THE REGULATION OF CAPITAL REQUIREMENTS FOR MARKET RISK

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Abstract[1]
With a view to guaranteeing the prudential operation of banks, the goal of regulators – besides maintaining adequate levels of regulatory capital – is to see that institutions gain as accurate an appraisal as possible of their risk profile and sensitivity to risk. In some countries, however, calculation of the capital requirement for market risk is based exclusively on the less developed standardized method, since application of an internal model-based calculation would disproportionately increase the capital requirement. In this article we present the evolution of market risk regulation, with special regard to the post-crisis introduction of Stressed Value at Risk into capital calculations. Through the example of the Hungarian equity market, we demonstrate that the diversification discount attainable via internal models only slightly offsets the higher capital requirement arising due to the applicable multiplier, while the additional introduction of Stressed Value at Risk leads to an approximate trebling of the internal model-based own funds requirement. Finally, we examine the principles and effects of the latest direction in regulation, the Basel standard defining minimum capital requirements for market risk that was published in January 2016.

JEL codes: G15, G21, G28, G32

Keywords: Basel regulations, capital requirement for market risk, Stressed Value at Risk, Expected Shortfall (ES)

1. INTRODUCTION

By virtue of their central and specific role in the economy, the stability of financial institutions is critical from the point of view of the economy as a whole. The financial difficulties of individual players in the banking sector may trigger knock-on effects that potentially lead to a crisis within a significant portion of the economy. When banking crises occur at the systemic level, compensating for the capital losses of depositors and banks alike, as well as welfare losses that arise from the lack of provision of banking functions, represent serious costs to society.

1 This article was prepared using Judit Anna Miskó's degree thesis entitled: "The Evolution of Prudent Regulation at Banks: Focus on the Impact of Stressed Value at Risk."

The individual attitude to risk is dependent on several factors and is not constant in time (*Berlinger–Váradi*, 2015), which contributes to the evolution of economic cycles. The task of regulation, therefore, is to oversee the prudent, stable operation of financial institutions, thereby reducing the probability of banks getting into financial difficulties or panic situations developing in the banking sector. Due to the increasing internationalization of financial institutions in the wake of the rapid growth and globalization of the financial sector, the need has arisen for uniform regulation at the international level.

The first step on the road to internationalization of regulation was the creation of the Basel Committee on Banking Supervision (hereinafter: BCBS) in 1974, triggered by a number of serious banking crises. Comprising leaders of national authorities and central banks of individual countries currently responsible for banking supervision in 28 member countries, the body formulates recommendations for the prudent operation of banks, while providing a forum for cooperation on banking supervisory matters. Its goal is to increase global financial stability through strengthening the practice of regulation and supervisory activity. The most important part of the BCBS's activity is to determine prescriptions pertaining to capital requirements. Its recommendations do not carry legal binding force, and individual countries must implement them separately within their own legal systems (BCBS, 2015a).

In 1988, with a view to ensuring the prudent operation and solvency of the banking system, the committee elaborated the accord entitled "International Convergence of Capital Measurement and Capital Standards" (BCBS, 1988), which become known as Basel I. The accord was the first to establish a connection between credit risk and the capital indispensable for safely maintaining operation (Balin, 2008).

Among the most important criticisms directed at the Basel capital accord was the observation that it only took credit risk into account, while its imposition of the same conditions on all institutions failed to stimulate the development of more advanced risk management methods. To remedy this, the Accord was supplemented in 1996 to include prescriptions pertaining to the determination of capital requirements to cover market risk, which, in contrast to the earlier regulations, enabled and even necessitated the application of individual risk management methods. At the same time, Value at Risk (VaR) became known as a measure of risk, opening up a new perspective in the field of risk measurement and the application of internal models.

The next stage in Basel regulation was the Revised Capital Framework published in June 2004, which became known as Basel II (BCBS, 2004). On the one hand, this demands the quantification of additional risk types, while on the other hand showing a significant shift towards a risk-focused, closer association between risk

and the level of capital. The three main pillars of the accord are: (1) the determination of minimum capital requirements with respect to credit risk, market and operational risks; (2) the institutionalization of supervisory review; and (3) the formulation of disclosure requirements.

In response to the banking losses of the 2008 crisis, a series of fresh recommendations were drawn up as supplements that became known as Basel 2.5 (BCBS, 2009). These primarily contain innovations with respect to market risks, introducing Stressed Value at Risk, and affecting securitization and pillars (2) and (3). A comprehensive review of bank regulation is contained in the Basel III recommendations (BCBS, 2010), which reappraise credit risk alongside market risks, and which contain liquidity and systemic risk as new risk factors (*Hull*, 2012; *Walter*, 2016).

