World Academy of Science, Engineering and Technology
International Journal of Economics and Management Engineering
Vol:5, No:5, 2011

Approaches to Determining Optimal Asset Structure for a Commercial Bank

Svetlana Saksonova

***Abstract*—**Every commercial bank optimises its asset portfolio depending on the profitability of assets and chosen or imposed constraints. This paper proposes and applies a stylized model for optimising banks' asset and liability structure, reflecting profitability of different asset categories and their risks as well as costs associated with different liability categories and reserve requirements. The level of detail for asset and liability categories is chosen to create a suitably parsimonious model and to include the most important categories in the model. It is shown that the most appropriate optimisation criterion for the model is the maximisation of the ratio of net interest income to assets. The maximisation of this ratio is subject to several constraints. Some are accounting identities or dictated by legislative requirements; others vary depending on the market objectives for a particular bank. The model predicts variable amount of assets allocated to loan provision.

***Keywords*—**asset structure, commercial bank, model, optimisation

I. Introduction

DESIGNING the model of the optimal bank - that is the bank, which is completely safe for depositors and possesses an optimal asset and liability structure is just one of the several steps in the asset structure optimisation. There are several types of models in the literature that consider the optimisation of the banking process..

First, there are models, which mathematically describe what could be an ideal bank, but are not in themselves optimisation models. A notable early example is the work of F. Edgeworth "*Mathematical Psychics: An Essay on the Application of Mathematics to Moral Sciences*" in 1881. Second, there are different optimisation models, which are aimed to pick the best option from the various courses of action. Because the object of modelling — the bank — is an extremely complicated one, there is a multitude of models, each one with its own advantages and disadvantages.

One can also draw a different line of distinction among the models available in the literature -- there are, for example, partial optimal bank models, which are founded on the optimal portfolio management principles and risk management methods. The advantage of such models is that they take into account risk and uncertainty factors and ensure the solution to the liquidity problem. The disadvantages, on the other hand, include the fact that the models abstract from the costs of real resources and do not consider the impact of the change in resource costs. Examples of these models include the ones proposed in [1] and [2].

Another group is the models, which use the theory of the firm, which is modified and adjusted to the specifics of the banking business. These models e.g. [3] include the costs of real resources and reflect the influence of the change in resource costs, however, they abstract from asset risks, which makes them dangerous to apply in reality and they do not envisage the possibilities of asset management.

The complete optimal bank models, for example, [4] unify the two approaches discussed above. They describe the functions of the bank as a complete system and include consideration of asset transformation, liquidity management, asset portfolio choice and asset and liability pricing. Such models also take into account the two most important factors that influence bank operations - the cost of resources and risks associated with assets (see, for example, [5]). Of course, these models cannot consider every aspect of a bank in detail; therefore they are not entirely `complete'. In addition, in some models there is no provision for the optimal asset and liability structure.

In this paper the author generally follows the model developed by Baltensperger [6], which has the following desirable characteristics:

- the objective function to be maximised is the ratio of expected net interest income to assets;
- the model takes into account various profitabilities and risks of different asset positions as well as liability costs and associated reserve requirements;
- the solution of the model is the optimal structure of both assets and liabilities;

Section II of this paper develops the model of an optimal bank taking into the account the requirements of the regulatory institutions and best practices of the industry. This model is general, easily extensible and adaptable and can be used by any Latvian or foreign bank. In Section III the author applies the model to the aggregate data of the Latvian banking industry over the time period from 2000 to 2007, a time period in which Latvian banking industry experienced significant growth. Finally, Section IV concludes.

II. The Model

It is the task of every commercial bank to determine the optimal asset portfolio depending on the profitability of various asset classes and chosen constraints. The author proposes one of the instruments for achieving this purpose - the model of asset structure optimisation.

