DESIGNING THE DEPOSITS MANAGEMENT MODEL IN FUNCTION OF BANKING ACTIVITIES OPTIMIZATION

Ticijan Peruško, PhD
Juraj Dobrila University of Pula, Department of Economics and Tourism «dr. Mijo Mirković»
Address: Preradovićeva 1/1, 52100 Pula, Republic of Croatia
Phone: ++38552377051; E-mail: tperusko@efpu.hr

Robert Zenzerović, PhD
Juraj Dobrila University of Pula, Department of Economics and Tourism «dr. Mijo Mirković»
Address: Preradovićeva 1/1, 52100 Pula, Republic of Croatia
Phone: ++38552377051; E -mail: robert.zenzerovic@unipu.hr

Abstract

The purpose of this paper is to improve the banks deposits' management process that will ultimately result in the collection of deposits at lowest costs. In order to achieve the aforementioned purpose, the authors have derived model using statistical and mathematical methods. Statistical method of double logarithmic regression was applied in order to determine the relations between the costs and amount of funds collected from each deposit product, while in the process of deposit assortment optimization nonlinear programming was applied, as the correlation between costs and the amount of collected funds from the sale of deposits products is nonlinear what is shown in the selected regression model too. In order to present the usefulness and wide possibilities of its use, the deposits management model was employed on the example of one large bank that operates in the Croatian banking market. The model is applicable both to the retail sector and corporate sector deposits. Information derived from the model application help banks management in making appropriate decisions regarding planning and managing the sales of deposits and, along with other existing instruments, complements the database of banks management information system.

Key words: *banking activities optimization, deposits management model, banking cost management, double logarithmic regression model, nonlinear programming*

1. INTRODUCTION

Planning the banking activities includes collection and analysis of all relevant information important for everyday banking operations in order to determine current market position, estimate planned market position and set the measures to reach estimated values (Sinkey, 2001, p. 201.). Adequate market strategy mostly includes the management of the set of banking products i.e. improving the existing and introducing the new products as well as customer relationship management (Sinkey, 2001, p. 204. – 205.).

The researches in the field of banking management are quite broad. Some of them, that include comprehensive analysis of banking management on the global level, could be found in the works of

Heffernan (2005) and Mathews and Thompson (2005). In their works the analysis of existing and estimation of new trends in banking are shown as well as the measures of banks performances and the causes of banks' bankruptcies. Chorafas's (1991) researches are focused toward banking products and improvement of banking activities. According to his researches, cost control along with improvement in sales channels, business units' organization and markets' possibilities recognition are basic assumptions of successful banking.

Banking market is constantly and rapidly changing facing the banks with rising needs to adjust to newly market conditions. The size of the bank in this sense is important factor in facing the new conditions. Banks are merging making in this way big banking groups that consist, not only of banks, but the other financial institutions as well, like insurance and investment companies, pension funds and others. Andreloni, Barga and Carlucci (2007) emphasize in this sense the importance of performing the researches of new possibilities in managing the banking activities.

Significant segment of the banks business success is reflected in the collection of cash funds in the banking market through the sales of deposits products at the lowest cost, and in creation of loan products and their sale to customers at competitive prices i.e. interest rates. In Croatian banking market the proportion of traditional banking intermediation, i.e. the proportion of collected deposits in banks' consolidated balance sheet is 75,05% (http://www.hnb.hr/publikac/hpublikac.htm) what clearly indicate the importance of performing appropriate banks deposits' management processes as a part of overall banking activities optimization. In order to improve the competitiveness of banks operating in the Croatian banking market, it is necessary to develop scientifically based model that will allow better planning and management of deposits products supply in order to optimize banks' costs i.e. minimize the costs of predetermined amount of the deposits that banks plan to collect. In this sense the authors decide to apply quantitative scientific methods that will result in generating deposits' management model and ultimately improve the process of banks deposits' management.

