

CONSUMER LENDING IN BANKS: SYSTEM DYNAMICS MODELLING

Modern consumer lending, which is carried out by banks, financial companies, and, to a lesser extent, credit unions, is a complex system. This system includes many blocks that interact with each other and affect the result. As a result of their interaction in dynamics, the values of indicators of effectiveness are formed. The task that arises is to identify the mutual dependency of the constituent units and their influence on the result of consumer lending over time. The aim of the article is to model consumer lending processes using system dynamics methods. The model proposed in the paper by the system of dynamics makes it possible to display the behaviour of the consumer lending system over time. To display the logic of the system, we used the causal loop diagram tool. This made it possible to visualize the consumer credit system taking into account interconnections. The system is structured into blocks that characterise the main components of the functioning of the lending system. When building the model, four important units of the system were analyzed: technological rating, marketing funding, marketing strategy, and risk management. For this, a simulative analysis was applied. Based on this, it is shown that the marginal results are quite different. The ways are provided to optimize priority of expenses. The dependency of income management has a specific non-linear form. It is possible to find out the level of rigidity of risk management by using simulation analysis.

Keywords: system dynamic methods, simulation analysis, consumer lending, credit granting, marketing, risk management.

JEL classification: G21, E47

Introduction and the research problem.

Consumer lending is an integral part of modern economic relations and one of the important segments of lending activities. It allows to design a ratio between current and future consumption for individuals, and to expand the capacity for consumer goods and real estate markets.

A high level of consumer lending development is illustrated in Table. Here are figures for consumer credit market in the USA which characterise current volumes of consumer loans in this country.

Consumer lending is also highly developed in the EU. Thus, European Union's household debt reached \$6531,8 billion in February 2019 [4]. Taking into account Ukrainian consumer lending it should be noted that the volume of banking credits for physical persons in Ukraine is UAH 201,5 billion. Moreover, in Ukraine there is extremely highly developed payday lending.

It should be emphasized that consumer lending is press forward development at the trend of digitization processes which we observe last years. The online loan granting procedures is an actual tendency in this sphere. The digitization processes call forth new direction in verification and risk assessment procedures. Some new forms of credit relations arise through digitalization [12].

Banks, financial companies, and credit unions are the main providers of consumer lending. All of them issue the challenge of organization the functioning of the consumer lending system. The focus of our attention in this study consists precisely in modelling of consumer lending system for an individual lender. The model should be dynamic in order to understand the system's behaviour over time. This will allow to predict the results of the credit business and assess the likelihood of achieving the set goals. To do this, we have considered the task of using tools of System

Table. Characteristics of consumer loans at the market of the USA

Loan Type	Mortgages	Car loans	Personal loans	Credit card	PayDay Loans
Number of active loans	53,1 millions	81,9 millions	20,3 millions	425,1 millions	~12 millions (borrowers)
Average debt per borrower	\$205782	\$18835	\$8338	\$5580	\$350

Sources: [14; 18]

Dynamics (SD) for our modelling. The main conceptual approach of SD lies in consideration structure of system, marking of essential blocks and analyzing their mutual influence, including causal interrelations, feedbacks, and delayed reaction on influence. Such consideration includes an analysis of system behaviour through time.

The logic of applying SD tools can be explained by real complexity of modern credit systems in bank or financial company. Such systems include a number of subsystems as funding, operational costs, marketing, risk-management, collection activity, and others. These subsystems interact with one another and change one element raise impact for all others. Very often these interactions are non-evident, non-linear, and include a delayed reaction.

Recent publications analysis. Consumer lending business is dynamically developing sphere after Second World War. So, many publications were devoted to basic subjects of it. Second edition of book Lawrence and Solomon [13] can be indicated as resource of fundamental knowledge about this business. Synopsizes of all subjects of consumer lending business are involved in this book: marketing, risk management, managing profitability, and so on. Risk management is a vital ingredient of consumer lending business, and modern non-formal perspective exposition of it is presented in [3]. The structure, conceptual approaches, and tools of credit risk management are presented in [7]. A very important topic devoted to audit of risk management is discussed in [11]. It approaches using the bureau of credit histories in consumer lending processes presented in [8]. The article [9] discusses the development of risk management in the segment of micro credits.

