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OVERVIEW OF BASEL III: CHANGES IN RISK MEASUREMENT APPROACH FOR FINANCIAL INSTITUTIONS

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Abstract

This article is reviewing the historical premises of the financial crisis that took place in 2007–8, the reaction of the industry on it (in particular – Basel III framework defined by Basel Committee of Banking Supervision (BCBS)). A high-level analysis of the main changes to the risk assessment approach. Focus is put on the approaches for the market risk measurement, Standardized approach and Internal Model approach definitions are introduced. High level overview of Value at Risk and Expected shortfall methods shared. Various methods to calculate VaR/ES are introduced. Next steps of the ongoing research are defined to outline the overall expected result.

Keywords

Basel III, Market Risk, Financial Crisis, Value at Risk, Expected Shortfall

Introduction

The financial crisis began in 2007 with bankruptcy of mortgage companies in the USA and spread onto the banks, insurers and mortgage companies of European Union. After a short pause in October 2008 the stock indices dropped significantly alongside with the oil price. The USD to Euro exchange rate went up. The global financial crisis spread across the real economy taking over each global financial center [1].

Shortly before this crisis the percentage of the high-risk mortgages hit more than 20% percent. The loans were granted without sufficient due diligence (i.e. borrower's income or assets were not checked appropriately), and there were cases

when they were granted to borrowers with poor credit histories, which allowed the Americans to buy the second or the third house hoping to sell it with premium afterwards (which was promoted in the media as an investment) and this contributed to even further growth of the «bubble» on the market.

However, the prices for the secondary estate stopped growing and selling the real estate was no longer sufficiently profitable.

Thus, many borrowers couldn't afford to make their payments (25-30% for those non-standard credits VS 2-3% for the regular ones) since mostly the only purpose was to re-sell the house or to refinance the house at the lower interest rate.

The number of collateralized debt obligations (CDO – a structured financial product that pools together cash flow-generating assets and restructures this asset pool into discrete tranches that can be sold to investors) greatly increased during the housing-bubble.

As the housing prices declined, the holders (including big financial institutions) of such obligations reported significant losses which made them go bankrupt or being put through government intervention, since the amount of money they had was often not sufficient to fulfill their obligations [2].

On August 2007 the stock market collapsed and hit hard the investment banks. Their average equity-asset ratio was ca. 1:25 – 1:35. On September 2008 Lehman Brothers that by that time was the 4th largest investment bank in the US collapsed. The rest of the top banks, that also underestimated the risks due to allowance of the lower risk-weighted assets for AAA-banks, were sold at the low price (Bear Sterns, Merrill Lynch) or became commercial banks (e.g. Morgan Stanley, Goldman Sachs).

Being "too big to fail" the banks got a huge amount of money from government as a countermeasure; otherwise the new collapse would hit the economy way too hard.

The crisis spread onto European banks since the American CDO's were purchased actively, resulting in bank failures, declines in stock indices, and noticeable reductions in the market.

Unlike the European banks the Russian ones considered the CDO's to be low-income so were not exposed to the issue that much, however situation caused instability of USD that was considered as the "reserve" currency, the outflow of foreign capital and decline in exports which indirectly impacted Russian banks as well. In response to the collapse of Lehman Brothers, the stock prices of various Russian companies dropped, which set the market in a state of the uncertainty and caused further issues [3].

Basel III recommendations are the reaction of the Basel Committee of Banking Supervision (BCBS) on this global financial crisis [4]. This voluntary framework considers the deficiencies in financial regulation, revealed by crisis and tries to establish the basis for the stable banking system.

The framework's implementation was scheduled in 2018, but on December 7th, 2017 implementation schedule was extended until January 1st, 2022.

In a nutshell, BCBS aims to strengthen the requirements on bank's minimum capital ratios, to enhance the quality of the risk management and liquidity and to restrict the leverage ratio and procyclicality [5].

Also, it has been noted by the Committee, that during the global financial crisis the bank's own reports on the risk-weighted assets (RWA) were either misleading or inaccurate and the variability of methods of bank's RWA calculation is worrying. Thus, the new Committee revises the regulatory framework for the calculation of the RWA to restore its credibility.

The most important part of the new framework is the risk management overall since the significant cause of the global financial crisis of 2007-2008 is underestimation of risks. The new approaches and changes for each category of risk calculation have been introduced in Basel III.

This article will cover the main risks categories according to Basel III Framework and will highlight the main changes introduced and methods of approaching those risks.

Problem statement

Considering the all above, also the fact that Russian representative has a place in the Basel Committee on Banking Supervision and the application of Basel framework with partially stronger regulation and country's own specifics, the new version of the Basel framework must be analyzed to be implemented as a mathematical and computing model in the future.

