

# Macroeconomic Analysis of Prudential Instruments of Bank Risk Management

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**Abstract**—The article analyzes instruments of prudential<sup>1</sup> regulation of banking activities, provides a comparative analysis of their effectiveness, and also suggests the use of the discussed instruments by bodies of monetary policy, depending on the institutional conditions. The influence of different modes of banking regulation on the accumulation of risks in the banking system is also analyzed.

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The international financial crisis that erupted in 2008 and that has hit many developed and developing countries around the world has attracted much attention from the side of monetary policy authorities, politicians, members of the professional community, and media representatives. Large-scale expenses due to this crisis in all sectors of the economy (public, industrial, and household) necessitate the development of new risk management instruments within the financial system.

In [1, 2] mathematical methods and computational approaches developed by us are given, and using them it is possible to diagnose the risk of a crisis in the financial system, as well as to analyze the potential risk transmission channels between different markets. The obtained results can be used to construct a system of early warning indicators of financial crises. However, the stable and crisis-free functioning of the economic system in general and banks in particular is not only determined by the capabilities of government authorities to identify proactively the possible points of tension in the work of financial intermediaries, but also by measures that allow one to carry out the management of risks, accumulated on the balance sheets of credit and financial organizations.

In this paper, we analyze risk management instruments of credit institutions, selected as a primary object of study, due to the fact that banking institutions in Russia currently have financial resources that exceed the capital, concentrated in other financial institutions (management companies, insurance companies, private pension funds, etc.).

The specificity of regulation for banking institutions is determined by the following circumstance. According to the traditional economic theory, the purpose of a commercial organization is to maximize profits or increase the shareholder's value, etc. Managers are responsible for corporate results, and in case

of a poor solution of the tasks entrusted to them they can be deprived of some material and social benefits: it can be dismissal, transfer to lower position, or restriction of any monetary compensation. It is assumed that the costs associated with erroneous (incompetent) decisions of managers and employees of a company are fully borne by the company. However, these arguments do not take into account the possibility of bankruptcy. In case of a company's financial insolvency, the costs of wrong decisions are not encountered by the workers of the company, but by its shareholders and creditors<sup>2</sup>. This problem is most important for banking institutions that draw funds from the population and businesses, and the amount of such funds many times (even hundreds of times) exceeds the amount of own funds (equity) of banks. Thus, managers can make decisions related to a significant increase in risks associated with corporate activity (and therefore increase the possibility of short-term profits and material rewards), which is one of the bankruptcy factors (as opposed to increasing the shareholder value in the long run).

Risks, accumulated in the banking sector, can be managed by public authorities using two types of tools: first, tools that limit certain activities associated with the accumulation of risks and, second, tools that are aimed at reducing incentives for banks to use risky operations (in this case, immediate barriers are not created; however, managers avoid decisions that lead to an increased risk of bankruptcy).

**Tools that limit risk accumulation.** This class of tools of prudential regulation includes, for example, limits on certain types of investments that are either too risky or extremely difficult to estimate and pre-

<sup>1</sup> Prudential regulation allows one to register potential complications and problems associated with the activities of financial institutions.

<sup>2</sup> Bankruptcy laws may make managers subsidiarily liable for a company's bankruptcy (if a court establishes that the bankruptcy was caused by the actions of managerial bodies). Reputational costs may also to some extent limit unqualified decision making. However, the experience taught by crises that occurred in different countries shows that these institutional arrangements do not solve the above problem.

dict<sup>3</sup>: investments in real estate, derivatives, currency assets, etc. Due to the fact that government supervisors have less information (as compared to banks) on the quality of loan portfolios, when establishing such restrictions, they can use simpler “mechanical” rules rather than advanced risk assessment methodology, for example, set a marginal value for foreign exchange positions, maximum amount of investments in real estate, etc. Also, restrictions may be extended to the ability of banks to lend to highly indebted companies. Excessive debt payments deteriorate the financial attractiveness of an enterprise and increase the risk of bankruptcy. In addition, the relevance of the problem of moral hazard, due to which companies can directly raised funds to finance risky (speculative) operations in the hope of obtaining superprofits, increases.