The conceptual foundations of SD were formed by J. Forrester in the 1950s and are presented in fundamental papers (for example, [5]). Application features of SD for business processes modelling are presented in [16]. It should be noted that the application of SD to the credit activity modelling has been started relatively recently (may be only in the last decade). The publications [19; 1; 17] are described some approaches of using SD in credit activity modelling. It is interesting model of bank's credit risk management we can found in PhD thesis of Muhammad Ishtiaq [6]. However, the institute of credit history bureaus is not represented in his model, which is very important for risk management in consumer lending

We would especially like to mention the book [15]. Different theoretical and methodological aspects for modelling dynamic models are considered in this book.

In the aspect of using software to simulate the tasks of system dynamics, we used the product Stella. And the logic of application in our research is based on iThink10 [20].

Unsolved parts of the problem. The analysis of papers which are devoted to applications of SD for economic problems takes to the following conclusion. System dynamics as an efficient tool have been applied to modelling different economic problems. The circle of such problems is ever-increasing. Nevertheless, application to model systems of credit relationships is not highly developed yet. At the same time credit systems in modern financial institutions become very complex and include a number of subsystems. That is why the construction of system dynamic model for systems of credit granting is an actual problem.

Research goal and questions. The goal of our paper is to construct a SD model for creditor's system of personal (unsecured) loan granting. We have applied ISEE systems' software as instruments for goal achievement. Inalienable component of our modelling is simulative analysis. It provides an opportunity to consider various scenarios for the development of the system depending on consumer lending parameters. The finding of optimal solution through such modelling is a good base for effective consumer lending organisation.

Main findings. The SD model was designed for a bank which organizes the system of personal (unsecured) loan granting. Causal loop diagram (CLD) of this system is presented at the Fig. 1. The basic element of such system functioning is funding the credit activity process. This variable includes initial resources which allocated by the bank to credit activity and complete by interest income dynamically. Funding is distributed between two basic directions of the credit activity process. First direction represents properly resources which creditor draws for borrowers. Such part of resources is indicated in model as variable "Funds available for loans". Second direction forms operational costs of functioning the credit granting system. This variable characterises funds that are directed to five structural elements of the lending organization.

The first structural element is computer software, which bank uses for the credit activity process. It includes computer programs that ensure the implementation of the calculation different loans parameters, the implementation of risk management procedures, storage of information and other functions related to processing within the bank. An important component of the software is computer programs that provide interconnection borrower with creditor and a set of services. For example, it

could be Internet banking, various applications related to displaying credit information in a cell phone, and more. Practice shows that the quality of such applications directly affects the choice of customers, forming its attractiveness for clients. At the same time, another important component of the bank for customers is the interest rate for the loans. These two parameters form a bank's rating in our model, which has an impact on attracting new customers (the variable "Attract new clients").

The second structural element, which is funded from operating expenses, is marketing (involved into the CLD as variable "Marketing"). According to our approach, consumer finance marketing can be structured into external and internal marketing. Internal marketing supposes working with existing (and existed) borrowers. The essence of the external marketing is to attract new customers who are not yet so at the moment. Internal marketing is focused on the development of credit relations with those who are already borrowers of the bank. It is clear that the effectiveness of internal marketing essentially depends on the database of borrowers. The larger database forms greater potential for internal marketing. The essence of internal marketing is manifested in the analysis corresponding "risk-income" for existing borrowers. Focus marketing activity for those borrowers who bring income at a certain level of risk. Such clients as a rule should receive specially composed credit offers. The marketing strategy variable characterises in CLD the prioritization of marketing efforts.

The next component of operating expenses represents the cost of organization credit activity at the bank's branches. Branches include the cost of organization credit services in offices, as well as arrangement customer relations. The flow of customers interested in consumer loans is largely determined by the number of branches and their customer relations level (but of course this diminished with the digitization processes).

