DOI: 10.5281/zenodo.1302958
UDC Classification:658.012.2
JEL Classification: G32, C63

CASH FLOW MODELING OF INDUSTRIAL ENTERPRISES IN CONDITIONS OF UNCERTAINTY IN THE MARKET

МОДЕЛЮВАННЯ ГРОШОВИХ ПОТОКІВ ПРОМИСЛОВИХ ПІДПРИЄМСТВ В УМОВАХ НЕВИЗНАЧЕНОСТІ РИНКУ

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Recieved: 16.01.2018

Соколовська З.М. Моделювання грошових потоків промислових підприємств в умовах невизначеності ринку. Науково-методична стаття.

Стаття присвячена моделюванню грошових потоків підприємств в умовах невизначеності. Доводяться можливості прогнозування динаміки грошових потоків на базі розробленої імітаційної моделі. Модель побудована з використанням методу системної динаміки на платформі Ithink. Доцільність залучення методології обгрунтовується необхідністю відтворення досліджуваних процесів в динаміці з імітацією впливу багатьох детермінованих та стохастичних факторів внутрішнього й зовнішнього оточення підприємства, а також забезпеченням потрібного ступеня агрегації. Робота моделі проілюстрована фрагментами імітаційних експериментів за матеріалами підприємства легкої промисловості. Продемонстровані можливості параметричного налаштування експериментів, окреслені напрямки подальшого удосконалення моделі-тренажера.

Ключові слова: підприємство, грошові потоки, прогноз, імітаційна модель, системна динаміка, імітаційні експерименти

Sokolovska Z.M. Cash flow modeling of industrial enterprises in conditions of uncertainty in the market. Scientific and methodical article.

The article is devoted to the modeling of cash flow businesses in the face of uncertainty. The possibility of forecasting cash flows on the basis of the developed simulation model is presented. The model is constructed using the method of system dynamics on the platform Ithink. Engaging methodology justified playback studied processes dynamics simulation of the influence of the many deterministic and stochastic factors internal and external company Wednesday, as well as ensuring the necessary degree of aggregation. Model illustrated fragments of simulations on the materials of the light industry. Demonstrated ability of parametric settings experiments identified areas for further improvement of model-Simulator.

Keywords: business, cash flows, prediction, simulation, System Dynamics, simulations

The research of processes of formation and movement of enterprises' cash flows is one of the most urgent tasks of modern financial management. Serving various aspects of economic activity, efficiently organized cash flows are the basis for ensuring a positive dynamics of enterprise development, achievement of high performance indicators.

Cash flow management in a market environment has significant effects on many stochastic factors in the external and internal environment, which increases the risk and uncertainty. Under such conditions, the use of traditional methodological approaches to the diagnosis of the current state and the subsequent movement of the studied streams is ineffective, which raises the problem of attracting new, modern methods of analysis and forecasting.

Analysis of recent researches and publications

The management of the processes of formation and enterprises' cash flow devoted a large number of domestic and foreign experts' works, among them [1-8]. In spite of this, experts in the field of financial management point out that the concept of cash flow as an independent object of financial management has not been sufficiently reflected in the special literature yet [2-3]. In particular, this refers to the incompleteness of the mathematical base of the study of the composition, structure and dynamics of cash flows associated with various aspects of the activities of industrial enterprises.

Conducting a comprehensive economic analysis of cash flow, especially in the future, requires the use of a flexible mathematical tool, along with known methods and techniques of quantitative analysis. As such a research device, simulation modeling is proposed, namely the system dynamics method, implemented on many effective software platforms. This method, proposed by J. Forester [9], has been widely used in modern economic research and has been introduced into the practice of many firms and companies [10-15], and others.

The use of this simulation methodology is appropriate due to the possibility of considering the studied processes in dynamics with the simulation of

the influence of many deterministic and stochastic factors of the internal and external environment of the enterprise. The degree of aggregation of processes provided by this method is sufficient to solve the problem.

The aim of article is to provide opportunities for forecasting the dynamics of cash flows of the enterprise based on the system-dynamic paradigm of simulation modeling.

The main part

The role of simulation research is of great significance today in connection with the possibility of constructing simulator models that allow timely prediction of the emergence of bottlenecks in the process of implementing various activities of enterprises.

System-dynamic (SD) methodology is used to determine the general trends in the development of processes. It involves a high level of aggregation of objects. SD approach is used when the dynamics of the model of the object is determined in the form of evolutionary changes, without the reproduction of individual elementary events. Software platforms for the implementation of system-dynamic methodology are – DYNAMO, Stella, Vensim, PowerSim, Ithink, Rethink, ModelMaker, etc. [13-17].

