Simulation of Credit Restructuring Impact on Household Financial Welfare in Crisis

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Abstract: - The study aims to investigate the effects of credit restructuring on household welfare during crises, focusing on deriving insights to manage and develop robust financial systems. The paper presents a simulation model based on the system dynamics approach, which delves into the difficulties of multiple loan restructuring strategies under various crisis scenarios, e.g., in a wartime economy, COVID-19 crisis, or a widespread financial crisis. The model illuminates the dynamics of borrowers' solvency, optimal timelines for restructuring, and the potential paths households take in the face of declining incomes or increased economic pressure. The study systematically reviews traditional and aggressive restructuring schemes and investigates the individual and combined effects on a household's financial welfare. The findings reveal critical periods for initiating loan restructuring and the inadequacy of traditional methods involving up to 25% reduction in loan payments. The system-dynamics-based model offers a comprehensive analysis of the implications of credit restructuring on household welfare, e.g. budget incomes, expenses, and liquidity, particularly during system and local crises.

Implementing the model can significantly reduce borrowers' likelihood of defaulting. It helps borrowers in crises and reduces bank risks. The proposed approach is universal and can be used to solve many problems associated with credit restructuring.

Key-Words: - credit restructuring, household budget, household welfare, simulation, system dynamics, crisis, wartime economy.

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1 Introduction

The onset of a crisis, whether economic, political, or due to war, presents significant challenges for individuals and households trying to manage their financial obligations. A critical obligation that frequently becomes especially burdensome is servicing credit or loan repayments. Job losses, salary cuts, a general economic downturn, and other crisis factors can significantly reduce household income and complicate loan repayment. This often increases the risk of loan defaults. Therefore, it can severely affect households and the banking and financial system. In such circumstances, credit restructuring emerges as a potential solution. By modifying the terms of a credit agreement — such as decreasing the monthly payment, adjusting the interest rate, or extending the payment duration — credit restructuring can provide essential relief to borrowers. These managerial tools can alter household commitments, thereby reducing default risks.

The repercussions of Ukraine's most recent widespread credit restructuring were heavily influenced by the international financial crisis (2008) and the extensive war (2022). Previously, investors' eagerness to maximize their stake in the growing lending market led to lenient credit terms, including lending without income verification and favorable repayment terms in the early stages, as described in [1], [2], [3], [4]. This leniency eventually created repayment challenges for borrowers, and banks experienced a subsequent decline in the quality of their credit portfolios.

Numerous studies thoroughly examine the interplay between household debt, credit policies, and economic crises. Studies [5] and [6] discuss the role of home equity and household debt during economic crises, underscoring how household leverage can propel economic downturns and possibly hinder consumption. These observations propose that household debt might signify or precede financial crises, prompting credit restructuring.

Similarly, studies [7] and [8] explore household debt theories and related policies, examining the role of monetary policy in household consumption and deleveraging, providing crucial insights. Additionally, research [9], [10], [11] expands the discussion to encompass global economic contexts and different regions.

These papers and others comprehensively understand credit restructuring's impact on household budgets during systematic economic crises. They highlight the intricate relationship between household budgets, credit restructuring, and economic crises and their reciprocal influence on macroeconomic policies. However, these studies focus on economic crises, often overlooking household-specific financial issues or non-financial crises such as wars. While large-scale economic crises have extensive impacts, individual household crises — caused by job loss, health crises, or other personal financial setbacks — also significantly impact household budgets and might require credit restructuring. Moreover, non-economic crises, such as wars, present unique challenges for households and economic entities. Wars can dramatically alter income and wealth distributions, disrupt financial markets, and amplify uncertainty, affecting household budgets and the demand for credit restructuring.

2 Problem Formulation

2.1 Theoretical Background

One of the primary reasons for loan defaults was banks' need to assess individual borrowers' capabilities further. Various authors proposed models of individual borrowers' financial conditions during a crisis, [12]. These models enable predictions about the consequences of shifts in the balance of a borrower's income and expenses, such as a decrease in salary or an increase in loan repayments. However, during the current economic and political instability, a more relevant task for banks is establishing methodological guidelines for restructuring problematic loan debts. This involves altering the terms of loan agreements to facilitate the resumption of customer payments.

Drawing on the comprehensive data in [9], it becomes evident that the relationship between debt and non-performing loans (NPLs) is multifaceted and deeply intertwined with macroeconomic factors conditions. Their analysis pivots around the causality direction within Eurozone countries, providing pivotal insights for policymakers and financial analysts alike. It underscores the necessity for prudent fiscal management but needs to show the answer to the problems of SMEs or individual loans.

In the other paper [13], the authors examine Brazil and Mexico's differing paths in response to economic crises and challenges of personal housing credits, shaped by each country's unique political and economic landscapes. In Mexico, aggressive mortgage expansion and mass housing production, realized by credit liberalization and real estate firms accessing diverse funds, led to significant household financial risks. In contrast, Brazil offered deep subsidies to low-income families, connecting private housing supply with publicly subsidized demand, albeit with varying degrees of success. Furthermore, the analysis reveals the complexity of financial processes and their impact on households and underscores their criticality when constructing a system dynamics model. Such a model could simulate how different housing financialization strategies, when combined with credit restructuring initiatives, affect household financial stability, particularly in times of crisis. The contrasts between Brazilian and Mexican policies may serve as case studies within the model to assess the long-term welfare implications of such financial strategies on households.

