УДК 519.8:336.7

DOI: 10.18523/2519-4739.20205.1.69-75

A. Kaminskyi, O. Petrovskyi

ONLINE PAYDAY LENDING: SYSTEM DYNAMICS MODELLING

The purpose of the article is to model the payday lenders activity, which carries out crediting on-line in the segment of subprime small-dollar credits (payday loans). The relevance of the research in this segment is stipulated by its dynamic developing in the latest decade. This is explained by intensive implementation of on-line technologies into the lending processes. The segment has distinctive features of credit activity, the analysis of which is presented in the article. Such basic features are a high risk, a highly competitive environment, and a high interest rate. Similar features generate the importance of the strategy of the company development, because a wrongly formed strategy generates a high enough risk of bankruptcy. The system dynamic application is presented for modelling of the credit activity of such companies. This approach allowed to model the influence of change of one element on another and on the system of payday lending as a whole. The built model includes four main 'cornerstones' of the system. Namely: the investor's capital flow, the process of attracting borrowers, the dynamics of the transition of borrowers in the loan portfolio from one type to another, and the rigidity of credit risk management. The investor's capital flow is a J-curve. The process of attracting borrowers is structured in the attracting of new borrowers and repeat borrowers. A feature of the payday loan market is the decreasing of borrower's quality over time. The model presents the division of borrowers into five types depending on the revenues they generate for the lender. For each type, the model presents what profit/loss can be expected from customers of this type. The model takes into account such important relationships as the impact of interest rates on the deterioration rate of the borrower's financial condition (transition between types of borrowers) and the impact of attracting new borrowers on their quality (distribution of borrowers by type), taking into account that borrowers leave the company. This model was illustrated using a simulation analysis, which allows to find the optimal lending parameters in relation to the amount of the lender's initial capital.

Keywords: consumer lending; payday loans; online lending; system dynamic methods; simulation analysis.

JEL classification: G21, E47

Introduction and research problem. Consumer lending is a complex system that can be considered and investigated in various ways. Thus, the functional representation of such systems reflects the transfer of consumption over time by using credit. Within the framework of the structural presentation, consumer lending can be considered through establishing types of loans. In particular, loans can be typified by availability of collateral, by schedule of payment (instalment or credit line), by level of risk and so on. The classical approach of structuring types of consumer loans looks as:

- Mortgages;
- Car loans;
- Personal unsecured loans;
- Credit lines;
- Payday loans.

The focus of our research in this paper is concentrated on payday loans (PDL) or so called 'subprime small-dollar credits'. More precisely, the consideration is focused on online PDL. This segment is characterized by quite significant specifics which are relatively fully represented in the article (Nuñez et al., 2016). Borrowers of this type of loans are quite diverse, but a significant proportion of them have a low or very low credit rating. The associated with such lending risk poses high risk premium embedded in the accrued daily interest. As an example, the annual percentage interest rate (APR) in the USA is 396 % (on average). Such a level of interest rates often attracts criticism based on their interpretation as "predatory practice". In any case, the PDL segment is an essential part of the consumer credit market and constitutes a relatively self-contained sub-system. There are 12 mln Americans who use PDL each year (Payday Loan, 2020). The market size of the Check Cashing & PDL Services in the American industry is 11.2 bn in 2020. The PDL segment in Ukraine demonstrates exponential growth and estimates as USD 1.5 bl in 2020 (figures for crediting in online form).

Starting business of online PDL lending is based on private investment and cannot use deposits as a bank. Online PDL business is an ongoing process in a very competitive environment. This is due to high profitability and permanent implementation of fintech. Competitive environment generates systemic factors which affect the business development of lenders. If the factors change in the system, the company must take them into account and adapt business in a certain way. This indicates that it is appropriate to consider the business model at the framework system online lending. At the same time, the procedural representation of the credit system provides dynamics of the system. On this basis, we formed the main idea of our research, which is to construct a business model of an online payday lender using the SD Toolkit. The advantage of using System Dynamics models in this case is generated by the presence of anticipative changes over time in such a complex system as payday lending. This approach implements the process representation of a system object as a dynamic object characterized by a sequence of its states over time.