The deposit management model developed in this paper expands existing management decision support instruments used in the segment of planning and sale of various deposits products. A series of scientific method were used in the process of model creation. Methods of description, analysis and synthesis were applied in determining the relationship between movements in the costs per deposit product and sales volume per deposit product as a starting point for the quantification of that relationship and optimization of deposit range which is achieved by applying statistical and mathematical methods, among which the most emphasized are methods of regression analysis and nonlinear programming. Quantitative methods application and details on model development are presented in the next chapter, while the aspects of its' practical application can be found in the third part of the article.

2. DESIGNING THE DEPOSITS MANAGEMENT MODEL

In the process of collecting funds from customers through the sale of bank's deposits products, management tries to structure the bank's liabilities in a the way to obtain the minimum total costs based on transactions with deposits products. The overall costs of the deposit product portfolio are the sum of the costs per each deposit product which the bank offers in the competitive market. In this sense when planning the sources of funds, management must be precisely directed to the sources that are most acceptable in the sense of lowest costs, taking into account the current prevailing constraints on the banking market, i.e. bank management has to determine on which deposits products bank should be focused in order to raise funds at minimal costs.

Forecasting costs growth for particular deposit product in relation to the planned increase in volume of funds collected from the same deposit product requires the analysis of historical costs patterns in relation to the amount of funds collected via deposits i.e. the volume of sales of deposits products. The statistical method of regression analysis was applied in order to determine the above mentioned relation between the costs and amount of funds collected from each deposit product. Regression analysis was performed using different relations between dependent and independent variables: from linear to various nonlinear relations. The double logarithmic regression model was found to be the most appropriate according to the high values of coefficient of determination which shows the representative ability of the regression model.

This regression model has a further standard form (Sosic, 2006, p. 427):

$$\hat{Y} = ax^b \tag{1}$$

Where,

$\hat{Y}$ – represents costs per deposit product (dependent variable),

x – represents the amount collected per deposit product (independent variable),

a – represents constant and

b – is regression coefficient.

In double logarithmic regression model independent variable *x* consist of the amount of funds collected by each deposit product, while the dependent variable *y* refers to the costs per deposit product. Usage of regression analysis resulted in determination of corresponding relation which represents the starting point for the projection of future trends in costs per deposit product depending on the planned increases in the amount of deposits. Representative ability of the regression model is determined by the coefficient of determination, while the average deviation of empirical value of dependent variable from the regression value of dependent variable is determined by standard deviation or standard error.

Banks' management has the emphasized need for the information that will enable him/her to plan and manage the assortment of deposits products in the process of funds collection at minimum costs, taking at the

same time into account the prevailing business' constraints. In this sense mathematical programming, that deals with optimization problems in which the optimizer encounters limitations, is found to be very useful method that will, along with regression analysis, result in shaping the deposit management model as a management decision support tool. In terms of deposits products, business' constraints include market limitations that consist of limited funds supply in the banking market by the customers and limited clients demand for specific deposit product that is under the direct influence of the tendency of savings and the availability of competitive banking and nonbanking products. In the process of deposit assortment optimization nonlinear programming was applied, as the correlation between costs and the amount of collected funds from the sale of deposits products is nonlinear what is shown in the selected regression model too.

Nonlinear programming that minimizes the function has the following general form (Chiang, 1994, p. 716):

$$\begin{aligned} &\text{Minimize} && C = f(x_1, x_2, \ldots, x_n) \\ &\text{according to conditions} && g^1(x_1, x_2, \ldots, x_n) \geq r_1 \\ & && g^2(x_1, x_2, \ldots, x_n) \geq r_2 \\ & && \ldots\ldots\ldots\ldots \\ & && g^m(x_1, x_2, \ldots, x_n) \geq r_m \\ &\text{and} && X_j \geq 0 \qquad (j = 1,2,\ldots, n) \end{aligned} \tag{2}$$

Or in abbreviated form:

$$\begin{aligned} &\text{Minimize} && C = f(x) \\ &\text{according to conditions} && g^i(x) \geq r_m \qquad (j = 1,2,\ldots, n) \\ &\text{and} && X \geq 0 \end{aligned} \tag{3}$$

Optimization process application on deposits products results in minimizing the total costs of deposits products portfolio according to the following conditions:

- Maximum demand for deposits products is estimated according to the market conditions and represents the upper limit constraint;
- Bank intend to collect funds at minimum costs per each deposit product and consequently minimum costs for total deposits products portfolio;
- Initial balance of deposit portfolio is the lower limit constraint.