To provide the input information for the model it is first

University of Latvia, Faculty of Economics and Management, Aspazijas Blvd. 5., Room 229, LV 1050, Riga, Latvia.
Email: svetlana.saksonova@lu.lv.

necessary to have a parsimonious description for the asset and liability structure in a typical commercial bank. Tables I and II provide this summary together with the information on asset risks and profitability as well as the reserve norms and costs for different classes of liabilities. The numerical indicators are computed as rolling averages over the seven year period from 2000 to 2007.

The level of detail for asset and liability categories is chosen to create a suitably parsimonious model and to include the most important categories (by proportion in total assets and liabilities) in the model. The model abstracts from the income from commissions and non-interest expenditure. These categories are less likely to be important for commercial banks, which operate in transition economies like the one in Latvia. Nevertheless, the model considered is easily extendable to include these additional categories. There are also limitations due to limited information availability for an external observer. The author had used weighted average interest rate and average profitability for different asset classes in order to smooth over the influence of random fluctuations and to provide a more realistic picture of the financial conditions that the bank has to operate in [7].

The most appropriate optimisation criterion for the model is the maximization of the ratio of net interest income[1] (P) to assets (A). This ratio shows the ability of the bank to generate net profit by placing funds into profitable assets and it also simplifies the derivations, because the solution of the model will be the optimal weight of different categories of assets and liabilities in the total structure.

The model parameters are summarised in Table III. The objective function is given by the following:

$$\frac{P}{A} = \sum_{i=1}^{M} x_i^A l_i - \sum_{j=1}^{N} x_j^L l_j , \quad (1)$$

One can consider the objective function (1) to be a logical conclusion to the banks' profit motive. The increase in net interest income is at the foundation of all strategic tasks such as development or increasing shareholder value. The chosen objective function is considered by many authors to be the best indicator for evaluating the efficiency of the bank's operation, because it describes the efficiency of resource utilisation by the bank [8]. Implicit in the choice of the objective function is the assumption that non-interest expenditure can be completely covered with non-interest income and therefore can be abstracted from.

The objective function is maximised subject to the most important constraints. When determining constraints the author strives to achieve the most parsimonious formulation of the model that reflects the most important characteristics of the bank and ignores characteristics, which are secondary to the solution of the problem. In practice, of course, it is never possible to formalise all of the constraints that face such a complicated economic agent as a bank [9]. The author therefore chooses to focus on the following constraints:

- balance sheet equality constraint;
- mandatory reserve requirements constraint;
- liquidity constraint;
- capital adequacy constraint;
- open currency position constraint;
- large, risky transactions constraint;
- 'common sense' constraints[2];

One can consider these constraints in order. The *balance sheet equality constraint* is given by:

$$\sum_{i=1}^{M} x_i^A = \sum_{j=1}^{N} x_j^L = 1 , \quad (2)$$

Since it is the proportions of particular categories of assets and liabilities to the total that are added up in (2), they sum to one.

The *mandatory reserve requirements* constraint exists due to the fact that most central banks in transition economies require the creation of reserves in the central bank or in cash (in the domestic currency) for the part of liabilities that is subject to mandatory reserve requirements. In the context of this paper the reserve requirement is determined based on the sum of the monthly average balances on balance sheet accounts, which is calculated using the balance sheet account balances on the four reporting dates during the month.

To find the liabilities subject to the mandatory reserve requirements one should sum the term deposits and deposits on demand as well as issued bonds and other debt securities and subtract liabilities to the state treasury (if they exist), deposits attracted from the branches abroad and liabilities to other credit institutions. This is multiplied by the mandatory reserve percentage, which in the time period considered was on average equal to 5 percent. Thus the mandatory reserve requirement can be formulated as follows:

$$\sum_{i \in I_1} x_i^A = 0.05 \times \sum_{i \in J_1} x_j^L \quad (3)$$

Mandatory reserves consist not only of the deposits in the central bank, but also of cash holdings in the domestic currency. The subsidiary requirements to cash holdings can be formulated as:

$$\sum_{i \in I_2} x_i^A = 0.05 \times K \times \sum_{i \in J_1} x_j^L , \quad (4)$$

where K is the part of mandatory reserves in cash (obviously $0 \le K \le 1$). With time the requirements for this coefficient tend to decrease in transition economies and may, in fact, disappear completely.

