BANK STRESS TESTS, FINANCIAL STABILITY AND SIMULATION OF "FEEDBACK" EFFECT

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Abstract: *Stress testing is one of the main key quantitative tools for assessment of financial stability. In this process, the assets of banks are exposed to the stress of adverse effects of defined shocks derived from historical and hypothetical scenarios. The aim of stress testing is to verify the hypothetical whether the banking sector is sufficiently resistant to the potential effects of adverse shocks and whether it would not be a threat to financial stability in case of their realization.*

This article aims to present the current system of stress testing in the Czech Republic and to define the possible impact of selected scenarios for stress testing on the business of banks and capital adequacy. Banks stress testing may result in pro-cyclical behaviour of the banking sector, which under certain conditions may exhibit the reverse negative impact effect on the economy. In the article we use the basic methodology for calculating capital requirements for stress testing, adjusted by own scenarios of adverse shocks.

Results of our research point to existing pro-cyclical relationship between regulatory rules and trading activities in the banking sector. Tightening of banking regulation creates conditions for a gradual reduction of the economy performance.

Keywords: *Financial stability, Banking regulation, Stress testing, Bank risks, Pro-cyclical behaviour.*

JEL Classification*: G21.*

Introduction

Stress tests are used by central banks and regulators as a tool for testing of the institutions resistance or resistance of the whole sector to adverse development of the economic environment. Although stress testing (particularly financial institutions) is performed for many years, the global financial crisis has revealed in many countries deficiencies in up to now established methodology of used test that failed to indicate the start of undermining of the financial stability of the sector and even more outbreaks of subsequent significant shocks. These shocks exceeded the adverse scenarios which were during their compilation in the test periods seen as very unlikely. Because of these facts regulatory rules are strengthened and continuous innovation of stress testing methodologies are done. These rules relate primarily to capital adequacy of banks.

This article aims to analyse the relationship between stress testing and its reverse impact on the management of the bank. This relationship may, under certain circumstances, affect both the financial institution itself and the entire economic system. Certain measures which are based on the test results of individual banks may cause negative repercussions on economic activity and financial stability.

1 Financial stability and stress testing

The Central Banks define financial stability as a situation where the financial system fulfils its function without any major problems and undesirable effects. It should also show a high degree of resilience to adverse shocks and unexpected operating events. Therefore, indicators of financial stability are established, whose main objective is to provide a picture of the health of the financial sector as a whole. [9]

Mostly tracked and used basic indicator of financial health at the international level is the capital adequacy ratio, which represents the required amount of capital that banks hold in relation to the risks that it incurs and which often result from actual exposure to financial markets. Capital adequacy is the ratio of equity to risk-weighted assets, off-balance equivalents and market risks. Concept of capital adequacy is intended to serve as a tool through which the banks are forced to hold sufficient amount of capital that will serve to the bank as a buffer to coverage of unexpected losses in times of unfavourable development. [1]

The distortion of stability is the result of both internal and external influences that may cause instability and disruption of the overall economic functioning of both the country and the whole financial system. To test the financial stability of banks is used stress testing which measures banking sector exposure, their sensitivity and resistance to risks. [11]

The bank is the bearer of risk, especially because of the fact that the critical part of its assets consist of financial instruments and financial risk is one of three fundamental aspects of the economic content of each financial instrument. ″The financial risk is generally defined as the potential financial loss of a subject that is not already realized or unrealized existing financial loss, but loss resulting from future commodity or financial instrument or commodity or financial portfolio.″ [15]

The main objective is to limit the emergence and spread of the risk which leads at the end into significant losses throughout the economy in the sense of real output, and may also result into disruption of the proper functions of individual cash flows. Therefore are gradually created stress tests, which are designed to reduce the impact of these shocks.