The proposed simulation model of the forecasting of enterprise's cash flows is based on the method of system dynamics. The Ithink package is used as a software implementation platform. The package recreates the structural-functional approach, which is based on the methodology of structural analysis and design. This involves the possibility of implementing several levels of presentation of the model – a high-level representation in the form of a flowchart using CASE-tools, as well as lower levels – flow diagrams and code.

The frame structure of the model is shown in fig. 1.

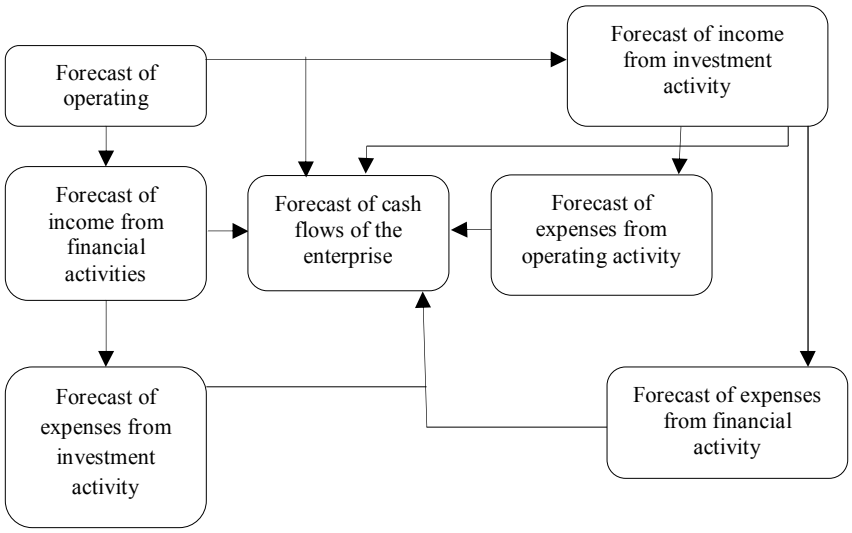


Fig. 1. Frame structure of the forecasting model of enterprise's cash flows
Source: own elaboration

The model contains the following blocks:
— Forecast of operating income.
— Forecast of income from investment activity.
— Forecast of income from financial activities.
— Forecast of expenses from operating activity.
— Forecast of expenses from investment activity.
— Forecast of expenses from financial activity.
— Forecast of cash flows of the enterprise.

Blocks for forecasting revenues from three types of activities – operational, investment and financial – carry out a forecast in two versions: on the basis of available statistical information, taking into account the preservation for the future periods of the previous trend, and also taking into account the effects of the stochastic factors of the internal and external environment of the operation of the enterprise.

Blocks for forecasting costs from the above activities also provide the results without taking into account and taking into account the effects of stochastic factors in the environment of the operation of the enterprise.

The "Cash Flow Forecast" block collects information from previous units and provides results regarding the forecast dynamics of total cash receipts and expenditures. Two cash flows are calculated – taking into account and excluding stochastic influences.

The flow diagrams of the presented blocks in a generalized form are shown in fig. 2-3.

Let's consider in more detail the main components of the blocks.

The values of the converters "Projections of income from operating (investment, financial) activities" are determined by means of converters "Receipts from operating (investment, financial) activity statistics", which are specified by the function

GRAF (Time), where Time is the current time within the modeling process.

Thus, the GRAF (Time) function specifies statistics available on a specific indicator. To determine the values of the converters "Forecast of income from operating (investment, financial) activities," the FORCST function is used, which extrapolates the trend "Revenues from operating (investment, financial) activity Statistics" for a given distance to the future. FORCST calculates the input trend based on the values of the input converter, the values of the exponential mean input of the first order and the mean time. Then FORCST extrapolates the trend towards the future. Example, FORCST (Receipts_from_operational_activities_statistics,(year _data-2011+1),5), where year_data is the variable that stores the expiration time of the available statistics (it can be set by the user automatically at the CASE level using the standard Graphical Input Device block). In the example above, the constant 2011 is the year of the beginning of the available statistics.

Blocks KF1, KF2, KF3 – integral variables whose values are formed taking into account the influence of the complex of stochastic factors of the internal and external environment of the operation of the enterprise.

The values of the converters "The forecast of receipts from operating (investment, financial) activity with the influence of factors" are calculated using the data obtained on the basis of available statistics and the values of the factor influences that are formed in the integral variables.

Similarly, forecast calculations are made regarding the cost of cash from operational, investment and financial activities in the respective units.