In the second part of this article, we present the evolution of market risk regulation and the practice of capital measurement. In the third part, using the example of Hungarian equity market instruments, we illustrate the size of capital requirements under current regulations according to the standardized and internal model-based methods. In the fourth part, we look at the latest regulatory developments and changes that can be expected in future.

2. THE REGULATION OF MARKET RISK

The 1996 amendments were adopted by Hungary with the entry into effect of Government Decree No. 244/2000 (XII. 24) (Kkr.) on the rules for setting capital requirements to cover positions and risk exposures in the trading book, foreign exchange risks and large exposures, as well as detailed rules on maintaining the trading book.

By market risk we mean the risk of changes in value arising from changing market prices of products traded on financial markets – equities, bonds, foreign currencies and commodities. This potential loss represents a risk to banks primarily in the case of securities held for trading purposes, and for this reason the regulations prescribe that the elements of a bank's portfolio held for trading purposes are recorded in the trading book, while traditional banking activities are recorded in the banking book. This division is essential because, among the three market risk categories appearing in the regulations, the capital requirement on the position risk needs to be met only for items on the trading book, while the capital requirements on the commodity and exchange rate risks must be met for the bank's entire position (*Radnai–Vonnák*, 2010). The risk of changes in the prices of debt securities or equities was included in the regulations as a position risk. Within the position risk, the regulator deals separately with the individual risk of securi-

ties, which is determined by the individual characteristics of the debtor or issuer, while risks due to factors impacting the market as a whole appear as general position risks.

2.1 Capital requirements for market risk in Basel II

The regulatory environment essentially offers two methods of calculating capital requirements for market risk: the standardized approach based on regulatory prescriptions, and the internal model-based method built on the results of institutional risk measurement.

2.1.1 Standardized approach

Calculation of the own funds requirement by the standardized approach is based on a strict series of steps established by regulators, which differs in the case of equities or debt securities.

When determining the individual position risk of bonds, the value of the bond must be multiplied by the risk weights differentiated according to the issuer and the time left to maturity. In the case of general risk, two methods can be chosen: the maturity-based and the duration-based calculation methods. In the case of the simpler, maturity-based calculation, the individual instruments must be assigned into bands based on the time left to maturity or until the next fixing of interest, and the value of the position multiplied by the relevant weight of the band. With the duration-based method, the regulator takes into account that interest rate sensitivity depends not on the time left to maturity but on the duration, and consequently bonds in this case are classified into bands depending on their modified duration. A predetermined, hypothetical interest rate change applies to each individual band, with the help of which the value of the potential loss can be quantified. In the case of short and long positions, the weighted positions must be reduced, using the gradual matching methods appropriate to the approach. In the case of equities, the general rule is that the capital requirement for the individual equity risk is the value of the bank's combined gross equity position multiplied by 4%. The capital requirement for general equity risk, meanwhile, is the value of the bank's combined net equity position multiplied by 8%.

In the case of derivatives, prior to quantifying the risk, the transactions must be broken down according to the underlying product types, with these then classified into the appropriate categories. Equity and bond positions originating from derivatives are to be treated together with other equity and bond exposures. With respect to the capital requirement of option transactions, financial institutions may choose whether to apply the (standardized) delta-plus method or the internal model. In the case of the delta-plus method, it is necessary to use the prescribed

method to calculate not only the delta risk of option transactions but also the capital requirement for the gamma and vega risks, while the total risk of the option is modelled under the internal model[2] (Kkr.).

The standardized method only takes correlations between individual products into account to a minimal degree, and for this reason the regulator – subject to the fulfilment of specific conditions – permits financial institutions to calculate the capital requirement for market risks by their own method, based on "internal models."

2.1.2 Own funds calculation based on internal model

When calculating the capital requirement for market risk, in order for credit institutions to be able to make use of the internal model based on Value at Risk, a number of qualitative criteria must be satisfied, of which the most important are: (1) the model must form an integral part of the daily risk management process; (2) the organizational unit dealing with risk assessment must be independent and prepare reports directly for the management with the authority to influence the undertaking of risk; (3) the institution must employ staff with the relevant expertise in the area in question; (4) it must regularly carry out tests in case of unfavourable developments in the market situation; (5) the methods applied must be transparent and well-documented.