An optimally operating bank also has to full obey *current liquidity constraints*. Liquidity constraints arise due to the fact that the bank has to fulfill clients' orders for money transfers without delay and must stand ready to pay out clients' money on demand. This means that the bank, in order to ensure the servicing of current liabilities the bank either has to ensure sufficient liquidity or it has to be able to attract interbank loans.

[1] Net interest income is the difference between the interest income and expenditure.

[2] Common sense constraints are defined to be the constraints, which are not determined in the regulations and which the banks develop themselves according to the accepted development strategy and policy.

Before formulating this constraint, it is useful to specify which assets should be considered liquid. According to the definitions of most supervisory institutions, including financial and Capital Market Commission (FCMC) in Latvia, liquid assets include:

- cash holdings;
- claims on demand to the central bank and solvent credit institutions as well as claims, which are maturing within 30 days;
- claims with a different maturity term, if the contract provides for the possibility to obtain funds earlier (paying the applicable penalty);
- investments in securities, if they have an established, unlimited market, that is they can be sold in the short term without notable losses or they can be used as a collateral in obtaining a loan;

The current liabilities are client deposits on demand as well as other liabilities, which are maturing within 30 days. According to the FCMC requirements liquid assets must not be less than 30 percent of the total volume of current liabilities. Thus the liquidity constraint can be written as:

$$\sum_{i\in I_3} x_i^A \geq 0.3 \times \sum_{j\in J_2} x_j^L , \quad (5)$$

This constraint is subject to change due to the changes in policy of regulating institutions. Occasionally, though infrequently, reserve requirements can also be used by monetary institutions as a monetary policy tool.

Capital adequacy constraint arises due to the requirement of the regulating institutions that equity must not be less than 10 percent from the risk weighted assets, which can be written as:

$$\sum_{j\in J_3} x_j^L \geq 0.1 \times \left(0.2 \times \sum_{i\in I_4} x_i^A + 0.5 \times \sum_{i\in I_5} x_i^A + \sum_{i\in I_6} x_i^A \right) \quad (6)$$

The left-hand side of (6) represents equity and the right-hand side is the risk weighted assets (see Table I). The weights for different risks are also determined by the regulating institution[3] and are therefore variable.

Although the regulatory requirements only require equity to be more than 10 percent of risk weighted assets, this paper adopts a more stringent limitation and requires that equity is larger than risk weighted assets. At the same time, having large amounts of equity is not necessarily the most efficient way of funding, since it excludes the benefits of leverage. One can limit equity between 10 and 20 percent of total liabilities. The last two restrictions can be written as:

$$\sum_{j\in J_3} x_j^L \geq \left(0.2 \times \sum_{i\in I_4} x_i^A + 0.5 \times \sum_{i\in I_5} x_i^A + \sum_{i\in I_6} x_i^A \right), \quad (7)$$

and

$$0.1 \leq \sum_{j\in J_3} x_j^L \leq 0.2 , \quad (8)$$

[3] These constraints are formulated based on the demands of the Latvian national banking regulator - the Financial and Capital Markets Commission in 2004 and can change among countries and between years.

The last two restrictions – (7) and (8) are part of the *common sense* restrictions that can be varied by the bank according to its own attitudes to risk and objectives. These kinds of restrictions can also be used to factor in the necessity to comply with the more stringent capital adequacy standards, which are likely to be adopted by the Basel Committee on Banking Supervision after the recent financial crisis (the so called Basel III standards).

