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CREDIT MARKET IMPERFECTIONS IN THE THEORY OF CREDIT RATIONING

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Summary

The article aims at comparative analysis of the nature and dimensions of credit rationing on the grounds of theory of finance. The paper identifies the essence of credit rationing through the prism of its most important endogenous and exogenous prerequisites, assuming the lack of adequate instruments that could be used by banks to individually select borrowers (the so-called screening devices) in conditions of their heterogeneous risk-related breakdown. The paper points out the scope of idiosyncratic attributes of the credit market which prevent it from achieving a state of Walrasian equilibrium, which leads to petrification of credit market imperfections (credit market failure).

JEL classification: G21, G14, G32
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Introduction

The analysis of credit rationing characteristics has fundamental significance to the theory of finance, as it gives grounds for a peculiar state of permanent equilibrium in credit market, despite the fact that real loan demand exceeds its supply in the banking sector. On the basis of exogenous and endogenous prerequisites, a fundamental assumption can be figured out that entities from the real sphere do not receive adequate financing or see their loan applications turned down so their demand for bank financing is not met. Furthermore, limited availability of loans occurs in favorable for banks market circumstances as potential borrowers are in a position to fulfill all objective requirements listed by banks within the price and non-price elements of a loan contracts (e.g. requirements of specified own contribution, collaterals, minimum rate of return on investment project). Consequently, in spite of potential borrowers' sufficiently high creditworthiness and declared willingness to make all obligatory payments, banks unilaterally decide to stop financing or to limit the amount of loan with regard to all or some borrowers. The limited loan supply is a basic argument for credit market imperfection (Balstensperger, 1978, p. 170).

In banking practice, credit rationing is often associated with market failure in form of supply shock on loan market, known as credit crunch, which was typical for the initial stage of the financial crisis of 2007-2010. However, the theory of finance points out that the analyzed phenomenon is not transitory and form an idiosyncratic feature of banking activity, even though it contradicts the assumptions of banks' rationality as profit-oriented institutions. As a result of the credit rationing, loan activity is conducted at lower interest rates than it would

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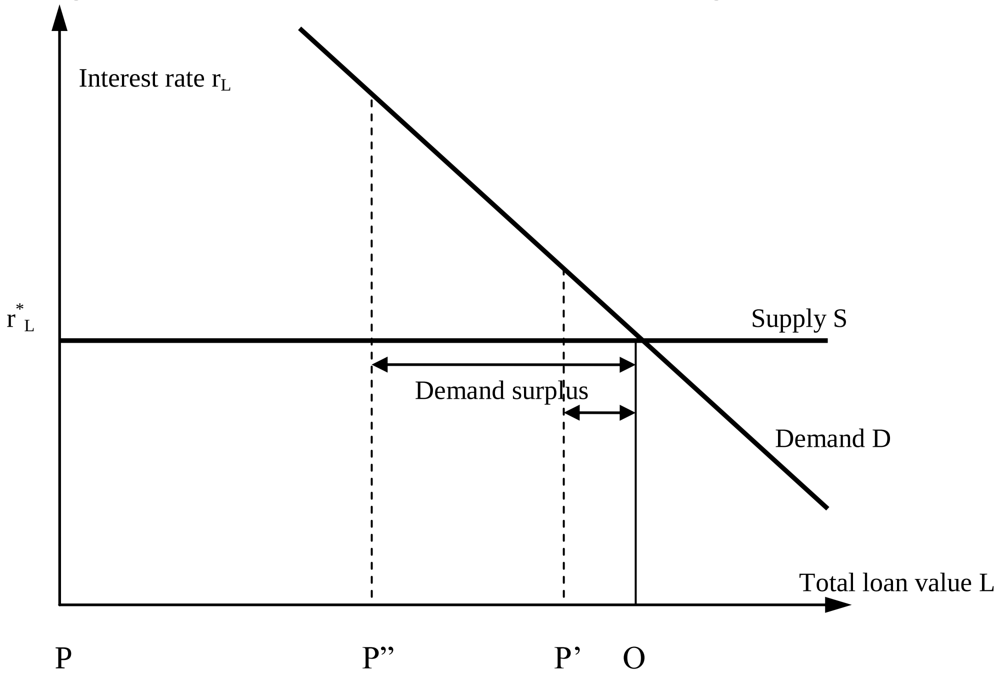
have been expected from the scope of actual demand from potential borrowers. Therefore banks on one hand aim at maximizing profits and on the other hand they deliberately resign from some of their interest income, that would have been achieved within full-scale loan activity.
In light of the above assumptions, the aim of this paper is to make a cross-section comparative analysis of the prerequisites for the credit rationing phenomenon in the theory of finance. In line with this aim, the research is focused on identifying and exploring the main characteristic of this phenomenon through the prism of the most fundamental models that deal with the credit rationing assuming a deliberate lack of appropriate screening devices in case of heterogeneous risk-related breakdown of potential borrowers.