Recent publications analysis. One of the fundamental books devoted to the analysis of the PDL segment is written by Carl Packman (2014). This book presents a conceptual investigation of the payday loan industry. First of all, the author analyses the genesis of this industry at the frameworks of consumer credit development frameworks. Secondly, the positive interest of this book is raised from comparative analysis of PDL developing through different countries. There is a deep comparison of PDL market specificities in the USA, the UK, European countries, and Australia. The paper (Payday Loan, 2020) presents complex statistics which allow us to understand basic indicators of PDL lending. Except others, we have used these indicators for simulation analysis. Access trends and for Check Cashing & Payday Loan Services in the USA and industry analysis is considered in (IbisWorld). Distinctive features of microfinance crediting in Ukraine was analyzed in (Kaminskyi, 2016). The aspects of organizing payday loan business had been examined in (Eltag, 2016a, 2016b). The two latter sources are used for building the economic model of PDL business, among others.

The System Dynamics approach was elaborated by J. Forrester in the middle 1950s and was submitted, as an example, in (Forrester, 1990). The consideration of applying the System Dynamics toolkit for business processes modelling is presented in (Morecroft, 2015). The papers (Skriban, 2009; A System Dynamics Approach, 2010) are focused on using SD for modelling the lending processes. We also consider application of the SD approach to lending processes in banking (Kaminskyi & Petrovskyi, 2019). It should be noted that book (Lukianenko & Faryna, 2016) presents different ways of applying SD models.

The application of software to simulation procedures in our research was in large degree based on (Wheat, Stelmashenko & Faryna, 2013).

Unsolved parts of the problem. It can be noted that application SD toolkits for the credit systems forms the trend upwards. Researchers are concerned about different directions in modelling credit systems. At the same time, SD applications to the PDL subsystem of credit activity are not elaborated yet. A systematic view of this industry is very useful from our point of view. Moreover, this system is developing very dynamically, especially, in the online segment. Therefore, the construction of a dynamic model for the PDL system is an actual research problem.

Research goal and questions. The basic goal of research is to elaborate SD model for online payday loan credit activity. The background of applying SD toolkit is raised from clearly expressed system characteristics, which affect any PDL lender. The application of ISEE systems Stella architect software was used for goal achievement. Of course, the mentioned goal is closely connected with finding optimal solutions for business running. This goal was achieved by simulation analysis.

Main findings

1. Specific characteristics of online PDL business. We have indicated the following specific characteristics of online PDL lending. The first characteristic is a special type of investment project model. In this segment, the start-up of the company and the financing of loans is carried out mainly at the expense of a private investor (or investors). The difference from banks is that such companies, as a rule, cannot attract financing in the form of deposits. This determines the investment model. Initial stage includes investment which is divided between two directions. The first direction includes funding of business processes launch (software, website, rent, staff salaries, marketing, organization of risk management, collection, etc.). The second part of the investment is directed to the issuance of payday loans. The volume of investment in a loan portfolio should be calculated on the basis of certain parameters. They are as follow: 1) the time $T_{start\text{-}up}$ for which the investment should pay off (in fact, the operating start-up time); 2) the income (paybacks) is supposed to be received by the investor every quarter (or monthly). Together, these conditions determine cash flow in the form of J-curve (see Fig. 1). There are two parts of the cash flow: the outflow investment (the expense) and then the inflow of revenue (the return).

The second characteristic reflects the features of marketing in this segment. The online payday loan segment is a fairly specific environment. Clients simultaneously make queries to several lenders. Therefore, the task of marketing is to convince the client that this lender is most appropriate. Practice shows that attracting a client for the first loan is carried out at a 0 % interest rate on loans. The income focus is usually focused on repeat borrowers. Which, with the proper organization of customer relations, can develop into the permanent use of PDL.

Type A. The borrower takes a loan, uses it for the term (up to 1 month usually) and repays principal and interest in full. A certain delay (a couple of days) for which there is a penalty is possible. In the event of a delay of more than 15 days, it will fall into category E. Return in this case is the result of the collector's work with class E.