The developed deposits management model that is used to optimize deposits products assortment consists of further elements:

- double logarithmic regression models, that predict the movement of costs for each deposit product in the future depending on the planned sale of deposits products, and
- nonlinear programming process.

Deposits management model allow the forecasting with which deposits products bank can obtain the lowest costs, and accordingly shape the deposits business strategy that will result in a greater sales of bank's deposits products that are most acceptable in the terms of costs.

3. DEPOSITS MANAGEMENT MODEL APPLICATION

In order to present the usefulness and wide possibilities of its use, the deposits management model was tested on the example of one large bank that operates in the Croatian banking market. The information gathered from this bank regards the amount of collected funds from sale of deposits products to retail banking sector, i.e. amounts of collected deposits, and associated costs for the period from 2003 to 2007 (Table 1).

Table 1: The amounts of deposits collected with associated costs

TYPES OF DEPOSITS PRODUCTS		2003.	2004.	2005.	2006.	2007.
Short term time deposits - residents	Amount at 31.12.	3.000.986.193	3.666.894.819	4.232.841.393	4.306.263.624	4.637.535.595
	Costs	128.433.209	155.179.836	170.438.399	173.335.106	197.969.793
Long term deposits - residents	Amount at 31.12.	3.085.596.715	3.211.776.515	3.523.794.416	3.496.922.538	3.716.599.042
	Costs	101.773.252	105.266.507	112.023.815	111.351.059	118.392.226
Short term time deposits - nonresidents	Amount at 31.12.	191.354.294	167.041.371	183.269.119	142.782.668	120.908.705
	Costs	5.809.624	4.835.887	5.611.940	4.115.727	3.683.072
Long term deposits - nonresidents	Amount at 31.12.	356.421.613	335.337.468	366.943.377	359.123.599	299.181.059
	Costs	16.826.537	15.076.550	17.191.440	16.290.522	13.683.173

Source: Bank's internal financial statements

The deposits management model formation involves two basic stages. In the first phase the double logarithmic regression models for each type of banking deposits products are derived along with appropriate parameters. Double logarithmic regression models, derived on the basis of historical data, are used to estimate the increase in costs according to the planned increase of funds collected from the sale of each deposit product. The resulting regression models for each deposit product are shown in table 2 and are calculated using the information on amounts and costs per deposit from table 1.

Table 2: Double logarithmic regression models for each deposits products

TYPES OF DEPOSITS PRODUCTS	REGRESSION MODELS	r^2	ADJUSTED R SQUARE	*p*	STANDARD ERROR
Short term time deposits - residents	$y = 0{,}2667x^{0{,}9159}$	0,9701	0,960186132	0,00220	0,013887936
Long term deposits - residents	$y = 4{,}3785x^{0{,}7762}$	0,9890	0,985386888	0,00048	0,003083767
Short term time deposits - nonresidents	$y = 0{,}0189x^{1{,}0241}$	0,9778	0,970352	0,00141	0,014668566
Long term deposits - nonresidents	$y = 0{,}0057x^{1{,}1061}$	0,9583	0,944440907	0,003656	0,009558567

Source: Authors' calculations according to data from table 1

In the second stage, having in mind the upper constraints of market demand for any retail sector deposit product, the nonlinear programming process is used in order to generate information about planned funds collection that minimize total costs of the deposits products portfolio. The table below shows the initial information that will be used to determine the optimal value of each deposit product that should be sold. In the column *x* the lower limit constraint is shown per each deposit product and it represents the deposits balance at the starting point of time (31.12.2007.).

