ORIGINAL PAPER

Credit Rationing Equilibrium Achievement in the Conditions of Digitalization

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ABSTRACT

The author clarified the degree of achievement of the credit market equilibrium in the conditions of information asymmetry and active digitalization of processes in activity of credit market participants. The **subject** of research is the economic and technological conditions for achieving credit rationing equilibrium. The **purpose** of the research is to highlight the nature of the impact of digitalization on the degree of achieving equilibrium in the credit market in the context of digitalization. The author focuses on the new conditions of functioning of the credit market, when the current digitalization allows to significantly complement the credit profile of borrowers, and new participants appear in the credit market. The **objective** of research is assessment of compliance of theoretical postulates on achieving the credit rationing equilibrium in the context of digitalization of processes associated with the lending. The authors' **hypothesis** is that the credit market has the potential to increase the return on a loan per currency unit of borrowers' loans, and the current estimates of the of defaults borrowers' probability, interest rates are "biased". As the main methods, the author used systematic and logical methods, which made it possible to consider the credit market equilibrium in terms of the economic relationships between its participants and the achieved economic indicators. As a **result** of the analysis of theoretical concept of credit rationing equilibrium, taking into account the identified qualitative changes, that take place in the credit market in the context of digitalization. The author **concludes** that is the potential increase the rate of return on credit operations. Extending the borrower credit data with alternative, non-credit sources, as expected, allows to get more accurate creditworthiness assessment. The **results** of the research to some extent serve as a rationale for possible decisions of central banks to expand the traditional sources of borrowers' credit histories, reconfigure the existing information exchange architecture in the credit market.

Keywords: information asymmetry; credit market; digitalization of the economy; credit rationing equilibrium; credit supply and demand; moral hazard; adverse selection risk; credit history bureaus (CHBs); enriched data; credit histories

INTRODUCTION

Development of modern information technologies and their active implementation in the credit market provides new insights into the existing problem of information asymmetry. If before professional creditors in the person of the same credit and microfinance organizations were guided by credit histories of borrowers when assessing credit risks, then in the conditions of active digitalization, penetrating into all spheres of life, both the part of information exchange participants and the types of analysis are increasing, which, in fact, can "enrich", qualitatively complement available credit information. In these conditions, the national monetary regulators responsible for ensuring financial stability in the financial market were actively involved in the work on the effects of digitalization.[1]

Discussion of information asymmetry in the credit market has been going on for a long time. Interest in credit rationing was driven by the need for central banks to take into account autonomous credit restrictions (credit rationing) by banks in implementing the transmission mechanism of monetary policy [1]. In addition, a number of papers studied the issues of credit rationing in terms of achieving macroeconomic equilibrium under conditions of rational expectations [2, 3], the need for the development of infrastructure institutions of the credit market, which carry out information exchange of credit information [4], regulation of interest rates and risk neutrality of borrowers [5–7].

Beginning in the 80s of the 20th centuries in the scientific works of B. Bernanke and M. Gertler [8], A. Blinder and J. Stiglitz [9], B. Greenwald and J. Stiglitz [10] highlight issues of endogenous money supply, assess the role of credit in the business cycle and features of the transmission mechanism of monetary policy. It is questioned in imperfect information theory, that interest rates emerging in the capital market fully reflect the impact of financial variables on aggregate demand.

The problem of information asymmetry is an ongoing problem for creditors. Crediting is characterized by information asymmetry *"ex ante"*, since creditors need to determine and assess the risk profile of potential borrowers in advance before approving a loan, and *"ex post"*, as they need to monitor the solvency (state) of borrowers once the loan is granted [11].

There are two types of risks associated with incomplete/inaccurate information in the lending process. First of all, it's a *risk of moral hazard*[2] and *risk of adverse selection*.[3] In the aspect of the credit process, these risks can be formed most as at the initial stage of the credit placement, when the loaned value is granted for temporary use, and at the subsequent stage of the borrower's use of the loaned value. Depending on what "volume" credit information has creditor in relation to the borrower, how adequate are the econometric credit scoring models used, accurate in forecasting the borrower's behavior in relation to credit debt servicing, as well as what costs payable for *ex-post monitoring* the status of clients, will be determined the final amount of the credit interest rate. In an information asymmetry where credit risks to different borrowers can be either overestimated or underestimated, interest rates become *"biased"*. Part of fair borrowers "unfairly" faces higher rates, and unfair borrowers receive the credit funds they need.

It is known that reduction of negative effects from asymmetry of information is achieved through the development of financial intermediation. The classic institution of financial intermediation involved in the distribution of the total risk

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[1] On the development strategy of the credit histories bureau' services market. 2017. URL: https://www.cbr.ru/Content/Document/File/50684/Consultation_Paper_171024.pdf (accessed on 08.04.2022).

[2] Moral hazard — unfair execution risk by the borrower of their obligation under the credit contract.

