЩЕНИЕ

В статье проведено исследование зависимости обьемов финансового инвестирования от затрат на привлечение ресурсов и доходов за купленными ценными бумагами. Построено двофакторную линейную модель, определяющую силу влияния каждого фактора на независимую переменную. Проведено проверку адекватности построеной модели и статистической значимости параметров и регрессоров модели. Признано целесообразным применять построенную линейную регрессионную модель в процесе принятия управленских решений относительно обьемов финансового инвестирования учереждения.

Ключевые слова: *финансовые инвестиции банка, ленейная регрессионная модель, корреляционная зависимость, доходность ценных бумаг, стоимость финансовых ресурсов, статистическая значимость.*

Formulation of the Problem. During the procedure of bank investment activities, classified as financial instruments, dynamic analysis, the necessity to determine factors, influencing changes in indicators of growth and increase, has risen. Obviously, such factors can be divided into two groups – external and internal. And

while external factors, such as economic cycle phases rotation, political conditions and modifications of the rules regulating stock exchange operations, can't be coordinated by bank managers, internal factors, on the other hand, can be identified, measured and corrected. To measure the strength of impact of each internal factor on the amount of financial investments, correlation and regression methods of factor analysis should be implemented. Correlation analysis enables to reveal the fact of statistically significant relations availability, while regression analysis provides mathematical description of the determined type of dependence, which includes the class of regressive function selection and regressors parameters measurement [1, c. 91].

The latest researches and publications analysis. Methodic of correlation and regression analysis is applied with the aim of mathematical explanation of economic operations to develop descriptive models of certain economic processes development. Theoretic grounding of correlation and regression analysis is performed in scientific papers of many scientists, which are the following: A. M. Dubrova, V. C. Mchitarian, L. I. Troshina [1], E. V. Bereschna, V. I. Bereschnoy [2], V. P. Bocharov [3]. Nevertheless, the fact that practical aspects of correlative and regressive analysis of bank investment activity weren't disclosed in scientific papers of any native and foreign authors, determines the actuality of the research performed.

The aim of the research. The aim of the article refers to the factors determination, econometric model of the dependence of financial investments amounts of the determined factors building and statistic significance of the model parameters verification. The investigation aims at regression model adequacy confirmation and its implementation in the process of investment activity analysis.

The statement of the research with the scientific results grounding. With the aim of identification of the reasons of investment amounts changes, the investigation is determined to be performed with the use of investment activity results of Intesa Sanpaolo banking Group, introduced on the Ukrainian territory by the Pravex Bank business activity. Group investment activity during 2003-2012 has been standing for a substantive part of the financial assets operations (Figure 1), that confirms its active position on the financial investments market.

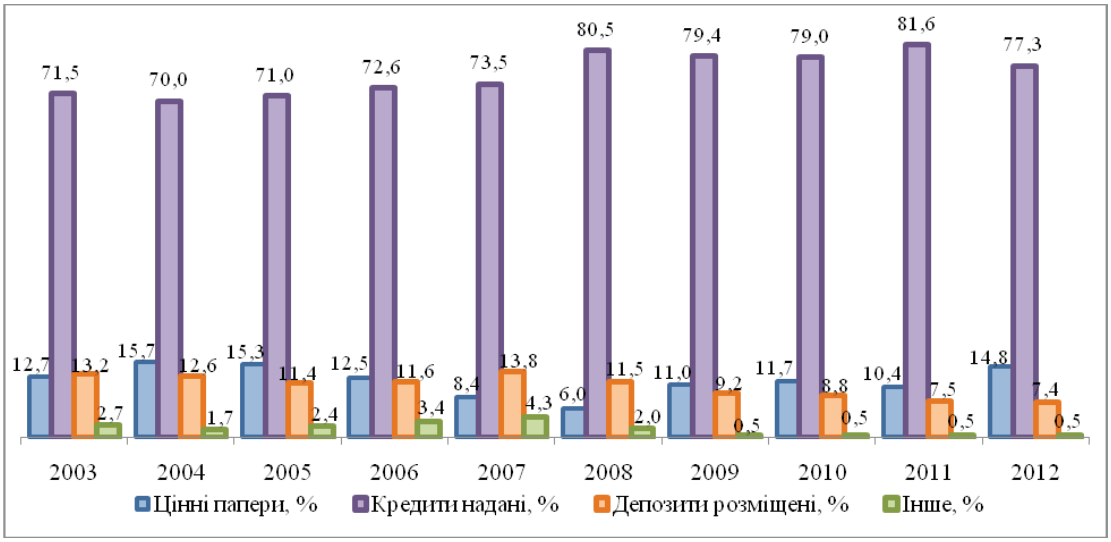

Figure 1. The structure of financial assets of Intesa Sanpaolo Group in 2003-2012, %