The first form of the stress tests appears at the turn of 1999 and 2000, when was primarily evaluated the adequacy of policies in the field of financial sector from the view of its stability. Over time, its formation war performed, in which was as an essential element in the test models used comparison and evaluation of the capital adequacy of banks to particular date preceding the shocks (initial capital adequacy) and following the shocks (end capital adequacy). [10]

Methods of the capital requirement calculation are divided into several groups according to the instruments held of the banking portfolio. For purposes of this article and generated simulation of stress testing will be used for capital requirement to credit risk. According to Dvorak is this capital requirement most important of them all. It applies to both balance sheet and off-balance sheet assets included in the banking portfolio. [13]

It is calculated according to the following formula:

$$RWA = (A + B) / 0{,}08 \quad (1)$$

where RWA are risk-weighted assets of the bank portfolio, for which applies:

RWA = balance sheet RWA + off-balance sheet RWA, where balance sheet RWA represent Σ (risk asset - adjustment) x risk weight, off-balance sheet RWA represent Σ (credit equivalent of off-balance sheet assets) × risk weight, credit equivalent of off-balance sheet assets = (off-balance sheet asset × conversion factor) - reserves. A shows the value for balance sheet RWA and B shows the off-balance sheet RWA.

Risk-weighted assets are included in the calculations of stress testing, which is formulated as follows:

$$CAR = (C / RWA) \times 100(\%) \quad (2)$$

Where C is the capital after taking into account the negative effects of the credit shock, the RWA is risk-weighted assets after taking into account the negative effects of the credit shock and the CAR is final value of the capital adequacy in per cent. [10]

2 Predictive models

There is wide range of stress scenarios. Each scenario works with various determinations of individual shocks and the risk that is gradually changing. In connection with effects of the global financial crisis and the instability of the overall financial system was reinforcing the importance of monitoring and predicting tools for better preservation of stability of the system. As the starting points for the correct calculations usage are used alternative macroeconomic scenarios, where is the credit risk used most frequently.

Cipra divides the credit risk into various forms. As **direct credit risk** is inscribed the classic risk of loss from a partner's failure (*default*) for the relevant balance sheet items. It is without doubt the most significant financial risk including the banking system in the CR. **Risk of credit equivalents** is described the possibility of the loss from a partner's failure in off-balance sheet items, which are for example provided guarantees, documentary letters of credit, derivatives, etc. **Risk of credit rating change** – it is risk of loss of opportunities from difficult possibility to obtain at reasonable cost financial sources, which is due to a reduction of official credit rating. As **settlement risk** is inscribed risk of loss from the failure of financial transactions in the process of settlement, where the value was supplied to the partner, but the contract counter value from his side is not yet at the disposal. This risk is typical for the settlement of foreign exchange transactions and the purchase or sale of securities. **Risk of credit exposure** refers to risk of loss from excessive credit exposure targeted on certain partners, states, economic sectors, etc. This risk can be reduced for example by introducing so-called credit lines. [7]

Forecast of macroeconomic and financial variables in the stress tests is directly reflected in the forecast of main balance and flow indicators of the banks. For each item in the assets, liabilities, revenues and expenses there is a default (the last truly known) status to which is added / subtracted the impact of shocks within a given

period (this period is typically one quarter). This final state then serves as a baseline for the next period. This logic is repeated in all periods for which forecasts are generated.

In the following simulation model of various scenarios is working with credit risk, which is used for prediction of the main credit risk parameters, especially the value of the probability of default (PD). This is accompanied by the required capital structure and assigned risk weight.

3 Simulation of stress scenarios of feedback effect

Precise identification of the individual shocks and their range is very difficult. For its needs and better representation this article works with credit risk model, which represents the most significant area of stress tests. This is based on the use of PD values for each of the four major segments of the loan portfolio (non-financial enterprises, loans to households for house purchases, consumer loans to households and other loans). The second parameter of credit risk is the loss given default (LGD), which is expertly adjusted in different levels for different scenarios and different credit segments in accordance with the anticipated development of the economy, including real estate prices, regulatory rules, and practices in commercial banks, approaches applied in some existing credit rating agencies and existing estimates based on market data. The third parameter is the exposure at default (EAD), which is also set up expertly.