The *open currency position*[4] constraint is also a consequence of regulatory requirements. Typically open currency position is related to equity in the regulations. In order to fully eliminate currency risk, this constraint will mandate a zero currency position. This can be written as follows:

$$\sum_{i\in I_7} x_i^A - \sum_{j\in J_4} x_j^L = 0 , \quad (9)$$

It should be noted that this constraint operates with a certain degree of approximation, which is determined by the level of detail on assets and liabilities in this model. For example, the government bonds or interbank loans (see Table I) are not split into the foreign and domestic currency positions. Of course, this drawback is easily rectified by any particular bank, because it has more precise data that is not available to an external observer.

There is also a second norm in the regulations that open currency position in any given currency must not exceed 10 percent of bank's equity. This requirement is secondary to the constraint described above and, once again, can be implemented within the bank, which has a more detailed breakdown of assets and liabilities in foreign currencies. The level of detail for these assets and liabilities in this model does not allow formulating this constraint, since it does not detail assets and liabilities by currency.

The *large risky transactions constraint* can only be introduced into the model with a certain level of approximation. The Law on Credit Institutions in Latvia, for example, specifies that the total volume of risky transactions (transactions, where exposure exceeds 10 of equity) must not exceed equity by more than a factor of eight. Regulatory requirements in other jurisdictions are likely to differ and be more or less stringent. Since the author does not possess detailed information on the transactions of every individual bank, it is possible to introduce a more stringent limitation by assuming that profitable assets are the result of risky transactions. The constraint can then be formulated by requiring that the profitable assets do not exceed the equity of the credit institution by more than a factor of eight. Thus in terms of the parameters of the model, one can write:

$$\sum_{i\in I_8} x_i^A \leq 8 \times \sum_{j\in J_3} x_j^L , \quad (10)$$

Finally, it is useful to consider introducing additional constraints that do not follow from the regulatory requirements - the `*common sense*' constraints. In order to manage liquidity more successfully, industry practice had developed certain requirements to the asset structure. Of course, these requirements are not defined in the legislation;

[4] The difference between the assets and liabilities in a given currency.

therefore every bank can formulate them relatively freely, taking into account its target niche on the market, development strategy, limitations of the credit policy and other factors.

In order to formulate additional constraints it is useful to separate liquid assets into primary and secondary reserves, because it allows a more complete illustration of the transformation of liquid assets. The primary reserves (in the domestic and foreign currency) include:

- cash holdings in the domestic and foreign currency;
- cash in the mandatory reserve accounts in the central bank (claims to the central bank);
- cash in the correspondent accounts at other banks (claims to credit institutions).

Secondary reserves include highly liquid securities. This type of asset can complement primary reserves, in case they are insufficient. The liquidity of loans, other less liquid securities as well as fixed assets is lower.

In order to ensure the stability and liquidity of a commercial bank it is optimal to introduce the following limitations to the asset structure:

- primary reserves should be at least 10 percent of the deposits. In terms of the model parameters this can be written as:
$$\sum_{i\in I_9} x_i^A \le 0.1\times \sum_{j\in J_5} x_j^L , \quad (11)$$
- secondary reserves should be at least 15 percent of the deposits. In terms of the model parameters this can be written as:
$$\sum_{i\in I_{10}} x_i^A \le 0.15\times \sum_{j\in J_5} x_j^L , \quad (12)$$
- loans should not exceed more than 65 percent of assets so that exposure to credit risk does not exceed tolerable levels. This condition is particularly relevant for transition economies. In terms of model parameters:
$$\sum_{i\in I_{11}} x_i^A \le 0.65 \quad (13)$$

In addition it is necessary to introduce a constraint, which is related to the fixed assets and other assets for example accruals. They do not bring any income, however the bank cannot exist without a certain base of capital (technological infrastructure, etc.), thus after reviewing annual reports of the commercial banks during the time period considered it seems prudent to require that fixed assets are at least 3 percent of the total assets. In terms of the model parameters, one can write:

$$\sum_{i\in I_{12}} x_i^A \ge 0.05 \quad (14)$$

It should be noted that over time fixed assets grow much slower than other assets in a commercial bank or do not grow at all, thus this assumption might need to be reviewed periodically.