Based on the findings in [14], variations in mortgage modifications are used to distinguish the effects of reducing long-term obligations without changing short-term payments ("wealth") from reducing short-term payments without altering long-term obligations ("liquidity"). Using regression discontinuity and difference-in-differences methods with administrative data on default and consumption, it becomes evident that principal reductions that increase wealth without affecting liquidity have no impact. In contrast, maturity extensions that enhance only liquidity show significant effects.

The findings of [10] are based on investigating the intersection of credit-based social policy and welfare state development in Germany. The study explores the gradual importance of credit in German social security, driven by a decline in savings promotion and the expansion of quasi-public loan schemes. The results show the critical concepts of household finance behavior.

The study of credit inclusion strategies in the agricultural sector of Northwestern Vietnam, as presented in [15], demonstrates the substantial influence of credit policies in many socio-economic settings. The authors discuss the One Commune One Product program (OCOP) in Vietnam and its dependence on relaxing credit access constraints for primary OCOP producers to fulfill their investments. The paper suggests redesigning the "one size fits all" bank credit policy to suit different OCOP programs and promoting multiparty cooperation between banks and other actors as sustainable directions in connecting household agricultural credit supply and demand.

The authors of [16] contribute to this discourse by demonstrating how families manage their finances and debt, particularly in economic instability. The authors examine consumer spending behavior concerning income. Using detailed financial data, it documents that individuals spend more immediately after receiving income, irrespective of the predictability of the payment. The study also investigates whether this behavior is due to liquidity constraints, revealing that even households with significant liquidity exhibit this pattern. This has implications for understanding economic behavior and financial welfare, particularly in crisis management and credit restructuring. Credit restructuring during a crisis should consider borrowers' immediate liquidity needs and spending behaviors in response to income changes.

The article [17] addresses the challenges small businesses face due to the energy crisis triggered by military conflicts, notably in Ukraine. Such analyses could inform the construction of simulations of crises' impact on household budgets. However, the paper needs to extend its findings to household-level credit restructuring.

While the overarching effects of credit restructuring are recognized, there is a demand for more detailed and contextual comprehension. This study aims to address this void by using simulation methodologies to profoundly investigate the effects of credit restructuring on household budgets during crises. Our objective is to derive insights that could instruct competent management and assist in developing robust financial systems that can endure future challenges. Therefore, the purpose and the central hypothesis of the paper are as follows:

The study's **objective** is to identify and analyze the causal loops and relationships that determine the impact of credit restructuring on household financial welfare, employing system dynamics modeling as

the methodology.

The primary **hypothesis** is that credit restructuring schemes significantly impact household financial welfare during crises, influencing factors such as income stability, budget balance, and solvency.

It posits that system dynamics modeling will reveal substantial changes in households' financial equilibrium post-restructuring.

2.2 Methods

In the context of the paper, "financial welfare" is the overall well-being of households regarding their financial health and capabilities and the balance of the household budget, especially in different crises (global financial crisis, after COVID-19 crises, wars, and local conflicts). It includes household income and expenditure, the ability to manage debt, access to credit, and the resilience to withstand financial welfare such as job loss or economic downturns. The paper suggests that restructuring credit – changing the terms of a credit agreement – could relieve households by adjusting their debt obligations to more manageable levels, thus improving their financial welfare. This concept is explored through a system dynamics model, which aims to simulate the impact of various credit restructuring strategies on household finances during crises, offering insights for robust financial system development.

The primary method in this paper is system dynamics thinking and modeling, which encompasses several stages, including problem identification, causal loop diagramming, scenario planning, model implementation, and decision-making learning. Jay Wright Forrester founded the system dynamics (SD) method in his seminal work Principles of Systems, [18]. It is a methodological framework for understanding and modeling complex systems. It uses stocks, flows, feedback loops, and time delays to simulate and analyze the behavior of systems over time. The Causal Loop Diagram (CLD) is a fundamental tool in this methodology. It visually represents the system using the causal relations mechanism in dynamics. Utilise CLDs to illustrate the complex interplay between credit restructuring policies, household financial behaviors, and broader economic indicators during a crisis.

The SD method involves creating a simulation model that represents the financial dynamics of households under different credit restructuring scenarios during crises. The SD method explores how economic conditions and credit policy changes affect household welfare by modeling the flow of financial resources, loan repayments, and income variations. The model integrates real-world data and theoretical constructs to test various strategies and predict their potential impacts on the financial stability of households. Through iterative simulations, the study aims to identify leverage points and suggest regulatory interventions that could improve household financial outcomes during challenging economic times.

The typical procedure for simulating intricate systems, as indicated in [19], [20], [21], [22] and [23], involves the following steps:

- Identify the underlying problem.
- Formulate a dynamic hypothesis that elucidates the root causes of the issue.
- Design the foundational structure using a causal loop diagram.
- Enrich the causal diagram with detailed information.
- Transform the enriched causal diagram into a system dynamics flowchart.
- Convert the system dynamics flowchart into either SD software formats (e.g., PowerSim, VENSIM, STELLA, AnyLogic, etc.) or appropriate equations.

The software application of the system dynamics methodology incorporates various types of variables, as highlighted by the sources:

LEVEL or STOCK: These represent the quantities accumulated over time within the system, like a household's savings or debt.

RATE or FLOW VARIABLES: These variables control the rate at which the stock variables change. In the study context, this could be the rate at which households earn income or make debt payments.

AUXILIARY VARIABLES: These variables support the model but are not part of the main stock-flow structure. They often calculate intermediate values or represent regulatory parameters.