Within the "Forecast of cash flows of the enterprise" net (balance) cash flows without consideration and taking into account the influence of environmental factors of the operation of the enterprise are modeled in the form of appropriate funds – "PPP" and "PPP factors". The rates of input flows (aggregated income from different activities) are determined using the IF function.

Example,

iftime<=2018 then

(Receipts_from_investment_activities_statistics+
Receipts_from_operational_activities_statistics+
Receipts_from_financial_activities_statistics)

else

(Forecast_income_from_investment_activities+Fo
recast_income_from_operational_activities_
+Forecast_income_from_financial_activities)

Output flow rates (aggregated cost of funds for different types of activities) are determined similarly with the IF function.

The term of the forecast period and the expiration date of the available statistics (variable "data year") can be determined using the standard KnobInputDevice block, which is set at the CASE level. At the beginning of the experiment, the GraphicalInputDevice units that have been brought to the CASE level allow even untrained users to easily enter the available statistics of the relevant indicators.

Let's look at the model's work on the example of fragments of simulation experiments on the materials of the open-type Chernivtsi Open Joint Stock Company (TRT) "Trembita", one of the leaders in the production of men's and women's clothing in Ukraine and abroad.

Step imitation – one year; forecast period – by 2020. The timing of experimentation may be different depending on the needs of users.

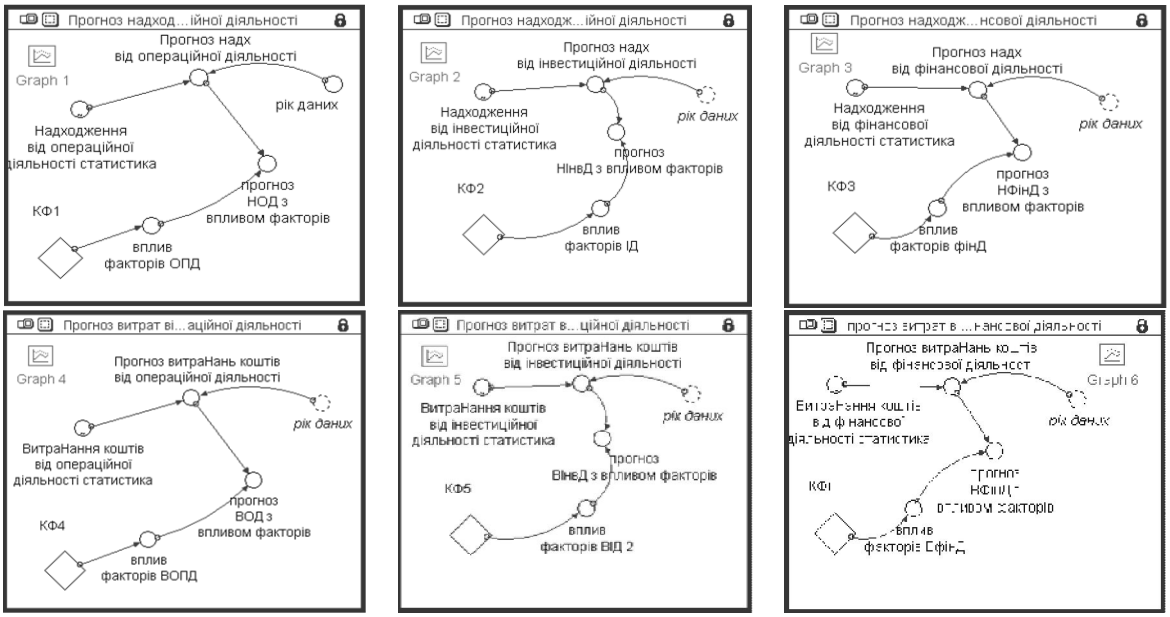


Fig. 2. Flow charts of blocks of forecast of cash receipts and expenses related to types of enterprises' activity