The exogenous dimension of credit rationing

In Walrasian equilibrium model, surplus of demand for particular goods over their supply in a competitive market triggers intrinsic stabilizers which eventually lead to the sales growth or increased prices until a new state of market equilibrium is achieved with fully satisfied demand (Daal and Jolink, 1993, p. 22-24). In this classic concept of market equilibrium, the phenomenon of credit rationing is analyzed through the prism of a short-term supply shock which should be eliminated by proper adjustment of market parameters, mostly by changes to loan interest rate. On the basis of these assumptions, for decades theory of finance (for example Samuelson, 1952, p. 695-701) showed lack of potential failures in the competitive loan market that would lead to a permanent distortions creating a supply and demand gap.
Keynes (1930, p. 364-367) was one of the first economists who noticed the phenomenon of credit rationing, claiming that the loan market is far from the state typical of a perfect market, as there is always a certain share (so-called fringe) of borrowers whose demand for loan is not met. Furthermore, within his concept banks are likely to influence the size of such borrowers by deliberately adjusting the volume of granted loans without changing interest rates. Keynes' observations became the foundation in formulating the macro-economic concept known as the availability doctrine. It is based on the assumption that banks limit supply of loan even though there is quite high demand as a consequence of the external monetary and supervisory influence exerted on them (Roosa, 1951, p. 23-45), (Scott, 1957, p. 45-48).
The models representing the availability doctrine focus on explaining the consequences of monetary policy instruments in the context of Keynesian restrictions existing in the economy, especially in form of relatively low flexibility of aggregated demand for loan compared to interest rate. It is assumed that it is the size of spare capital resources in banks, not the interest rate that determines the credit supply-demand interrelations in the real sphere. Consequently, if the central bank limits money supply, it negatively influences the availability of loans for the real sphere, with relatively little influence on the interest rate level. The fundamental question of the availability doctrine is how attractive the operational conditions in an open market with limited resources of liquid assets are for the banks. In case of limiting money supply, banks are stimulated to invest in secure, though not very profitable, treasury bonds, which limits capital resources allocated for credit operations. Banks prefer to invest in treasury bonds in asset management processes, which means that credits are always subject to the rationing phenomenon due to the effect of capital substitution in banks' investment portfolios, with different scale of influence on particular segments of borrowers. As it is assumed that the share of loans in bank's assets is low, the loan supply is perfectly flexible,

with full-scale loan activity of banks at certain interest rate (r^*_L)[2] This level is determined by the shape of supervisory regulations defined for this market (Figure 1).

Figure 1: Credit market supply and demand, exogenous dimension



Source: Matthews, K., Thomson, J. (2008). The Economics of Banking. Second Edition. England: John Wiley & Sons, p. 118

The scale of investments in treasury bonds results from the nature of monetary policy conducted by the central bank and influences adequate limitations in size of resources banks allocate for credit activity, which prevents them from achieving the state of market equilibrium of demand and supply at a particular size of credit activity determined by the state of balance (O). In case of liberal monetary policy, the limitation in supply of credit may be relatively small (P’O section). With raising importance of Central Bank operations, the surplus of loan demand over its supply also increases (P’’O section). Reduced capital resources allocated for loan activity prevents banks from fully satisfying the demand voiced by potential borrowers, which leads to credit rationing processes. In extreme cases, some segments of borrowers may be totally excluded from the loan market (the so-called red-lining). However, it should be emphasized that if the loan demand of these customers is not satisfied due to lack of sufficient collaterals or inadequate value of predicted cash-flows from investments, such a case cannot be called credit rationing (Jaffee and Stiglitz, 1990, p. 848).
The explanation of the credit rationing phenomenon on the basis of exogenous premises, such as interest rate ceiling or monetary aggregates related to development of loan activity points at a number of constraints of the model. First of all, limitations of loan interest rates, or current shape of monetary policy may lead to rationing credit during their offering. If only these external factors were influencing the loan market distortion, after their elimination, the market

[2] In this context an example of a regulated maximum value of interest rate may be a nominal interest rate of consumer credits, limited in Poland by four times the credit rate of Central Bank against securities.

would reach a new point of equilibrium, equaling the size of supply and demand. However, in spite of deregulation of bank loan activity and expansive monetary policy, the phenomenon of credit rationing still exists. Moreover, model assumptions stipulate that the loan activity is always more profitable than investments in treasury bonds, the availability doctrine indirectly assumes that banks are entities maximizing their profits without dealing with the risk issue. Therefore we should conclude that the influence of external parameters is not the only factor of credit rationing.

The endogenous dimension of credit rationing

Contrary to availability doctrine, the concepts of endogenous credit rationing analyze this phenomenon through the prism of risk factor in processes of bank assets and liabilities management. Starting from the assumptions of the Hodgman model (1960), the activity of banks as credit providers can be analyzed through endogenous factors conditioning credit rationing processes. It is vital to show direct relation between credit rationing and the scope of credit risk. Generally, banks aim at maximizing profits in their loan activity but higher value and scope of granted loans implies higher risk of violating the terms of credit agreement by debtors (credit default).

In the process of creditworthiness evaluation, the bank determines the likelihood of paying back the loan depending on objective and subjective factors, thus defining the volume of available loan. This correlation takes the form of function Q(y), which is decreasing (that is, increased amount of loan lowers the probability of its full repayment), continuous and differentiable for most values of y.

