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АГЕНТ-ОРИЕНТИРОВАННОЕ МОДЕЛИРОВАНИЕ КАК КОГНИТИВНО-ИНФОРМАЦИОННАЯ ТЕХНОЛОГИЯ СРАВНИТЕЛЬНОГО АНАЛИЗА ПАРТНЕРСКОЙ И ТРАДИЦИОННОЙ ФИНАНСОВЫХ СИСТЕМ*

Аннотация

Среди когнитивно-информационных технологий изучения общественных процессов в последнее время развивается агент-ориентированное моделирование, являющее современным видом имитационного моделирования. Общественный процесс представляется в виде взаимодействующих между собой агентов, соответствующих реальным агентам. В статье эта технология применяется и процессу сравнительного анализа двух моделей финансовых систем: традиционной и исламской модели, в которой запрещен процент. В традиционной модели агент-банк предоставляет кредиты, беря в залог имущество клиента, в исламской модели агент-банк инвестирует деньги в проект клиента, становясь его партнером (по этой причине исламский банкинг также называют партнерским банкингом). Доходы от совместных инвестиций агент-банк и агент-клиент делят в определенной пропорции. В обоих моделях изначально одинаковое количество клиентов, в ходе эмуляции меняются доходы банков и количество клиентов. В данном докладе представлены результаты наиболее простой схемы, существующей в исламских (партнерских) финансах. Реализация модели проведена студентами в рамках дипломного проектирования на агент-ориентированном языке NetLogo. Развитие этого подхода позволит сделать обобщающие выводы о сравнительных преимуществах традиционной и партнерской модели финансов.

Ключевые слова

Когнитивно-информационная технология, агент-ориентированное моделирование, имитационное моделирование, исламская финансовая модель, партнерская финансовая модель.

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AGENT-ORIENTED SIMULATION AS COGNITIVE-INFORMATIONAL TECHNOLOGY OF COMPARATIVE ANALYSIS OF PARTNERSHIP AND TRADITIONAL FINANCIAL SYSTEMS

Abstract

Among cognitive-information technologies for the study of social processes, agent-oriented modeling has recently developed, which is a modern type of simulation. The social process is represented in the form of interacting agents, which correspond to real agents. In the article this technology is applied to the process of comparative analysis of two models of financial systems: the traditional one and the Islamic model, in which the interest rate is banned. In the traditional model the agent-bank provides loans, pledging the client's property. In the Islamic model the agent-bank invests money in the client's project, becoming its partner (for this reason, Islamic banking is also called partner banking). Revenues from joint investments done by agent-bank and agent-client are divided in a certain proportion. In both models, initially there is the same number of customers, during the emulation the income of banks and the number of customers are changing. This report presents the results of the simplest scheme that exists in Islamic (partner) finance. The implementation of the model was carried out by students in the framework of the thesis project using agent-oriented language NetLogo. The

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development of this approach will make general conclusions about the comparative advantages of the traditional and partner finance model.

Keywords

Cognitive-information technology, agent-oriented modeling, simulation modeling, Islamic financial model, partner financial model.

Introduction

In the modern conditions of the world entering the fourth technological revolution [1], the education system faces new challenges related to a constant increase in the flow of information, the need to search for the necessary information, to process big data and assimilate information to the level of its effective use in work and life. Among these challenges, it is necessary to single out the massivization of education, expressed in the fact that in developed countries the availability of higher education, not just secondary education, becomes the norm for the entire population of the country [2]. And in Russia, the vast majority of graduates of secondary schools go to universities, and those who enter secondary special educational institutions (colleges), finally also in their considerable part receive higher education. Education becomes a public good on a global scale [3], which requires new forms of education, the mastery of knowledge.

A special place in these forms of education is provided by cognitive technologies that enable them to learn in the game form the situations arising in business processes and in making financial decisions [4]. The greatest difficulty is the understanding of completely new processes, new financial and economic technologies and processes. So, in recent decades the partnership model of finance is developing actively, differing from the traditional, existing throughout the history of humanity, a number of principled positions.

The partner model is also known as the Islamic model of finance, since it originated in Islamic countries and is based on important postulates of the Islamic religion, including prohibition of interest in financial transactions, prohibition of risky financial transactions, as well as prohibition of purchase and sale of non-existent tangible assets, i.e. prohibition of forward contracts. On the one hand, these restrictions exclude the emergence of financial bubbles and, accordingly, financial crises. On the other hand, they reduce the maneuverability of financial flows, and may not be as effective in this respect as traditional financial institutions.