Source: own elaboration

Note: Software in Ukrainian

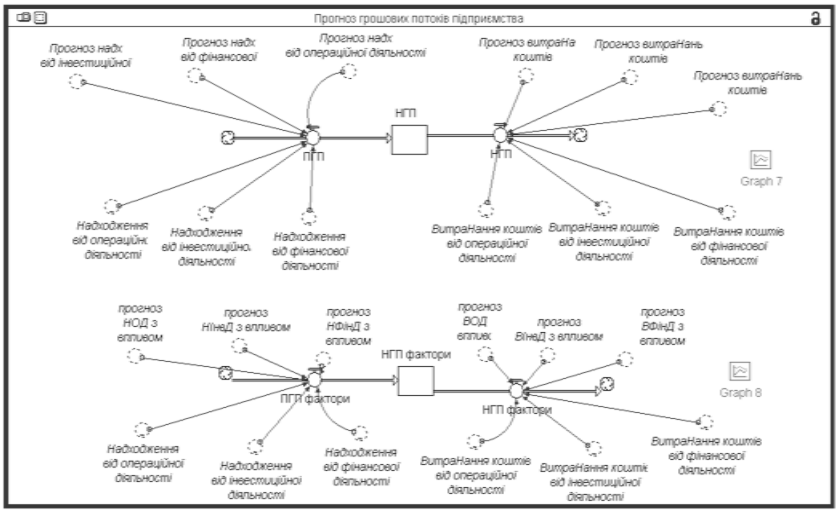
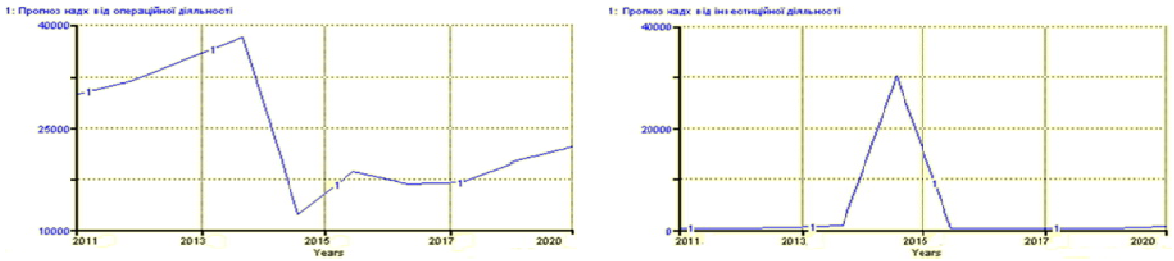
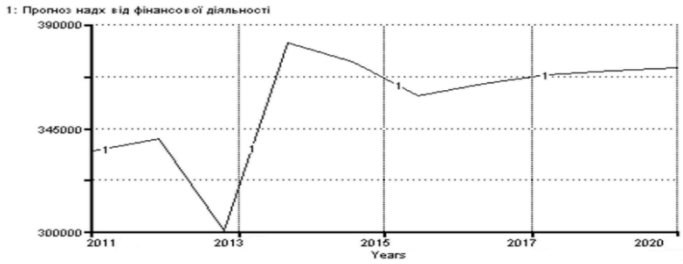


Fig. 3. Flow diagram of the block "Forecast of cash flows of the enterprise"
Source: own elaboration
Note: Software in Ukrainian

The forecast data on the company's cash receipts, obtained on the basis of the constructed trend, without taking into account the influence of factors of the external and internal environment of the enterprise, are shown in fig. 4



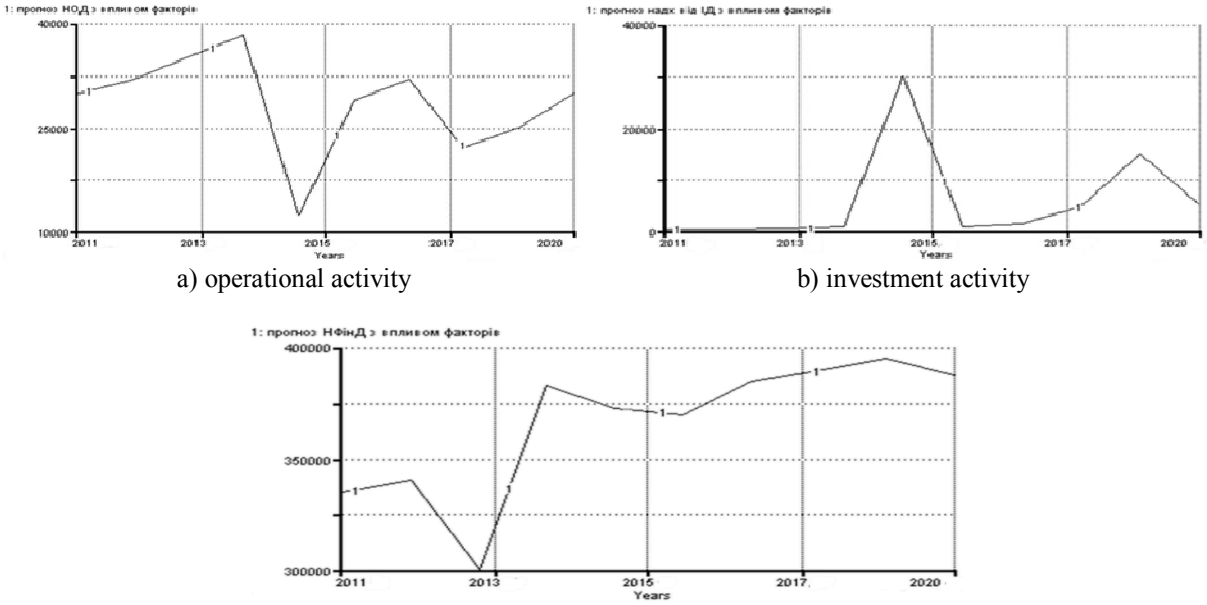
a) operational activity b) investment activity