Type B. The borrower takes a loan, uses it (as a rule, the maximum possible period) and rollover it also for the maximum period. Rollover may be several times. At the end, the principal and interest

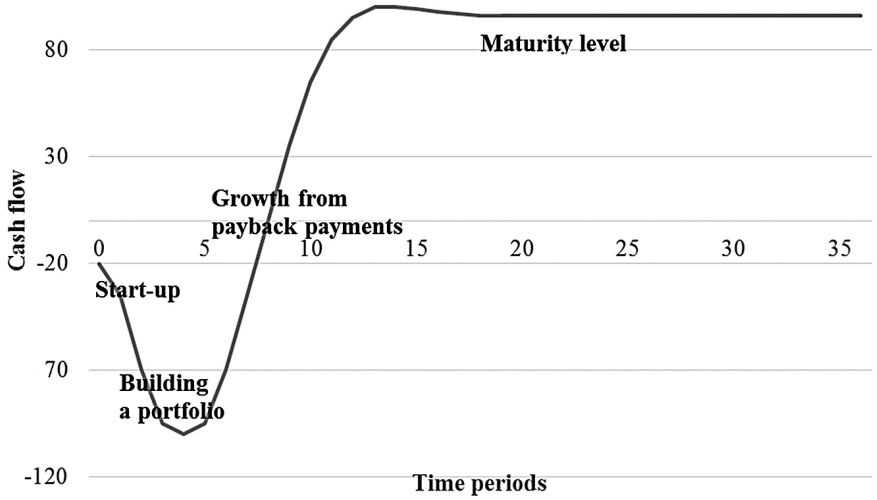

Fig. 1. Starting PDL lending: J-curve of capital flow

The third characteristic concerns the important role of IT technology. IT technology is an important component of this business. Technologies are constantly being improved, and the first way of their use aims to the speed of processing applications and interaction with the borrowers. The second way of using IT concerns risk management. Its quality directly affects the level of differentiation between good and bad borrowers. And this, in turn, determines the profitability of the loan business.

The fourth characteristic is the specificity of the types of clients. Analysis of the credit business in the online segment allowed us to develop a classification of borrowers, consisting of 5 types given below.

are returned. There may be a certain delay in the payment of the body at the end of the extension (up to 15 days) for which there is a penalty. In the event of more than 15 days delay, it will fall into category C. Return in this case is considered the result of the collector's work in class C.

Type C. The borrower takes a loan, rollover and pays interest. Rollover may be several times. In the end, he does not return the principle and the interest payments for last rollover.

Type D. The borrower takes a loan, pays interest only. Go into default without rollover.

Type E. Borrower goes to default without any payments. Some return can be received from collection activity. This type includes swindlers also.

Table. **Characteristics of financial discipline of different type of borrowers**

	Planned redemption of principal	Planned redemption of interests	Rollover	Charges and fines	Collection
Type A	+	+	-	+/-	-
Type B	+	+	+	+/-	-
Type C	-	+	+	+/-	+
Type D	-	+	-	+/-	+
Type E	-	-	-	-	+

The fifth distinguishing feature is risk management for payday lending. Risk management in this segment has special features in each of its three basic components: 1) borrower identification; 2) application scoring; 3) analysis of information from the bureau of credit histories. First component should include different technologies which allow us to identify a borrower remotely. In the application scoring component, the differences are manifested as follows. Data which cannot be verified accurately (for example, socio-demographic characteristics) should receive lower weights. The characteristics of the Internet inquiry are added (often the borrower himself does not know about this) to the scoring. The logic of borrower's credit reports analysis should separate credit information about payday loans and such information from banks.

2. Systemic point of view. The systemic points in the modelling of the credit process are as follows. The first point is the investor's capital flow through the time. The capital generates the issuance of loans (outflow of money). Loans give rise the repayments of loans (cash inflow). System point showing itself in the generation of stable income in the long term. Therefore, "money circulation" is an important system component in the long term.

Second system point concerns marketing and the borrowers' acquisition. The online lending market is very competitive, and the borrowers can apply to several lenders at the same time. Therefore, to develop a business, it is necessary to systematically attract the borrower. Consistency is manifested in the fact that market development in this regard greatly affects the dynamics of an individual lender.