CONSTANT: These represent the parameters within the model that stay the same throughout the simulation unless intentionally changed as part of a scenario analysis, such as fixed rates, periods, etc.

A pivotal outcome of the System Dynamics model is the prediction of the LEVEL variables, influenced by regulated constants. This forecast stems from a series of iterative processes. For the scope of this paper, the leading modeling priorities are establishing the causal graph's basic structure and converting the system dynamics flowchart into PowerSim software format. Subsequent research can explore detailed practical applications. The PowerSim has brought the conceptual model to life, enabling a thorough examination of how household

budgets respond to the ebb and flow of financial variables. The simulation's precision in mirroring real-life scenarios portrays the household's financial pulse, with variables like income, expenses, and loan repayment schemes being the lifeblood. The shifts in these variables, prompted by real-world occurrences, are now open for analysis, discussion, and understanding. This is where the theory meets reality, and the complex dance of financial planning is observed, analyzed, and understood.

In PowerSim's System Dynamics models, Causal Loop Diagrams are foundational tools that visually represent the interplay of variables within a system. They elucidate how different elements interact through feedback loops, where an arrow illustrates a direct and inverse relationship. A crossed-out arrow marks a delayed dependency, indicating a time lag in the effect. Squares symbolize Level or Stock variables, capturing quantities that amass over time. Circles represent rate or auxiliary variables that influence the accumulation or depletion of stocks. Rhombuses designate Constants, the unchanging parameters that underpin the system's functions. These graphical elements are essential for dissecting and understanding the multifaceted and often intricate connections characterizing the system's behavior, including dynamic relationships, delayed effects, and other complex influences.

Therefore, the System Dynamics methodology is well-suited for examining complex systems, such as the impact of credit restructuring on household financial welfare during crises. It allows for the detailed modeling of intricate interdependencies and feedback loops, enabling a deep understanding of how changes in economic policies and conditions can ripple through a household's financial situation. Through simulations, it can provide valuable foresight into the consequences of financial decisions and potential crises, thereby aiding policymakers and financial institutions in creating more resilient economic systems.

3 Results and Discussion

3.1 Simulation Model

The study has crafted a model that mirrors the nuanced interplay between various financial factors affecting household budgets by identifying the core issues and hypothesizing dynamic causal relationships.

In line with the typical procedure for simulating intricate systems described above, our study has completed identifying the underlying problem and synthesizing a dynamic system to solve it. Next, developing and analyzing the foundational structure using a causal loop diagram is necessary before constructing the simulation model. The analysis of the previously discussed factors that influence household budget formation highlights that the budget formation process can be described as follows in the absence of credit restructuring mechanisms.

The main factor influencing expenditure levels through psychological mechanisms is the size of household savings. In turn, savings are shaped by income and obligatory expenditures, including housing, food, basic medical care, other socially necessary expenses, and credit payments. Over time, an increase in savings levels leads to a rise in "consumer appetite," i.e., expenditures previously perceived by the household as unaffordable or unreasonable. The corresponding causal loop diagram is shown in Figure 1.

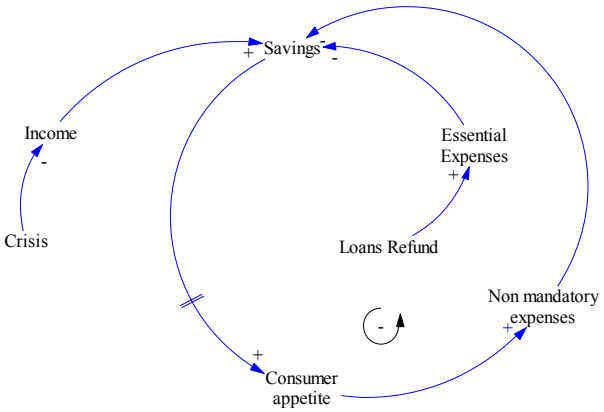

Fig. 1: Causal Loop Diagram for Household Savings and Expenditure Dynamics (without restructuring mechanism)
Source: authors' results

The analysis of the causal loop diagram (Figure 1) reveals that external disturbances, particularly income reductions due to a crisis, are only compensated by one balancing loop that operates through consumer appetite and non-mandatory expenses. However, this compensation may be insufficient to smooth out sharp changes in external factors, potentially leading to depleted savings and household bankruptcy.

Introduce an additional balancing loop to achieve a more effective stabilization. The analysis in Figure 1 suggests that this can be accomplished by implementing a credit restructuring mechanism at the onset of the crisis. This approach is illustrated in Figure 2, which shows a causal diagram of household budget formation under the influence of

credit restructuring.

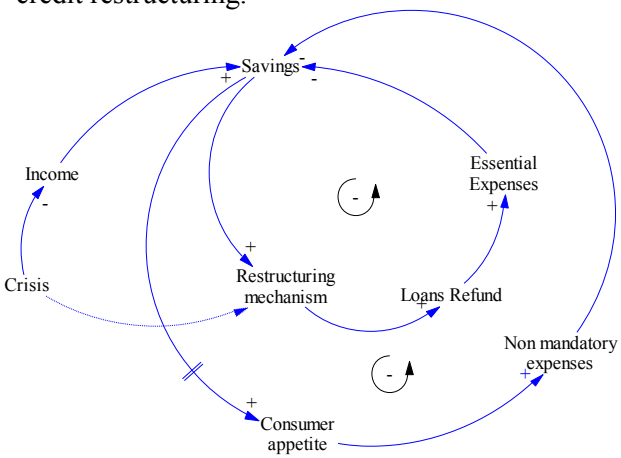

Fig. 2: Causal Loop Diagram for Household Savings and Expenditure Dynamics under the influence of credit restructuring
Source: authors' results

Figure 2 indicates the focus is on how credit restructuring impacts household savings and spending behaviors, encapsulated within causal loop principles. The effectiveness of financial stabilization is enhanced because the second balancing loop contains no delay elements, allowing it to act faster than the first.