It is completely unclear whether the Islamic financial model can provide faster growth of the economy, in comparison with the traditional one. Islamic banks, as we know them today, appeared in the Middle East in the 1970s, during petrodollars pouring into these countries. Oil magnates of the Gulf countries did not want to use Western banks, because they are based on the collection of interest (contrary to the Sharia). Evidently, the rapid growth of Islamic banking in the world, its penetration and development in Europe (the so-called Islamic windows in conventional banks), which has been observed for almost half a century, is determined by the growing flow of petrodollars to these countries with a predominantly Muslim population, and also by the time that the Islamic banking began to attract Muslim funds for religious reasons.

But the question arises: does Islamic banking have some advantages in comparison with the traditional ones in terms of creating more favorable conditions for economic growth? For example, the economy of one of the two abstract countries will develop faster if one is based only on Islamic banking, and the other only on the traditional one, while in all other respects these two countries are absolutely equal: equal natural and climatic conditions, the presence of natural resources, the same institutions (except those that regulate the banking sector)? Effective study of this task, the search for answers to the questions posed is possible with the use of advanced cognitive-information technologies, to which we can safely refer agent-based modeling.

Methodology

Agent-based modeling, also called multi-agent modeling, opens great opportunities in the development of cognitive-information research of social processes, which are difficult to understand due to they are affected by millions of factors. Real political processes, in which there are myriad factors associated with complex relations, often of a probabilistic nature, are attempted by political scientists, economists, and sociologists. To create their own theories of various social processes and phenomena, they create mental models, in which, of course, they simplify reality. This simplification comes to verbal descriptive models, an example of one of them is K. Marx's class theory, in which, as we know, the development of society is explained through the interaction of only a few actors – the social classes of workers, capitalists, feudal lords, peasants. Another well-known sociologist, Epstein Joshua, suggested that the society as a set of individual agents, create models of an artificial society, which would allow making more informed judgments [5].

The essence of agent-based modeling is the representation of all members of society in the form of virtual agents in a computer model. Each agent has its own algorithm of action, has, as in life, free will within its own rules. In this case, banks and their clients act as agents. Within the framework of the above-mentioned scientific problem, we solve a specific problem: a comparative analysis of the Islamic financial model and the traditional financial

model in the effectiveness of their fulfillment of the classical functions of the state financial system: the redistribution of financial resources between sectors of the economy, between the state and the economy, between population and economy, between different strata of the population, between regions and territories. Islamic financial model is also often called an affiliate (partner) financial model, because transfer of money to the conditional borrower is carried out on the basis of the bank's partner participation in the client's business project.

The criterion of effectiveness in this comparative analysis is which of the models provides the state with the highest rates of economic growth, all other things being equal, when all other parameters of the state are the same (natural and climatic conditions, presence / absence of natural resources, institutions (except for the regulating financial system, which are obviously different)).

Model

Here we describe an agent-oriented model implemented under our guidance in the language of NetLogo [7] within the framework of development this approach [8] and studies of the Islamic financial model, which we conducted [9]. There are 3 types of agents in the model: classical (traditional) bank, Islamic bank and clients. Each bank has 100 potential customers. Customers offer the same projects, they differ only in knowledge in doing business. The more a business has knowledge, the higher the probability of success of an investment project.

The activities of the traditional bank are described as follows: the bank issues a loan to the customer 100,000 rubles at 20% per annum, a pledge is stipulated. The client invests the received loan in the investment project. If the project turned out to be profitable (profit more than 120,000 rubles), the client returns a loan to the bank in the amount of 120,000 rubles; in the case of a non-profitable project (profit less than 120000 rubles), the bank takes the pledge from the client. If in the traditional bank the profit is less than 120,000, then the client dies (he will not be able to re-take the loan).

A traditional bank is guaranteed to receive its profits at the expense of a pledge, even if the project is unprofitable. The need to provide pledge limits the number of financed investment projects (Fig. 1). If the bank does not have enough money for all projects, it starts giving loans primarily to those customers who will offer a greater deposit.