Third systemic point is the ratios of borrower's types in the lender's portfolio. Our analysis has shown that in a long-term trend, borrowers with certain probabilities move down the classes. At the same time, the inflow of new borrowers provides a positive effect on financial results.

Fourth system point corresponds to risk management rigidity. On the one hand the quality of risk management determines the structure of the loan portfolio. On the other hand, "rigidity of risk management" affects the volume of issued loans. Insufficient volume of active loans (due to strict risk management) can lead to the inability to increase capital in the lending process.

These four system points form the basis for building the Causal Loop Diagram and final model.

1. System dynamic model constructing

The dynamics of the online lending business is modeled by us with the help of CLD. SD model is presented in Figure 2. Systemic points are the basis of the design.

2. Simulation analysis

Model was built by the means of the package Stella (IThink 10). Simulation analysis was realized by different indicators for a typical project of organizing payback lending in Ukraine. Capital flows is one of the basic indicators which was modeled. The economic logic of such an indicator corresponds to the payback period. The lender can actively invest in building a loan portfolio. This supposes a higher volume of initial investment but shorter payback period. A smaller initial investment pre-determines a longer payback period. We have simulated correspondence investment capital-payback period at the frameworks of following conditions:

Average PDL amount = UAH 3,000;
Percentage interest rate = 1.08 % (daily);
Percentage interest rate for delay period = 2 % (daily);
Loan duration for borrowers from type A = 14 days;
Loan duration for borrowers from other types = 28 days;
Initial investments for start-up = UAH 500,000 and
Fixed costs = UAH 400,000 (monthly);
New customer per amount of money spent = UAH 484 per client;
Maintain existence clients = UAH 121 per client;
Expenses for credit bureau service = UAH 64 per query;
Approval rate = 30 %;
Transfers from types of clients is 70 % during four months;
Cut-off at transfer B→C = 30 %; Cut-off at transfer C→D = 55 %; Cut-off at transfer D→E = 75 %.
Type A: part of borrowers which get in delinquency = 20 %, delinquency time is 12 days;
Type B: part of borrowers which get in delinquency = 30 %, time in delinquency is 15 days, number of rollovers = 2;
Type C: part of borrowers which get in delinquency = 35 %, time in delinquency 5 days, number of rollovers = 2, collection rate 25 %;
Type D: collection rate 25 %.
Type E: collection rate 10 %.

Simulation of capital flows is pictured at Figure 3. Simulation of a number of clients is presented at Figure 4.

Conclusions and further research proposals. PDL is a widely developed segment of modern consumer lending in many countries. Last decade this segment actively moved to implementing online