However, it should be kept in mind that tools of prudential regulation can be an independent source of risk. For example, in many countries, the requirements for the presence of collateral, as well as its size, are established to reduce the credit risk of banks. In accordance with regulatory requirements, the magnitude of the market value of collateral should usually exceed the amount of the credit issued by a certain established amount. This helps to protect the interests of banks in case of changes in the market value of the collateral used (on the corresponding markets under normal, and not crisis, circumstances), as well as in case of abuses by an appraiser<sup>4</sup>. In addition, the risk of losing collateral, the value of which exceeds the amount of debt, stimulates borrowers to make productive investments that have a high probability of payback (i.e., the relevance of the moral-hazard problem is reduced.) However, the requirements for the presence of collateral can be a source of risk. In case of an economic recession, borrowers may not be able to serve credit lines which will provoke banks to sell mortgaged property. In turn, such massive sales will become an impulse to a decrease in collateral prices and will thus lead to increased losses for banks. This mechanism of crisis proliferation has a sustained character. Lower prices increase the probability of bankruptcy (as the incentives of borrowers to service loans, the volume of which is smaller than the price of the collateral used decrease), and an increase in bankruptcy cases provokes more active sales by banks and a further reduction in prices.

With the introduction of systems of prudential regulation of banking risks, it is necessary to consider their impact on the motives of financial intermediaries. Thus, in many countries, as a result of the banking crisis, state authorities have made a decision to cancel the revaluation of assets in accordance with market prices (a similar situation took place in Russia after the

1998 crisis). The purpose of such decisions is to present the financial situation of a bank as more attractive to investors. However, such measures can have extremely negative consequences for the stability of the banking sector even under normal (not only under postcrisis) conditions. In case of a cancellation of the revaluation of assets, banks are interested in selling assets, the market value of which exceeds the book value (since it allows them to fix profits). If the market value of assets is less than the book value, a bank will keep them on the balance sheet. Thus, the balance sheet valuation of assets, reflected in financial statements, will be overstated relative to the real value of assets. In addition, abolition of the revaluation of assets encourages banks to adopt a more aggressive (risky) investment policy. This happens due to the fact that the negative results of investments can be hidden, while superprofits from speculative transactions can be reflected in financial statements and presented to shareholders and the governing bodies of a company.

Let us consider another example of the possible impact of instruments of prudential regulation on banks' incentives to undertake risky operations. In order to minimize speculative transactions committed by commercial banks, the central bank may establish restrictions on certain types of investment activities. The establishment of such restrictions will reduce the profitability of bank operations. Although some types of risks will be reduced, the motives of banks to conduct speculative and risky operations will only increase. Under the conditions of imperfect bank supervision, banks will search for other less state-regulated areas of investment and opportunities of taking excessive risks, which will in turn reduce the quality of bank assets. Thus, these innovations can increase the systemic vulnerability of the banking sector rather than reduce it.

Of course, the presented list of tools of prudential regulation of banking risks is not complete. Many countries have introduced limits on insider lending, liquidity requirements, standards of the maximum amount of large credit risks, etc. However, an analysis shows that these instruments are not a panacea for solving issues related to risk management in the banking sector. If state authorities are not able to assess adequately the position of the banking system, banks will make risky (extremely profitable) operations. This situation was observed, for example, before the crisis in Russia in 1998, when the standards used by the central bank indicated a stability of commercial banks, and only the involvement of banks in the crisis revealed their weaknesses. The next class of tools of prudential regulation of banking risks aims to eliminate these shortcomings.

*Tools that reduce the incentives of banks to accumulate risks.* Within this approach, supervisors provide (create) conditions that encourage banking institutions to form productive investment portfolios. We

<sup>3</sup> For example, due to a high level of volatility in the corresponding market or it being a new market.

<sup>4</sup> If the cost of services of an appraiser is paid by a borrower, there is a conflict of interest that leads to the fact that an appraiser may inflate the estimated value of the collateral.

consider two types of tools of this type: capital adequacy ratios and control of deposit interest rates.

Banks' equity is a "safety cushion," which protects the interests of bank customers. In addition to this protective function, capital adequacy ratios can reduce the incentives of banks to conduct risky operations. Classic arguments explaining the emergence of this effect are as follows. An increase in equity relative to assets under management means that a greater amount of potential losses resulting from risky operations will be compensated at the expense of the involved bank's equity. In this regard, banks, which do not intend to spend own funds, form portfolios with limited risks.

Capital adequacy ratios are widely used in many countries<sup>5</sup>. However, regulatory instruments of banking risks, based on capital adequacy ratios, have several disadvantages.