Next, we will proceed with the construction of the simulation model

Let us consider a simulation model of a household budget based on the principles of system dynamics. The model allows us to analyze the change in cash flows of the household budget when the balance of income and expenses changes (Figure 3). The model was implemented using PowerSim Studio.

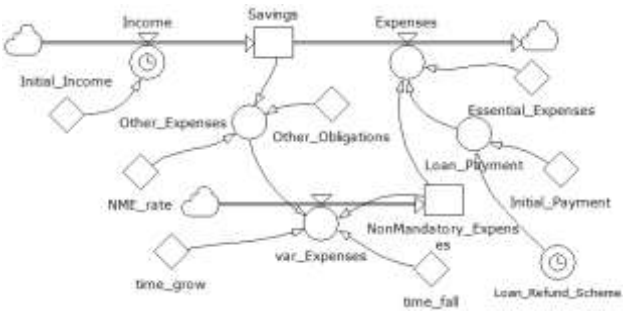

Fig. 3: A simulation model of the impact of credit restructuring on household budgets based on system dynamics methodology
Source: authors' results

The PowerSim model's initial condition sets the time step to one month, and the simulation covers 100 months. This enables a detailed analysis of household budget dynamics and credit restructuring impacts over time.

The main flows in this model are income (*Income*) and expenses (*Expenses*). Simulation parameters are determined using a system of constants and initial conditions, the primary ones being:

Initial_Income – initial household income;
Loans_Refund_Scheme – the amount of loan payments;
Essential_Expenses – first necessity expenses;
Other_Expenses – discretionary expenses;
Savings – the amount of available savings;
NonMandatory_Expenses – non-essential expenses.

The delayed mechanism, represented by *Savings* and *Consumer appetite* variables *(Figure 2*), operates based on constants *time_grow* and *time_fall*. The greater the value of these time delays, the slower the household's expenses adapt to increases or decreases in income. A sudden income (*Income)* change occurs at a certain point in the model.

The monitoring block of the results for the presented model can be shown as follows (Figure 4).

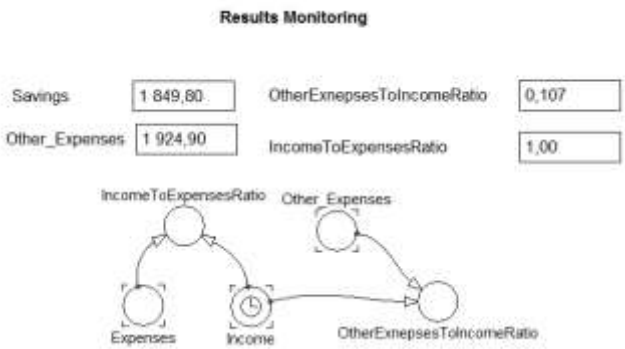

Fig. 4: Monitoring Block for the simulation model of the impact of credit restructuring on household budgets
Source: Authors' estimates

As shown in Figure 4, additional variables such as *IncomeToExpensesRatio* and *OtherExpensesToIncomeRatio* are presented in the monitoring block, indicating changes in the household budget's consumption structure.

Table 1 presents the initial values of the model's variables and parameters. This set represents the characteristics of a hypothetical bank borrower at the beginning of the simulation period.

Table 1. Initial values of the model's variables and parameters

Variables	Initial Value
Savings	26 000
NonMandatory_Expenses	14 000
Initial_Payment	10 000
Essential_Expenses	6 000
Other_Obligations	1 000
Initial_ Income	30 000
time_fall	6
time_grow	4
NME_rate	0.5

The core variables of the model are defined as follows:

$$Income = Initial\_Income \cdot (1 + STEP(\bullet)),$$

$$Loan\_Payment = Initial\_Payment \cdot LRS,$$

$$Expenses = NME + Loan\_Payment + EE,$$

$$Other\_Expenses = Savings \cdot NME\_rate + OO,$$

$$\text{var}\_Expenses = \begin{cases} OE > NME \Rightarrow \dfrac{NME}{time\_grow} \\ OE < NME \Rightarrow \dfrac{NME}{time\_fall}, \end{cases}$$

where:
OE – Other_Expenses;
LRS – Loan_Refund_Scheme;
EE – Essential_Expenses;
NME – NonMandatory_Expenses;
OO – Other_Obligations.

The Income Equation represents the RATE-typed variable *Income*, which controls the rate at which household income changes over time. The function *STEP* introduces a sudden change in income at a specific time step, simulating external disturbances or other unexpected modifications. The *Loan Payment* Equation defines the AUXILIARY-typed variable *Loan_Payment,* which calculates the loan repayment amount at each time step. It is influenced by the *Loan_Refund_Scheme* to account for varying repayment strategies. The *Expenses* Equation combines RATE-typed variables representing household expenses. These include *NonMandatory Expenses, Loan_Payments, and Essential_Expenses*, modeling the household's dynamic financial outflows. The *Other_Expenses_Equation* is an AUXILIARY-typed variable that links *Savings* with discretionary spending through the *NME_rate* (the constant). It incorporates *Other_Obligations* to consider for external financial commitments. Finally, the *var_Expenses* represents a RATE-typed variable to simulate behavioral expense adaptations. The mechanism uses constants *time_grow* and *time_fall* to model the gradual response to income changes based on the relationship between *Other Expenses* and *NonMandatory Expenses.*

Let us observe the model's behavior when income decreases by 20%. Assume that such a decrease occurs in the 24th period of model time, equivalent to two years in real-time. This can be described in the *Income* definition through substitution: ●=(-0.2, 24)

Figure 5 displays the dynamics of the model's variables in this case.