c) financial activities

Fig. 4. Forecast of cash receipts from various types of activity of the enterprise without taking into account the effects of stochastic factors (ths. UAH)
Source: own elaboration
Note: Software in Ukrainian

From the data shows that the main flow of funds at the enterprise generates financial activity. According to the preservation of the current trend, this tendency will continue. At the same time, there is a decline in 2015 (operating activity has absorbed rather than generated cash flows), the proceeds from operating activities are gradually being corrected. The overall positive dynamics is predicted by 2020. Significant investment income was observed from 2014 through 2015. Then there is a sharp drop in investment. Some revival of the investment process is projected since 2019, although this forecast requires significant refinement taking into account the influence of factors of the investment sector – in general, the enterprise belongs to investment activity objects. The last observation is confirmed by simulation experiments taking into account the effects of stochastic factors – fig. 5.



a) operational activity

b) investment activity

c) financial activities

Fig. 5. Forecast of cash receipts from various types of enterprise's activity, taking into account the effects of stochastic factors (ths. UAH)

Source: own elaboration

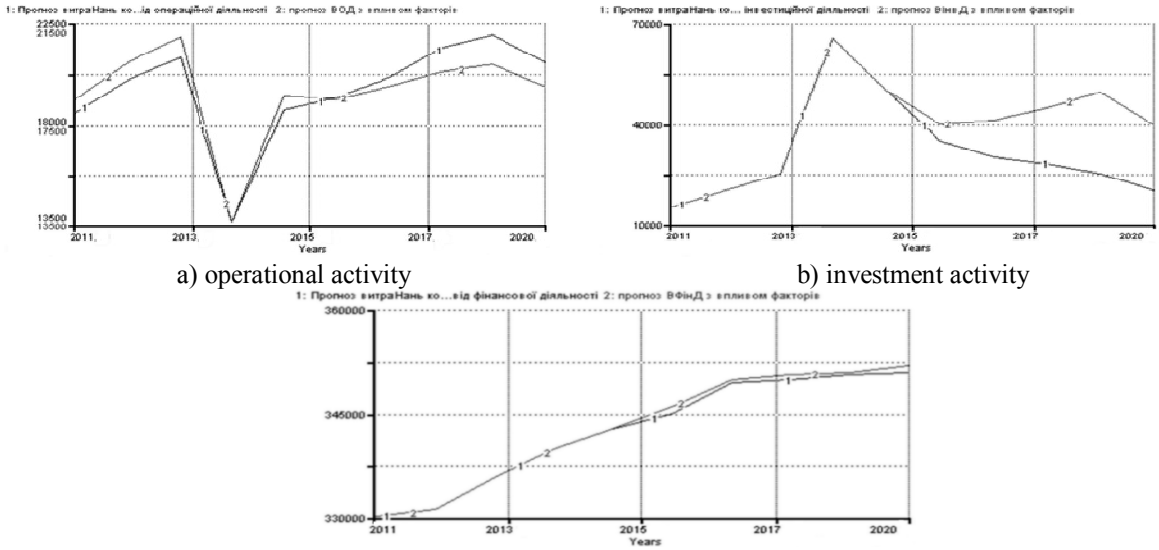
Note: Software in Ukrainian

According to the latest forecast, a significant revival of investment activity and a gradual increase in investment income are expected: the largest investments are expected during 2018-2019.

Taking into account the influences of the environmental factors of the enterprise also leads to adjusting the dynamics of cash flows from operating activities.

As you can see, significant investment inflows lead to an increase in revenues from the main – operational – activity of the enterprise. After the cash takeover period, operating activities are in the role of their generator. The large share of cash receipts of the enterprise for the prospective period will generate financial activity – there is a positive influence of the factors of the environment of the operation of the investigated object.