In the example it is assumed that the amount of deposits will not decrease. Column *y* represents appropriate costs per each deposit product in 2007, while the column z shows maximum demand i.e. upper market constraint which is the result of management professional judgment.

Table 3: Deposits balances, costs, corresponding double logarithmic regression models and upper limit market constraint

No	TYPES OF DEPOSITS PRODUCTS	BALANCE OF THE DEPOSITS ON 31.12.2007. IN KUNAS	COSTS IN 2007 IN KUNAS	REGRESSION MODELS	MAXIMUM DEMAND (MARKET LIMITATION) IN KUNAS
		x	y		z
1.	Short term time deposits - residents	4.637.535.595	197.969.793	$y = 0{,}2667x^{0{,}9159}$	5.565.042.714
2.	Long term deposits - residents	3.716.599.042	118.392.226	$y = 4{,}3785x^{0{,}7762}$	4.274.088.898
3.	Short term time deposits - nonresidents	120.908.705	3.683.072	$y = 0{,}0189x^{1{,}0241}$	142.672.272
4.	Long term deposits - nonresidents	299.181.059	13.683.173	$y = 0{,}0057x^{1{,}1061}$	367.992.703
5.	**TOTAL**	**8.774.224.401**	**333.728.264**		**10.349.796.587**

Source: Tables 1 and 2.

Suppose that the bank plans to collect new funds (deposits) from retail sector in the amount of 925.775.599 kunas. As the consequence, the total portfolio of deposits products would increase to 9.7 billion kunas. Bank management needs to raise these funds through the sale of deposits products at the lowest total costs. The deposits management model application results in generating the information on the amount of increase in each deposit product at the lowest cost per each deposit product, and therefore the lowest costs on the entire portfolio of deposits products.

Terms of nonlinear programming are as follows:

Minimize: total costs (Y_5)

according to constraints:

upper limit constraint: $X_1 : X_4 \leq Z_1 : Z_4$ (4)

lower limit constraint: $X_1 : X_4 \geq$ initial balance of deposits portfolio as at 31.12.2007.

and

X_5 (total balance of deposits products portfolio) = 9.700.000.000 kunas.

Where:

X – balance of the portfolio by type of deposit product for retail sector;

Z – market constraints by type of deposits products for retail sector.

The values obtained are systematized in table 4 in a way that shows the balances of deposits achieved in 2007 and the planned balance of individual deposit product in order to achieve a given goal – minimum total costs for collecting amount of 925.775.599 kunas. Additionally listed are the costs achieved in 2007 and their forecasted values that are expected due to the planned growth of deposits.

Table 4: Planned portfolios and planned costs values for deposits products according to the model applied

TYPES OF DEPOSITS PRODUCTS	BALANCE OF THE DEPOSITS ON 31.12.2007.	PLANNED BALANCE OF DEPOSITS	COSTS IN 2007	PLANNED COSTS
Short term time deposits - residents	4.637.535.595	4.984.057.771	197.969.793	203.254.115
Long term deposits - residents	3.716.599.042	4.274.088.898	118.392.226	130.853.733
Short term time deposits - nonresidents	120.908.705	142.672.272	3.683.072	4.239.562
Long term deposits - nonresidents	299.181.059	299.181.059	13.683.173	13.683.173
TOTAL	**8.774.224.401**	**9.700.000.000**	**333.728.264**	**352.030.583**

Source: Authors' calculations according to data from table 3

For a more detailed analysis of the obtained model values, it is necessary to consider them in the relative context. In such a way management get the information about the relative increase of the deposits products values and their appropriate costs compared to the basic period. These relationships are shown in the table 5. In the example, increase in total sales of retail sector deposits products of 925.775.599 kunas results in the increase of the total costs of this group of products by 18.302.320 kunas. The amount of increase in total costs is the lowest increase in costs that can be achieved in raising the necessary funds by the sale of deposits products within a set of constraints. Deposits management model application in this example indicate that the lowest total costs, for planned amount to be collected, will be reached by increase in portfolio of short term time deposits from residents by 346.522.176 kunas, increase in portfolio of short term time deposits from nonresidents by 21.763.567 kunas and by increase in portfolio from long term deposits of residents by 557.489.856 kunas. As the consequence, the total balance of short term time deposits from residents would be 4.984.057.771 kunas, short term time deposits from nonresidents would be 142.672.272 kunas and the balance of long term deposits from residents would be 4.274.088.898 kunas. Long term deposits from nonresidents generate the highest costs and therefore bank management has no plans to collect funds through these deposits products.