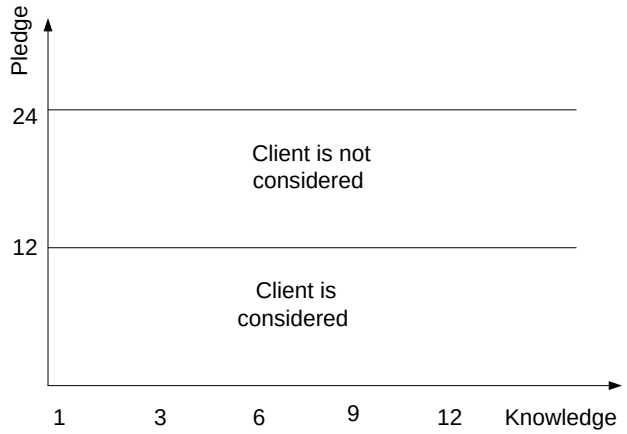

Fig.1. Dependence of financed investment projects on the size of pledge and client's knowledge of business in the traditional financial model

The activity of an Islamic bank is described as follows: The client and the bank invest their funds in a common investment project: the bank invests money (100,000 rubles) and expert knowledge, and the client invests expert knowledge of business. The parties of the deal agree in advance on the share of profits (60% to the bank, 40% to the client). If the profit is more than 100,000 rubles – the project is profitable, and if the profit is less than 100,000 rubles – the project is not profitable. The profit is divided between the parties of the deal (and partners of the project). The loss if it happens falls entirely on the bank. If the profit from the project is less than 100,000, the loss lays in the bank (the client also dies). If the bank does not have enough money for all projects, it finances primarily the investment projects of those clients who have the greatest knowledge and further in descending order of knowledge (Fig. 2).

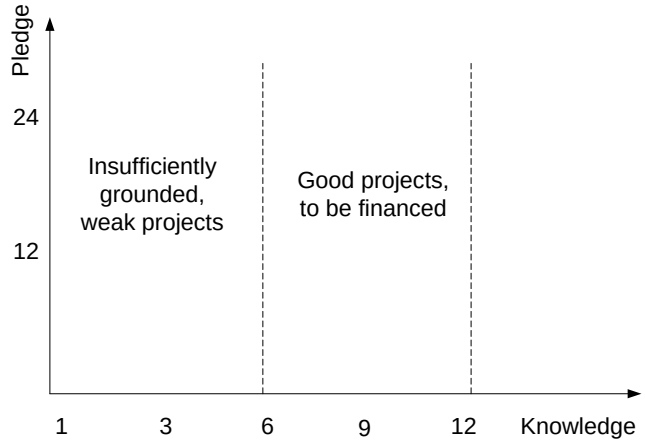

Fig.2. Dependence of financed investment projects on the size of pledge and client's knowledge of business in the partner (Islamic) financial mode

The probability of successful implementation of the project (the fact that the project will be profitable) is a function of the client's knowledge: the more knowledge, the higher the probability that the client is realizing its business project successfully. In the Islamic model, the probability value is higher than in the traditional financial model with each client's knowledge, because Islamic Bank, unlike the traditional one, invests in the project its expertise (knowledge) (Fig.3).

The experimenter can establish external conditions for banks and customers: initial capital of banks (start_bank) and costs (bank_cost); the likelihood that the project will be successful on the basis of the expertise of the Islamic Bank (expert_knowledge) and minimal knowledge of clients (min_knowledge).

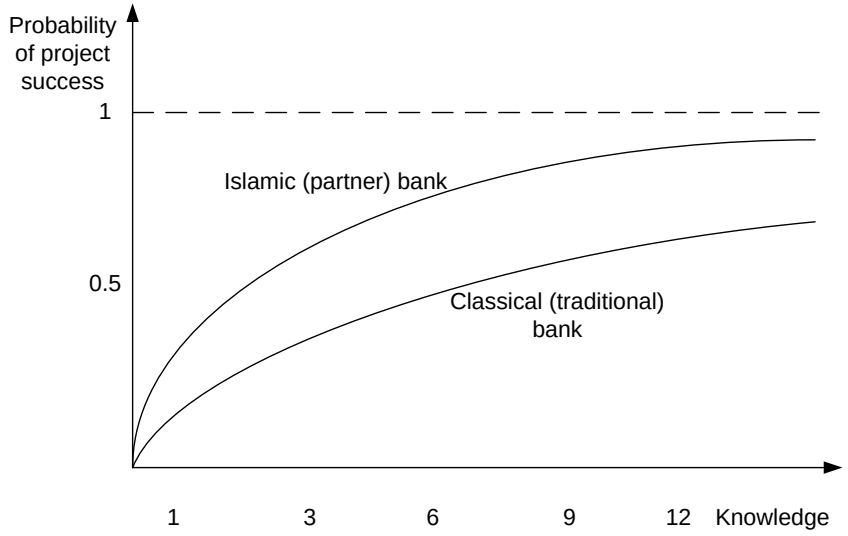

Fig.3. Dependence of the probability of successful implementation of the investment project on the amount of knowledge that the client has got

Computer simulations

Further, let us consider the experiments performed in [7] basing on [9].