In the extreme situation Q(0) = 1 means no default risk, which implies that for very small loans the certainty of their repayment is assumed. On the other hand, in the event of limited resources of debtor's own share and increasing value of loan, the probability function aims at 0 ($Q(y) = 0$, when $y \to +\infty$).

The condition of profitable loan activity is the repayment of loan (y) in relation to the declared by the debtor obligation to repay (s). Thus we have two options:

1) q(s) = 1 when payment is performed in accordance with original obligation of the borrower,
2) q(s) < 1 when payment is lower than s.

Assuming that the borrower repays the amount of loan whenever he or she is objectively able to do so, Y means the breakdown of credit repayments, while the distribution of the function Y takes the following values:

$$\begin{cases} P(Y = s) = Q(y) \\ P(Y \leq y) = 1 - Q(y), y < s \end{cases} \qquad (1)$$

where

s = obligation made by the borrower to repay the loan,
y = potential repayment of the loan,
Q(y) = the function of loan repayment probability,
Y = actual repayment of the loan.

The probability of loan repayment $P(Y \leq y)$ is increasing until it reaches s, where it jumps to the value of one, as the borrowers will not pay back more than the amount of their obligation towards the bank. Assuming that Q (y) is differentiable in the interval 0 < y < s, the likelihood of breakdown Y is determined by the density function –Q'(y) in the interval 0 < y < s and with non-zero likelihood in point s:

$$\begin{cases} P(r < Y < t) = \int_r^t -Q^{'}(y)dy, \quad 0 \le r < t \le s \\ P(y = s) = Q(s) \end{cases} \qquad (2)$$

where r,t = variations of loan repayment,
$-Q^{'}(y)$ = the function of loan repayment likelihood density,
$Q\ (s)$ = the function of loan repayment likelihood in accordance with the original obligation of the borrower,
other denotations as in formula 1.

The above considerations are based on the assumption that a bank as lender uses the function of loan repayment breakdown density to determine the ability of borrowers to repay loan of various sizes. Increased exposure to credit risk becomes then the basic reason for the appearance of the credit rationing phenomenon. The scale of the borrowers' insolvency risk (default) for the bank is reflected by the ratio of expected value of actual loan repayment to expected value of losses in case no repayment is made (EY/EZ).
The expected value of loan repayment is revenue from loan predicted by the bank, depending on the likelihood of loan repayment Q(y) and the obligation to repay the loan made by the borrower:

$$EY = sP(Y = s) + \int_0^s -yQ'(y)dy = \int_0^s Q(y)dy \qquad (3)$$

where EY = expected value of actual loan repayment,
other denotations as in formula 1.

Thus the function of the amount of loan repayment is monotone and non-decreasing, while its derivative due to s will take the form of loan repayment probability depending on the size of the borrower's obligation in the credit agreement.

$$\frac{\partial EY}{\partial s} = Q(s) \qquad (4)$$

where denotations as in formulas 2 and 3.

EZ, on the other hand, is the expected value of losses in case no repayment is made (a debtor fails to meet its loan obligations). The bank incurs the loss if the amount of actual repayment is lower than the size of available loan. Then:

$$\begin{cases} Z = 0 \ dla \ Y \ge a \\ Z = a - Y \ dla \ Y < a \end{cases} \qquad (5)$$

where Z = the size of the loss incurred by the bank,
a = the amount of granted credit,
Y = the actual credit repayment.

The expected value of loss does not depend on loan interest rate, but on the capacity of the borrower to service the loan repayment assessed by the bank (function Q), as well as on the obligation made by the borrower to repay the loan and on the size of granted loan. Then:

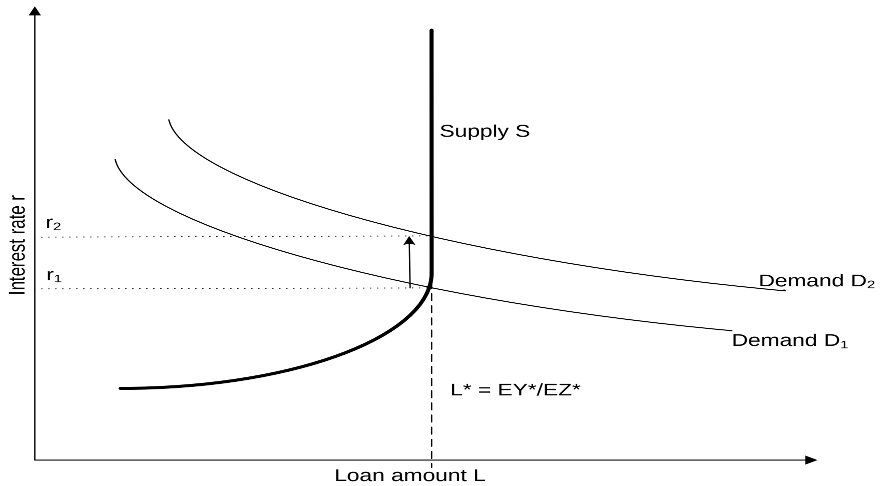
$$EZ = \int_0^a (a-y)[-Q'(y)]dy$$

$$\begin{cases} EZ = a - \int_0^a Q(y)dy, & dla\ a \le s \\ EZ = a - \int_0^s Q(y)dy, & dla\ a > s \end{cases} \qquad (6)$$

where EZ = value of potential loss,
other denotations as in formulas 1 and 5.