[3] Adverse selection risk — risk of the loan to the least reliable borrower.

premium is the banks themselves, which attract the free money and transform it into credit and investment. As noted in several research studies on the effects of exchange of information in the credit market [12–16], the asymmetry of information associated with the risk of adverse selection and risk of moral hazard can be significantly reduced by establishing a system of exchange of credit information between creditors. And scientists identify quite economic prerequisites for such an exchange. It is noted that even banks that have an information monopoly on their customers[4] and extract high *information rent*, may face the problem of *incentive effect* from borrowers to support business efficiency. Borrowers understand that the source of interest rate-based information rent is entrepreneurial and/or personal income. Accordingly, the higher the lending rate, the more of its income borrowers will give to owners of loan capital, thereby limiting the growth of their wealth. A modern view on this problem is presented in the work of the Central Bank of the Russian Federation [17].

Banks are therefore economically motivated to exchange credit information. In the process of such exchange of information rent, that generating income *(P)* is distributed among all creditors, motivating the latter to find and improve their competitive advantage. In the end, *all other things being equal*, the active exchange of credit information will help to reduce the unpredictable amount of risks and, consequently, will reduce the average interest rate in the credit system. In other words, more accurate assessment of the creditworthiness of customers, their possible defaults will allow more adequate adjustment of interest rates for the respective groups of borrowers.

Separately, we note that at present, questions remain open for discussion on how complete the information exchange between creditors in a market economic system should

be. It is quite possible that a "partial" rather than a full exchange of information can be economically more profitable for some creditors and borrowers, debt issuers and investors [13]. This is especially relevant for economic systems with a high concentration of bank capital. In our opinion, in this case it is the State that is able and should lay the foundations for the development of "rules", rules for information exchange, ensuring competitive access to critical information to a wide range of financial market participants, to be used in the decision-making process to extend credit.

The scientific works of J. Stiglitz and A. Weiss [18] show in a systematic way how the balance in the credit market can be formed under conditions of asymmetry of information (*credit rationing equilibrium*). According to scholars, the interest rate fluctuation is determined not only by the level of competition in the credit market, but also to some extent by the (not) uniformity distribution of information about borrowers among lenders themselves. It follows that, all other things being equal, the increase in profitability of credit operations is determined by changes in the quality of borrowers. As the interest rate on the credit grows, the share of "quality" borrowers who could service their credit debts in full and on time will gradually decrease. Conscientious borrowers faced with higher interest rates will refuse credit. They will be replaced by less reliable borrowers who allow delay payments on the part of existing debt and/or can use the loan funds not for designated purpose. Consequently, a further increase in interest rates will increase the number of high-risk borrowers (*adverse selection effect*).

The response of banks to the presence of asymmetry of information in the credit market is credit rationing. Moreover, credit rationing can be at least two types. Thus, the first type of rationing relates to the situation where, at a given interest rate, the lender limits the amount of the credit to the individual borrower. The second type of rationing occurs when

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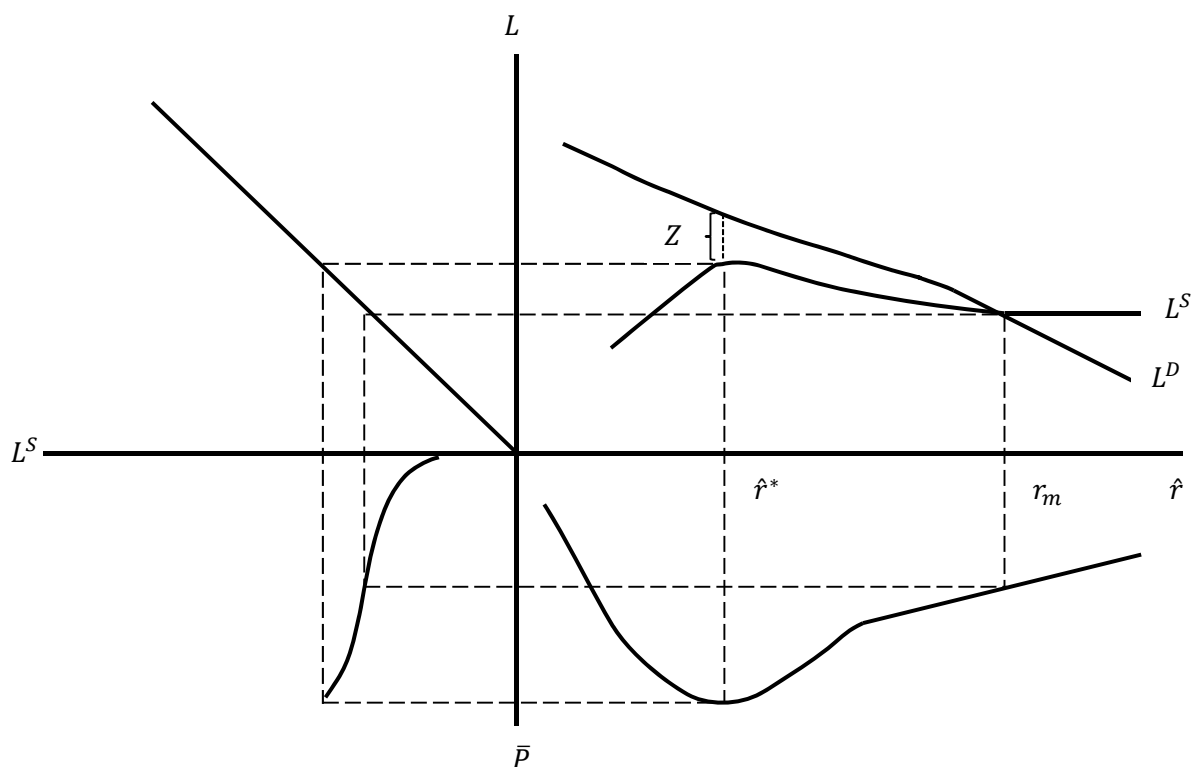
[4] If it is treated as the ultimate hypothetical version.