Logic analysis has enabled to determine two major factors, influencing the volumes of investments performed – the cost of resources accomodated and the revenues on investments performed. The availability of two factors of influence on the investigated value requires two-factor linear regressive model building, in which the volume of financial investments is determined as dependent variable Y, while revenues on securities purchased and the value of resources accommodated are designated as independent variables X_1 and X_2 consequently. Assumption concerning linear connection between researched values will be confirmed or denied by verifying the adequacy of the model.

The information concerning the volume of securities investments and the amounts of revenues during 2003-2012 is received from the notes of the Statement of financial position and Income statement [4-13] and is systemized in the Table 1.

Table 1
Securities investments of the Intesa Sanpaolo Group in 2003-2012

Period	Securities, million euro	Revenues on securities, million euro	Securities rate of return, %
1	2	3	4=3/2*100%
2003	27602	1275	4,62
2004	35849	1363	3,80
2005	36577	1966	5,37
2006	32645	1938	5,94
2007	38397	3137	8,17
2008	29438	2360	8,02
2009	51591	1819	3,53
2010	55980	1657	2,96
2011	47816	1896	3,97
2012	71855	2183	3,04
$\bar{r}$	x	x	4,94

Expenses on the financial resources accommodation for their further allocation in securities is measured as the sum of interest expenses on bank deposits, client deposits, issued bonds, financial liabilities available for sale and those, measured at fair value through profit or loss, accommodation. The data relating the volume of interest expenses is presented in the note «Interest expenses» of the Income statement of the Group [4-13]. The sum of expenses, falling on financial investments is measured on the basis of the formula (1):

$$E_i = \frac{E_{L_f}}{A_f} \cdot I_f \text{ , (1)}$$

where E_i – expenses on the financial resources to perform investment activities, million euro; E_{Li} – expenses for financial liabilities, million euro; A_f – financial assets, million euro; I_f – financial investments, million euro.

The measurement of the expenses on the financial resources accommodation is adduced in Table 2.

Table 2
The measurement of the expenses on financial resources allocation of the Intesa Sanpaolo Group in 2003-2012

Peroid	Interest expenses on financial liabilities, million euro	Financial assets, million euro	Financial investments, million euro	Expenses on financial resources accommodation, million euro
1	**2**	**3**	**4**	**5=2/3*4**
2003	4424	216885	27602	563,02
2004	3835	228324	35849	602,13
2005	4626	238798	36577	708,57
2006	5950	262095	32645	741,1
2007	14154	455469	38397	1193,21
2008	14912	489270	29438	897,21
2009	8350	469560	51591	917,42
2010	6875	478736	55980	803,91
2011	7727	460199	47816	802,86
2012	8408	485765	71855	1243,72

Theoretically, multiple linear model of the dependence of the volume of financial investments on the amount of expected revenues and incurred expenses can be represented as (2):

$$Y=\beta_0+\beta_1X_1+\beta_2X_2, \text{ (2)}$$

where Y – the volume of securities financial investments, million euro; X_1 – revenues on financial investments, million euro; X_2 – expenses on financial resources accommodation, million euro.

The indexes of independent variance and two regressors for 10 periods build data massive for the linear model construction (Table 3).

Table 3

The data massive for the two-factor linear model construction

Financial investments, million euro (y)	Revenues on financial investments, million euro (x1)	Expenses on financial resources accommodation, million euro (x2)
1	2	3
27602	1275	563,02
35849	1363	602,13
36577	1966	708,57
32645	1938	741,10
38397	3137	1193,21
29438	2360	897,21
51591	1819	917,42
55980	1657	803,91
47816	1896	802,86
71855	2183	1243,72

Empiric model of the researched connection can be represented in matrix form (3):

$$\vec{y} = X \cdot \vec{\beta}, \quad (3)$$

where $\vec{o}$ – the vector of dependent variance Y; $\vec{\beta}$ – the vector of β-parameters.

Statistical measures of β-parameters are determined as followed (4):

$$\vec{\beta} = (\tilde{O}'\tilde{O})^{-1} \cdot \tilde{O}'\vec{o}, \quad (4)$$

where X – the matrix of regressors X; $\tilde{O}'$ – transposed matrix X.