In the above model, there is a direct relation between maximization of bank's utility in loan activity and optimization of the value of EY/EZ ratio. Thus it is possible to identify the minimum level of the ratio determining the maximum credit risk the bank can accept in the situation of equilibrium in a perfectly competitive market (EY*/EZ*).
As a result, the borrower receives a loan of value a if the assessed insolvency risk in his case does not exceed the limit adopted by the bank. Thus, for a particular amount of credit, individually calculated EY/EZ ratio must be higher or at least equal to EY*/EZ* for the application of a potential borrower to be accepted. The level of EY/EZ risk is determined by the amount of credit, not the interest rate level. Therefore we can differentiate the maximum amount of available credit (the so-called cut-off point) determined by EY*/EZ*, beyond which banks avoid conducting credit activities.

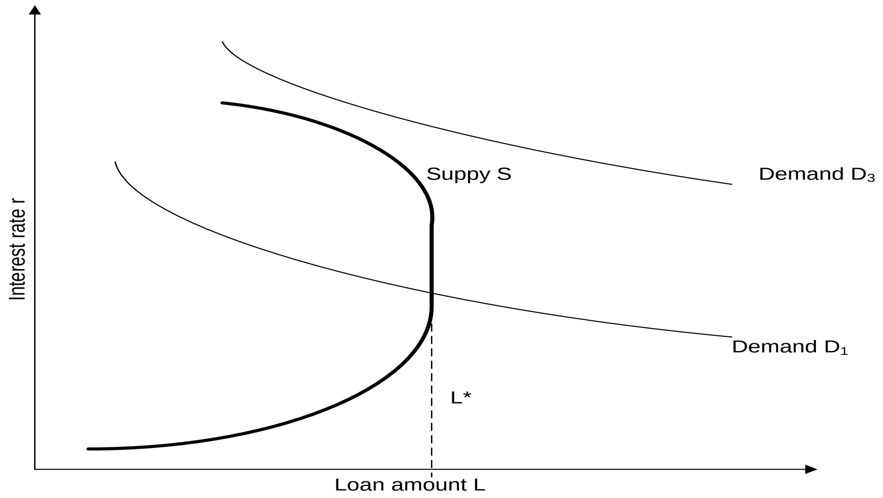
Figure 2: Limitation of loan supply as a result of banks' aversion to risk



Source: Hodgman, D. (1960). Credit Risk and Credit Rationing. The Quarterly Journal of Economics, 74 (2), 258-278

The supply function in the border loan amount L^* becomes nonflexible in relation to interest rate r. It means that in case of higher loan value ($L>L^*$), banks will not offer loans to potential customers in spite of their formal and actual acceptance of higher interest rates. The shift of the demand function (D_2) will not lead to the increased availability of loans but will result only in increased loan interest rates (from r_1 to r_2). This phenomenon stems from rising risk aversion of banks where ceiling value of loan reflects the acceptable risk scale, which means that this relation is constant and the amount of credit L^* will become the level corresponding to market equilibrium.
The model contains a number of assumptions which create major simplifications of a loan market. First of all, we do not always observe a direct relation between the amount of granted loans and the ability of borrowers to pay them back (for example when technological projects financed by banks significantly increases production capacity of a company). Moreover, if the value of EY/EZ ratio determines the scope of loan extension in the market, it means that banks will equally treat a borrower offering low expected revenue (EY) at very low expected value of loss (EZ) and the borrower planning to finance very risky project, but potentially generating very high income. It prompts the conclusion that if a borrower could provide the bank with very high revenue (EY), then the bank will finance the project with above-the-average risk of failure (Chale, 1961, p. 327).
The development of the concept of credit rationing based on risk factor was greatly influenced by depicting credit rationing phenomenon through the apparent shift to the left of the loan supply curve in its top course (Marshall and Gordon, 1965, p. 397-410). It is assumed that the bank aims at optimization of loan size depending on the level of interest rate. Thus regardless of the size of offered interest rate, borrowers will not be granted loans which exceed the maximum amount available in a particular bank. In case of limited capital resources in banks allocated for loan activity, the size of deposit supply will determine loan supply. Diminishing bank capital resources in face of continuously growing loan demand must finally lead to credit rationing. An additional argument for shifting to the left the supply function stems from the idiosyncratic nature of bank loan activity. With increased loan interest rates a bank may decrease loan accessibility in order to achieve adequate benefits as in large-scale financing, which limits bank's willingness to offer credit of maximum size L*. Graphic illustration of this phenomenon (figure 3) is the "backward bending" of the loan supply, which finally leads the unsatisfied demand for loans among certain segments of prospective customers (D_3).