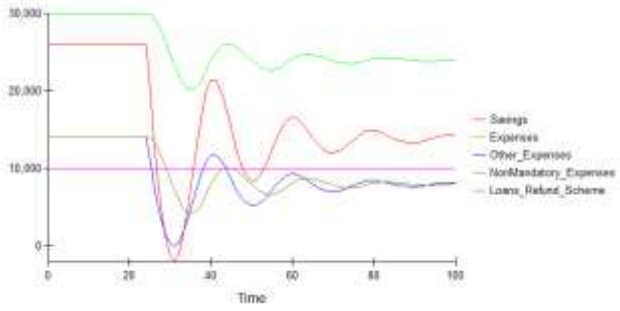

Fig. 5: Dynamics of changing models at *ΔIncome = -20%.*
Source: authors' estimates

Analysis of Figure 5 proves that with a reduction in income, the amount of money available for financing other expenses (variable *Other_Expenses*) decreases. In contrast, the expenses remain at the same level for now. Therefore, previously accumulated funds (variable *Savings*) cover these. The amount of savings then begins to decrease rapidly. The reduction in available funds leads to a gradual decrease in expenses, but this reduction occurs slower than the decrease in savings.

As the modeling shows, even a minor change in a borrower's income can lead to a substantial decrease in the household budget balance, reaching a deficit of -1918 UAH. However, such a deficit usually does not lead to catastrophic consequences, as it can be relatively quickly compensated from additional sources of income. Subsequently, fluctuations in the parameters characterizing the state of the household budget gradually fade and stabilize at a new level of values.

In the considered model, solvency can always be restored if a ratio is fulfilled:

$$Income \geq Expenses. \quad (1)$$

However, in practice, with a relatively significant drop in income, the insolvency period increases so much that it exceeds the maximum limits set However, in practice, a relatively significant drop in income increases the insolvency period to such an extent that it surpasses the maximum limits established by the country's Central Bank. For instance, in Ukraine and many EU countries' legislation [24], similar regulatory frameworks categorize loans as non-performing if payments are overdue by more than 90 days or if the borrower is unlikely to fulfill their obligations. As a result, the obligor falls into the “bad” or “default” category.

Let us consider, for example, the model's behavior when the income is not reduced by 20%, as above, but by 40% (Figure 6).

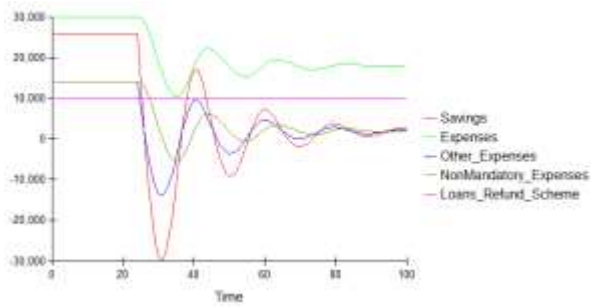

Fig. 6: Dynamics of changing models at ΔIncome = -40%.
Source: authors’ estimates

Figure 6 shows that with a 40% reduction in the profitable part of the household budget, the budget shows a deficit already after 3 months, falls dramatically to -29837 UAH after 4 months more, and returns temporarily to a positive balance only after 10 months. As a result, the loan will be classified as 'bad.' This is disadvantageous for both the bank and the borrower, as the bank is likely to lose the remaining outstanding debt while the borrower’s credit rating decreases. Additionally, both parties may face legal expenses. Therefore, banks use various methods of restructuring credit agreement conditions to reduce the debt burden on the borrower. The following restructuring schemes are usually encountered in most countries, particularly in Ukraine [4] and Tajikistan [25]:

- replacing the loan currency from foreign to national;
- replacing the interest accrual scheme from repaying the central part of the debt in equal parts to an annuity;
- extending the term of the loan agreement.

The downside of the listed schemes is a relatively small reduction in the payment size (usually at most 25%) provided by their use. In addition, other weaknesses can be identified, in particular:

- Late start of the restructuring process, as a result of which the borrower's financial condition deteriorates so much that the fulfillment of the requirements of the new agreement for him is often also tricky;
- Only the conditions related to the repayment of the principal amount of the debt are subject to restructuring, while the banks continue to demand interest payments in full;
- The terms of the loan agreement are changed until the end of its validity, i.e., even after the borrower copes with his financial difficulties, the restructured agreement will continue to apply to him.

The listed shortcomings not only reduce the effectiveness of restructuring as a method of reducing the financial burden but also lead to a growth of distrust towards the banking system, considering the apparent gap between the declared loyalty to the customer and the actual actions of the banks.

3.2 Simulation Scenarios

The simulation model of the impact of credit restructuring on household budgets allows for a detailed analysis of the consequences of applying various loan restructuring schemes. Let us take a closer look at the case of reducing the income of a hypothetical borrower by 40%.