Thus in this model the bank maximises the objective function (1) subject to balance sheet equality (2), mandatory reserve requirements (3) and (4), liquidity constraints (5), a stricter version of capital adequacy constraints (7) and (8), open currency position constraint (9), a stricter version of limitations on large, risky transactions (10) and finally common sense constraints given in (11), (12), (13) and (14).

III. Results

This model can be easily solved on the computer using any commonly used table processor or a more specialized mathematical software. In this case, the model is solved using the rolling averages of the industry wide profitability and cost parameters over the seven year period in Latvia from 2000 to 2007. The source data on profitabilities and costs, as well as required risk weights for different assets is given in Tables I and II. In the beginning of this period, commercial banks were still feeling the implications of the aftermath of the economic crisis in Russia, which had repercussions in Latvian banking industry [7]. Clearly this had motivated additional attention to the asset structure in the subsequent years [10] and during the rest of that time period commercial banking industry had experienced rapid growth and expansion. In 2008, the situation changed again and, owing to the rise of non-performing mortgage loans, Latvian banking industry had to deleverage substantially.

The solution of the model is an optimal structure of assets and liabilities, which ensures maximum ratio of the net interest income to assets, while satisfying all of the constraints. Note, that this paper had adopted a somewhat conservative bias, with the stringency of the requirements exceeding the regulatory policies. The resulting asset and liability structure is given in Table IV and V.

In Table IV in the Appendix, one can see that the model typically predicts highest asset allocation to claims to other credit institutions. This is evidence of the fact that under circumstances of transition economy lending on the interbank market is a less risky activity than lending directly to businesses. The proportion of loans in the optimal asset allocation also rises towards the fourth period of estimation reflecting an improvement in Latvian macroeconomic prospects at that time (before 2007). Table V shows the optimal liability structure of the bank. The model predicts fairly low level of leverage, which is consistent with conservative assumptions specified in the common sense restrictions.

Tables IV and V, of course, only provide a rough level of approximation to the actual optimal asset and liability structure. This is due to the fact that the profitability of assets l_i in Table I and the costs of liabilities in Table II are only weighted average rates in the industry at the end of the year. In addition, the `common sense' constraints can vary across different banks.

Still, *every bank can utilise this model to plan its asset structure and use real asset profitabilities that it is facing.* This is particularly relevant to such asset classes, where the overall profitability is hard to evaluate by using aggregated industry level data. Therefore *the higher the precision of the available data, the more precise can be the model and the*

offered solutions, thus each bank can obtain exact and not the approximate solution.

It is important to note, that the solution is obviously dependent on interest rates, which are highly variable and generally depend on the overall economic climate. The solution is also sensitive to different risk weights, for example, for loans to OECD and non-OECD residents. Implicit in the model is that these factors do not change over a certain time period, thus the *bank has to choose a certain frequency for solving the optimisation model.* This can, for example, be a period for which the financial plan for the bank is created – a month, a quarter or a year; or the period in which, according to the bank policy, interest rates are not reviewed.

Recognizing that every bank has to operate under constantly changing circumstances it is useful to *regularly review optimal asset and liability structure*, because asset profitabilities and liability costs are likely to change. Results of the review can inform subsequent refinements of the model. For example, when optimising only highly liquid asset structure, a bank can take a whole series of measures:

- minimising cash holdings and claims to the central bank, which are not interest bearing and thus do not generate any income;
- placing funds on the interest bearing correspondent accounts and providing interbank loans to increase profitability;
- creating a portfolio of highly liquid investment-grade securities from local and foreign issuers, which provides profitability that is higher than money market rates;
- placing funds in the short-term financial instruments on the international financial market with fixed income and risk parameters;

The results of the optimisation exercise can be submitted to the management, which can, if necessary introduce changes in the measures related to attracting and placing resources. If necessary the common sense constraints can be changed.