Figure 3: Credit rationing and the course of its supply function



Source: Marshall, F., Gordon, M. J. (1965). Why Bankers Ration Credit? The Quarterly Journal of Economics, 79 (3), 403

The influence of information asymmetry on credit rationing

The original endogenous models of credit rationing identified dysfunction of loan supply exclusively through the prism of credit risk in terms of standardized profit variation depending on loan parameters, but they did not explain the actual prerequisites for this phenomenon. Consequently, further development of endogenous models points at the significance of credit rationing through the prism of the loan market factors resulting from various imperfect information factors affecting risk acceptance in banks.

The problem of moral hazard

The cornerstone endogenous credit rationing model of Jaffee and Russell (1976, p. 651-666) points at crucial importance of moral hazard streamlining the concept of risk. In this model borrowers are classified into segment of "reliable ones", who accept only such terms of loan agreement they will be able to keep, and the so-called "unreliable ones", who stop fulfilling their contractual obligations if the costs of violating the loan agreement are quite low. The latter segment of borrowers is able to increase they utility level on the basis default losses in banks.

Moreover, a two-phase structure of consumption and income is assumed, in which loans with interest rates as cost burdens increases the volume of current consumption but decreases the size of future income due to the obligation to pay them back:

$$\begin{cases} C_1 = Y_1 + L \\ C_2 = Y_2 - (1 + r_L)L \end{cases} \qquad (7)$$

where Ct = size of consumption in t=0 and t=1,
Yt = size of income in t=0 and t=1,
r_L = loan interest rate,
L = amount of credit.

The model assumes that all borrowers have the same incomes and consumption preferences, but they differ in terms of credit risk acceptance. The size of demand is negatively correlated with interest rate. The costs of loan default incurred by a borrower are broadly set (for example entering data in the register of unreliable debtors, limiting the future possibilities of credit, as well as social ostracism). From the point of view of maximizing individual utility of borrowers, these costs are trigger moral hazard when their total amount is lower than the sum of loan repayments:

$$Z_i < (1 + r_L)L \tag{8}$$

where Z = default costs,
r_L = loan interest rate,
L = loan size.

Simultaneously, reliable borrowers try to repay their loan, thus from their point of view, the default costs are higher than in case of borrowers with low credibility. Banks know the credit risk breakdown among their borrowers, but due to information asymmetry they are not able to identify individual amounts of default costs for particular borrowers. At the same time loans are financed from fixed interest rate deposits. As banks have the potential to identify the share of reliable borrowers in population at a particular level, the function of the bank profits takes the following shape:

$$\Psi = \Gamma\,(1+ r_L)\,L - (\,1 + r_D)\,L \tag{9}$$

where Ψ = bank's profits function,
Γ = share of reliable borrowers,
r_D = deposit interest rate,
r_L = loan interest rate,
L = loan size.

Differentiating the profit function against the size of credit L and assuming that in a perfectly competitive market bank's profits equals zero, we can calculate the level of interest rates for loans in a market equilibrium r_L^*:

$$\frac{\partial \psi}{\partial L} = \Gamma(1+r_L) - (1+r_D) = 0$$

$$(1+r^*{}_L) = (1+r_D)/\Gamma$$

$$r^*{}_L = (1+r_D)/\Gamma - 1 \tag{10}$$

where $r^*{}_L$ = loan interest rate in a market equilibrium situation
other denotations as in formula 9

The above formulas show that the loans interest rate ratio $(1+r^*{}_L)$ exceeds the cost of obtaining resources for credit activity $(1+r_D)$ by the value of $1/\Gamma$, which compensates bank's losses from credit risk materialization in relations with unreliable borrowers. In the equilibrium market state, loans are is offered at $r^*{}_L$ rate, so the bank offers all borrowers loans at the same amount and interest rate, which entails rationing both reliable and unreliable borrowers (the so-called pooling contract).
Reliable borrowers have the reason for signing credit agreement with the bank on different terms, as they are currently subsidizing unreliable borrowers with the difference of $(r_L^* - r_D)$. However,

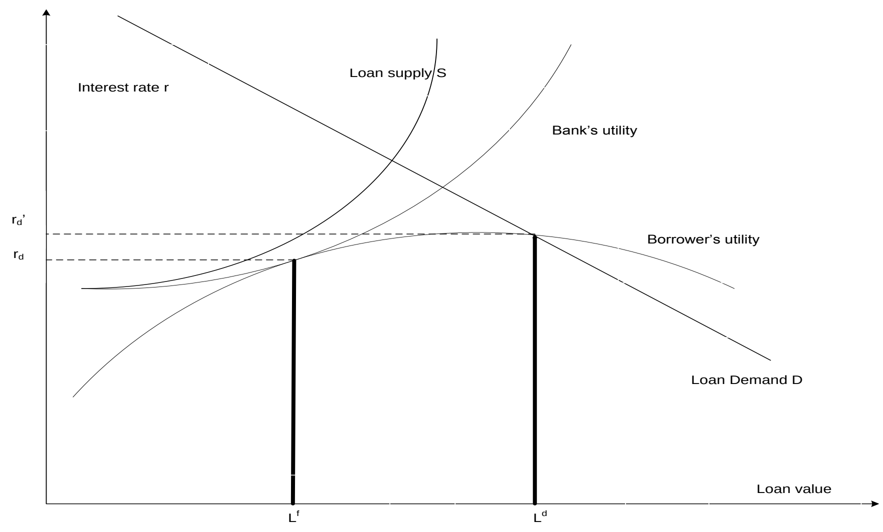
under information asymmetry and no obligation of supplying loan collateral, differentiating loan prices by the bank make it impossible to achieve the state of long-lasting market equilibrium. Increasing interest rates in order to compensate for the loss related to credit risk leads to similar increase of the default costs (Z_i) limits. As the consequence, the moral hazard in population of borrowers is growing, changing the risk-related breakdown of borrowers (Γ). Therefore it stimulates the share of unreliable borrowers, and the rising size of their demand for loan affects the limitation of loan availability for reliable customers.