In the first experiment, the following external values were initially set: the starting capital of the bank is 3,000,000 rubles, this amount is enough to issue a loan to only thirty customers. The probability that the project will be successful is 0.3. Minimal knowledge of customers about business is three.

Each bank will work with the thirty clients that it considers to be the best. A traditional bank will pay attention to those who offer the largest pledge, and Islamic one will work with those clients who have the greatest knowledge about business, investment projects and their implementation. In Fig. 4, red figures are those to whom banks have given out money, gray ones – those who did not have enough money.

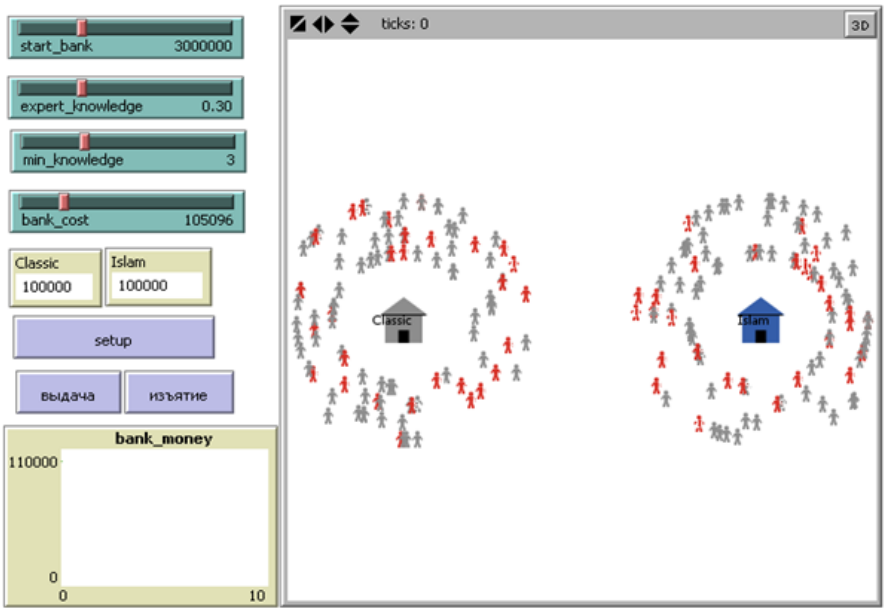

Fig.4. The interface of the model and the initial values of the first experiment

After a while, clients of banks should return money, in Fig.5 we see this moment. The people marked in green successfully implemented their projects and returned money (debts in case of the traditional model) to the bank, and those who could not pay off "died".

The graph at the bottom left of the interface in Fig. 5 shows the amount of money in the banks. Blue line shows the amount of money in a classic bank, green line shows the amount of money in an Islamic bank. There the abscissa is the time. On the left side there are the tablets Classic and Islam. They show the size of the capital at the moment, respectively, in a classic and Islamic bank.

After a few periods, the classical bank has few clients, most of them failed to successfully implement their projects. But the capital of a classic bank increases on the expense the pledges of those clients who "died." In the end, the classic bank does not have clients, and its capital decreases, as seen in the graph in Fig 6. The partner bank at this time continues to cooperate with almost the same number of clients as at the initial moment, and the bank's capital continues to increase.