Taken together, the above three elements affect the flow of customers for loans (the variable "Inflow"). Inflow of borrowers forms the crucial parameter for consumer credit business from economic point of view.

The fourth and fifth elements of "Operational costs" are connected with risk-management. The fourth element is presented in the model through variable "Quality of Risk Management". This variable characterises costs of precisely the quality setting of the risk management system (the instruments themselves are presented in the variable "Rigidity of Risk Management"). The quality of risk management is based at our investigation on

expenses for regular update models of risk estimation, attract new data for analysis and so on. The "quality" is determined by minimizing errors of the first and second kind. The first kind of errors is credit granting for borrower who does not repay a loan. The second type of errors is the rejection to issue a loan for a borrower who would return the loan when it is received. Errors of the first kind leads to credit money lost and errors of the second kind consist in *lucrum cessans*. The fifth element is "Quality of Collection". It represents effectiveness of procedures with overdue loans. Effectiveness of collection procedures admits to have good approaches to contact with debtors and to convince them return debt. The quality of such procedures admits to reduce the Bad Rate and reduce reserves.

It is necessary to note that all above mentioned variables suppose initial values (for example, initial investments for variables from operation costs) and dynamical character after that.

The key block of the model is the "Inflow" block. It represents core of the credit granting process. Demand for the loans affects the variable "Inflow" directly. Other elements which also affect the inflow are as follows: rating of the bank, marketing, the number of branches, and the credit amount proposed by the creditor.

The inflow of inquirers transforms into a number of issued loans. The percentage of inquirers for loans which became borrowers is called the Approval Rate (APR). APR can vary over wide limits due to the type of lending strategy – aggressive, cautious, etc. Typically, APR lies in the range of 30–50 %. The crucial element, which largely determines the number of loans issued, is such a significant factor as the rigor of "Rigidity of Risk Management". CLD, representing the risk management system model is presented in [10].

The structure of Risk Management presents the impact on APR the three components. The first component includes verification procedures. It includes a number of queries into registers and databases. The second component consists in internal scoring which provides risk estimation based on application data of borrower. As a rule, this is statistically defined regularities which indicates percentage of Good and Bad borrowers for different attributes (social-demographic, professional, and others). A basic regularity is relationship between scoring values and the bad rate. The third component is query into bureau of credit history. The receiving credit report is very informational source for credit decision. Rigidity of risk management connected with rules of applying each component. Economic logic for risk management impact: high rigidity is