The currently used approaches to the calculation of capital adequacy ratios do not allow one to "detect" many risks faced by banks. For example, the correlation between different types of assets is not taken into account. A bank portfolio consisting of strongly correlated, but relatively low-risk, assets may be generally more risky than a portfolio that includes risky assets, negatively correlating with each other (or the correlation between them is insignificant). The situation is complicated by the fact that the degree and sign of the correlation between the profitability of different assets may depend on the macroeconomic situation in the country. Thus, due to objective reasons, the capital adequacy ratio is a tool, using which it is almost impossible to take into account the number of risks. However, if certain types of risks are not properly reflected when determining the capital adequacy ratio, banks can take advantage of this opportunity to carry out risky operations (this will allow, on the one hand, to meet the nominally requirements of the regulator and, on the other hand, to ensure a high yield). Thus, capital adequacy ratios that do not take into account bank risks may provoke a counterproductive effect, which leads to hidden accumulation of risks rather than to their limitation.

The cost of equity (capital) exceeds the cost of borrowed funds. [3] An increase in the capital adequacy ratio actually means an increase in the proportion of more expensive funds in the total bank balance; i.e., it must be accompanied by a decline in profitability. In this regard, an excessive increase in the capitalization of a bank may rather strengthen the incentives for risky transactions as opposed to reducing them (this corresponds to the traditional approach). (For a formalized mathematical description of this effect, see the Appendix). This effect is closely related to the so-called "predatory" behavior of managers. Risks asso-

ciated with speculative investments increase the likelihood of a bank failure. Managers, who have insider information on the status of a bank and anticipate difficulties in its financial position due to poor investment results, may use the most attractive assets of the bank for personal gain (for example, by granting credits to "overnight" companies, which are subsequently canceled).

In our opinion, the role of control over deposit interest rates in limiting banking risks has not been adequately addressed in scientific literature. Establishing control over deposit interest rates can increase the profitability of banking operations by reducing interest costs of banks. If the state establishes a lower interest rate for an extended period of time, banks are able to generate a steady stream of cash income. In this regard, banks aimed at obtaining income make productive (not speculative) investments. Banks' participation in highly risky projects means an increase in the probability of bankruptcy and thus does not allow for the using of the provided opportunities for gaining additional profits due to lower interest costs.

Deposit interest rates are a simple tool of prudential regulation of bank risks (checking interest rates is not a difficult analytical task). In addition, monetary policy authorities have a great potential for monitoring deposit interest rates. Banks are not interested in "bypassing" the limits set on deposit interest rates, as this will reduce the profitability of operations<sup>6</sup>. In any case, the deposit interest rates of each individual bank are public information that may be available not only to the population and businesses, but also to the regulator (the central bank).

In [4] it is shown that the savings elasticity of the interest rate is sufficiently low (at least, for interest rates that exceed the inflation rate). This means that households, when choosing a form of cash saving, not only pay attention to interest rates, but also to other factors. Taking into account that households are usually not inclined to take risks, one of the key factors determining the form of cash savings is the degree of reliability of investments. In addition, a developed banking infrastructure also needs to increase the amount of funds borrowed by the population. Let us show that the establishment of control over deposit interest rates helps to both improve the reliability of banking institutions and develop the banking infrastructure.

As noted above, under the conditions of state control over deposit interest rates, the motives of banks to make highly risky (speculative) investments are reduced. Banks act as long-term financial agents, aimed at establishing partnerships with their clients. As a result, the stability of the financial sector

<sup>5</sup> Tools intended for the control of deposit interest rates were used by many countries at certain stages of development (including the United States (rule Q), Japan, etc.). Currently, however, capital adequacy ratios are used almost everywhere in systems of prudential regulation of banking risks.

<sup>6</sup> In some cases, banks may be interested in setting a higher (compared to the maximum allowed) deposit interest rate, for example, for wealthy clients. However, it is quite obvious that the effect of such measures will be negligible.

increases, the investment risks accumulated by banks decrease, and the public confidence in the activities of financial intermediaries grows. This situation is favorable for banks to attract household savings.