Of course, it is necessary to note that even with adjusting at regular intervals the profitabilities and costs associated with assets and liabilities, the model is still an example of a static optimisation problem. However, *this optimisation model does not contradict the idea of optimisation in a broader sense of the word, which is not a static procedure*. Optimisation, in a broader sense, is not limited to simply finding the optimal point or set – the path, which brings the system to the desired condition, the sequence of managerial actions, their timing is more important.

It is important to note that the suggested model is not the only possible instrument of optimising banks' asset structure. It also cannot be the only instrument, because one has to consider the fact that the processes occurring in the bank can develop according to different alternative scenarios, because there exists a large number of operations and a diversity of resource flows. The advantage of this model, however, is that it is very easy to combine with other managerial techniques and other instruments, in particular, those focusing on the management of financial flows.

Another important consideration relates to the forecasting of asset profitability characteristics. The events of the economic crisis in 2008 had illustrated that historical profitability indicators, for example, for mortgage loans cannot always be an accurate guide to the future values of that profitability. Consequently, bank managers have to pay special attention to the forecasting of different asset profitability indicators, which can then be used as inputs to the model.

IV. Conclusion

In this paper the author had developed a model of optimal asset and liability structure for a commercial bank. This model is based on the regulatory requirements as well as industry practices. The author also applied the model using the data from Latvian commercial bank industry over the seven year period - from 2000 to 2007.

The model is easily customised for the specific circumstances of every individual bank and easily implemented with the aid of computer software. The model is solved using the industry averages of asset profitabilities and costs associated with liabilities. In practice, of course, each bank can create its own asset structure depending on the chosen development strategy. Every individual bank aiming to utilise this model can use their own profitability data to achieve the most precise conclusions.

Thus it is worth stating again that despite the fact that banks can choose different strategies, all banks - inside and outside Latvia - can used the suggested model, because it's easily adaptable for every bank by changing the constraints of the optimisation or introducing new ones. This is especially applicable to `common sense' constraints. Thus, for example, a bank, which desires to specialise or gain market share on the mortgage or loan market, can change the constraint, which influences loan provision.

The resulting asset structure can describe the niche on the bank services market that the bank either occupies or desires to occupy. It can depend on the demand for various banking operations, profitability of various assets as well as the ability of the management to predict the most promising directions for operations. Due to the variability of the input data to the model, it is important for the bank to choose a particular time period, which determines how frequently the optimisation exercise is performed, for example, quarterly or annual.

The financial crisis of 2008 had underscored the fact that sophisticated asset and risk management models can still prove inadequate for ensuring that commercial bank asset portfolios have adequate quality. The model proposed in this paper is intuitive and allows for a transparent assessment and adjustment of various parameters. It can therefore be useful for commercial banks as they reconsider their asset portfolios in the aftermath of the financial crisis.