Fig. 1. The Market Equilibrium in the Credit Market with Information Asymmetry

Source: [18].

Note: L^S — supply of loan; L — loans (supply/demand); $\overline{P}$ — average expected return (credit body and interest) per currency of loan; $\hat{r}$ — loan interest rate; L^D — demand for loan; $\hat{r}^*$ — the optimal interest rate; r_m — the interest rate at which the demand for loan equals the supply for loan; Z — the excess (unsatisfied) demand for loan.

borrowers do not differ in the parameters assessed, but creditors do not satisfy all applications [19]. These measures of banks are very logical, as the interest rate and the volume of mortgaged property have a direct impact on the quality of the credit portfolio.

Credit rationing in the credit market may generate an excess (unsatisfied) demand for credit $\left(Z = L^S - L^D\right)$. Nevertheless, this credit market condition is described as the balance of credit rationing (*Fig. 1*).

Emphasize that currently there are different versions in the description of market equilibrium in the credit market under conditions of asymmetry of information. One of the first works can be considered by J. Stiglitz and A. Weiss [18], D. De Meza and D. Webb [20], W. English [21]. This study will be based on the basic model J. Stiglitz and A. Weiss and its analytical description presented in the paper D. De Meza and D. Webb. The feature of the basic model is

the consideration as borrowers of entrepreneurs who plan to take a credit to cover the deficiency amount *(B)* in the implementation of projects. The initial assumptions are that entrepreneurs and banks are risk-neutral and all business projects have the same return *(R)* and differ only in the level of risk. The risk of adverse selection and the *main source of information asymmetry* is that banks do not have complete information about the success of projects, while entrepreneurs are more aware. Each entrepreneur applies to the bank for a credit with one project (i). The probability of project success is equal (p_i), and each entrepreneurial project provides income (R^s). In this case, some projects will fail with probability $(1 - p_i)$ and will bring the same low income in size (R^f).

The expected income of the entrepreneur is determined by the expression:

$$E\left(R_i\right) = p_i \cdot R^s + \left(1 - p_i\right) \cdot R^f, \qquad (1)$$

and expected profit of the entrepreneur, taking into account the costs of repayment of principal and interest payments:

$$E(\pi_i) = E(R_i) - (1+r) \cdot B, \qquad (2)$$

where r — credit interest rate, uniform for all borrowers (entrepreneurs).

If the project fails, the profit of the entrepreneur is zero:

$$R^f - (1+r) \cdot B = 0, \qquad (3)$$

i.e. the income from the project is at best sufficient only to cover the cost of the base debt and interest.

Income from business projects is a source for repayment of loaned value to the bank and payment of interest. In other words, the bank receives a portion of the business income received, which covers the amount of credit provided (B) and provides interest rate $(r \cdot B)$, i.e. interest income. In an analytical form, the income that entrepreneurs give to banks is: $(1+r)B$. The probability of an entrepreneur applying for a loan to finance the project (i) is ρ_i.

When describing the expected income that entrepreneurs have to give to the bank, it should be noted that unsuccessful projects will lead to problematic debts with creditors, i.e. banks will not receive the planned increase in loan capital:

$$R^f < (1+r) \cdot B. \qquad (4)$$

In the case of limiting, when projects bring no business income at all, $R^f = 0$.

Hence, the expected total repayments (loan body and interest) that the bank will receive from entrepreneurs, including taking into account the implementation of failed projects, is described by the function:

$$E(R_b) = (1+r) B p_i \int_0^\rho g(\rho_i) d\rho_i + \\ + R^f (1-p_i) \int_0^\rho g(\rho_i) d\rho_i, \qquad (5)$$

where $g(\rho_i)$ — density functionя (ρ_i) on entrepreneurs; ρ_i — the probability of entrepreneurs turning for a loan, which takes many possible values on a segment $[0, \rho]$ and is monotonously decreasing function at interest rate (r):

$$\rho = e^{(-a_1 r)}. \qquad (6)$$

In the case of limiting, if the interest rate *(r)* was zero, then the probability of customers turning to the bank would be 100%.

The first term in formula (5) reflects a certain set of entrepreneurs who applied to the bank for a credit with probability (ρ_i), with successful projects, which provides a positive increase in the bank's loan capital. The second component of formula (5) shows that credit is sought by those entrepreneurs who are more aware that their projects will fail.