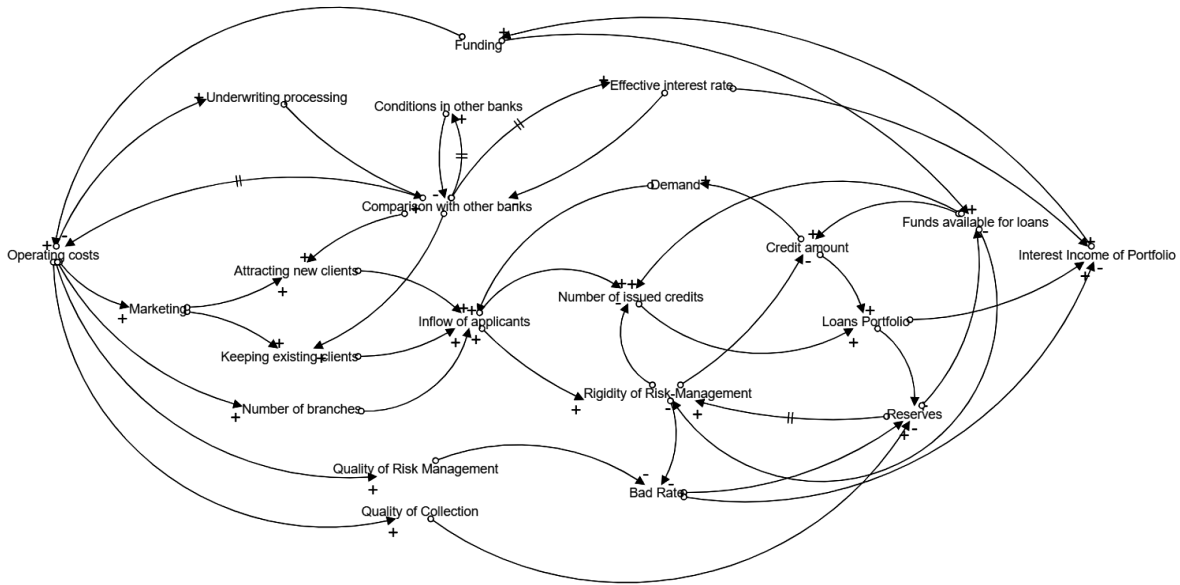


Fig. 1. Credit Activity CLD

characterised by low APR, a low bad rate, and a low income (because such good clients form a relatively small group). Low rigidity is characterised by a higher APR, a higher Bad Rate, and tends for an initially higher income than the income decrease.

The number of issued loans impacts on the loans portfolio which includes all issued loans with characteristic of delinquency. By-turn presence of delinquency generates reserves which divert resources from funding. The loans portfolio generates income from interest payments which complete circle of movement money.

Simulation analysis. The elaborated model was realized in package Stella (iThink 10). It provides an opportunity to consider various scenarios for the development of the system depending on consumer lending parameters. Our focus was on income dynamics depending on four parameters: technological rating, marketing funding, rigidity of risk management, and the marketing strategy. The graphs of simulation analysis are presented in Fig. 2. Graphs as results of simulation analysis for technological rating, marketing funding and the marketing strategy illustrate marginal increase of