The reaction of the banks manifested in another increase of interest rate as a premium for growing credit risk, further deteriorates the situation of reliable borrowers, so to protect their utility they should accept the bank loan conditions offered in period of equilibrium despite their demand is not fully satisfied at interest rate r^*_L, which triggers credit rationing at the state of market equilibrium.

The credit rationing phenomenon in asymmetry conditions influences marginal utility of all borrowers. It is assumed that banks approve loan applications of all borrowers, but offer them lower amount of loan than customers' preferences and acceptable level of interest rate would imply. Such a state is defined in the theory of finance as first type credit rationing. On the other hand, we can distinguish a state in which despite lack of formal differences among borrowers, they are not treated equally (i.e. second type credit rationing). As a result, some of them obtain credit in the amount they desired, while others are fully excluded from the loan market (Freixas and Rochet, 1997, p. 137).

On the basis of Keeton's model (1979) we can present the non-price model of credit rationing, assuming that in loan market we can distinguish a curve representing the profit function depending on the level of loan interest rate and its size (isoquant of bank's profit), which in a perfectly competitive market assumes the value of zero. Simultaneously, there is a function of borrower's utility with the same parameters.

Figure 4: Credit rationing as the result of loan agreement parties utilities



Source: Keeton, W. (1979). Equilibrium Credit Rationing. New York: Garland Publishing, 56

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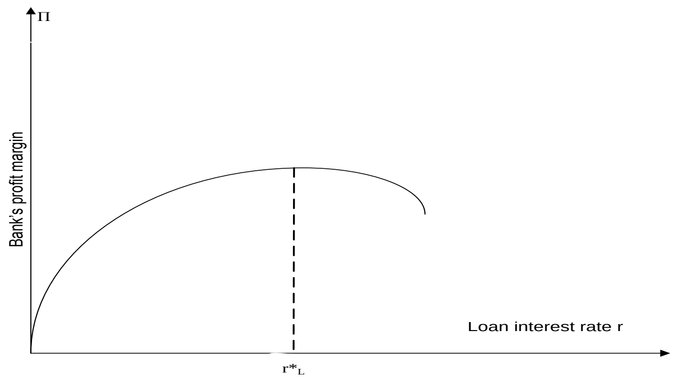
Then the market equilibrium takes place for the loan amount of L^f corresponding to the point of tangency of the isoquant of bank's profit and borrower's utility. With such a loan activity, the size of loan supply does not balance the demand in scale illustrated by section $L^f L^d$, and the bank grants loans at a lower interest rate (r_d) than the borrower is willing to accept ($r_{d'}$).

Problems of negative selection

One of the most fundamental endogenous aspects of the second rationing is the analysis of the information asymmetry triggers in terms of negative selection (Stiglitz and Weiss, 1981, p. 393-410). The model assumes the differentiation of the likelihood of loan repayment in a given population of borrowers. At the same time, loan interest rate cannot be used by the bank for borrowers differentiation, as this change influences directly the risk factor in investment projects and thus determines the borrowers' loan preferences. Increased interest rate lowers project profitability and encourages borrowers to take up more risky projects or to join the segment of unreliable borrowers, who fail to service the loan properly. As a result of credit risk materialization, further increases in loan interest rate diminishes the bank's profits. These losses are related to larger bank's exposure to credit risk. Therefore bank can gain maximum profits at certain value of the optimal interest rate (r^*_L).

Figure 5: Credit interest rate and the bank's profit margin



Source: Stiglitz, J., Weiss, A. (1981). Credit Rationing in Markets with Imperfect Information. American Economic Review, 71 (3), 394

Constraints of bank loan activity to the size are determined by optimal interest rate makes the market demand-supply equilibrium impossible according in terms of Walrasian equilibrium. Thus, although the loan demand may exceed its supply, the bank is not willing to increase interest rate, as it would create conditions for financing ever riskier projects. Therefore in turbulent market environment, the bank prefers to lower interest rate to avoid losses related to above-the-average credit risk even though the current demand for credit is very high.

The model is based on the assumption that the bank may determine the risk of potential borrowers on the basis of projection of average return rate on investment project, while it cannot identify variations for each of them, which makes it impossible to measure parameters of individual risk. Moreover, all projects are planned in the same dimension and the loan agreement stipulates the same collateral, which means that it cannot be used by the bank as a selection tool. Then the bank's profit margin is determined by the following formula:

$$\Pi = min\{(1+r_L), X/L\} \qquad (11)$$

where X = return on investment project rate,
Π = bank's profit margin,
L = size of projected loan,
r_L = loan interest rate.