The ratio of aggregate repayments to loans granted $(\overline{P}_b)$ describes the degree of loan capital increase:

$$\overline{P}_b = \frac{E(R_b)}{B}. \qquad (7)$$

According to the basic model, a single bank can achieve the highest average expected total repayments of its credit debt (curve in the lower right quadrant *Fig. 1* at the optimal rate $(\hat{r}^*)$ and a certain ratio of the combination of conditionally "good" and "bad" borrowers). In other words, the bank calibrates the interest rate *(r)* so as to maximize the total cash flow in the form of loan payments, i.e. equality is ensured $dE(R_b)/dr = 0$:

$$\frac{dE(R_b)}{dr} = B \underbrace{\int_0^\rho p_i g(\rho_i) d\rho_i}_{\substack{payments\ on \\ successful \\ projects}} + \\ + \underbrace{\left(\frac{d\rho}{dr}\right)\left[(1+r) B p g(\rho) + R^f (1-p) g(\rho)\right]}_{\substack{reduced\ potential\ repayment \\ of\ credits\ (negative\ component)}}. \qquad (8)$$

As the interest rate rises, the right part of the term (8) will also increase: a set of clients with successful projects that could provide the bank with total value $(1+r)B$, will decline, good borrowers will be replaced by unfair. This allows banks to implement credit rationing.

If any creditor considers it necessary to raise the rate, for example, $r_2 > \hat{r}^*$, to attract borrowers serviced by other banks, it will lead, first of all, to the inflow of high-risk borrowers to it and, as a result, to reduce the aggregate credit payments.

At the same time, there is a certain rate in the credit market (r_m), at which the demand for credit can be fully satisfied $(Z = 0)$. However, this rate is not equilibrium under conditions of information asymmetry in the credit market. By offering a lower interest rate $(\hat{r}^*)$ than the rate (r_m), the creditor will attract more borrowers and provide a higher total debts ratio per currency of loaned funds $(\overline{P})$.

In our opinion, the above conclusions are also valid in the case of the analysis of borrowers — individuals. Despite credit market and institutions such as credit bureaus that reduce information asymmetry, adverse selection risks remain in modern infrastructure. Among the borrowers will always be citizens who have no credit history or do not have a long-term credit relationship with banks, on the basis of which it is possible to form the most accurate estimates on their creditworthiness. The distribution of such borrowers into credit rating categories does not yet guarantee the fact that all loan applications within one subgroup will be satisfied or that the interest rate will be strictly dependent on a subgroup of borrowers. It is the implementation of credit rationing that allows banks to form a loan portfolio that combines various groups of borrowers accessing credit on various terms.

RESULTS

In order to develop scientific research on the problems of asymmetry of information, we suggest taking into account *those qualitative changes that occur in the credit market in the context of digitalization, among which we can highlight*:

• arrival of analytical companies providing collection and processing of large amounts of information calculated credit ratings for users of credit histories (creditors);

• expansion of the functionality of existing infrastructure credit market institutions, including credit history bureaus;

• emergence of new participants' credit market (for example, *BigTech-* companies), offering their own loan programs;

• development of models and online information platforms for providing credit that exclude traditional banks in a certain part (P2P, P2B-lending);

• development of information exchange channels among users of credit information, including blockchain technologies.

Fig. 2 schematically presents new technologies, which are gradually introduced into business processes of formation of credit reports.

With digitalization and the accumulation of large amounts of household data, it is possible to supplement traditional (credit) information with alternative non-credit data (municipal services, telecommunications operators, payment platforms, etc.), *Fig. 3*.

In this aspect, the Central Bank of the Russian Federation analyses the legal and economic basis for "enriched data"[5] of credit histories with alternative data. In 2017, the Central Bank of the Russian Federation initiated a discussion on the possible addition of suppliers of credit histories (banks, microfinance organizations) data sources such as the Pension Fund of the Russian Federation (PFR); the Federal Tax Service (FTS); the Federal Bailiff Service (FBS); the Federal Service for State Registration, Cadaster and

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[5] Data enrichment is a well-established term that describes qualitative addition of traditional credit information to other, non-credit information, which allows to increase the adequacy in the formation of assessment of creditworthiness of borrowers. This term is used by the Bank of Russia.
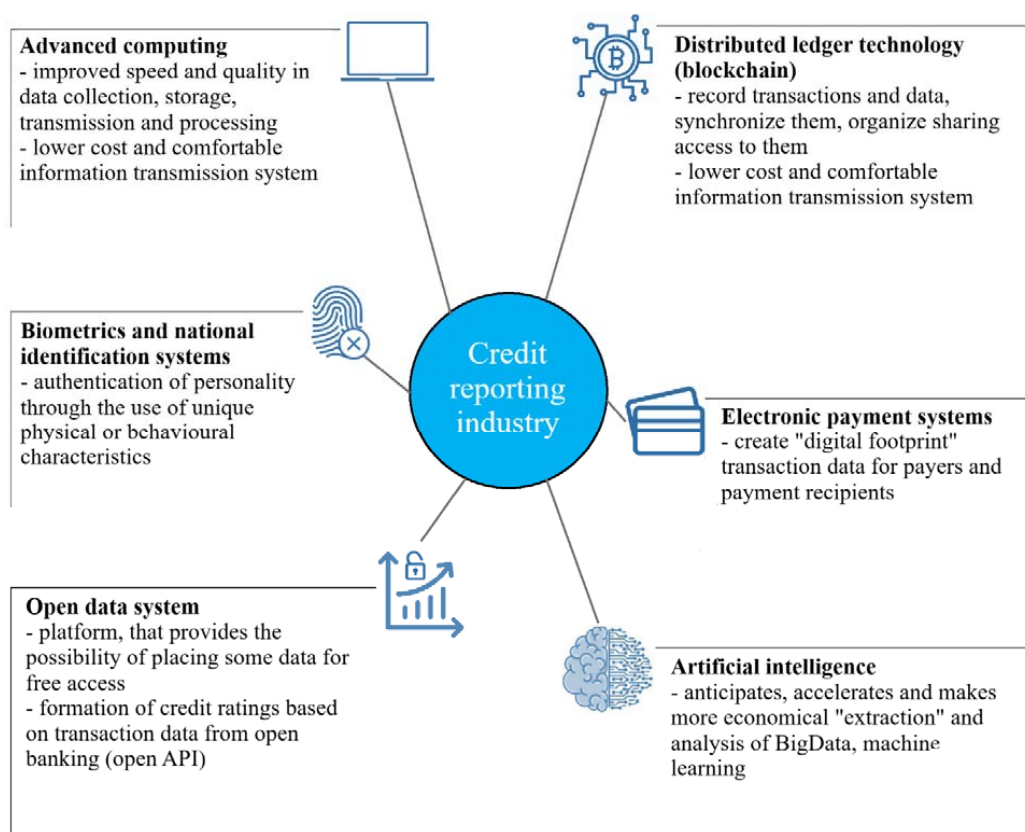
Fig. 2. **New Technologies Used in the Credit Reporting Industry**