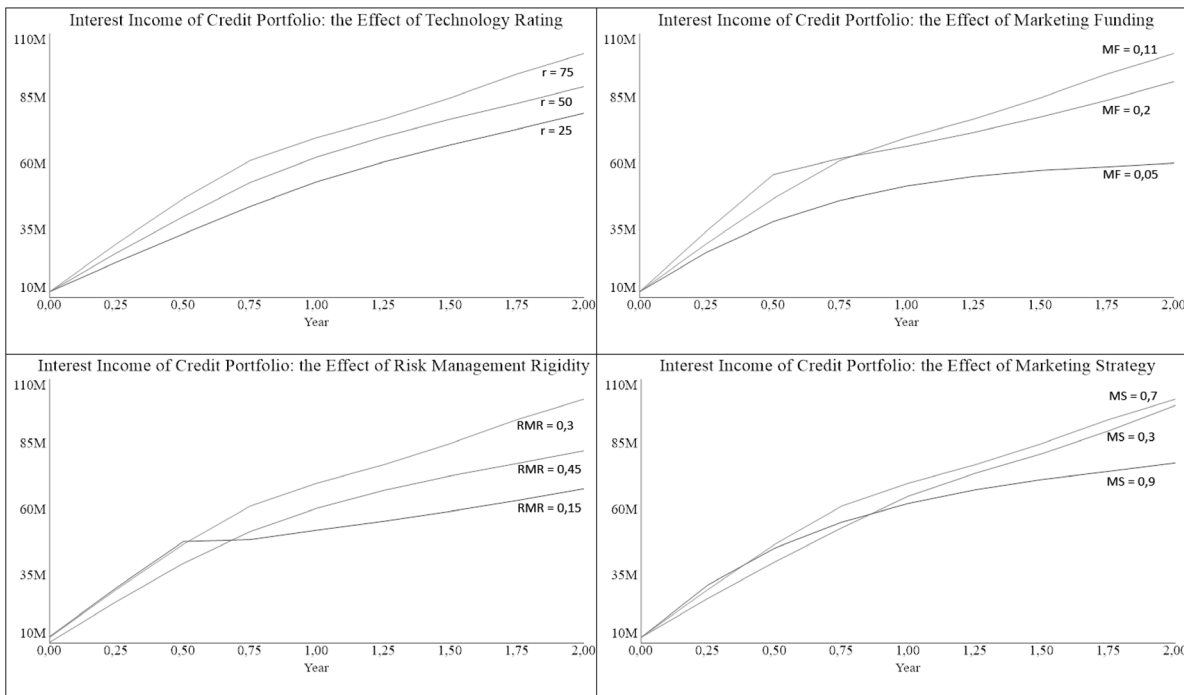


Fig. 2. Simulation analysis

income in dynamic. The situation with risk management is more complex. There is nonlinear dependency between rigidity and income. So, simulation analysis helps to find an optimal solution through such modelling. Such modelling is a good base for organising effective consumer lending.

Conclusions. Modern consumer lending is a complex system which includes different blocks. These blocks in different ways affect the results. Moreover, they can interact with one another in different ways. The approach based on SD enables to construct a model which illustrates the dynamic of crucial indicators of lending. Simulation analysis for such a model makes it possible to find marginal increments in time for parameters of different blocks. The authors have focused on

simulation analysis of four blocks: technological rating, marketing funding, the marketing strategy, and risk management. The first three blocks correspond to classical formula “The more expenses the higher result.” Of course, the marginal results are quite different. This provides possibilities to optimize priority of expense. The dependency of income on rigidity of risk management has a specific non-linear form. It is possible to find an optimal level of rigidity of risk management by using simulation analysis.

Acknowledgement. *Authors would like to thank professors Iryna Lukianenko and David Wheat for their expert advice and encouragement our desire to apply System Dynamics for modelling credit activity processes.*

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СПОЖИВЧЕ КРЕДИТУВАННЯ В БАНКАХ: СИСТЕМНО-ДИНАМІЧНЕ МОДЕЛЮВАННЯ

Сучасне споживче кредитування, яке здійснюють банки, фінансові компанії та меншою мірою кредитні спілки, є доволі складною системою. Ця система має низку компонентів, які взаємодіють між собою та впливають на результат діяльності. Унаслідок їхньої взаємодії в динаміці формуються значення показників ефективності. Постає завдання ідентифікації взаємної залежності компонентів системи, її аналіз та моделювання. Метою статті є аналіз та моделювання процесів споживчого кредитування з використанням методів системної динаміки. Модель системної динаміки, запропонована в цій роботі, дає змогу відобразити поведінку системи споживчого кредитування банку в часі. Для відображення логіки функціонування системи застосовано інструментарій CLD (Causal Loop Diagram), що дало змогу візуалізувати систему споживчого кредитування з урахуванням взаємозв'язків. У межах нашого підходу систему структуровано у блоки: блок, відповідний фондуванню кредитування, та блок операційної діяльності, що забезпечує функціонування самої системи кредитування. Під час побудови моделі було виокремлено 4 компоненти системи: технологічний рейтинг, витрати на маркетинг, маркетингова стратегія (внутрішні та зовнішні клієнти) та управління ризиком. Ці компоненти безпосередньо впливають на показники ефективності системи, а значення параметрів цих характеристик визначають розвиток системи в динаміці. Для аналізу ступеня впливу застосовано метод імітаційного моделювання, внаслідок чого отримано різні результати для компонентів. Перші три зазначені компоненти характеризуються різним ступенем маржинальних приростів доходу банку в динаміці. Водночас імітаційне моделювання впливу компонента, пов'язаного з управлінням ризиком, показує наявність оптимального рівня «жорсткості» системи ризик-менеджменту. Цей ефект зумовлюється тим, що за жорстких правил ризик-менеджменту відсікається багато потенційних позичальників, спроможних обслуговувати кредит. А за м'яких правил у кредитний портфель потрапляє багато неплатників за кредитами та система показує в динаміці падіння доходу. Розроблена модель може бути застосована до різних напрямів споживчого кредитування та узагальнена на випадок портфеля кредитних продуктів банку.

Ключові слова: методи системної динаміки, метод імітаційного моделювання, споживче кредитування, кредитні рішення, маркетинг, ризик-менеджмент.

Матеріал надійшов 27.04.2019