The multiplication of these three parameters is the expected loss (EL), which leads to a reduction of capital adequacy:

$$EL = (PD \times LGD \times EAD) \tag{3}$$

To simplify the simulation this article works only with credit risk. For the simulation we have chosen four scenarios in which the capital requirement will be changed in individual years. The basic value of the capital requirement is taken from the Czech National Bank report about financial stability, which at the end of 2010 was 128,041 mil. CZK. The proposed shock scenarios represent for future years increase of this requirement in the following values that involve primarily the increased credit risk.

- 1. scenario - an capital requirement increase of 10%
- 2. scenario - an increase of 15%
- 3. scenario - an increase of 20%
- 4. scenario - an increase of 25%

Tab. 1: Capital adequacy in individual scenarios

In millions of CZK	31.12.2010	1.scenario	2.scenario	3.scenario	4.scenario
Total capital requirement	128041	140845	147247	153649	160051
Regulatory capital	240429	240429	240429	240429	240429
Capital adequacy in%	15.02	13.66	13.06	12.52	12.02

Source: Own processing

Change in value of the total capital requirement in each scenario is calculated as the sum of the basic values of the capital requirement, which is credited by percentage increase of capital requirement basic value according to the chosen percentage change in the scenario.

The total capital adequacy ratio is then calculated as the quotient of total RWA and regulatory capital, whereas the RWA is calculated as the quotient of the capital requirement and capital adequacy divided by 100, thus by the value of 0.08.

Even though in the different scenarios the capital adequacy did not fell below the 10% barrier, its reduction may cause the rebound of PD parameter. With this change comes an increase in expected loss, which would be reflected in next economy of the bank. The increase in PD risk parameter can have three main impacts on individual banks:

- For each credit segment are calculated expected credit losses, against which banks will form a new provisions in the same amount and account them on the cost side of income statement as impairment losses.

- To reduce the capital adequacy of the bank and therefore increase of its own PD follows another iteration of negative effects transmission on other banks through an increase of expected losses. These iterations take place until this "domino effect" of interbank contagion does not stop, i.e. until the induced increase of one banks or group of banks PD does not lead to an increase of other banks PD. This is the risk of interbank contagion, which represents the mutual exposures between banks.

- The Bank may try to get at the initial value of capital adequacy by additional measures. This causes a rebound of capital requirement, which causes a further reduction of capital adequacy. This leads to cyclical movement, which is shown below.

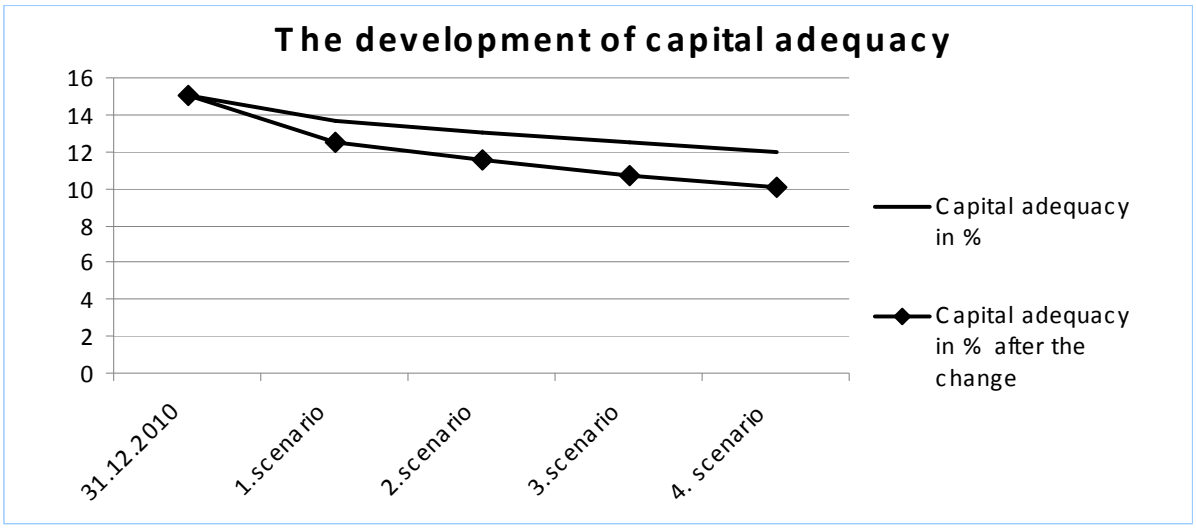
Tab. 2: The capital adequacy after repeated increase