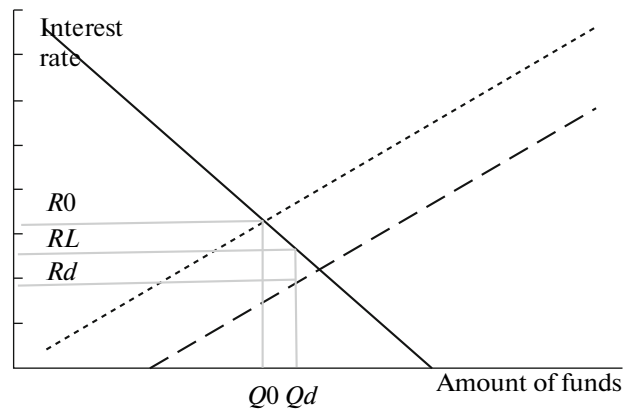
Under the conditions of perfect competition, the interest rate on active operations should be equal to the deposit interest rate. In these circumstances, there is no reason for banks to expand their customer base, since it does not result in additional revenues. In turn, the establishment of control over deposit interest rates will allow banks to increase their revenues by attracting customers. In these circumstances, banks are interested in developing their infrastructure to facilitate the expansion of the customer base (by opening additional branches, conducting active advertising campaign, etc.)<sup>7</sup> [5].

The influence of control over deposit interest rates on the amount of financial savings accumulated by banks is shown in the figure [6]. Establishing control over deposit interest rates ( $R_d$ ) leads to an increase in credit interest rates, which are established in the market. As a result, banks have an opportunity to collect additional profits due to higher interest rates on active operations (relative to the basic level ( $R_0$ )) and a reduction in interest rates on passive operations which allows them to ensure the expansion of their infrastructure (branch networks) and to improve the reliability of investments.

We assume that the effect of increased financial savings as a result of the reliability of banks and the development of the banking infrastructure exceeds the effect of reduced savings due to lower interest rates. In this case, an increase in the financial savings accumulated by banks will lead to a reduction in lending rates already to the  $RL$  level and to an increase in lending from  $Q_0$  to  $Q_d$ .

Of course, the improvement of the efficiency and effectiveness of control over deposit interest rates requires a careful study and implementation of related activities in other areas of economic policy, including changing the dividend policy (restrictions on dividend payments to the shareholders of banks make it possible to avoid the cashing of profits), tightening capital flow control (this will reduce the attractiveness of investments in foreign assets, which are substitutes for bank deposits), etc. It should also be noted that excessive lowering of deposit interest rates (especially, if the maximum allowable interest rate is set below the inflation rate) can lead to a net outflow of money from bank deposits to other financial market segments. In addition, the argument regarding the beneficial effect of control over deposit interest rates on the development of the banking infrastructure only takes place in countries where a large number of households are not involved in the process of saving money in

<sup>7</sup> Of course, in reality, the interest rates on active and passive operations do not coincide. However, this does not fundamentally affect the above arguments.



Supply ----- before and — — after the establishment of control) and demand ——— curves depending on the interest rate;

banks. In developed countries, where the population is quite familiar with bank deposits and widely uses this financial instrument, additional investments in the development of the banking infrastructure are unreasonable from a macroeconomic point of view (since it only leads to greater competition among banks, attracting customers from each other, but is unable to significantly increase the inflow of household funds into the banking system as a whole).

In this connection, it can be concluded that control over deposit interest rates is particularly important for developing countries and countries with economies in transition. In these countries, there is often a regime of capital control, stock markets are underdeveloped, and there are more households (especially in small towns, rural areas, etc.) that do not use the services of financial intermediaries.

**Peculiarities of banking regulation in transition economies.** As shown in [7, 8], the process of liberalization of the banking system, which consists of a consecutive removal of barriers and restrictions in the financial sector, in many developing countries (including Russia) was accompanied by banking crises. There are several reasons for the accumulation of crisis risks, such as a lack of experienced banks in the new environment, shortage of skilled professionals able to adequately assess the risks of new investment products, delay in the formation of a legal framework regulating the activities of financial intermediaries, etc. However, it appears that even a successful solution to these problems in transition economies does not allow them to avoid shocks in the banking system. This is related to the fact that financial liberalization in fact means increasing competition in the banking market, resulting in a decreased level of profitability of relevant activities. Banks that are interested in maintaining (increasing) their income, actively use speculative (high-risk) markets, and this fact promotes the growth in risks in a banking system. The foreign exchange market, government debt market, interbank market, and others can serve as such markets. In fact, the active participation of Russian banks in these markets led to

a crisis in the interbank market in 1995 and a monetary and debt crisis in 1998. In Southeast Asia, before the crisis of 1997, the real estate market and corporate debt had become sources of systemic threat.