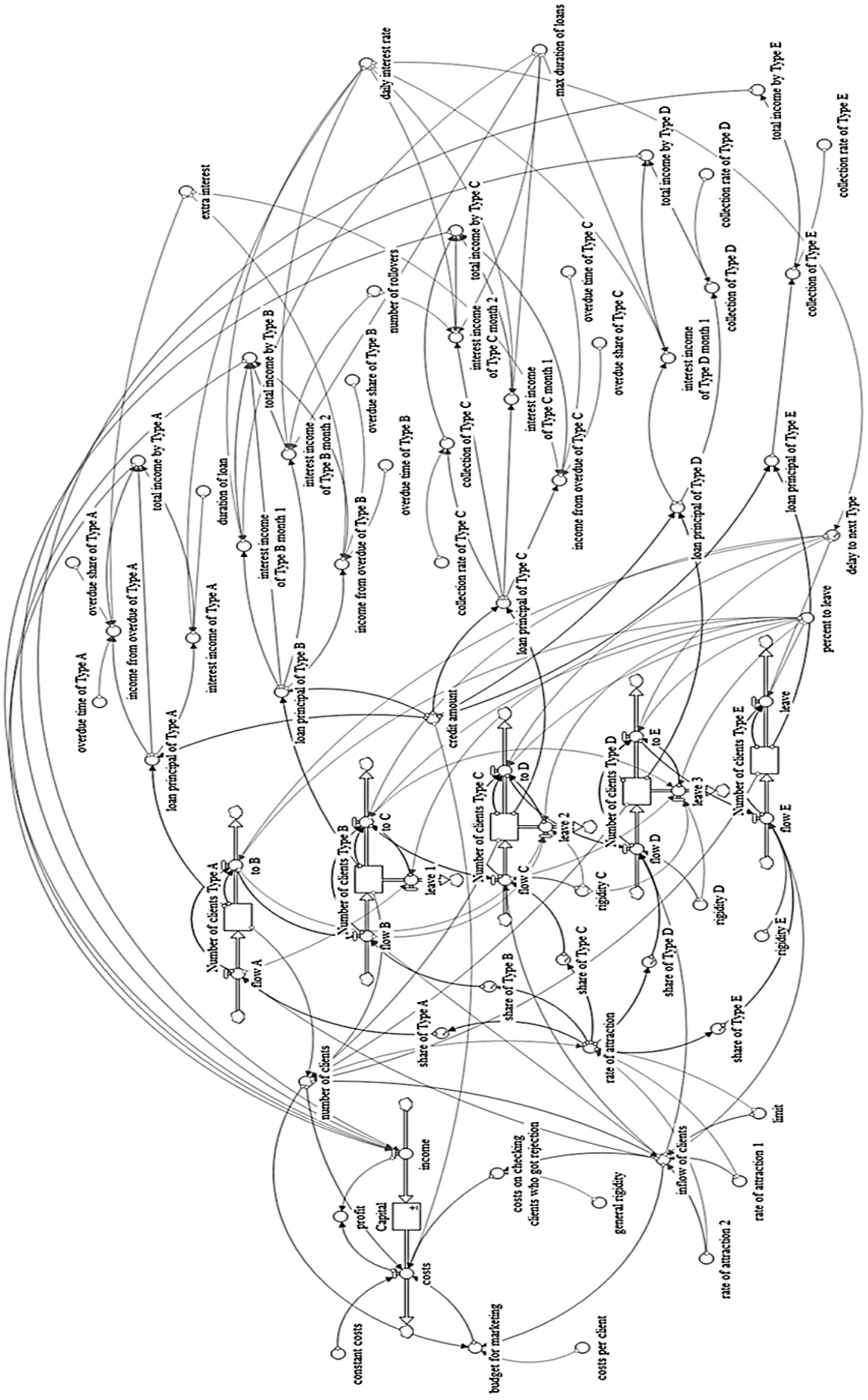

Fig. 2. System dynamic model of payday lending activity

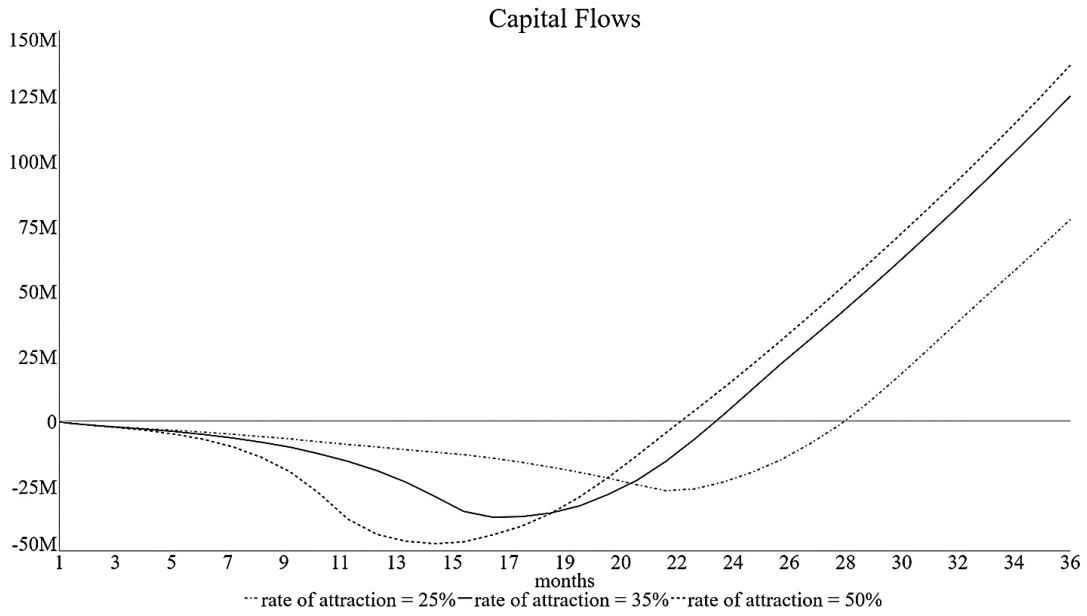

Fig. 3. Simulation of capital flows for typical payday lender

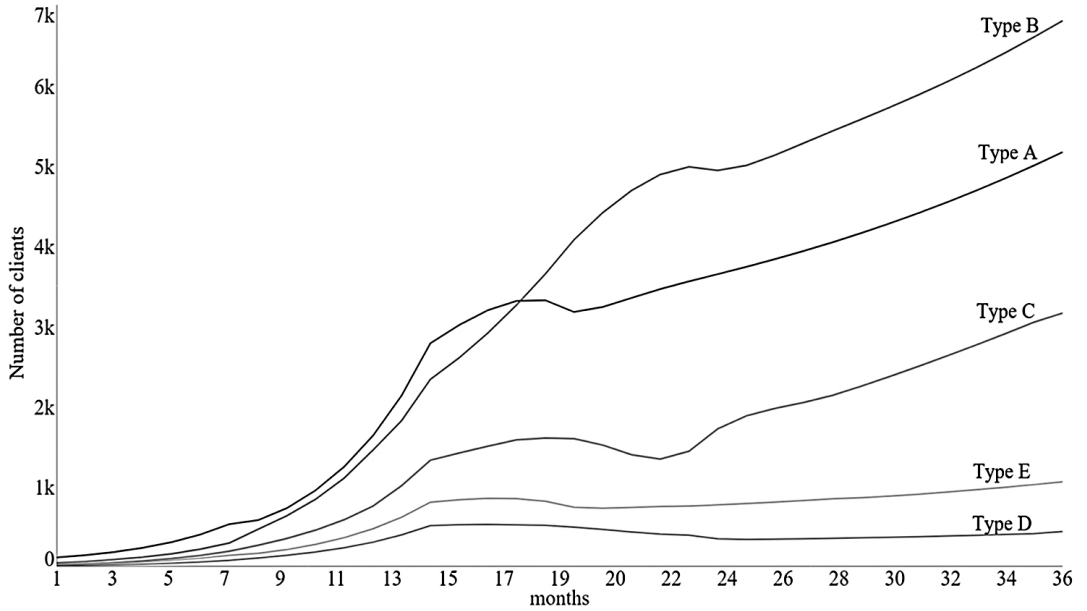

Fig. 4. Simulation of number of borrowers from different types in dynamic

credit granting. We have identified a number of systemic characteristics of online payday lender activity. These characteristics are different from classical features of banking systems. We have used toolkits of system dynamics to realize modelling on the base of our analysis of such a system. The result of this approach provides a possibility to understand the dynamics of business development for payday lenders. The simulation analysis shows a good illustration of application system dynamics.

The following development of applying system dynamics is seen in modelling a general consumer credit system. The general system involves different segments which are interacted one to another. As example, online loan granting (not obviously PDL) had taken a chunk out of the classical banking segment. The modelling following dynamics with SD toolkits may be very perspective.

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

References

A System Dynamics Approach to Understanding the Use of Banks and Alternative Financial Services in St. Louis. (2010). Social System Design Lab Washington University in St. Louis. https://www.stlouisfed.org/~/media/files/pdfs/community%20development/washu-social-sciences-design-lab-report-1-21-11.pdf

Eltag, K. (2016a). *How to Start a Payday Loan Business: Making Money Lending Money.* Kindle Edition.

Eltag, K. (2016b). *How to Run a Payday Loan Business: The Daily Grind.* Kindle Edition.

Forrester, J. W. (1990). *Principle of systems*. Portland, Productivity Press.

IbisWorld. (n.d.). Check Cashing & Payday Loan Services in the US Market Size 2003–2025. https://www.ibisworld.com/industry-statistics/market-size/check-cashing-payday-loan-services-united-states/

Kaminskyi, A. (2016). Characteristic singularities of risk management in the micro crediting segment. *Scientific Papers NaUKMA. Economics, 1*(1), 80–85.