The main goal is to examine the bridge from existing framework to Basel III, a document called "The Fundamental Review of the Trading Book" and then review the new approaches to assess different types of risks given in Basel III, define the requirements on the model's implementation and consider the existing mathematical models that can be applied to this type of problem.

Considering this intent, the primary goal of this review process is to cover the new framework which covers the risk and choosing the most suitable model for research.

The further review will be based on the published documents of the Basel Committee on the Banking Supervision [6] as for theoretical part.

Risk measurement framework defined by Basel III

There are three main types of risks defined in Basel III:

- the operations risks (the risk of a change in value caused by the fact that actual losses, occurred because of inadequate or failing internal processes, people and systems mistakes or from external events, differ from the expected losses);
- the credit risks (the risk of inability to fulfill obligations on a debt that may arise from a borrower inability to make required payment);
- the market risks (the risk of losses in position arising from movements in market prices);

The main changes to the operations risk framework are:

- replacing three old approaches (the basic indicator, the standardized and the advanced measurement approaches) with the unified one;
- improving the risk sensitivity by adding historical data for 10 years;
- simplifying the calculation of the risk-weighted assessment using internal models [6].

Operational risks. The capital requirement equals BIC x ILM, where BIC – Business Indicator Component = $\sum$ (α_i, BI_i). BI – Business Component, which is a sum of the three following components: the interest, leases and dividend component, the services component, the financial component. α_i – is defined in Committee's documents. ILM – internal loss multiplier – which represents a scaling factor that is based on the BIC and bank's average historical losses.

The model of the operation risk is pretty simple and has almost no research possibilities.

Credit risk. There are two approaches for that might be applied by the credit organizations: the Standardized approach and the Internal Ratings-Based (IRB) approach. Applying IRB approach on the capital requirements is considered by the banks themselves. The risks are classified by the Committee and the probabilities of unexpected losses and default are applied. The default risk is estimated either by the bank itself or by the regulatory.

The most banks use the standardized approach, where the banks are given the risks weights by the regulatory.

The changes to the credit risks calculations are: the simplification of the standardized approach (minimizing the dependency on the credit rating) and restricting the usage of the internal models.

Though it is worth to mention that associated models are either simple or pretty well developed.

Market risk. This is the area that has a good research field and is considered to be a subject of further work.

In Fundamental review of the trading book, also known as «Basel 2.5», two approaches to segregate the trading portfolio and the banking portfolio were given: the trading-evidence and the valuation-based approach.

This is an important notion as due to the nature of this portfolios (trading for active trading, probably taking more risk; banking for more long-term investments with less risk) different risk profiles are to be used to assess them. In Basel III the trading-evidence approach was adopted. It is based on the bank's intention to trade the instruments and in the end defines the capital requirement for a position [7].

The main change on market risk is the movement from Value-at-Risk (VaR) towards the Expected Shortfall (ES) approach for calculation of the risk.

VaR of a portfolio is calculated as the largest number such that the probability that the losses in portfolio value over some period is greater than the VaR:

$$\Pr(r_t < -VaR) = \alpha$$

Where $r_t = W_t - W_{t-1}$ – stands for the change in the value of the portfolio for defined time interval.

The Expected Shortfall (ES) is calculated as the expected value of the portfolio loss given a Value-at-Risk exceedance occurred

$$ES = \left[\frac{W_1 - W_0}{Wo} \middle| \frac{W_1 - Wo}{W_0} < -VaR\right] = E[r_{t-1} | r_{t-1} < -VaR]$$

Where $W_t, t = 0,1$ – stands for the value of the assets in the portfolio (and 0 and 1 measure an arbitrary length of time).

Using ES instead of VaR helps to estimate the tail risks. Two portfolios may have the same VaR, but the tail risk, which is out-of-scope for VaR, may be significant. One may say, VaR is how bad thing may get and ES is the losses if the things do get bad.

Two approaches by the Basel Committee were given in the new framework:

– the Standardized Approach (SA)

– the Internal Model Approach (IMA)

The standardized approach is simple, more conservative and depends on the «bucket» (a type) of an instrument. The parameters are pre-defined in the Basel Accord.IMA is flexible yet complex and allows banks use their own model if it will be

approved by the regulatory authority. For the IMA, Basel shares rather the suggestions on how the model should look like (for example, the ES should be calculated daily using 97.5 percentile relying on the last 12 months) though do not define it strictly.