Even government statements regarding plans to make transition to a free financial market may trigger the accumulation of risks. Even supposed future liberalization may lead to adjustments by banks of their current investment strategies. The desire to compensate for the expected drop in future earnings due to increased competition increases the interest of banks to invest funds in speculative assets. In this case, the problem of "predatory" behavior of bank management is actualized. Bank managers can make decisions about investments not only in risky, but also in knowingly unprofitable, projects for personal gain.

Thus, to ensure the transition to a free market, stricter banking regulation to prevent the intensification of risks in the financial system is required. In practical terms, this principle is as follows. If the mode of control over deposit interest rates operates in a banking system, then the liberalization of the financial system should be accompanied by a decrease in the maximum allowable deposit interest rate and not by the abolition of control over interest rates. It appears necessary for two reasons. First, a reduction in the maximum deposit interest rate will allow for a reduction in interest costs and incentives for banks to undertake speculative activities. Second, low interest rates provide banks with more opportunities to increase their own funds (capital) from retained earnings. When banks reach a certain level of financial stability, it is possible to weaken control over deposit interest rates.

Banking regulation in a transition period may cover more than only deposit interest rates. For example, it is advisable to introduce a temporary moratorium on the payment of dividends to banks' shareholders. This will enable banks to direct the additional profit, received as a result of control over deposit interest rates, for the replenishment of own funds (capital) and not for dividend payments to shareholders.

It is also necessary to consider that some of the measures of prudential regulation of banking risks should be implemented gradually over a long period of time during which banks will adapt to new conditions. This particularly applies to the capital adequacy ratio. If monetary policy authorities set excessively high requirements for the amount of own funds (capital) and give banks little time to meet these new requirements, it may cause an economic recession. In transition economies, characterized by underdeveloped stock markets and distrust of foreign investors in the activities of banks, banks will be limited in their ability to replenish equity through external financial sources. In addition, increased demand for financial resources will cause their appreciation. To meet the new requirements, banks will be forced to reduce the level of lending activity, sell part of their assets, organize a process of early repayment of loans, etc. As a result, asset

prices will fall, accompanied by the fixation of banks losses; industrial activity will reduce; investment projects will be frozen; unemployment will rise; etc.

Thus, the views concerning the development and implementation of tools of prudential regulation of banking risks, outlined in this paper, imply a need for further studies of banking risk control systems for an analysis of the externalities and side effects associated with different modes of regulation of banking risks, as well as preparation of proposals for the use of prudential tools by monetary policy authorities in a variety of macroeconomic conditions.

## Appendix

### *Influence of the Amount of Equity on Banks' Investment Policies*

Let us consider a bank that has an ability to invest in one of the following classes of assets: risk-free assets with return  $\alpha$  and risky assets that provide return  $\gamma$  with probability  $\theta$  or return  $\beta$  with probability  $1 - \theta$ . It is assumed that the profitability of risk-free assets exceeds the average return on risky assets, but, if the risks associated with risky assets are not realized, the return on such assets exceeds the return on risk-free asset; i.e.,

$$\alpha > \theta\gamma(1 - \theta)\beta, \quad (1)$$

$$\gamma > \alpha. \quad (2)$$

It is assumed that there is a system of deposit insurance. In this regard, clients select a bank based on the deposit interest rate<sup>8</sup> only.

A bank invests raised funds  $D(r)$  and equity  $kD(r)$  for  $T$  periods ( $r$ , deposit interest rate; and  $k$ , the ratio of the own funds (capital) of a bank to its borrowed funds). At the end of the reporting period, the central bank verifies the solvency of the bank. If the bank invests in risky assets and the risks associated with these assets are realized, then the bank will cease to function (i.e., it is assumed that the profitability of risky assets is insufficient to provide benefits to the bank's customers)<sup>9</sup>.

The profit of a bank, which invests in risk-free assets, in a single reporting period is:

$$\pi_p = D(r)\{\alpha(1 + k) - \rho k - r\}, \quad (3)$$

where  $\pi_p$  is the profit of the respective bank in a single reporting period, gained from investing in risk-free activities and  $\rho$  is the cost of the bank's own funds. In [3] it is shown that  $\rho > \alpha$ .

The profit of a bank, which invests in risky assets in a single reporting period, is

$$\pi_p = D(r)\{\theta(\gamma(1 + k) - \rho k - r) - \rho k\}, \quad (4)$$

<sup>8</sup> Due to possible implicit government guarantees, as well as the phenomenon of "too big to fail," this condition is quite realistic, even in case of the absence of a formal (established at a legislative level) system of insurance of bank deposits.