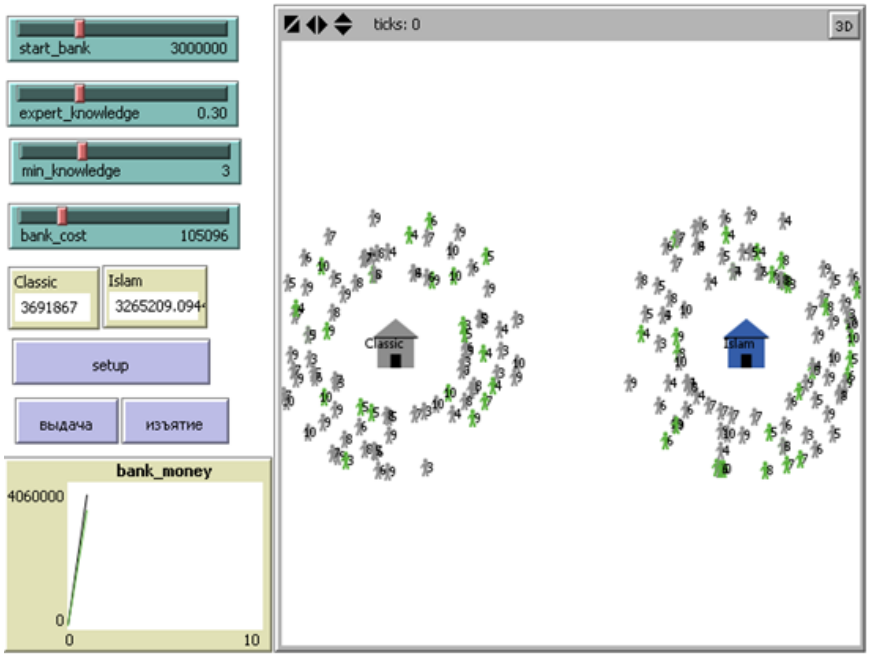

Fig.5. Getting the model started

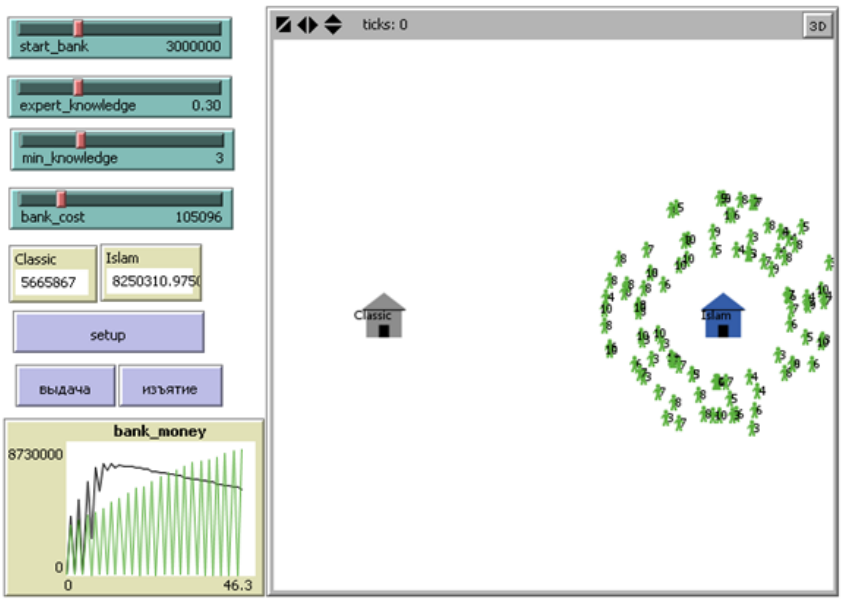

Fig.6. The stage of emulation, when the capital of a traditional bank begins to decrease

The second emulation experiment. Here, banks have a relatively large starting capital, equal to 7000000 rubles, 70 customers in each bank can expect to receive money for their investment projects. In this case, the traditional bank first increases the capital, and later it decreases. This situation can be explained by the fact that banks at the very beginning issued a large number of loans. Then, in a classic bank that does not take into account knowledge of clients on business, many clients have not been able to profit from their projects. They had to close their debts with the help of pledges. Due to these pledges, a sharp increase in the capital of the classical bank occurred. In a short time, clients disappeared, and capital began to decline. At this time, the Islamic Bank cooperates with many clients, the amount of its money does not decrease, but it grows slowly.

The third simulation experiment. In this case, the starting capital of banks and the minimum knowledge of business are the same as in the first case, and the probability that the project will be successful is 0.7. In this case, the Islamic Bank is rapidly and steadily developing, and the classic bank does not have clients and it has less money with each moment of time.

We can explain this phenomenon as the following: we asked a great probability, and the probability of the success of the project, as already mentioned above, depends on the knowledge of the clients. The more knowledge, the higher the probability. The Islamic Bank chose the clients who had the highest knowledge in granting loans, and added their own to their knowledge and experience. The traditional bank also cooperates with those clients who have little knowledge, and accordingly, the probability of success will be small.