Source: Compiled by author based on World Bank materials. URL: https://documents1.worldbank.org/curated/en/587611557814694439/pdf/Disruptive-Technologies-in-the-Credit-Information-Sharing-Industry-Developments-and-Implications.pdf (accessed on 08.05.2022).
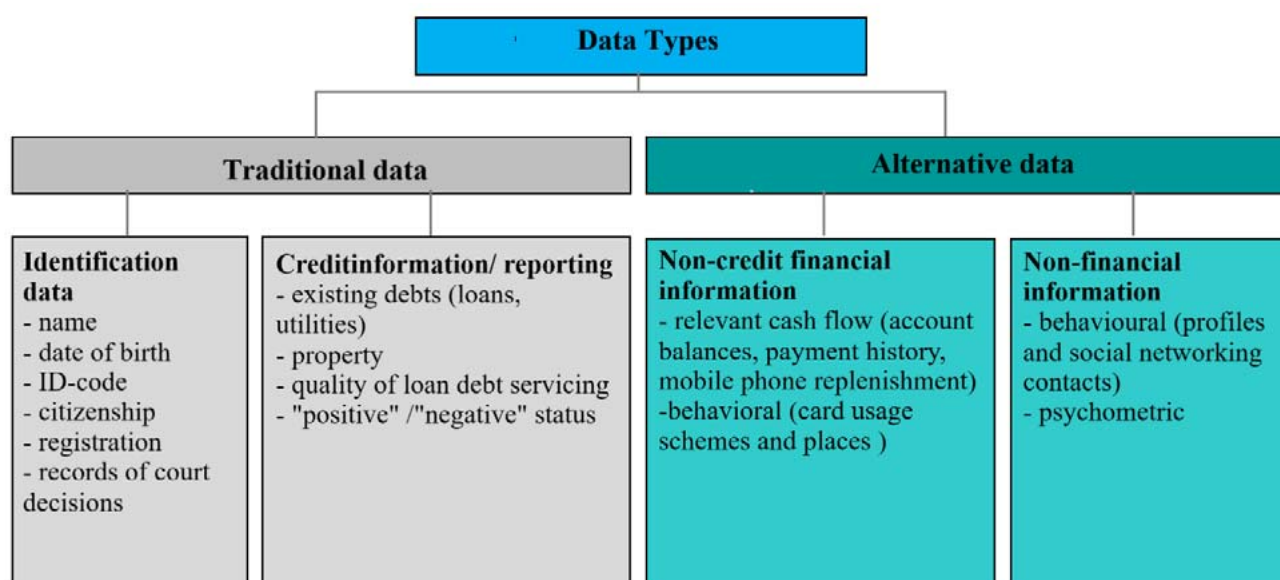

Fig. 3. **Types of Data for Current and Perspective Credit Reports**

Source: Compiled by author based on World Bank materials. URL: https://documents1.worldbank.org/curated/en/587611557814694439/pdf/Disruptive-Technologies-in-the-Credit-Information-Sharing-Industry-Developments-and-Implications.pdf (accessed on 08.05.2022).

Cartography (Rosreestr); the State Inspection for the Safety of Road Traffic (SISRT or GIBDD in Russian); the Federal Service for Supervision of Communications, Information Technology and Mass Communications (Roskomnadzor) [1, 23]. It is suggested that a broader range of borrower information may even lead to a reassessment of the importance of collateral as an indicator of creditworthiness [24].

Implementation of the Central Bank of the Russian Federation's intentions on "enriched data" of credit histories implies further development of the system of infrastructure institutions of the credit market: credit history bureaus (SHBs), rating agencies, analytics companies that aggregate *Big Data* and use *machine learning* technologies to calculate credit ratings. In the foreign scientific literature, the same institute SHBs is often referred to as an information broker [14], which provides accumulated information on borrowers to users of credit information. In this way, SHBs can reduce creditors' costs of finding the necessary information [25] and provide more equitable access to it.