As a result of certain mathematical operations performance with the matrix X and the vector $\vec{o}$, statistical measures of the model parameters are calculated:

$$\vec{\beta} = \begin{pmatrix} 22067,09 \\ -29,66558 \\ 93,0397078 \end{pmatrix}$$

Thereby, β_0=22067,09, β_1=–29,66558, β_2=93,0397078.

Consequently, the dependence of the volumes of investments on the revenues on securities and the cost of resources accommodated can be described in the form of the following equity:

$$y_i = 22067,09-29,67x_{i1}+93,04x_{i2}$$

The next stage, following linear model building, is the performance of the procedure of the model adequacy analysis and the statistical significance of parameters and regressors determination. Complementary information relating the measurement of determined above characteristics, is given in the Table 4.

The measurement of the accuracy of the built regression model includes its adequacy level calculation, the determination index measurement, and the statistical significance of the regressors x_1, x_2 and β_0, β_1, β_2 parameters calculation (Table 5).

Thereby, regression analysis of bank investment activity has resulted in the regression equity of financial investments dependence on two factors – the cost of resources accommodation and the revenues on their allocation, building. Received results indicate, that the increase of revenues on securities for 1 million euro leads to the investments amounts decrease for 29,67 million euro, while the increase of the cost of resources for 1 million euro leads to investments amounts decrease for 93,04 million euro. It must be mentioned, that reverse relation between revenues and the amount of investments can be explained by the higher risk of more profitable assets and by the implementation of the risk-diminishing leverages in case of risk increase by using the method of securities diversification and their reallocation to the less profitable and less risky assets.

Table 4

Complementary calculations to determine the adequacy of the linear model

№	y_i^*	$e = y_i - y_i^*$	$e_з^2$	$y_i^* - \overline{y}$	$\left(y_i^* - \overline{y}\right)^2$	$y_i - \overline{y}$	$\left(y_i - \overline{y}\right)^2$
1	36627,35	-9025,35	81456886,99	-6147,65	37793638,42	-15173,00	230219929
2	37655,57	-1806,57	3263686,75	-5119,43	26208587,37	-6926,00	47969476
3	29670,30	6906,70	47702541,75	-13104,70	171733232,03	-6198,00	38415204
4	33527,55	-882,55	778893,37	-9247,45	85515343,37	-10130,00	102616900
5	40022,76	-1625,76	2643079,85	-2752,24	7574851,65	-4378,00	19166884
6	35533,12	-6095,12	37150486,48	-7241,88	52444827,52	-13337,00	177875569
7	53462,69	-1871,69	3503226,38	10687,69	114226734,25	8816,00	77721856
8	47707,53	8272,47	68433806,04	4932,53	24329824,69	13205,00	174372025
9	40519,70	7296,30	53236025,10	-2255,30	5086387,80	5041,00	25411681
10	73023,45	-1168,45	1365270,24	30248,45	914968593,81	29080,00	845646400
Σ	**x**	**0,00**	**299533902,9**	**x**	**1439882021**	**x**	**1739415924**

Table 5

Calculation of the indexes and coefficients, which characterize the adequacy level of the built linear model

№	Index	Method of measurement	Result	Conclusion
1	The level of adequacy	$\overline{e_i} = \frac{\sum (y_i - y_i^*}{n}$, $\overline{e} = 0$	$\overline{e} = 0$	The model is adequate
2	The level of adequacy	$\sigma^2_{\overline{y^*}} + \sigma^2_{\overline{e}} = \sigma^2_{\overline{y}} \Rightarrow$ *the* mod *el is adequate* $\frac{\sum_{i=1}^{n} e_i^2}{n} + \frac{\sum_{i=1}^{n}\left(y_i^* - \overline{y}\right)^2}{n} = \frac{\sum_{i=1}^{n}\left(y_i - \overline{y}\right)^2}{n}$	$\sigma^2_{\overline{o}} = \sigma^2_{\overline{o}^*} + \sigma^2_{\overline{a}}$	The model is adequate
3	Determina-tion coefficient R2	$R^2 = \frac{\sum_{i=1}^{n}\left(y_i^* - \overline{y}\right)^2}{\sum_{i=1}^{n}\left(y_i - \overline{y}\right)^2}$	$R^2 = 0{,}8278$	Factors, included in the model, explain changes in the volume of investments for 82,78%
4	Statistical significance of x1 and x2 criteria – Fisher F-criteria	$F^* = \frac{R^2}{1-R^2} \cdot \frac{n-m-1}{m}$, $F(\alpha = 0{,}05; f_1 = 2; f_2 = 7)$, $F^* > F_{\alpha, f_1, f_2} \Rightarrow H \notin [H_0 : R^2 = 0]$	$F^* = 16{,}825;$ $F_{\alpha, f_1 f_2} = 4{,}74;$ $F^* > F_{\alpha, f_1, f_2}$	Regressors x1 and x2 have an impact on the dependent variable y
5	Statistical significance of β0, β1, β2 parameters	$t^*_{\beta_i} = \frac{\beta_i}{S_{\beta_i}}$, $t''_{кр}(0{,}025;8) < t^*_{\beta_i} < t'_{кр}(0{,}025;8);$ $-2{,}365 < t^*_{\beta_i} < 2{,}365 \Rightarrow$ $\Rightarrow H \notin [H_0 : \beta_i = 0]$	$t^*_{\beta_0} = 18032{,}22;$ $t^*_{\beta_1} = -31132{,}71;$ $t^*_{\beta_2} = 41554{,}96.$ $t^*_{\beta_1} \notin [-2{,}365; 2{,}365]$ $t^*_{\beta_2} \notin [-2{,}365; 2{,}365]$ $t^*_{\beta_3} \notin [-2{,}365; 2{,}365]$	β0, β1and β2 parameters are statistically significant