Forecasted dynamics of enterprise's expenses from the main activities without taking into account and taking into account the influence of factors is shown in fig. 6.



a) operational activity

b) investment activity

c) financial activities

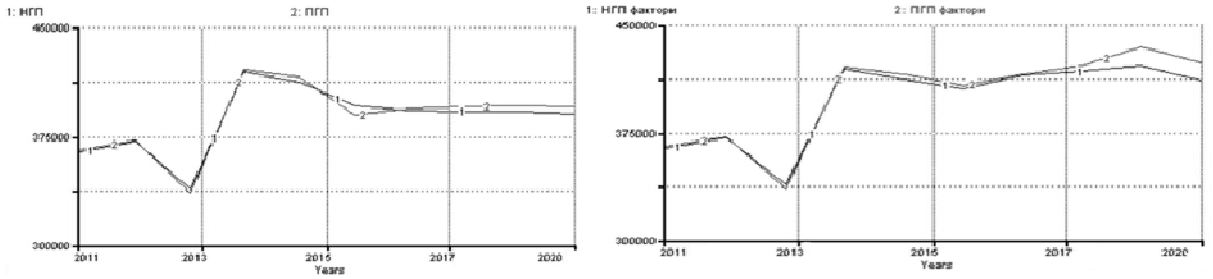
Fig. 6. Dynamics of expenses from the main types of activity of the enterprise without taking into account and taking into account the influence of factors (thousand UAH)

Source: own elaboration

Note: Software in Ukrainian

From the data provided, it can be seen that the implementation of concrete measures at the enterprise leads to a reduction in the cost of operating activities, especially from 2018. With regard to the cost of investment activities, then after 2015 according to the forecast, taking into account the factor impact, the growth of costs is observed compared to the forecast on the basis of the constant trend. However, as previous forecast data have shown, more active investment activity is foreseen in these periods. At the same time, it is evident from the data that the influence of factors does not significantly affect the overall cost dynamics.

The dynamics of accumulated revenues without taking into account factor influences (GWP) and taking into account (GWP factors), as well as accumulated costs (respectively, NWF and NWF factors) are shown in fig. 7. Dynamics of net (balance) cash flows is presented in fig. 8.



a) without taking into account the influence of factors b) taking into account factor influences

Fig. 7. Dynamics of accumulated cash flows (ths. UAH)
Source: own elaboration
Note: Software in Ukrainian

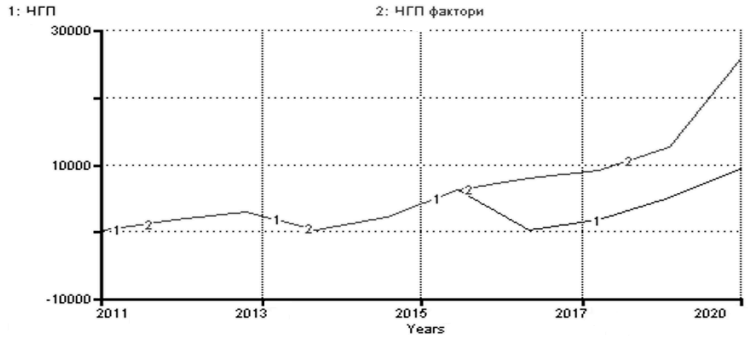


Fig. 8. Dynamics of net (balance) cash flows (ths. UAH)
Source: own elaboration
Note: Software in Ukrainian

Thus, the forecast dynamics of the company's cash for all types of activities can be considered favorable. However, this implies the development and adherence of an appropriate strategy for managing financial and economic activities.

Forecast dynamics of cash flows of the investigated enterprise, determined by means of simulation experiments on the model, was confirmed by available actual data and results of economic analysis conducted according to the standard method.

Repeated experiments with refinement of incoming information can provide a more reliable dynamics of cash flow, which is the basis for making sound management decisions.

Conclusions

The presented simulation model-simulator for forecasting the dynamics of cash flows of enterprises is considered in the most general terms. One of the main advantages of its use is the possibility of parametric adjustment, which provides sufficiently wide options for customizing the specifics of the object being studied. In addition, "parametrization" is understood in the broadest sense, from the user's task of the steps and the timing of the simulation to the definition of specific algorithms of the effects of stochastic factors of the internal and external environment of the enterprises on the dynamics of flows. That is, the algorithmic "filling" of the blocks of formation of integral variables can vary depending on the composition of factors that are taken into account in specific experiments; the choice of the laws of distribution of probability variables that reproduce the variability of the environment adequate to the realities; as well as using any expert information that the experimenter possesses.

It is necessary to emphasize the convenience of the interface of the model on the platform Ithink, as well as the possibility (thanks to CASE-technology) of automated input of input using the built-in standard blocks.