Kaminskyi, A., & Petrovskyi, O. (2019). Consumer Lending in Banks: System Dynamics Modelling. *Scientific Papers NaUKMA. Economics, 4*(1), 48–53. https://doi.org/10.18523/2519-4739.20194.1.48-53

Lukianenko, I., & Faryna, O. (2016). *Macrofinancial stability: models and assessment methods.* Kyiv: NaUKMA. http://www.ekmair.ukma.edu.ua/handle/123456789/10878

Morecroft, J. D. W. (2015). *Strategic modelling and business dynamics: a feedback systems approach.* (2nd ed.). New York, NY: Wiley.

Nuñez, S., Schaberg, K., Hendra, R., Sevron, L., Addo, M., & Marpillero-Colomina, A. (2016). Online Payday and Installment Loans. Who Uses Them and Why? https://www.mdrc.org/publication/online-payday-and-installment-loans-0

Packman, C. (2014). *Payday Lending: Global Growth of the High-Cost Credit Market.* Palgrave Macmillan.

Payday Loan Debt Statistics in the US. (2020). https://www.microcreditsummit.org/payday-loan-debt-statistics/

Skriban, V. (2009). Modelling Crediting Volume by Using the System Dynamic Method. https://mpra.ub.uni-muenchen.de/16353/1/MPRA_paper_16353.pdf

Wheat, D., Stelmashenko, Ya., & Faryna, O. (2013). *Systemic-dynamical models: basic stages of constructing system dynamic models by means program package iThink 10. Workbook of system dynamic for computer classes.* Kyiv: NaUKMA.

Камінський А. Б., Петровський О. В.

КОРОТКОТЕРМІНОВЕ СПОЖИВЧЕ ОНЛАЙН-КРЕДИТУВАННЯ: МОДЕЛЮВАННЯ НА ОСНОВІ СИСТЕМНОЇ ДИНАМІКИ

Метою статті є моделювання діяльності мікрофінансової компанії, яка здійснює кредитування онлайн у сегменті коротких споживчих кредитів (Payday loans). Актуальність дослідження цього сегменту зумовлена його динамічним розвитком в останнє десятиріччя. Це пов'язано з активним впровадженням онлайн-технологій у процеси кредитування. Сегмент має характеристичні особливості кредитної діяльності, аналіз яких зроблено в статті. Основними такими характеристиками є високий ризик неповернення кредиту, значна конкуренція, висока відсоткова ставка. Подібні характеристики породжують високу значущість стратегії розвитку компанії, тому що неправильно сформована стратегія породжує доволі високий ризик банкрутства. У роботі показано застосування системної динаміки для моделювання кредитної діяльності таких компаній. Такий підхід дав змогу змоделювати вплив зміни одного елемента на інші і на систему мікрокредитування загалом. Побудована модель має чотири «наріжні камені» системи, а саме: рух капіталу інвестора, процес залучення позичальників, динаміка переходу позичальників у кредитному портфелі з одного типу в інший, жорсткість в управлінні кредитними ризиками. Рух капіталу інвестора являє собою J-криву. Процес залучення позичальників структурується у припливі нових та кредитуванні повторних. Особливістю ринку коротких кредитів є погіршення якості позичальників з часом. У моделі представлено поділ позичальників на 5 типів залежно від надходжень, які вони генерують для компанії. Для кожного типу в моделі показано, який прибуток/збиток можна очікувати від клієнтів цього типу. Побудована модель враховує такі важливі зв'язки, як вплив рівня відсоткової ставки на швидкість погіршення фінансового стану позичальника (перехід між типами позичальників), вплив швидкості залучення нових позичальників на їхню якість (розподіл позичальників за типами), а також те, що згодом позичальники залишають компанію. Ілюстрацію цієї моделі було здійснено за допомогою симулятивного аналізу, який дозволяє знайти оптимальну швидкість залучення позичальників щодо обсягу початкового капіталу кредитора.

Ключові слова: споживче кредитування, короткотермінові споживчі кредити, онлайн-кредитування, методи системної динаміки, симулятивний аналіз.

Матеріал надійшов 30.04.2020