V. Appendix

TABLE I
WEIGHTED AVERAGE PROFITABILITY AND RISKS
FOR DIFFERENT CLASSES OF ASSETS, PERCENT

N	Asset Class	Y1	Y2	Y3	Y4	Asset risk
1	Cash holdings in lats	0	0	0	0	0
2	Cash holdings in foreign currency					
3	Claims to the Bank of Latvia	0	0	0	0	0
4	Correspondent accounts in foreign banks (OECD)	0	0	0	0	0
5	Correspondent accounts in foreign banks (non-OECD)	4.1	2.6	2.3	2.2	20
6	Claims on demand to other credit institutions (Latvia)	4.5	2.8	2.5	2.4	100
7	Claims on demand to other credit institutions (Latvia)	6.7	4.8	4.3	4.0	50
8	Government bonds and other fixed income securities (Latvia, OECD)	5.7	5.0	6.0	5.0	20
9	Government bonds and other fixed income securities (non-OECD)	7.7	7.0	6.5	5.5	0
10	Municipal government bonds (fixed income, Latvia, OECD)	10.0	12.0	12.0	11.0	50
	Municipal government bonds (fixed income, Latvia, non-OECD)	8.0	7.5	7.5	6.0	20
	Corporate securities (fixed income, Latvia, OECD)	11.0	13.5	12.0	12.0	100
	Corporate securities (fixed income, non-OECD)	9.0	8.5	8.5	7.0	100
	Shares and other securities with variable profitability	12.0	15.0	15.0	14.0	100
	Interbank loans (Latvia, OECD)	18.0	17.8	12.0	5.0	100
	Loans (lats, short-term)	6.7	2.7	3.3	4.5	20
	Loans (lats, long-term)	15.0	18.0	11.8	10.8	50
	Loans (OECD currencies, short-term)	15.3	16.0	10.8	9.8	50
	Loans (OECD currencies, long-term)	12.4	11.5	12.1	8.8	50
	Investments in subsidiaries and affiliates	11.1	10.6	10.4	8.3	50
	Fixed assets	4.0	4.0	3.8	3.8	100

TABLE II
WEIGHTED AVERAGE COSTS AND RESERVE NORMS
FOR DIFFERENT CLASSES OF LIABILITIES, PERCENT

N	Liability Class	Y1	Y2	Y3	Y4	Reserve norm
1	Deposits (lats, foreign currency) on demand	0.5	0.5	0.5	0.5	5
2	Short-term deposits (lats)	5.5	4.2	4.2	5.2	5
3	Short-term deposits (lats, due in one month)	5.5	4.2	4.2	5.2	5
4	Long-term deposits (lats, due in one month)	6.7	7.8	7.0	6.7	5
5	Long-term deposits (lats)	6.7	7.8	7.0	6.7	5
6	Long-term deposits (foreign currency, short-term)	4.5	4.8	5.9	3.8	5
7	Long-term deposits (foreign currency, short-term, due in one month)	4.5	4.8	5.9	3.8	5
8	Long-term deposits (foreign currency, long-term, due in one month)	6.3	6.6	6.5	5.6	5
9	Long-term deposits (foreign currency, long-term)	6.3	6.6	6.5	5.6	5
10	Liabilities to the Bank of Latvia	6	5.5	5.0	4.0	0
11	Correspondent accounts of other banks (currency)	4.1	2.6	2.3	2.2	0
12	Issued bonds and other debt securities (maturing within a month)	8.0	7.5	7.1	6.5	5
13	Issued bonds and other debt securities (for longer than a month)	7.5	7.0	7.1	6.0	5
14	Interbank loans (Latvia, OECD)	6.7	2.7	3.3	4.5	0
15	Equity	10	9.5	7.0	6.5	0