In millions of CZK	31.12.2010	1.scenario	2.scenario	3.scenario	4.scenario
Total capital requirement	128041	140845	147247	153649	160051
Regulatory capital	240429	240429	240429	240429	240429
Capital adequacy in %	15.02	13.66	13.06	12.52	12.02
Total capital requirement after the reduction		153521	166389	179769	192061
Regulatory capital		240429	240429	240429	240429
Capital adequacy in % after the change	15.02	12.53	11.56	10.70	10.01

Source: Own processing

Due to the fact that we are counting in the simulation only with PD, which creates a risk weight of 100% and therefore the only one affects the development, the capital requirement is increased in direct proportion by the percentage that arise as difference between the scenarios. How much was the capital adequacy ratio reduced in %, by the same value again raised the total capital requirement and thus was further reduction in capital adequacy in % realized. This iterative, therefore possibly cyclical development of the capital adequacy reduction is shown on below figure.

Fig. 1: The development of capital adequacy



Source: Own processing

For banks which record profit for the whole year is assumed that in the second quarter of the subsequent year are going to decide about profit distribution. In this point is assumed that each bank will be during possible capital increase realized from

retained earnings from preceding financial year trying to get at the initial capital adequacy, if it profit from previous year suffice. According to RWA development can occur several cases:

- Bank distributes whole profit and reinforce regulatory capital (in case of unchanged RWA);
- Bank will use part of the profit to strengthen capital and part distributes (if the RWA increase, but to even up capital for achieving the initial level not whole retained earnings from previous year will be needed);
- Bank will use the whole profit to strengthen capital (in case RWA will increase quite significantly), while according the RWA increase it may happen, that the original capital adequacy will not be achieved;
- Bank distribute in dividends more than its profit amounted to (in the case of a RWA decrease), which divides also part of retained earnings from previous years. [2]

This process may cause re-creation of reserves to maintain the initial level of capital adequacy. This will reduce the inflow of capital into economic activity, which is best represented by the GDP indicator. To better representation we will use generated simulations of the capital requirement with GDP growth.

For GDP indicator predicting we will use the prognosis of the Czech National Bank, which models the evolution of the GDP indicator using internal statistical methods. In the simulated example are data taken and discrete periods replaced with selected scenarios. The prognosis therefore calculates with the following percentage increases:

- 1. scenario - an GDP increase of 2%
- 2. scenario - an increase of 1.7%
- 3. scenario - an increase of 2.7%
- 4. scenario - an increase of 2%

Tab. 3: GDP in individual scenarios

	2010	**1.scenario**	**2. scenario**	**3. scenario**	**4.scenario**
GDP in billion CZK	3775.24	3850.74174	3916.20435	4021.94187	4102.381

Source: Own processing

In particular scenarios we are working with percentage GDP increase, which are further used in relation to capital adequacy. Prognosis of the Czech National Bank counts in the first and fourth scenario with the same increase. This prediction has been

preserved, because the value entering into the calculation from the previous scenarios is different. The capital requirement thus varies according to each scenario. The resulting difference represents an increase of this requirement, which reduces GDP development by current value in various scenarios. By how much the capital requirement increases by such difference the GDP shall be deduced. In the simulation, there is created an interconnection, where the constant increase of demands for higher capital holdings causes a gradual reduction in performance of the economy.