Within fully standardized agreements, borrowers pay back all credit obligations or otherwise they go bankrupt. Excluding bankruptcy costs, the bank's profit margin is a concave function of the financed investment project return. The borrower, on the other hand, generates return in form of:

$$\Phi = max\{0, X-(1+r_L)L\} \qquad (12)$$

where Φ = size of the income of the borrower running an investment project,
other denotations as in formula 11.

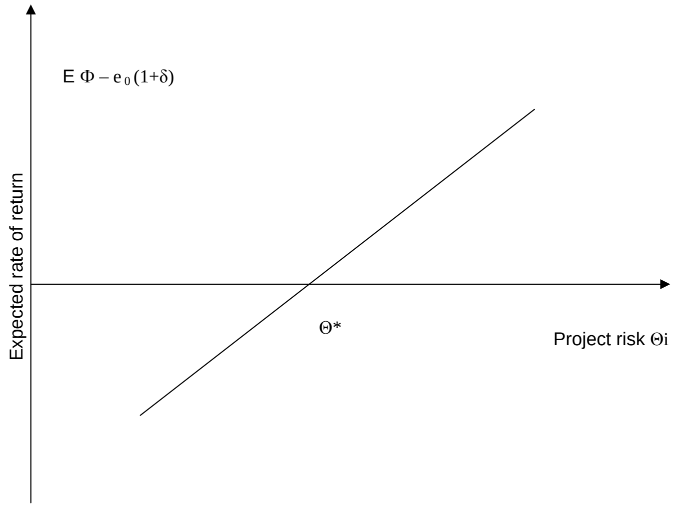
As the function of company profit is convex, borrowers who run more risky investments are more likely to achieve higher returns. As we indicated in the model above, the parameter of a single project risk θ_i is only known to borrowers, while banks may only assess statistically risk-breakdown θ in a set population of potential borrowers. In the event when risk-neutral borrowers must invest a certain amount of their own equity e_0, so they will realize the project if:

$$E\,\Phi > e_0\,(1+\delta) \qquad (13)$$

where $E\Phi$ = expected income of a borrower running an investment project,
δ = cost of own equity,
e_0 = own share of the borrower.

As the expected rate of return depends on the project risk, we can distinguish the risk level θ^* at which $\theta_i>\theta^*$ borrowers will realize the project using loan, while projects with lower risk $\theta_i<\theta^*$ will be abandoned due lack of economic profitability (too low income). Therefore, the expected project income for the borrower is the risk function, while the bank on the basis of interest rate level influences the risk of the project.

Figure 6: The influence of investment project risk on credit terms



Source: Jaffee, D., Stiglitz, J. (1990). Credit Rationing. In: B. M. Friedman and F. H. Hahn (editors), Handbook of Monetary Economics (p. 848-856). Amsterdam: North Holland, 856

If the bank increases interest rate, it will also increase the minimum rate of return for all borrowers. Shifting the profit curve downwards affects increasing scope of project risk θ^*, thus forcing borrowers to realize investment projects with higher rate of return. This fact brings special consequences to reliable borrowers, who plan investments with low risk $\theta_{i.}$ with adequately low rate of return. Increasing the loan interest rate has dramatic consequences for these borrowers as they will not obtain bank financing because loan costs exceeds the future rate of return. When such borrowers quit the loan market, the dominant position will enjoy those borrowers who plan to realize risky projects with high rate of return. This process favour negative selection in the credit market.

The above phenomenon of negative selection may be observed in a heterogeneous group of borrowers who can choose between two types of investment projects financed with bank loan. Assuming the level of rate of return at X^I and X^{II} (where $X^I > X^{II}$) and the likelihood of the investment success at E^I and E^{II} (where $E^I < E^{II}$), the projects from the first group are much riskier, but they offer higher rate of return than those belonging to the second group. If the company does not show any preferences concerning the choice of the project type at the interest rate r:

$$\{X^I - (1+r)L\}E^I = \{X^{II} - (1+r)L\}E^{II} \qquad (14)$$

where
- X^1 = expected rate of return on investment project I,
- X^{II} = expected rate of return on investment project II,
- E^1 = success probability of project I,
- E^{II} = success probability of project II,
- r = loan interest rate,
- L = loan size.

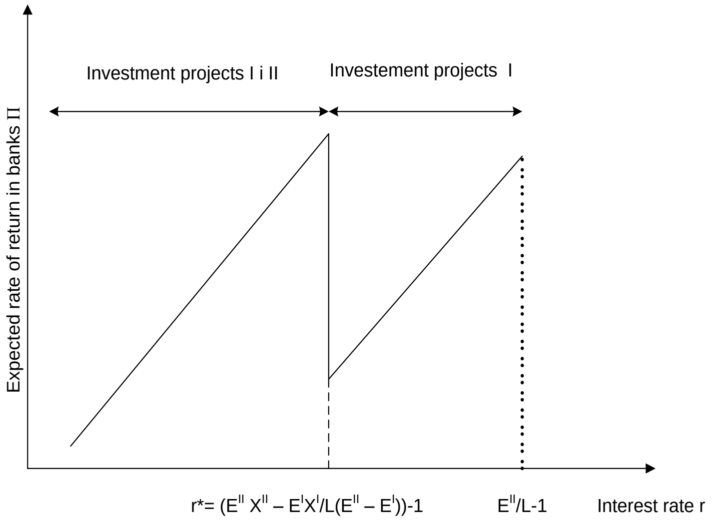
After transformations we obtain the following relation:

$$L(1+r)=\frac{X^{II}E^{II}-X^{I}E^{I}}{E^{II}-E^{I}}\equiv(1+r^{*})L \qquad (15)$$

where denotations as in formula 15.