TABLE III
MODEL PARAMETERS

Parameter	Economic Interpretation
P/A	The proportion of net interest income to assets.
M	The number of asset positions, indexed by i, thus $i = 1\ldots M$. Assets are summarised in groups (12 for this paper, although this number can vary), thus $A = I_1 \ldots I_{13}$.
x_i^A	The proportion of the i-th asset to the total.
l_i	The profitability of the i-th asset.
$I_1 = \{1, 3\}$	Total mandatory reserves, claims to the bank of Latvia and cash holdings in lats.
$I_2 = \{2\}$	Cash holdings in lats.
$I_3 = \{1, 2, 3, 4, 5, 8\}$	Liquid asset positions.
$I_4 = \{4, 7, 10, 15\}$	Asset positions with a 20 percent risk level.
$I_5 = \{6, 9, 16, 17, 18, 19\}$	Asset positions with a 50 percent risk level.
$I_6 = \{5, 11, 12, 13, 14, 20, 21\}$	Asset positions with a 100 percent risk level.
$I_6 = \{2, 4, 5, 7, 8, 10, 11, 13, 18, 19\}$	Asset positions in a foreign currency.
$I_7 = \{4 \ldots 20\}$	Asset positions that can be utilised in risky transactions.
$I_9 = \{1, 2, 3, 4, 5\}$	Primary reserves
$I_{10} = \{8\}$	Secondary reserves
$I_{11} = \{16, 17, 18, 19\}$	Loans provided
$I_{12} = \{21\}$	Fixed assets
N	The number of liability positions indexed by j, thus $j = 1 \ldots N$. There are five groups of liabilities, thus $L = \{J_1 \ldots J_5\}$.
x_j^L	The proportion of j-th liability to the total
c_j	The costs of the j-th liability.
$J_1 = \{1 \ldots 9, 12, 13\}$	Liability positions where the 5 percent reserve norm is applied.
$J_2 = \{1, 3, 4, 7, 8, 12\}$	Liability positions, which are payable within 30 days.
$J_3 = \{15\}$	Own capital.
$J_4 = \{6, 7, 8, 9, 11\}$	Liailities in foreign currency.
$J_5 = \{1 \ldots 9\}$	Clients' deposits

TABLE IV
OPTIMAL ASSET STRUCTURE PERCENT

Asset Class	Y1	Y2	Y3	Y4
Cash holdings	3.90	3.84	2.52	1.29
Claims to the bank of Latvia	3.90	3.84	3.78	3.01
Claims to other credit institutions	57.20	56.32	56.70	58.70
Loans	30.00	32.00	34.00	34.00
Other assets	5.00	4.00	3.00	3.00
Total	100.00	100.00	100.00	100.00
Net Interest Income on Assets, P/A	**5.8**	**7.1**	**5.4**	**4.9**

TABLE V
OPTIMAL LIABILITY AND EQUITY STRUCTURE, PERCENT

Liability Class	Y1	Y2	Y3	Y4
Client deposits on demand	65.00	64.00	64.00	62.60
Liabilities to the Bank of Latvia and other banks	15.00	16.00	17.00	17.40
Equity	20.00	20.00	20.00	20.00
Total	**100.0**	**100.0**	**100.0**	**100.0**

REFERENCES

[1] Pale D.H. On the Theory of Financial Intermediation, Journal of Finance, September, 1977, p. 262
[2] Sealy C.W. and Lindley J.T. Inputs, Outputs and Theory of production and Cost at Depository Financial Institutions, Journal of Finance, September, 1977, p. 289-314.
[3] Klein M. A. A theory of the Banking Firm. Journal of Money, Credit and Banking, May, 1971, p. 241-253.
[4] Sealy C.W., Deposit Rate Setting, Risk Aversion, and the Theory of Depository Financial Intermediates. Journal of Finance, December, 1980. p. 345-360.
[5] Baltensperger E. Alternative Approaches to the Theory of the Banking Firm, Journal of Monetary Economics, January, 1971, p. 205-218.
[6] Frolova L. Ekonomisko procesu matemātiskā modelēšana, Rīga, Turība, 2003.
[7] Фетисов Г.Г. Устойчивость коммерческого банка и рейтинговые системы ее оценки. Москва.Финансы и статистика.1999.
[8] Saksonova S. Commercial Banks in Latvia and the Questions of Creating optimum Asset Portfolio in the Circumstances of Decreasing Profitibility of financial instruments, Finance, Publishing house "Abagar", Veliko Tarnovo, 2002, p.797-813
[9] Saksonova S. Classification, the Principles of Creation and the Problems of Accounting Commercial Banks' Assets, Proceedings, Topical financial problems in transition economies, Tartu, 2001, p. 191-196.
[10] Kane E.J., Malkiel Burton G. Bank Portfolio Allocation. Deposit Variability and the Availability Doctrine. Quartely Journal of Economics, February, 1965. p. 113-134.