Internal models must model the loss distribution arising from risk, and for this: (1) daily calculations of Value at Risk must be made; (2) when making the calculations, a 99% reliable, unilateral confidence interval must be applied; (3) a minimum 10-day holding period is required; and (4) the observation period must be at least one year. In addition, (5) the database used for the calculations must be reviewed whenever there is a significant shift in market prices, but at least quarterly (Kkr). Furthermore, back-testing must be carried out in order to check on the accuracy and applicability of the model.

The regulations do not specify which model must be applied to produce the loss distribution, so that this may differ from bank to bank. Of applicable measures of risk, the Value at Risk measure that became most widespread from the mid-1990s was incorporated into the regulations, where the capital requirement (c) calculated according to the internal model will be equal to the larger of the previous day's Value at Risk (VaR_{t-1}) and the average Value at Risk calculated for the preceding 60 days (VaR_{avg}) multiplied by the multiplication factor (m_c):

$$c = \max\left(VaR_{t-1}; m_c \times VaR_{avg}\right) \tag{1}$$

2 The modelling options for risks appearing in various derivative products are presented by Medvegyev and Száz (2010).

The correction factor m_c incorporates the errors and overshootings committed by the model into the formula. Its minimum value is 3, which may rise to as much as 4, depending on the number of errors committed in the 250 days prior to the calculation.

The Value at Risk is the fixed quantile of loss distribution, its two important parameters being the time horizon for which we prescribe the distribution of losses and the significance level that determines the percentile iself. In the regulation of market risks, therefore, the 99% percentile of a loss distribution prescribed for a 10-day time horizon is the basis for the capital formation. The size of the multiplication factor is justified by the model risk. Based on Chebyshev's inequality, it can be shown that the value obtained with the multiplier of 3 signifies a robust upper barrier, even if the model specification is wrong (*Jorion*, 2007).

The modelling of loss and the prescription of the loss distribution, therefore, is the most important step in measuring risk. Essentially two different approaches can be applied to determining the loss distribution: directly from historical data or assuming some kind of distribution (usually normal), or by generating future losses via a Monte Carlo simulation. In internal models, the correlation between individual sources of risk is also to be modelled,[3] and the risk reduction deriving from diversification can also be quantified.

The reason for the spread of Value at Risk as a measure of risk is that it quantifies the downside risk with a single figure, and is extremely simple to interpret. The most important criticism against it, which already appeared at the start of the millennium, is that it does not take into account losses beyond VaR, so that it provides no information on the magnitude of really unfavourable outcomes. In the case of the fat-tailed distributions typical in reality, this leads to the underestimation of risk. Another significant shortcoming is that it does not meet every one of the coherence criteria formulated by *Artzner* et al. (1999), and does not always guarantee that the maximum portfolio risk is the sum of the risk of individual portfolio elements.

These problems were thrust into the spotlight particularly as a consequence of the crisis, to which regulators responded with the Basel 2.5 and Basel III recommendations.

2.2 Changes based on Basel 2.5

The Basel 2.5 recommendations were incorporated into European regulations with the adoption of Directive 2010/76/EU of the European Parliament and of the Council of 24 November 2010, with which the Hungarian legislation complied via the

3 For example, by revealing the underlying factor structure, as presented by Berlinger and Walter (1999).

adoption of Government Decree No. 348/2011 (XII. 30). This government decree comprised the appropriate supplements to the relevant regulations of the Kkr., which became void when the supplements entered into effect on 1 January 2012.

The Basel III recommendations, aimed at a comprehensive transformation of the regulations, were embodied in Regulation (EU) No. 575/2013 of the European Parliament and of the Council on prudential requirements for credit institutions and investment firms (Capital Requirements Regulation, CRR), and Directive 2013/36/EU on access to the activity of credit institutions and the prudential supervision of credit institutions and investment firms (CRD IV). The regulation (CRR) immediately became valid in all member states of the EU, and thus in Hungary, so that it did not need to be implemented through separate domestic legislation, and – with its entry into effect on 1 January 2014 – invalidated Government Decree No. 244/2000 (XII. 24) previously regulating market risks.

The 2012 amendment of the Kkr. only slightly modified the rules for calculating the capital requirement for market risk by the standardized method with respect to equities, with the capital requirement on individual position risk changing to 8%. The change in the calculation of position risk on bonds was justified by the difference in the capital requirement between positions recorded in the trading book and in the banking book. The capital requirement arising from individual risk on bonds cannot be less than the capital requirement for credit risk of the position recorded in the banking book.