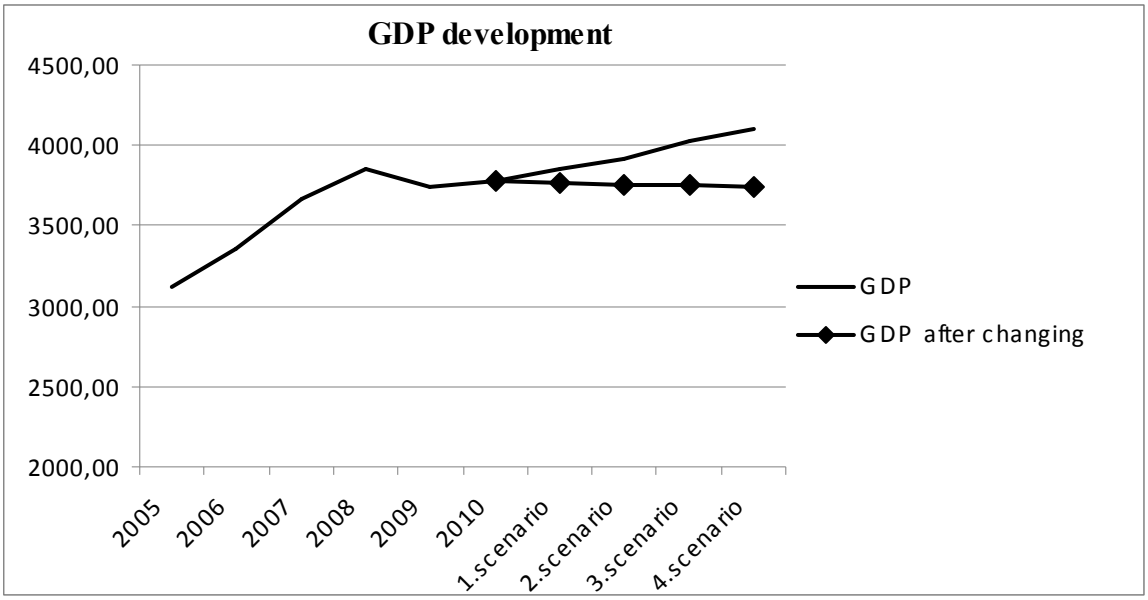
Tab. 4: The interrelation of capital requirement and GDP

In millions of CZK	**31.12.2010**	**1.scenario**	**2.scenario**	**3.scenario**	**4.scenario**
Total capital requirement	128041	140845	147247	153649	160051
Regulatory capital	240429	240429	240429	240429	240429
The increase		12804	19206	25608	32010
The value of GDP in billion CZK	3775	3762	3756	3750	3743

Source: Own processing

To view the development we will use the calculated change in the illustrated charts.