In our opinion, possible organizational and managerial decisions at the state level on the complex development of the system of credit infrastructure institutions, supporting the development of new channels of organizational relations between users and aggregators of credit information (professional creditors, SHBs, analytical companies), application of modern technologies of *Big Data* collection and analysis, *machine learning*, expansion of traditional sources of credit information alternative (non-credit) makes a qualitative contribution to solving the problem of asymmetry of information in the condition of digitalization.

In terms of the credit market, the expected economic effect of the implementation of organizational and managerial decisions is expected to be the achievement in addition of potential aggregate payments per unit of loaned funds $\left(\bar{P} \right)$. Banks will be able to more accurately assign borrowers to appropriate credit rating subgroups and assess their creditworthiness. At the same time, it is expected to increase the availability of credit to potential borrowers — individuals by analyzing alternative (non-credit) data. This, in turn, will allow for a greater degree to satisfy (latent) demand for credit from customers without credit history and/or demotivated due to determining their high interest rates.

Theoretically, we consider that the definition of market equilibrium in a credit market with information asymmetry, as illustrated above (*Fig. 1*), is, all other things being equal, a limit state: Interest rates are "biased" relative to the optimal value $(\hat{r}^{*})$, and the average ratio of the expected aggregate repayments to the value of the credit provided has the potential to increase.

In practice, under conditions of digitalization, the infrastructure and information development of the credit market only contributes to the movement of the credit market to achieve equilibrium credit rationing. Let's analyze this remark in *Fig. 4* taking into account the assumptions made in the basic model J. Stiglitz and A. Weiss.

Under this assumption, the banking system operates close to the optimum average expected cumulative payments per currency of loaned funds $\left(\bar{P}^{*} \right)$. On the graph these states are marked in the lower right quadrant by points A and A^{*} respectively. At point A in the credit market, the weighted average interest rate on the credit is formed (r_1), which provides the average expected aggregate repayments per unit of loaned funds $\left(\bar{P}_{b1} \right)$ under the current level of information asymmetry. In other words, in the market there is "bias" in assessments of the success of projects / creditworthiness of borrowers, which can be expressed in theory in absolute deviation of rates from its optimal value (ϑ_r):

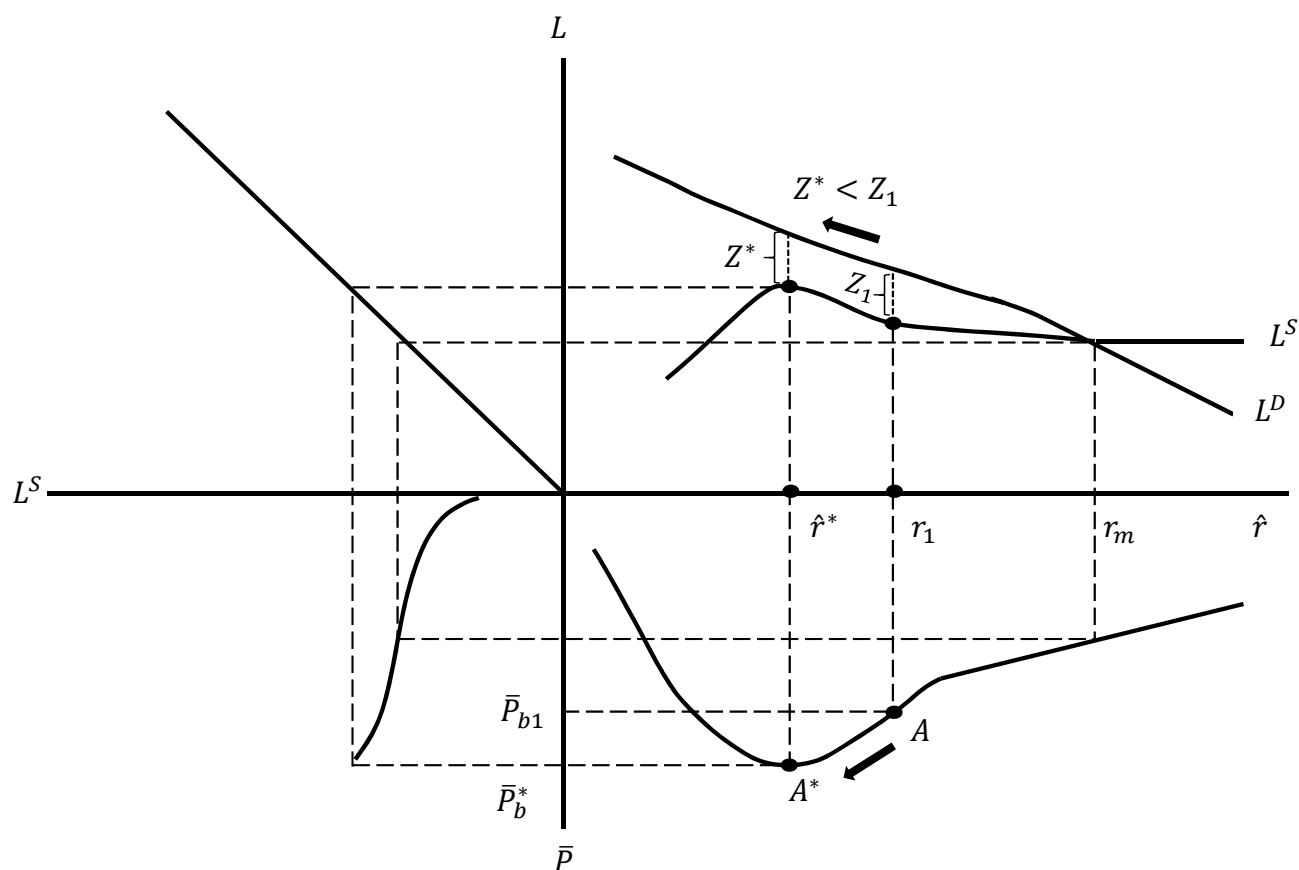$$\vartheta_r = r_1 - \hat{r}^{*}, \qquad (\vartheta_r > 0). \qquad (9)$$