The rules for own funds requirements according to the internal model changed substantially. The 2012 amendments permit not only the general position risk, but also individual position risk to be calculated based on the internal model. One of the main lessons from the crisis was that a risk calculated from a loss distribution calibrated on the basis of figures from a period of calm significantly underestimates the potential losses. Consequently, credit institutions applying the internal model have to calculate not only the Value at Risk as they have done so far, but also a Stressed VaR, based on a 250-day past stress period. In this way, the size of the capital requirement is a combination of the two Values at Risk, where the minimum correction factor of 3 is to be applied to both VaR figures. The capital requirement is thus:

$$c = \max\left(VaR_{t-1};\, m_c \cdot VaR_{avg}\right) + \max\left(SVaR_{t-1};\, m_s \cdot SVaR_{avg}\right). \tag{2}$$

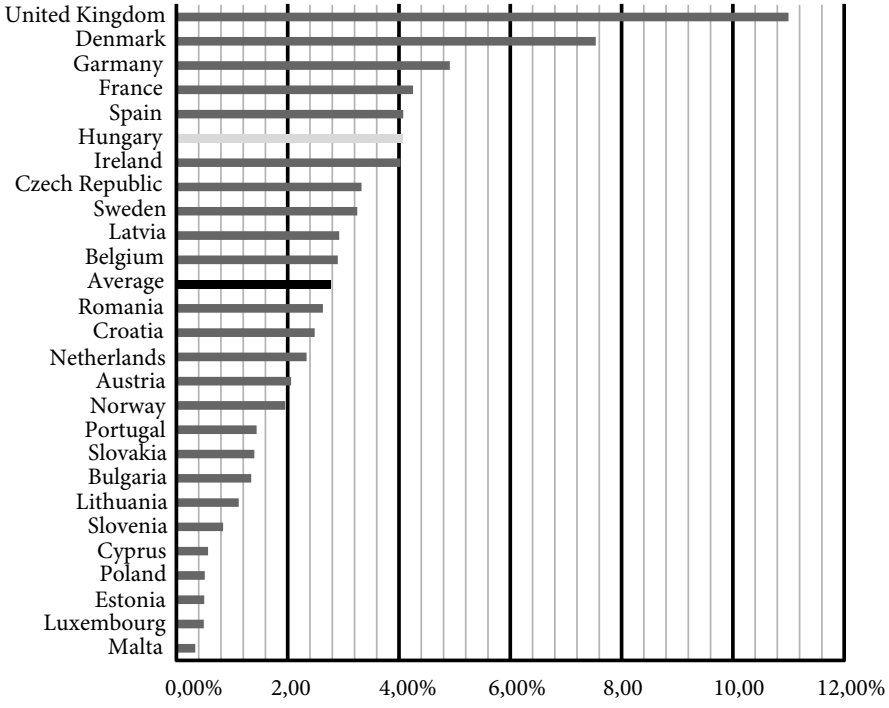
The first part of the right side of the equation is the same as the right side of equation (1), while the second part is the larger of the following two values: the previous day's Stressed Value at Risk ($SVaR_{t-1}$) and the average Stressed Value at Risk for the preceding 60 days ($SVaR_{avg}$), multiplied by a correction factor (m_s) which, depending on back-testing of the stressed model, can assume a value of between

3 and 4. Given that the size of the Stressed Value at Risk is always greater than (or equal to) the normal Value at Risk, the capital requirement according to the new calculations is a minimum double of the value prior to introduction of the new rules.

2.3 Capital requirements for market risk in practice

The proportion of capital set aside for market risks is small compared to the total capital requirement for risks under Pillar 1. *Figure 1* shows the specific values applying to credit institutions in 26 European countries, plus the average, according to aggregate statistical data from the European Banking Authority (EBA) from 2013.