The suggested methods of calculation of market risk being analyzed are:

Variance-covariance method:

Suggesting that the return function has normal distribution and the change in price is linear dependent, VaR is an α-quantile multiplied by volatility for exponentially-weighted moving average:

$$\sigma_t = \sqrt{\lambda\sigma_{t-1}^2 + (1-\lambda)r_{t-1}^2}$$

σ_t — volatility for a day, λ —decay factor, r_t—portfolio return, σ_{t-1} – volatility for the last day.

$$\mathbf{VaR}_{t-1} = -\varkappa(\alpha)_{\sigma_{t-1}}V$$

$\varkappa(\alpha)$ — α-quantile of standardized distribution, V – portfolio value.

Historical method:

The hypothetical time series for the portfolio is created using known data (in most cases – historical market data) and predictions. The data is split into the intervals in which the price increases or decreases. For 99% confidence interval VaR is defined by the price change on 99th percentile [8].

Monte-Carlo method:

Suggesting the distribution, the simulation of the price change is performed. After multiple iterations, the outcome with different market risk variables will generate a CDF which may be used to define VaR [9]. The same methods may be applied to the ES.

So, the problem is that by now there is no understanding of what should be done legislatively to allow financial institutions to implement Internal Model Approach.

At the same time there is a need of creating of numerical algorithms to be used in order to perform the calculation following various methods.

The actual need is also the Implementation of a prototype solution that would allow to calculate VaR/ES on a limited scope of financial instruments using different

methods, comparison of results and peculiarities of different methods (e.g. complexity of implementation / enhancement, demand in hardware resources for required calculations) and its assessment of a full-blown implementation of an enterprise-grade solution in terms of complexity, timelines, costs.

So the further research would be applied on detailed analysis of such a ways and creating of such an algorithms and creating a software for setting the task of Basel III recommendations implementation.

Conclusion

To sum up everything mentioned above it is necessary to stress once again on the next main outcomes of contemporary study:

1. The most important part of the new Basel III framework is the risk management overall since the significant cause of the global financial crisis of 2007-2008 is underestimation of risks. The new approaches and changes for each category of risk calculation have been introduced in Basel III;
2. The new version of the Basel framework must be analyzed to be implemented as a mathematical and computing model in the future (in each country in its own way);
3. It is to be said that market risk is the most important particular branch of the whole Basel III subject area that gives a good research field and is considered to be a subject of further studying;
4. The main change on market risk is the movement from VaR towards ES approach for calculation of the risk;
5. Using ES instead of VaR helps to estimate the tail risks. Two portfolios may have the same VaR, but the tail risk, which is out-of-scope for VaR, may be significant;
6. Two approaches by the Basel Committee were given in the new framework: the Standardized Approach (SA) & the Internal Model Approach (IMA);
7. It is important that when using the IMA (instead of SA, which parameters are pre-defined in the Basel Accord.IMA and allows banks use their own model if it will be approved by the regulatory authority) is more or less defined in Basel, which shares rather the suggestions on how the model should look like;
8. The suggested methods of calculation of market risk are: Variance-covariance method, Historical method & Monte-Carlo method;
9. One may say, VaR is how bad thing may get and ES is the losses if the things do get bad;
10. The problem is that no understanding of what should be done to allow financial institutions to implement Internal Model Approach;

11. Another problem is the of creation of numerical algorithms to be used in order to perform the calculation following various methods;

12. The actual need is also the Implementation of a prototype solution that would allow to calculate VaR/ES on a limited scope of financial instruments using different methods, comparison of results and peculiarities of different methods (e.g. complexity of implementation / enhancement, demand in hardware resources for required calculations) and its assessment of a full-blown implementation of an enterprise-grade solution in terms of complexity, timelines, costs.

Keeping in mind these 12 outcomes of the contemporary study we can set up systematic plan of our further research witch is enclosed in our next step below.

As mentioned above, the focus of further research would be applied on detailed analysis of the ways to allow financial institutions to implement Internal Model Approach.

This analysis will be split in several main parts:

- Review of the approaches proposed for assessment of the Internal Model Approach by the regulatory authorities will be studied;
- Detailed review and comparison of the different methods for calculation of Value-at-Risk and Expected Shortfall;
- Assessment of the numerical algorithms to be used in order to perform the calculation following various methods;
- Implementation of a prototype solution that would allow to calculate VaR/ES on a limited scope of financial instruments using different methods, comparison of results and peculiarities of different methods (e.g. complexity of implementation / enhancement, demand in hardware resources for required calculations);
- Assessment of a full-blown implementation of an enterprise-grade solution in terms of complexity, timelines, costs.

As a result of this work, recommendations on the way Internal Model Approach might be implemented will be defined and shared.

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[1] С английского существительное «hype» буквально переводится как «навязчивая реклама; шумиха, ажиотаж».