As shown in Figure 6, at step 26, the borrower's income and expenses balance decreases almost to zero after 3 months. The borrower's profits can no longer cover expenses at the next step. Thus, this period can be critical for deciding on debt restructuring. Otherwise, the client's financial condition can become "bad". On the other hand, choosing to restructure the loan terms earlier than a month after income reduction is difficult to implement due to the client's psychological inertia and organizational reasons. Therefore, the optimal time to start the restructuring process is 1-3 months from when the client's income falls.

Implementing the proposed restructuring scheme will help avoid the emergence of overdue debt under the loan agreement in real-life scenarios. For instance, considering the model (Figure 3) represents the credit restructuring scheme by the variable *LRS (Loan_Refund_Scheme)*, a 50% reduction in loan payments at step 26 may be described as follows:

$$LRS=1+STEP(-0.5, 26). \quad (2)$$

Let us consider different options for reducing the loan payment and their impact on the client's solvency (Table 2).

Table 2. Simulation results of the impact of different conditions for reducing the payment on the household budget level

Scenario Number	Rate of Loan Payment Decrease, %	Minimal *Savings* (budget) Level, UAH	The length of the period with a negative balance, month
1	25%	-19 600	9
2	50%	-10 400	7
3	75%	-3 160	4

From the analysis of the data provided in Table 2, traditional measures for restructuring loan terms, which typically allow for no more than a 25% reduction in the borrower's payment burden, do not sufficiently mitigate the negative consequences of a borrower's income drop. Only a significant decrease in the payment burden enables the borrower to emerge from the crisis. However, the payment size can only sometimes remain at such a level, as it does not even cover the bank's costs for the monetary resources required for lending. Therefore, if condition (1) is met, the payment should gradually increase to its initial value after stabilizing the borrower's financial situation. If condition (1) is not met, the bank and the borrower can reconsider the loan terms towards some reduction of the monthly payment using one of the existing restructuring schemes.

Let us consider different variants of the model's behavior as loan payments increase their initial value to an initial level of 10000 UAH. In the first case, the payment is immediately restored to its initial value. The best moment for such an increase is when other household budget expenses (related to the *NonMandatory_Expenses* variable) reach their minimum value. In the experiment, this occurs at step 33. The following equation defines the restructuring scheme:

$$LRS=1+STEP(-0.75, 26)+STEP(0.75,33) \quad (3)$$

The results of the experiment are illustrated in Figure 7.

The results of the data analysis in Figure 7 indicate that despite restoring the payment amount to the initial level only after seven months (see equations (2) and (3)), the borrower's income and expenses do not significantly imbalance decrease. For example, in this case, the maximum budget deficit is only -6,227 UAH (at step 41).

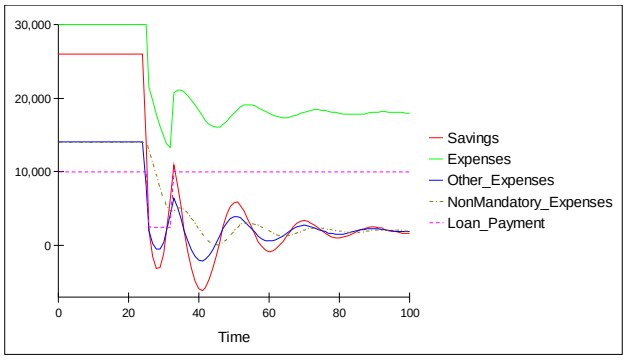

Fig. 7: Dynamics of model variables during a one-step payment restoration.
Source: authors' estimates

The central problem of this method is the difficulty in determining the optimal moment to restore the payment size, as the bank cannot directly control *NonMandatory_Expenses*. A more effective guideline is the household budget balance (variable *Savings*), which the bank can monitor by considering, for instance, the timeliness of the borrower's credit debt repayments. Experiments with the model indicated that a two-step payment restoration scheme, defined as:

$$LRS=1+STEP(-0.75,26)+STEP(0.5,31)+STEP(0.25,35) \quad (4)$$

should be applied in this case.

The graphical view of the experiment results is shown in Figure 8.

In this scheme, the first increase in payments (to 75% of the original amount) occurs as soon as the household budget balance (Savings) becomes positive (step 31, as shown in equation (4)). Four months later, the payment is restored to its original level (step 35, as shown in equation (4)). The maximum budget deficit, in this case, is only 3,167 UAH (at step 28, as shown in Figure 8), which is almost twice as low as in the single-step restructuring scheme.

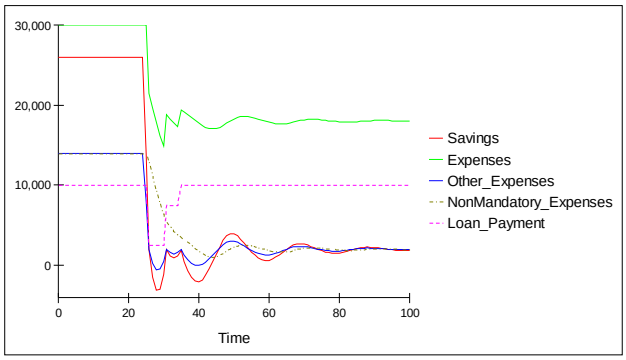

Fig. 8: Dynamics of model variables during a two-step payment restoration.
Source: authors' estimates

Thus, the overall term of the loan needs to be extended to compensate for the temporary reduction in payment. When practically implementing the proposed approach, one of the significant issues is compliance with banking legislation norms that require the mandatory and timely repayment of loan interest. Unfortunately, not all countries have such deferral options available. For instance, credit holidays are not provided for in Tajikistan under the legislation. In Ukraine, they are granted only in exceptional cases (for example, a three-month credit holiday was offered to borrowers after the onset of the Russian military invasion crisis). Therefore, this problem can be resolved at the state level by adopting regulations that govern the processes of restructuring credit agreements and at the local level through the execution of additional loan agreements.