In case of low loan interest rates (that is $r<r^*$), borrowers will choose the realization of safer projects. However, in line with increasing loan interest rates above r^*, borrowers will try to cover increasing loan costs by realization of more risky projects until the rate of return in relation to loan size remains profitability for them. Thus the maximum interest rate for financing safer projects equals the r^* rate, while the highest interest rate to maintain demand for loan for financing risky projects is $(R^1/L)-1$. This means that the expected return rate of the bank as a function of interest rate is not monotonic in point r^*.

Figure 7: The influence of interest rate on crediting investment projects



Source: Jaffee, D., Stiglitz, J. (1990). Credit Rationing. In: B. M. Friedman and F. H. Hahn (editors), Handbook of Monetary Economics (p. 848-856). Amsterdam: North Holland, 858

The bank will maximize its rate of return on loan agreements if it sets interest rate at the level of r^* on condition that:

$$X^{I}E^{I}<\frac{E^{II}(E^{II}X^{II}-E^{I}X^{I})}{E^{II}-E^{I}} \qquad (16)$$

where denotations as in formula 14.

Therefore, if the following condition $X^{II}E^{II}>X^{I}E^{I}$ is met, banks limit loan activity at the r^* level of interest rate, avoiding involvement in financing projects above the accepted limit of risk and thus create conditions for regular credit rationing in the market. Banks are not able *ex ante* to differentiate the risk scale of single investment projects, therefore r^* remains their

maximum interest rate. Limitations on bank loan activity cause bending the supply function to the left and leaving loan demand at higher levels of interest rates unmet.
According to the model assumptions, the optimal level of interest rates leads to lack of financing in case of some investment projects. However, modification of the above assumptions may lead to quite opposite conclusions. We can assume that the flows from projects have the same variation, but different average rate of return, contrary to the above-presented model, in which projects are characterized by various variations but the same average rate of return. In this situation it is possible to fully meet the demand for loan (de Meza and Webb, 1987, p. 281-292).
Although most models use various aspects related to information asymmetry, it should not be treated as the only source of market imperfections (de Meza and Webb, 1992, p. 1277-1290). In competitive markets with optimal information, credit rationing is also possible. The model is based on the assumption of limited responsibility of borrowers in loan agreement and the possibility of bankruptcy. If the financed project fails (the borrower goes bankrupt), the bank will take over all income generated by the project so far, but takes the risk that it will not recover the full amount of credit. Therefore borrowers will announce their demand for credit until the extreme income from the capital engaged in a successful project equals the marginal cost of capital. The bank maximizes its profit, taking into account both the success of the project and the full materialization of credit risk. In this way it will require the interest rate at which losses from project bankruptcies will be compensated with profits in case of their success, which leads to establishing a lower than optimal interest rate. However, at this level of interest rate credit demand exceeds its supply, which leads to the credit rationing phenomenon.

Conclusions

The analysis of the credit rationing process through the prism of basic features of credit markets points at the fundamental importance of risk in banking activity. Contrary to the market of goods belonging to the real sphere, a loan agreement is not finalized at the moment of signing it, as the payment flows are made in the future. Time shift between initializing and finalization of the loan agreement accounts for the uncertainty concerning meeting its requirements by the borrower. The problem is unequal information status of both sides. Borrowers usually possesses information advantage over the bank in this regard. Therefore the limitation of financing availability is not stipulated by objective elements of legal and economic environment of the bank (that is the shape of supervisory regulations, type of monetary policy), but it should be associated to the idiosyncratic nature of interest rate in the loan market.
Unlike in case of the market of tangible goods, where price determines value, interest rate in the credit market is significant both as the cost of capital determinant and the scale of credit risk assessed by the bank. These functions are performed inherently, which leads to disturbances when one of the above functions gain overwhelming importance. Increasing interest rates related to larger exposure to risk may stimulated reliable borrowers to look for cheaper, alternative source of financing. Similarly, lowering interest rates may encourage borrowers from other banks to use this offer in spite of inadequately high risk profile. Additionally, the level of interest rates does not optimally reflect the risk scale, as the parties to the contract agreement do not possess full information both *ex ante* (before signing a loan contract) and *ex post* (during loan contract borrowers acquire vital information about the risk much faster than banks). An additional factor hindering achievement of full efficiency of the

loan market is the fact that in spite of the heterogeneous risk-breakdown of borrowers, banks establish one interest rate for particular types of credit. All these factors lead to the credit rationing phenomenon contrary to Walrasian assumption that flexibly of prices lead eventually to constant demand-supply equilibrium.

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