Fig. 4. **Market Equilibrium Achievement in the Credit Market with Information Asymmetry in the Context of Digitalization**

Source: Compiled by author based on [18].

Note: $\overline{P}, \overline{P}_1, \overline{P}^*$ — average expected cumulative payments per currency of borrowed funds; $\hat{r}^*, r_1$ — loan interest rate; Z_1, Z^* — the different levels of excess of (unsatisfied) demand for loan.

Accordingly, the individual bank does not reach the potential accumulation of loan capital increase of $\left(\vartheta_{\overline{P}_b}\right)$:

$$\vartheta_{\overline{P}_b} = \overline{P}_{b1}^* - \overline{P}_b, \quad \left(\vartheta_{\overline{P}_b} > 0\right). \qquad (10)$$

Due to the fact that banks do not have reliable and complete information on the basis of which it would be possible to achieve the minimization of defaults or their local minimums as for existing borrowers, and for clients without credit history and/or demotivated previous experience of applying to the bank, credit demand remains unsatisfied at the rate of $\left(Z_1\right)$. However, as noted above, the construction of an effective system of exchange of credit information with the development of institutions of the credit market infrastructure, as well as the use of modern technologies of collection and processing of Big Data, is will expect to provide more precise adjustment of the interest rate, to increase the average level of return of the banking system on credit operations. Degree of "bias" of interest rates will decrease. All other things being equal, as a result of more efficient exchange of information, qualitative level of its processing, the interest rate on the credit $\left(r_1\right)$ will decrease and only in the limit can reach the amount $\left(\hat{r}^*\right)$, bringing the banking system to the optimal state $\left(\overline{P}^*\right)$. At the same time, we do not exclude that infrastructure and information changes will reduce the amount of unmet demand for credit: $Z^* < Z_1$.

Estimation the Increase in Loan Funds as a Result of a Loan

	Credit (traditional) sources					
Borrowers	Default prob. $(1-p_i)$	Credit rating category	Principal (B)	Rate of interest (r_1)	Total value $E(R_b)$	Exp. return on loan $(\bar{P}_b)$
Borrower 1	0	A	100	10	110	1.10
Borrower 2	0	A	100	10	110	1.10
Borrower 3	0.5	C	50	15	28.75	1.15
Totals			250	11.00*	248.75	0.995*
"Enriched" data about borrowers						
Borrower 1	0	A	100	10	110	1.10
Borrower 2	0.2	B	80	12	89.6	1.12
Borrower 3	0	A	100	10	110	1.10
Totals			280	10.57*	248.75	1.106*

Source: Compiled by the author.

Note: * The interest rate in the final line was calculated as a weighted average.

Alternative (non-credit) information in addition to information from credit reports is likely to lower price barriers for individuals who do not have a credit history and/or have a negative experience of applying to banking institutions for a credit. However, the opposite effect of reallocating existing borrowers to credit rating groups cannot be excluded. In addition, a certain share of the unsatisfied part of the demand for credit in today's digital economy may reasonably be satisfied through alternative banks "suppliers" of credit, for example, large technology companies (*BigTech*) with their own credit programs, as well as crowdlending online loan platforms.

Let us illustrate the above scientific findings with a small example. Suppose 3 borrowers apply to the bank for a credit of 100 currency units for a period of one year. Two of the borrowers have a credit history and the highest credit rating of 4 possible categories. The third borrower has no credit history, i.e. he is in some "gray" zone for the bank. Based on the hypothetical data presented in the *Table*, we will determine the increase in loan capital as a result of the provision of credit. In this case, consider two scenarios: a) the bank determines the amount and interest rate on the credit based only on credit (traditional) information, aggregated by CHBs in the Central Catalogue of Credit Histories; b) the bank determines the amount and interest rate on the credit on the basis of "enriched" credit information with alternative data, which become available in the digital environment.