4 Conclusion

The primary result of this study is a simulation model based on system dynamics methodology that thoroughly analyses the impact of credit restructuring on household budgets, especially during crises. The model highlights the cascading effects of restructuring decisions on borrowers' financial stability, making it a critical tool for stakeholders, including financial institutions and policymakers. It also demonstrates the advantages of the system dynamics method for addressing complex nonlinear issues and decisions.

Key findings from the simulation indicate that the optimal time to initiate restructuring is within 1–3 months following a substantial income reduction. Acting within this window mitigates further financial deterioration and reduces the likelihood of loan defaults. For example, the proposed restructuring scheme reduced the borrower's balance deficit from 29,837 to 3,167 UAH (nearly tenfold) following the crisis and ensured the resumption of payments.

A critical problem in determining the right moment for payment restoration is the unpredictable nature of household expenses. Instead of relying solely on the minimum value of household budget expenses, banks should consider more consistent factors such as the household budget balance, which can be monitored through loan repayment timelines.

The proposed two-step payment restoration process offers a sustainable alternative, balancing immediate relief with long-term repayment stability. Implementing the proposed restructuring scheme will help prevent the emergence of overdue debt under the loan agreement in real-life conditions.

In conclusion, the proposed simulation model provides a tool for improving household financial welfare and resilience during crises. Its adoption could transform credit restructuring practices, reducing default risks for borrowers while safeguarding the financial stability of lending institutions. This research informs policy decisions and sets a foundation for more resilient economic systems facing uncertainty.

5 Discussions

The findings prove the principal changes needed in managing crises within financial systems by offering a detailed analysis of the interplay between income stability and restructuring strategies. For instance, the simulation model could be expanded to incorporate how psychological factors, such as loss aversion or stressful decision-making, influence borrowers' repayment behaviors.

Future research could also explore integrating advanced technologies, such as AI, to enhance predictive accuracy or adapting the model to account for diverse economic and legal environments. Furthermore, understanding the unique challenges of different crises, such as pandemics or natural disasters, could refine the model's applicability. Addressing broader economic factors like unemployment and inflationary pressures can also enhance the model's applicability.

The model could be tailored to address regional and sectoral variations by incorporating such specific details into future refinements, thereby expanding its relevance and applicability.

Thus, expanding the scope to include the specifics of different crises, behavioral economics highlights, unemployment dynamics, and inflation effects may provide a more robust and comprehensive framework for effectively addressing household financial welfare supports. However, the model is a universal approach for the above improvements and practical application.

Declaration of Generative AI and AI-assisted Technologies in the Writing Process

During the preparation of this work, the authors used Grammarly in order to improve the readability and language of the manuscript. After using this tool/service, the authors reviewed and edited the content as needed and take full responsibility for the content of the publication.

References:

[1] O. Omelchenko, O. Dorokhov, O. Kolodiziev, and L. Dorokhova, "Fuzzy modeling of the creditworthiness assessments of bank's potential borrowers in Ukraine," *Ikonomicheski Izsledvania*, vol. 27, no. 4, pp. 100–125, 2018, [Online]. https://www.iki.bas.bg/Journals/EconomicStudies/2018/2018-4/6_Dorokhov_f-f.pdf (Accessed Date: October 20, 2024).

[2] A. Mints, D. Zherlitsyn, O. Khadzhynova, E. Kamyshnykova, and O. Kalinin, "Hierarchical fuzzy method of comparing bank products with complex tariff packages," *Journal of Information Technology Management*, vol. 13, Special Issue: Advanced Innovation Topics in Business and Management, pp. 66–80, 2021. https://doi.org/10.22059/jitm.2021.82607.

[3] E. Cubillas and N. Suárez, "Bank market power and lending during the global financial crisis," *Journal of International Money and Finance*, vol. 89, pp. 1–22, 2018. https://doi.org/10.1016/j.jimonfin.2018.08.003

[4] O. Vovchak and N. Polyak, "Reasons and consequences of the influence of the global financial crisis on the development of the banking and real sectors of the Ukrainian economy," *Visnyk NBU*, no. 8, pp. 22–27, 2009, [Online]. https://journal.bank.gov.ua/archive/2009/8.pdf (Accessed Date: October 20, 2024).

[5] K. Dynan, "Is a household debt overhang holding back consumption?" *Brookings Papers on Economic Activity*, vol. 6, pp. 299-362, 2012, [Online]. https://scholar.harvard.edu/sites/scholar.harvard.edu/files/kdynan/files/2012a_dynan-1.pdf. (Accessed Date: October 20, 2024).

[6] A. Mian and A. Sufi, "House prices, home equity-based borrowing, and the US household leverage crisis," *American Economic Review*, vol. 101, no. 5, pp. 2132–2156, 2011. https://doi.org/10.1257/aer.101.5.2132.

[7] M. Di Maggio, A. Kermani, B. J. Keys, T. Piskorski, R. Ramcharan, A. Seru, and V. Yao, "Interest rate pass-through: Mortgage rates, household consumption, and voluntary deleveraging," *American Economic Review*, vol. 107, no. 11, pp. 3550-3588, 2017. https://doi.org/10.1257/aer.20141313.