Fig. 2: GDP development



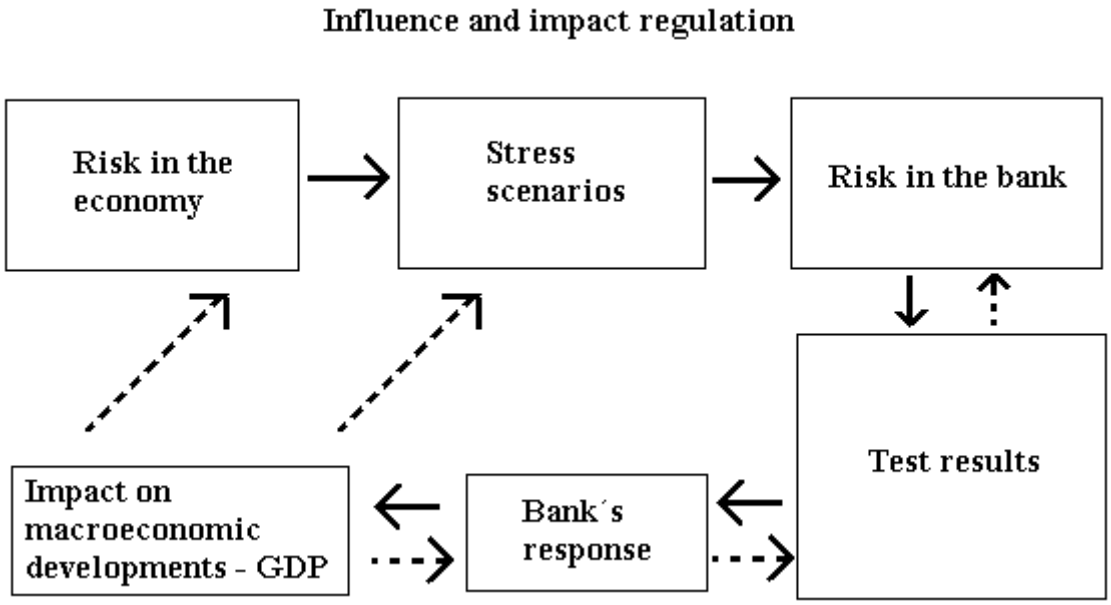
Source: Own processing

Despite the fact that in all four chosen scenarios, the 10% capital adequacy barrier was not broken the decisions of banks and the regulations may affect economic activity.

4 Discussion

Banking regulation may cause a worsening of economic development. Possible effects of stricter regulation on the economic system are shown in Fig. 3.

Fig. 3: Influence and impact of regulation



Source: [8]

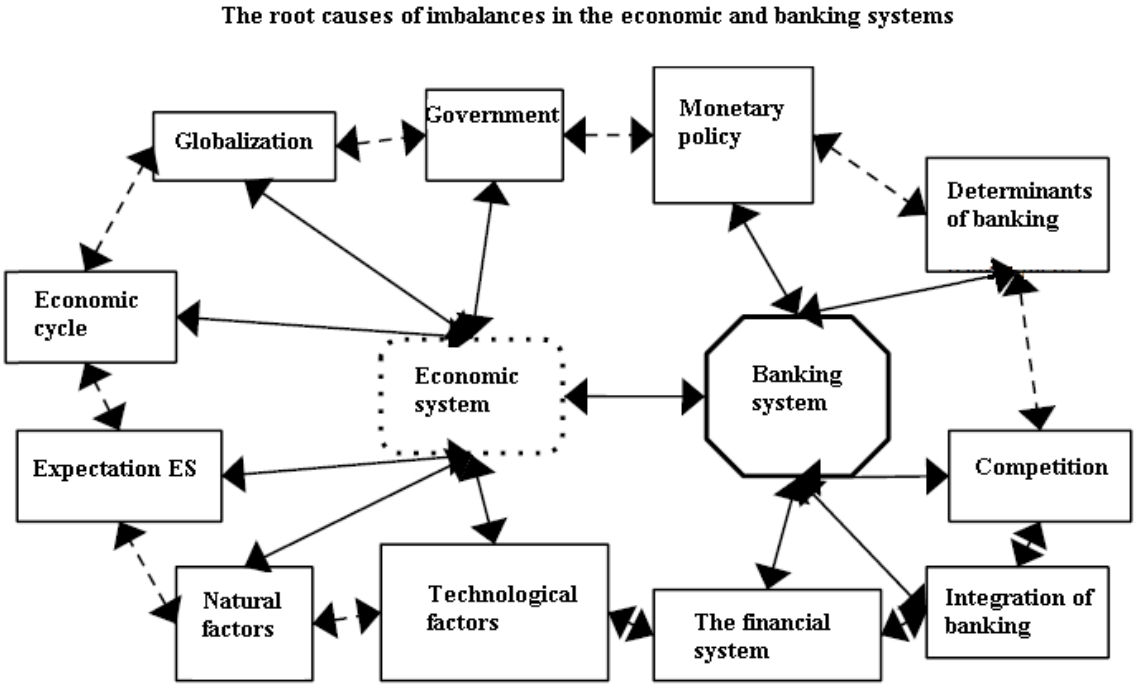
According to the survey of Institute of International Finance, that brings together 400 international banks, rules of banking regulation known as Basel may take in 2015 up to 3 per cent of global economic growth. In Europe, this could lead during this period up to 5 million lost jobs and GDP growth slowed by 4.4 per cent during next 10 years. According to the study requirements for capital adequacy and liquidity, proposed bank taxes and other possible reforms, which are currently being discussed at the international level, could very hardly hit economic growth. Gross domestic product in the United States, Euro zone and Japan should every year until 2015 drop by an average of 0.6 per cent and in the long term view until 2020 by an average of 0.3 per cent, said the institute in a report.