Further research is aimed at a more detailed reproduction of the composition and structure of cash flows from specific activities of enterprises based on multilevel simulation platforms. The development on the basis of the integrated system AnyLogic with the involvement, in addition to the system-dynamic, agent paradigm imitation modeling, as well as optimization tools to solve the problem.

Abstract

Entry. Cash flows serve various aspects of the economic activity of enterprises, are the basis for their sustainable growth and achieve high results. Cash flow management processes must take into account the impact of numerous stochastic factors internal and external enterprise Wednesday, creating conditions of uncertainty and risk. In such circumstances, the use of traditional methodological approaches to the diagnosis of the current state and movement of the investigated streams. With this in mind, forecasting cash flow dynamics requires flexible mathematical apparatus, as the simulation.

Results. On the basis of system-dynamic simulation model was developed methodology of forecasting cash flows of businesses, implemented on the software platform systems Ithink. The system implements the structural-functional approach that supports multi-level representation of the model. See the renderer and streaming model structure chart of the basic model blocks. Projected income and expenses in the context of three main activities-operating, investment and financial-formation dynamics of cleaner (balance) the cash flow. The forecast carried out in two versions-without taking into account and considering the influence given stochastic factors Wednesday the functioning of the enterprise. Model presented on the example of simulation experiments carried out relatively light industry enterprises. One of the main positive cash flow dynamics study on the presented model is the ability to configure a parametric simulations. The model has an open block structure. This provides ample opportunities adapt to the specifics of specific objects. Convenient and easy to use interface model, as well as input automation capabilities using the built-in building blocks provide its regular use as a simulator for management decisions. Further research aimed at increasing the detail of the composition and structure of the simulated cash flows from specific types of business enterprises. This is achieved through the use of hybrid simulation based on integrated systems. Attracting software platform AnyLogic systems provide not only different levels of detail of the studied processes, but also simulated experiments with a view to their optimization.

Список літератури:

1. Бланк И.А. Управление активами / И.А. Бланк. – Киев: Ника-Центр:, 2012. – 720 с.
2. Бланк И.А. Энциклопедия финансового менеджера в 4 т. Т. 4. Управление финансовой стабилизацией предприятия / И.А. Бланк. – М.: Омега-Л, 2008. – 512 с.
3. Бланк И.А. Управление денежными потоками / И.А. Бланк. − К.: Ника-Центр: Эльга, 2002. – 736 с.
4. Бригхэм Ю. Финансовый менеджмент / Ю. Бригхэм, М. Эрхардт. – Спб.: Питер, 2009. – 960 с.
5. Ван Хорн Д. Основы финансового менеджмента / Д. Ван Хорн, Д. Вахович. – М.: Вильямс, 2008. – 1232 с.
6. Власов А.В. Концепция управления денежными потоками в системе финансового менеджмента организации / А.В. Власов // Финансовый вестник: финансы, налоги, страхование, бухгалтерский учет. – 2015. – № 4. – С. 32-37.
7. Грызунова Н.В. Управление денежными потоками предприятия и их оптимизация / Н.В. Грызунова, М.Н. Дудин, О.В. Тальберг // Экономика, статистика и информатика. Вестник УМО. – 2015. – № 1. – С. 67-72.
8. Чараева М.В. Управление денежными потоками предприятия на основе их распределения по функциональному признаку / М.В. Чараева // Финансы и кредит. – 2013. – № 41. – С. 36-41.
9. Форрестер Дж. Основы кибернетики предприятия / Дж. Форрестер. – М.: Прогресс, 1971. – 765 с.
10. Богданова Е.А. Имитационное моделирование как инструмент принятия решений / Е.А. Богданова, А.А. Шерстянкина // NovaUm.Ru. – 2017. − №6.− С. 25-28.
11. Лычкина Н.Н. Ретроспектива и перспектива системной динамики. Анализ динамики развития / Н.Н. Лычкина // Имитационное моделирование. Теория и практика: материалы конф. ИММОД-2009. – СПб: ОАО «ЦТСС», 2009. – Т. 1. – С. 48-56.
12. Соколовська З.М. Прикладні моделі системної динаміки: Монографія / З.М. Соколовська, О.А. Клепікова. – Одеса: Астропринт, 2015. – 308 с.
13. Соколовська З.М. Комп'ютерне моделювання складних економічних систем: Монографія / З.М. Соколовська, О.А. Клепікова. – Одеса: Астропринт, 2011. – 512 с.
14. Цисарь И.Ф. Моделирование экономики в Ithink_Stella. Кризисы, налоги, информация, банки / И.Ф. Цисарь. – М.: «Изд-во ДИАЛОГ_МИФИ», 2009. – 224 с.