Figure 1
The proportion of the capital requirement for market risk within the combined capital requirement under Pillar 1

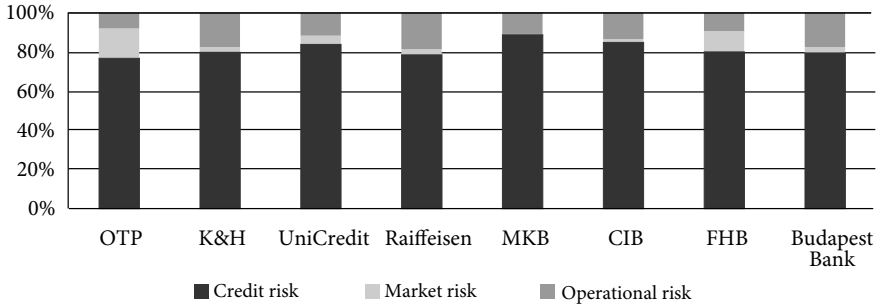


Source: EBA, own design based on 2013 data[4]

4 http://www.eba.europa.eu/supervisory-convergence/supervisory-disclosure/aggregate-statistical-data

The unweighted average amounts to 2.78%, so that the Hungarian value of 4.06% can be regarded as considerably above average, being the sixth highest among the examined countries. *Figure 2* shows the distribution of Pillar 1 capital requirements by type of risk in the year 2014 for the eight banks in Hungary with the largest balance-sheets that keep trading books.

Figure 2
Distribution of Pillar 1 capital requirements at eight largest banks in Hungary

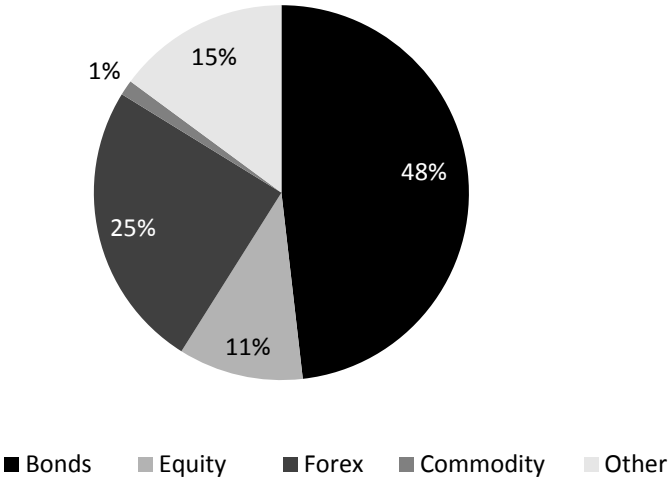


Source: own design, based on figures published according to CRR and the Act on Credit Institutions (Hpt.)

The sources of the data are the annual reports published by individual banks in accordance with the disclosure requirements institutionalized as Pillar 3 of the Basel recommendations.

The capital requirement for market risk pertains in the largest part to the position risk on debt securities and equities, as well as forex risk. *Figure 3* shows the distribution with respect to the year 2013 at credit institutions in the aforementioned European countries.

Figure 3
Distribution of capital requirements for market risk by instruments



Source: EBA, own design based on 2013 data

According to the EBA statistical data for 2008,[5] credit institutions in nine European countries calculate their capital requirements under Pillar 1 exclusively using the standardized method. These countries are Bulgaria, Cyprus, Estonia, Lithuania, Latvia, Malta, Poland, Portugal and Romania. In 2013, the circle of countries exclusively applying the standardized method expanded to include Slovenia and Hungary, while some credit institutions in Portugal converted to internal models.

The bias towards the standardized method is unequivocally due to the size of capital requirements that result from the use of internal models. Although the standardized method is simpler in terms of the necessary calculations, this is only a secondary factor, since most banks apply VaR-based models to measure the risk of instruments affected by market risk, and yet they still calculate their capital requirements based on the standardized method.

In the following section we present some calculations in support of this.

3. ANALYSIS: CAPITAL REQUIREMENTS FOR EQUITY PORTFOLIOS

In the following, we present calculations for the general position risk on equities, using the example of some listed Hungarian equities. We examine to what extent capital requirements have been modified by regulatory changes applying to the

5 http://www.eba.europa.eu/supervisory-convergence/supervisory-disclosure/aggregate-statistical-data

use of internal models and the introduction of Stressed Value at Risk, and we compare these results with the capital requirements according to the standardized model. We do not model the individual position risk, making the assumption that credit institutions always calculate this according to the standardized method.

3.1 The calculation procedure

The subjects of the investigation are the four individual shares that are the leading premium-category stocks traded on the Budapest Stock Exchange (BÉT) – OTP, MTELEKOM, RICHTER and MOL – as well as two equity portfolios. The "A" portfolio contains the aforementioned four shares, while the "B" portfolio, besides these four blue chips, includes four additional shares: RABA, ZWACK, ANY and GSPARK.

When making calculations, we took the effective returns based on the daily closing prices of the shares[6], taking 31 March 2016 as the date of the analysis.