The analysis of tabular data shows that in the digital environment, the available "enrichment" of traditional credit data by alternative sources allows to reduce the more unmet aggregate demand for credit:

a) $Z_1 = 300 - 250 = 50$; b) $Z_2 = 300 - 280 = 20$. In so doing, it is assumed, banks will be able to assess creditworthiness of borrowers with greater accuracy, including without credit history or having «short» credit history, which will eventually lead, all other things being equal, to a reduction in weighted average interest rates, defaults of borrowers and to increase in aggregate value payments in terms of loan debt servicing

CONCLUSION

In today's digital environment, it is possible to realize hidden reserves of growth of profitability of credit operations. To a certain extent, this is achieved through the development of financial intermediation, infrastructure institutions of the credit market and financial instruments. However, the State can make a significant contribution to solving the problem of information asymmetry in the credit market. In this respect, the supervisory authorities and, in particular, the monetary regulators have the regulatory potential both for the development of information exchange between users of credit information and for the development of functional institutions of the credit market.

REFERENCES

1. Scott I.O. The availability doctrine: theoretical underpinnings. *Review of Economic Studies.* 1957;25:41–48.

2. Hodgman D.R. Credit risk and credit rationing. *Quarterly Journal of Economics.* 1960.74:258–278. DOI: 10.2307/1884253

3. Miller M.H. Credit risk and credit rationing: further comments. *Quarterly Journal of Economics.* 1962.76:480–488.

4. Akerlof G.A. The market for "lemons": Quality uncertainty and the market mechanism. *The Quarterly Journal of Economics*. 1970;84(3):488–500. DOI: 10.2307/1879431

5. Freimer M., Gordon, M.J. Why bankers ration credit. *Quarterly Journal of Economics*. 1965.79:397–416. DOI: 10.2307/1882705

6. Jaffee D.M., Modigliani F. A theory and test of credit rationing. *American Economic Review*. 1969.59:850–872.

7. Jaffee D.M., Russell T. Imperfect information, uncertainty, and credit rationing. *Quarterly Journal of Economics*. 1976.90:651–666. DOI: 0.2307/1885327

8. Bernanke B., Gertler M. Agency Costs, Collateral, and Business Fluctuations. *NBER Working Paper*. 1986. URL: https://ideas.repec.org/p/nbr/nberwo/2015.html (accessed on 12.03.2022).

9. Blinder A., Stiglitz J. Money, Credit Constraints, and Economic Activity. *American Economic Review*. 1983.73(2):297–302. DOI: 10.7916/D 87371XD

10. Greenwald B., Stiglitz J. Imperfect information, credit markets and unemployment. *European Economic Review*. 1987.31(1):444–456. DOI: 10.1016/0014–2921(87)90062–6

11. Dewatripont M., Tirole J. The Prudential Regulation of Banks, London. England: The MIT Press; 1994. 272 p.

12. Vercammen J. Credit Bureau Policy and Sustainable Reputation Effect in Credit Market. *Economica*. 1995.62:461–478. DOI: 10.2307/2554671

13. Padilla J., Pagano M. Endogenous Communication Among Lenders and Entrepreneurial Incentives. *Review of financial studies*. 1997.10(1):205–236. DOI: 10.1093/rfs/10.1.205

14. Jappelli T., Pagano M. Information Sharing, Lending and Defaults: Cross-Country Evidence. *Journal of Banking & Finance*. 2002.26:2017–2045. DOI: 10.2139/ssrn.183975

15. Gehrig T., Stenbacka R. Information Sharing and Lending Market Competition with Switching Costs and Poaching. *European Economic Review*. 2007.51(1):77–99. DOI: 10.1016/j.euroecorev.2006.01.009

16. Padilla J., Pagano M. Sharing Default Information as a Borrower Discipline Device. *European Economic Review*. 2000.44(10):1951–1980. DOI: 0.1016/S 0014–2921(00)00055–6

17. Deryugina E., Ponomarenko A., Sinyakov A. Exploring the Conjunction Between the Structures of Deposit and Credit Markets in the Digital Economy under Information Asymmetries. 2021. URL: https://www.cbr.ru/StaticHtml/File/126315/wp-78.pdf (accessed on 25.03.2022).

18. Stiglitz J., Weiss A. Credit Rationing in Markets with Imperfect Information. *American Economic Review*. 1981.71(3):393–410.

19. Keeton W. Equilibrium Credit Rationing, N.-Y.: Garland Press; 1979. 279 p.

20. De Meza D., Webb D. Too Much Investment: A Problem of Asymmetric Information. *Quarterly Journal of Economics*. 1987.102(2):281–292. DOI: 10.2307/1885064

21. English W.B. Credit Rationing in General Equilibrium. 1986. URL: https://dspace.mit.edu/bitstream/handle/1721.1/14891/16133040-MIT.pdf?sequence=2 (accessed on 10.03.2022).

22. Lunyakov O.V. Traditional and alternative credit ratings: Fintech companies vs banks. *Bankovskie uslugi = Banking Services*. 2022;(1):18–27. (In Russ.) DOI: 10.36992/2075–1915_2022_1_18

23. Gambacorta L., Huang Y., Li Z., Qui H., Chen S. Data vs Collateral. *CEPR Discussion Paper*. 2020. URL: https://ssrn.com/abstract=3696342 (accessed on 20.03.2022).

24. Goldfarb A., Tucker C. Digital Economics. *Journal of Economic Literature*. 2019.57(1):3–4. DOI: 10.1257/jel.20171452

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