<sup>9</sup> This approach corresponds to practice which is becoming increasingly common in many countries and according to which the Central Bank monitors the systems of internal (developed by banks) methods of risk assessment rather than individual financial operations of banks.

where  $\pi_g$  is the profit of the respective bank in a single reporting period, gained from investing in risky activities.

A bank maximizes total profits for all periods:

$$V = \sum_{t=0}^T \sigma^t \pi_t, \quad (5)$$

where  $V$  is the total amount of profits for all periods;  $\sigma$  is the discount rate; and  $\pi_t$  is the bank's profit in single reporting period  $t$ .

Equation (5) for the case of investing in risk-free assets and risky assets takes the following form, respectively:

$$V_\rho = \pi_\rho / (1 - \sigma) \quad (6)$$

$$V_g = \pi_g / (1 - \sigma\theta), \quad (7)$$

where  $V_\rho$  is the total amount of profits for all periods gained from investing in risk-free assets and  $V_g$  is the total amount of profits for all periods gained from investing in risky assets.

The condition of investing in risk-free assets is that the amount of profit from investing in risk-free assets has to exceed the amount of profit from investments in risky assets:

$$V_\rho > V_g. \quad (8)$$

From expressions (1)–(8), the marginal (maximum possible) deposit interest rate at which a bank invests in risk-free assets can be obtained:

$$\begin{aligned} \bar{r}(k) = & (1 - \sigma)[(\alpha - \theta\gamma)/(1 - \theta)] \\ & \times (1 + k) + \sigma[(1 + k) - \rho k - r]. \end{aligned} \quad (9)$$

With deposit interest rates higher than  $\bar{r}(k)$ , a bank invests in risky assets. The indicated result means that the profitability of investing in risk-free assets does not allow a bank to finance high interest costs and it is forced to form a portfolio of risky assets.

The first summand in equation (9) positively depends on the norm of equity (capital) of a bank ( $k$ ). This means that an increase in equity (capital) allows a bank to invest in risk-free assets at high deposit interest rates. This effect corresponds to a traditional view, according to which an increase in the capital adequacy ratio encourages banks to adopt more cautious (conservative) investment policy.

The second summand in equation (9) ( $\sigma(\alpha(1 + k) - \rho k - r)$ ) negatively depends on the norm of equity (capital) of a bank. This summand describes the effect associated with the growth in costs at an increase in the equity (capital) of a bank: an increase in a bank's own funds—an increase in the value of the resource base—a reduction in profitability—an increase in incentives to conduct risky operations.

The cumulative effects of an increase in the norm of own funds (capital) of a bank on the value of marginal interest rate  $\bar{r}(k)$  is determined from expression (9).

The condition under which an increase in the norm of equity (capital) leads to a decrease in exponent  $\bar{r}$ ,

consists in the negative value of the first partial derivative of exponent  $\bar{r}$  depending on  $k$  (the equity):

$$\partial \bar{r} / \partial k < 0, \quad (10)$$

$$\sigma > \bar{\sigma} = (\alpha - \theta\gamma) / (\alpha - \theta\gamma + (1 - \theta)(\rho - \alpha)). \quad (11)$$

Thus, if a bank is developing an investment policy on a long-term basis (corresponds to the case of large  $\sigma$  values), then the growth in the norm of own funds increases the risks accumulated by the banking system.

If banks form their own investment decisions based on the level of profitability in the nearest future (equivalent to values  $\sigma > \bar{\sigma}$ , then an increase in the norm of equity (capital) increases  $\bar{r}(k)$ , but the extent of this increase is smaller than the traditional view suggests.

Equation (9) allows one to determine the maximum possible interest rate that can be used to establish control over deposit interest rates in the absence of regulatory requirements for the size of own funds (equity) of banks. In this case, the marginal deposit interest rate should not exceed rate  $\bar{r}$  calculated with the amount of own funds (capital) equal to zero.

In fact, the negative impact of an increase in the amount of own funds (capital) on the incentives for productive investment can be even greater than that described by formula (9). The model assumes that the cost of equity (capital) of banks ( $\rho$ ) is a constant variable. However, we can expect that increased requirements of the central bank for the minimum value of equity should lead to growth in the value of equity (capital), as the increase in banks' requirements to attract additional capital in the stock market leads to growth in the risk premium.

Thus, the tightening of the capital adequacy ratio leads to growth in the cost of equity (capital) and, consequently, to an increase in incentives to invest raised money in risky assets.

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