Table 5: Survey of absolute and relative increase in deposits products and absolute and relative costs increase in relation to basic period

TYPES OF DEPOSITS PRODUCTS	DEPOSITS PRODUCTS PORTFOLIO INCREASE (PLANNED DEPOSITS – DEPOSITS IN 2007.)	COSTS INCREASE (PLANNED COSTS – COSTS IN 2007.)	PORTFOLIO INDEXES (PLANNED DEPOSITS/ BALANCE OF DEPOSITS ON 31.12.2007.)	COSTS INDEXES (PLANNED COSTS/COSTS IN 2007.)
Short term time deposits - residents	346.522.176	5.284.322	1,07	1,03
Long term deposits - residents	557.489.856	12.461.507	1,15	1,11
Short term time deposits - nonresidents	21.763.567	556.490	1,18	1,14
Long term deposits - nonresidents	-	-	-	-
TOTAL	**925.775.599**	**18.302.320**	**1,11**	**1,05**

Source: Authors' calculations according to data from table 4

Ultimately, the total amount of deposits products would increase 11%, while the total costs due to the increase in deposits products would increase by 5%.

The information generated by the model represents a starting point for decision making and they must be considered in the broader context of managing the banking activities. In order to clearly represent the model practical application, the example assumed the irrelevance of deposits maturity and currency. The possibilities of deposits management model are certainly broader and allow the banks managers to consider various options in planning the collection of funds and the inclusion of additional restrictions like targeted amount of deposits products sale, their maturity and/or currency and according to that appropriate decision making.

4. CONCLUSION

The deposits management model represents decision support tool that helps banks decision makers to manage and plan the collection of necessary funds through the sale of deposits products i.e. collection of funds at the lowest costs. It complements existing decision support methods and is adaptable in terms of overall goals that the bank wants to achieve. The scientific contribution of this paper consists in determining the relations between the costs and amount of deposits collected and, consequently, in deposits management model derivation where appropriate statistical and mathematical methods were deployed. In the previous scientific research this approach was not used so the model derived represents a new banking management tool. Through the model presented bank management receives additional information for appropriate planning and management of the assortment of deposits products. Model is particularly useful in the process of planning the collection of funds through the sale of deposits products. It provides information by which type of deposits products bank can collect targeted funds in order to achieve the lowest total costs and ultimately higher profitability. The model is working in a way that it recognizes deposits products through

which bank achieves the lowest costs for planned funds collection, and incorporates these products into final information base. It also excludes deposits products that generate the highest costs in the observed group. By recognizing and grouping the deposits products according to the amount of costs obtained, the model is emphasizing the sale of those products that achieve the lowest cost, which ultimately results in a sales plan that allow effective cost control. This procedure allows the clustering of deposits products according to their performances and their improvement in terms of cost reduction when raising the funds. Comparing the relative increase in the amount of deposits products with the relative cost increase there can be observed corresponding disproportion of their movement which gives a signal to analysts to determine the significant factors that influence such movements. Using the information obtained from this model the bank management can continue to undertake the necessary business activities in order to reach the planned balances of deposits products. The information derived from model application, along with the information derived from existing instruments, represents qualitative extension of banks' management information system database. The model is applicable both to the retail sector and corporate sector deposits. Further research on the model improvement and application can be directed toward the analysis of bank deposits products by currency, as well as a detailed elaboration of the maturity within each group of deposits products.

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