15. Соколовська З.М. Прикладне імітаційне моделювання як аналітична основа прийняття управлінських рішень / З.М. Соколовська, Н.В. Яценко // Бізнес Інформ. – 2013. – № 6. – С. 69-76.
16. Назаров А.А. Характеристика современных инструментов для имитационного моделирования при исследовании механизмов управления социально-экономическими процессами и системами / А.А. Назаров // Имитационное моделирование. Теория и практика: материалы конф. ИММОД-2017. – Режим доступа: http://simulation.su/static/ru-articles-2017.html.
17. Рудь Н.О. Інструментальні засоби імітаційного моделювання / Н.О. Рудь // Имитационное моделирование. Теория и практика: материалы конф. ИММОД-2015. – Режим доступа: http://simulation.su/static/ru-articles-2015.html.

References:

1. Blank, Y.A. (2012). Asset management. Kyiv: Nyka-Tsentr: Elga [in Russian].
2. Blank, Y.A. (2008). Encyclopedia of financial manager (Vols. 1-4). M.: Omeha-L [in Russian].
3. Blank, Y.A. (2002). Cash flow management. K.: Nyka-Tsentr, Elha [in Russian].
4. Brigkhem, Yu., & Erkhardt, M. (2009). Financial management. Spb.: Piter [In Russian].
5. Van Khorn, D., & Vakhovich, D. (2008). Fundamentals of financial management. M.: Viliams [In Russian].
6. Vlasov, A.V. (2015). The concept of cash flow management in the system of financial management organization. Finansovyy vestnik: finansy, nalogi, strakhovaniye, bukhgalterskiy uchet, 4, 32-37 [In Russian].
7. Gryzunova, N.V., & Dudin, M.N., & Talberg, O.V. (2015). Enterprise cash flow management and optimization. Ekonomika, statistika i informatika. Vestnik UMO, 1, 67-72 [In Russian].
8. Charayeva, M.V. (2013). Cash flow management enterprises based on their distribution by function. Finansy i kredit, 41, 36-41 [In Russian].
9. Forrester, J.W. (1971) Foundations of Cybernetics company. M.: Progress. [In Russian].
10. Bogdanova, E.A., & Sherstyankina, A.A. (2017). Simulation as a tool for decision-making. NovaUm.Ru, 6, 25-28 [In Russian].
11. Lychkina, N.N. (2009). Retrospective and perspective of system dynamics. Analysis of the dynamics of development. Imitatsionnoye modelirovaniye. Teoriya i praktika, (Vols. 1), (pp. 48-56). SPb: OAO "TsTSS" [In Russian].
12. Sokolovska, Z.M., & Klepikova, O.A. (2015). Application of system dynamics model. Odesa: Astroprynt [in Ukrainian].
13. Sokolovska, Z.M., & Klepikova, O.A. (2011). Computer simulation of complex economic systems. Odesa: Astroprynt [in Ukrainian].
14. Tsisar, I.F. (2009). Modeling economy in Ithink_Stella. Crises, taxes, information, banks. M.: "Izd-vo DIALOG_MIFI" [In Russian].
15. Sokolovska, Z.M., & Yacenko, N.V. (2013). Applied simulation as analytical framework of managerial decision-making. Biznes Inform, 6, 69-76 [in Ukrainian].
16. Nazarov, A.A. (2017). Characteristics of modern tools for simulation in the study of mechanisms of socio-economic processes and systems. Imitatsionnoye modelirovaniye. Teoriya i praktika. Retrieved from: http://simulation.su/static/ru-articles-2017.html [in Russian].
17. Rud, N.O. (2015). Simulation modeling. Theory and practice: materials of conf. IMMOD-2015. Retrieved from: http://simulation.su/static/ru-articles-2015.html [in Russian].

Посилання на статтю:
Sokolovska Z. M. Cash flow modeling of industrial enterprises in conditions of uncertainty in the market [Електронний ресурс] / Z. M. Sokolovska // Економіка: реалії часу. Науковий журнал. – 2018. – № 1 (35). – С. 5-12. – Режим доступу до журн.: https://economics.opu.ua/files/archive/2018/No1/5.pdf. DOI: 10.5281/zenodo.1302958.

Reference a Journal Article:
Sokolovska Z. M. Cash flow modeling of industrial enterprises in conditions of uncertainty in the market [Electronic resource] / Z. M. Sokolovska // Economics: time realities. Scientific journal. – 2018. – № 1 (35). – P. 5-12. – Retrieved from https://economics.opu.ua/files/archive/2018/No1/5.pdf. DOI: 10.5281/zenodo.1302958.