The fourth emulation experiment. Let us now consider the case when the minimum knowledge of customers is six. If the knowledge of all customers is large, in a traditional bank, capital growth lasts longer than in the other cases considered (Fig. 7). That is, customers "live" longer and cooperate with the bank. But after a while they still all "die", and in an Islamic bank almost the same number of clients as at the initial moment, according to the schedule, there is a steady growth of capital. This situation is due to the fact that the Islamic Bank will invest its knowledge in the investment project, its goal is the success of the project. A traditional bank is more interested in making a profit: it does not matter from the success of the project or from the collateral that the client will provide in case of a non-profitable project.

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All possible combinations of conditions can also be considered. In the fifth experiment, a large start-up capital and a high probability of project success were given, and the minimum knowledge of clients is three. In this case, the classic bank loses all its clients in a very short time, and the Islamic bank cooperates with almost all its clients and stably develops.

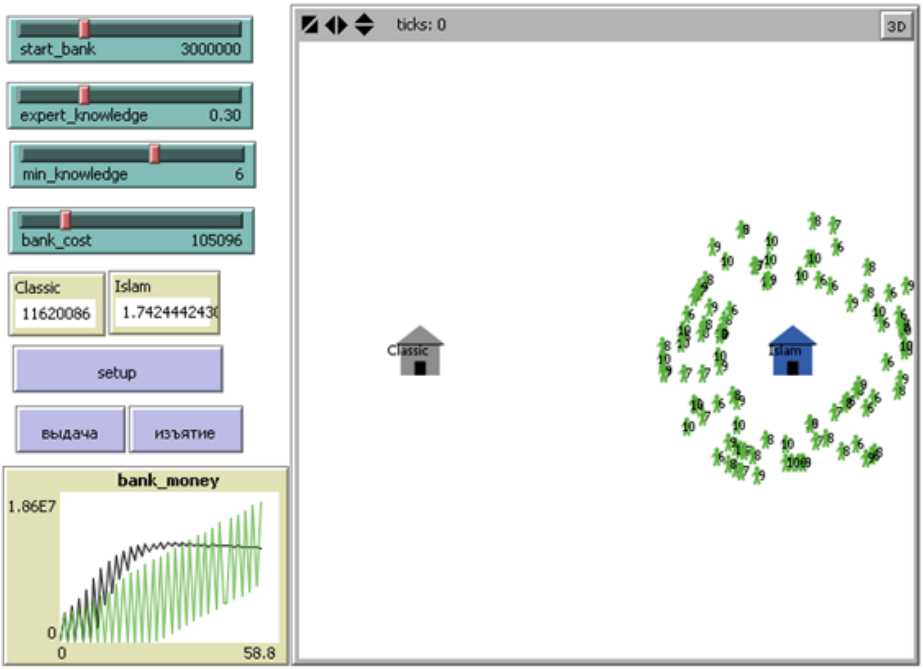

Fig. 7. The fourth emulation experiment with a great value of knowledge of customers

In the sixth experiment, a large starting capital of banks and minimal knowledge of clients equal to six, the following picture is observed: due to the fact that the knowledge of clients is not less than six, the classic bank has been developing for a long time, but after some time all the clients "die". The Islamic bank also has a constant growth of capital.

In the seventh experiment, the starting capital of banks is small, the probability of success of the project is quite high, the minimum knowledge is six. Initially, banks had a small amount of money. The classic bank gave its money on credit to clients with a large pledge, and could not achieve its own development in this way. The Islamic Bank, at the expense of high probability and large clients' knowledge, is developing rapidly.

Conclusions

We examined various combinations of the model. In all cases the following situation is observed: with equal initial conditions, the traditional bank at the beginning increases its capital at the expense of its clients' pledges, but after a longer time it remains without customers, and the amount of its money decreases. And the Islamic bank has a steady growth of capital, there are a lot of clients even when the classical bank has no one to cooperate with.

Hence, we can conclude that Islamic banks are less prone to ruin, to crises. They have their own rules in the economy, in banking, related to lesser risks. These factors outweigh the shortcomings of the partner financial model over the traditional ones, which consist in a lower rate of flow of financial resources from one market to another.

The use of the agent-oriented model in the study of these financial models shows its effectiveness as a cognitive-information technology in education and research.

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