[8] J. Zinman, "Household debt: Facts, puzzles, theories, and policies," *Annual Review of Economics*, vol. 7, pp. 251–276, 2015. https://doi.org/10.1146/annurev-economics-080614-115640.

[9] C. Agiropoulos, G. Galanos, and T. Poufinas, "Debt versus non-performing loans: An investigation on the causality direction within the countries of Eurozone," in T. Poufinas, Ed., *Debt in Times of Crisis*, pp. 215-235, Cham: Palgrave Macmillan, 2021. https://doi.org/10.1007/978-3-030-74162-4_7.

[10] D. Mertens, "Borrowing for social security? Credit, asset-based welfare and the decline of the German savings regime," *Journal of European Social Policy*, vol. 27, no. 5, pp. 474–490, 2017. https://doi.org/10.1177/0958928717717658.

[11] R. Stijepović, "Recovery and reduction of non-performing loans - Podgorica approach," *Journal of Central Banking Theory and Practice*, vol. 3, no. 3, pp. 101–118, 2014. https://doi.org/10.2478/jcbtp-2014-0017.

[12] O. Kolodiziev and D. Gontar, Scenario modeling of the bank's market value strategic management (Сценарне Моделювання Стратегічного Управління Ринковою Вартістю Банку) *Ekonomicnij Casopis-XXI* – *Economic* Annals-*XXI*, no. 9-10(2), pp. 19-23, 2014, [Online]. http://jnas.nbuv.gov.ua/j-pdf/ecchado_2014_9-10(2)__6.pdf (Accessed Date: October 20, 2024).

[13] A. Reyes and P. Basile, "The distinctive evolution of housing financialization in Brazil and Mexico," *International Journal of Urban and Regional Research*, vol. 46, no. 6, pp. 933–953, 2022. https://doi.org/10.1111/1468-2427.13142.

[14] P. Ganong and P. Noel, "Liquidity versus wealth in household debt obligations: Evidence from housing policy in the Great Recession," *American Economic Review*, vol. 110, no. 10, pp. 3100-3138, 2020. https://doi.org/10.1257/aer.20181243.

[15] D. X. Luan and D. T. Tung, "Formal credit inclusion within one-commune-one-product (OCOP) in the agricultural restructuring strategy of Northwestern Vietnam," *Economics & Sociology*, vol. 12, no. 2, pp. 94–108, 2019. https://doi.org/10.14254/2071-789x.2019/12-2/6.

[16] A. Olafsson and M. Pagel, "The liquid hand-to-mouth: Evidence from personal finance management software," *The Review of Financial Studies*, vol. 31, no. 11, pp. 4398–4446, 2018. https://doi.org/10.1093/rfs/hhy055.

[17] A. Mints, D. Zherlitsyn, V. Kravchenko, and

H. Doroshkevych, "Simulating strategies for mitigating the impact of the energy crisis on small-scale businesses," in *2023 IEEE 4th KhPI Week on Advanced Technology (KhPIWeek)*, Kharkiv, Ukraine, 2023, pp. 1–5. https://doi.org/10.1109/KhPIWeek61412.2023.10312984.

[18] J. W. Forrester, *Principles of Systems: Text and Workbook*, 2nd prelim. ed., Cambridge, MA: Wright-Allen Press, 1968.

[19] F. M. Arshad and K. M. Noh, "Systems thinking: System dynamics," in System Dynamics, Springer Texts in *Business and Economics*, pp. 15-35, Singapore: Springer, 2017. https://doi.org/10.1007/978-981-10-2045-2_2.

[20] M. Broy, "A model of dynamic systems," in S. Bensalem, Y. Lakhneck, and A. Legay, Eds., *From Programs to Systems: The Systems Perspective in Computing, Lecture Notes in Computer Science*, vol. 8415, pp. 39-53, Springer, Berlin, Heidelberg, 2014. https://doi.org/10.1007/978-3-642-54848-2_3.

[21] D. Kofjac, A. Skraba, and M. Kljajic, "Neural network modeling by system dynamics methodology," in Proc. *IEEE Region 8 EUROCON 2003, Computer as a Tool*, vol. 1, pp. 424-428, Ljubljana, Slovenia, 2003. https://doi.org/10.1109/EURCON.2003.1248057.

[22] S. Kozlovskyi, D. Bilenko, M. Kuzheliev, R. Lavrov, V. Kozlovskyi, H. Mazur, and A. Taranych, "The system dynamic model of the labor migrant policy in economic growth affected by COVID-19," *Global Journal of Environmental Science and Management*, vol. 6, pp. 95–106, 2020. https://doi.org/10.22034/gjesm.2019.06.si.09.

[23] J. Duggan, "An Introduction to System Dynamics," in System Dynamics Modeling with R, 1st ed., *Lecture Notes in Social Networks*, Springer, Cham, pp. 1–24, 2016. https://doi.org/10.1007/978-3-319-34043-2.

[24] Regulation (EU) No 575/2013 of the European Parliament and of the Council of 26 June 2013 on prudential requirements for credit institutions and investment firms and amending Regulation (EU) No 648/2012 Text with EEA relevance," *Official Journal of the European Union,* [Online]. http://data.europa.eu/eli/reg/2013/575/oj (Accessed Date: October 20, 2024).

[25] E. Todoroki, I. A. Fontan, F. Dancausa, and M. Iavorskyi, "Readiness for resolving nonperforming loans in Central Asia," *World Bank,* 2023, [Online]. https://documents1.worldbank.org/curated/en/099214003132333703 (Accessed Date: October 20, 2024).

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Conflict of Interest

The authors have no conflicts of interest to declare.