According to McKinsey & Company study the proposed changes to the composition of Tier 1 are likely to cause a severe shortage of capital in the European banking of 700 billion. EUR, which represents a 40% increase in equity Tier I (core Tier I) and in case of adopting the proposed leverage ratio, grow of equity Tier 1 capital will be required by up to 70%. New standards for liquidity are likely to stand for an increase of long-term financing from 3.5 to 5.5 trillion EUR and banks will have to hold another 2 trillion CZK in highly liquid assets. The overall impact on European banks costs are estimated by the study up to 190 billion EUR including 40 billion EUR representing the effect of additional financing costs and 150 billion EUR of necessary costs to comply the proposed capital requirements. Basel III. proposals may result into ROE reduction of 5% (without minimizing effects the banking sector). Banks will

probably have to give up profits in 3 to 4 years. Basel III. rules implementation may have some other negative consequences for example on the interbank market, reduction of lending capacity by 1.2-2.5 trillion EUR and even decrease of the financial system stability. [6]

Ironically, even these enormous costs to increase the banking sector resistance through the growth of capital adequacy are not a guarantee of future stability, because there are many causes which may cause imbalances in the financial system. The basic causes of imbalances in the economic and banking system are listed in Fig. 4.

Fig. 4: The root causes of imbalances in the economic and banking systems



Source: [14]

System of factors that can cause imbalances in the banking sector is complex, complicated, non-quantifiable and very difficult to manage.

In the system is a very close link between economic and banking system, the intensity of these factors is not precisely quantified, is dynamic and often contradictory, which result into unique economic imbalances and inexistence of universal procedures to solve them.

Management of partial imbalances carriers is the responsibility of different authorities, there are market principles and forces that are largely self-regulating, moods and preferences of economic subjects cannot be controlled by anyone as well as for nature shocks. To solve imbalances doesn't exist and even cannot exist comprehensive scientific management methods. In some partial areas are different sophisticated solution that does not always bring the expected results (e.g., banking regulation), whereas efficient and at the same time simple solutions are often ignored (e.g. in excessive indebtedness of countries, companies or individuals).

The system has a variety of political, power and economic interests of prominent world economy countries like the U.S., Europe or China. [6]

The current situation in the capital adequacy of the Czech banking sector is quite favourable, because the sector currently has capital adequacy value, which will be mandatory since 2019.

Effects of the introduction of new and more stringent rules for capital adequacy in the banking sector of the Czech Republic will be minimal. Global risks for financial stability in the Czech Republic can be seen in the following areas: growing unemployment, high debt ratios private sector in Europe, tightening of financial conditions of the banks to households and enterprises, high degree of uncertainty in the financial markets, the development of domestic public finances and fundamental unsubstantiated appreciation of the Czech crown. [5] [12]

Conclusion

The aim of this article was to analyse the relationship between stress testing of commercial banks and its impacts on the performance of the banking sector.

Regulation of the banking sector is primarily based on the calculation of risks and the determination of the minimum level of equity. In the article we use the basic methodology for calculating capital requirements for stress testing, adjusted by own scenarios of adverse shocks. The selected simulation was therefore composed using stress scenarios that dealt with increasing requirements for banks capital. Finding optimum equity is mainly influenced by excessive levels of regulation that may hinder the development potential of the financial and banking sector.

The results of our research have pointed to the possible pro-cyclicality of regulatory rules in the economic system, where increased capital requirement may cause a reduction in the value of GDP. In the simulation thus creates interconnectedness, where the constant increasing demands for higher capital holdings cause a gradual reduction in the performance of the economy.

The article also gives room for further discussion of the study area, where the lack of capital and weakened markets may compel the banks to sell rather better and healthier assets for which they get a fairer price than a weaker assets, of which will not be expressed sufficient interest. This can cause a drop in profitability, the need of follow-up capital increase, decreased willingness to provide new loans and thereby the reduction of economic activity of the entire market.

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