The built model is recognized as the adequate one, since the average value of the deviation of the independent averages from those, measured by the model, equals ē=0. The excess of the observation value of Fisher criteria over the tabulated value in the built model has become an evidence of the materiality of regressors' influence on dependent and independent variables. Parameters β_0, β_1, β_2 of the model are recognized as statistically significant, as received t-criteria for each parameter are beyond the tabulated range, so that H_0-hypothesis on the parameters immateriality is rejected. Measured index of determination explains, that factors, included in the model, explain

changes in the amount of investments for 82,78%, which means, that for 17,22% the invested sum depends on the omitted factors.

Conclusion. The performed research, which aimed in the factors of the amount of financial investments influence determination and the strength of such influence measurement, has resulted in the two-factor linear regressive model building. In the given model financial investments are identified as dependant variance, while the cost of resources accommodation and the revenues on their allocation are considered as independent ones. The built model is determined as adequate one, and the parameters are considered as statistically significant. The received results have enabled to make prompt judgment relating the applicability of regression analysis in the determination of economic factors, reflecting investment amounts modifications.

References:

1. Бережная Е. В. Математические методы моделирования экономических систем / Е. В. Бережная, В. И. Бережной. – М. : Финансы и статистика. – 2006. – 432 с.

2. Дубров А. М. Многомерные статистические методы / А. М. Дубров, В. С. Мхитарян, Л. И. Трошин. – М. : Финансы и статистика. – 2003. – 352 с.

3. Бочаров В. П. Регрессионный анализ динамических эффектов на финансовых рынках / В. П. Бочаров [Electronic source]. – Retrieved from : http://econ.vsu.ru.

4. Banca Intesa Annual Report 2003 [Electronic source]. – Retrieved from : http://www.group.intesasanpaolo.com.

5. Banca Intesa Annual Report 2004 [Electronic source]. – Retrieved from : http://www.group.intesasanpaolo.com.

6. Report and consolidated financial statements of Gruppo Intesa 2005 [Electronic source]. – Retrieved from : http://www.group.intesasanpaolo.com.

7. Report and consolidated financial statements of Gruppo Intesa 2006 [Electronic source]. – Retrieved from : http://www.group.intesasanpaolo.com.

8. Report and consolidated financial statements of the Intesa Sanpaolo Group 2007 [Electronic source]. – Retrieved from : http://www.group.intesasanpaolo.com.

9. Report and consolidated financial statements of the Intesa Sanpaolo Group 2008 [Electronic source]. – Retrieved from : http://www.group.intesasanpaolo.com.

10. Report and consolidated financial statements of the Intesa Sanpaolo Group 2009 [Electronic source]. – Retrieved from : http://www.group.intesasanpaolo.com.

11. Report and consolidated financial statements of the Intesa Sanpaolo Group 2010 [Electronic source]. – Retrieved from : http://www.group.intesasanpaolo.com.

12. Report and consolidated financial statements of the Intesa Sanpaolo Group 2011 [Electronic source]. – Retrieved from : http://www.group.intesasanpaolo.com.

13. Report and consolidated financial statements of the Intesa Sanpaolo Group 2012 [Electronic source]. – Retrieved from : www.group.intesasanpaolo.com.