We calculated the capital requirement by the internal model according to formula (1) prior to quantification of the stressed risk, as well as to the currently valid formula (2). The parameters to be calculated are:

a) the previous day's Value at Risk (VaR_{t-1}),
b) the average of Value at Risk figures for the preceding 60 working days (VaR_{avg}),
c) the latest Stressed Value at Risk ($sVAR_{t-1}$),
d) the average of Stressed Value at Risk figures for the preceding 60 working days ($sVaR_{avg}$),
e) the multiplication factor deriving from back-testing of the original model (m_c),
f) the multiplication factor deriving from back-testing of the stressed model (m_s).

We determined the Value at Risk by the parametric delta-normal method, assuming a normal distribution of the risk factor (daily effective return). The Value at Risk expressed as a percentage is:

$$VaR(\alpha, t) = (\mu + \sigma \cdot N^{-1}(1-\alpha)) \cdot \sqrt{t}\ , \tag{3}$$

where the alpha (α) probability is the 99% demanded by the regulations, while the holding period (t) is 1 day. Besides these inputs, we also need the expected returns and volatilities, which we have estimated based on available historical data from the preceding 250 days. In accordance with the rules, we converted the one-day

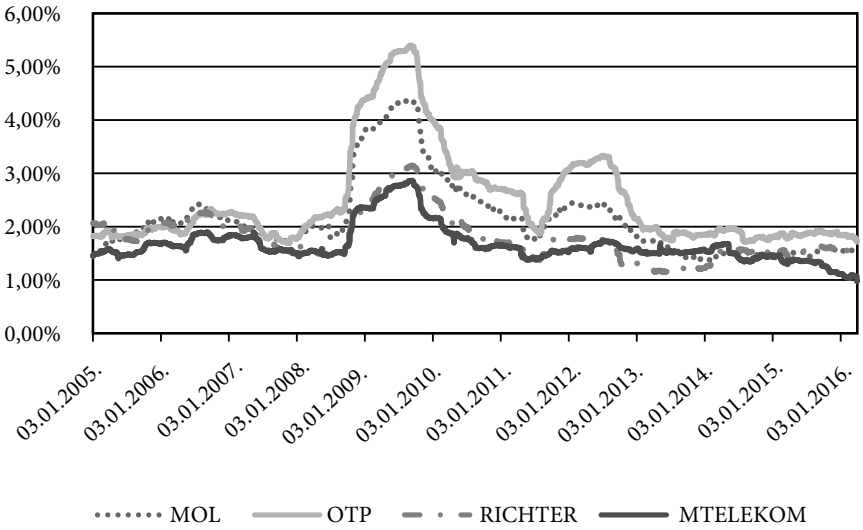
6 The source of the data is *portfolio.hu*.

VaR figures into 10-day values by multiplying them by the square root of 10. In a similar way, we determined the Value at Risk for the preceding 60 days, and took the average of this.

We chose the 12-month stress period for the equity market, needed for the determination of the Stressed Value at Risk, in accordance with the EBA (2012) recommendations, applying both expert and formula-based methods together.

The volatility of daily returns on individual shares is shown in *Figure 4*, calculated based on data from the preceding 250 days.

Figure 4
Historical daily volatility of single shares, 2005–2016



Source: own calculations and design

The leap in historical volatility is clearly visible in the period around 2008–2009, in response to the financial crisis. For this reason, we chose the historical one-year period between 03.11.2008 and 03.11.2009 as critical for equities, calculating the stressed parameters on this basis. We calculated the Stressed Value at Risk based on formula (3) using the stressed parameters.

We conducted back-testing, examining how many times VaR overshootings occurred in the preceding 250 days, i.e. how many times the actual daily loss exceeded the VaR of the previous day. Depending on the results of the back-testing, we determined the value of the multiplier factors relevant for the capital requirement. We found Stressed VaR overshootings only in exceptional cases, so that the value of the stressed multiplication factor remains at the minimal level.

We examined two kinds of weighting of individual equities within the portfolios: firstly, both portfolios contained an identical quantity (number of pieces) of the constituent equities (price-weighted), and then we examined a portfolio constituted with minimum variance in the possible set of given equities over the period (minimum variance).

The Value at Risk of the portfolios was likewise determined by the delta-normal method. Here we assumed normality of the joint distribution of stock returns, with parameters – similarly to individual shares – calibrated based on data from the preceding 250 days, with the help of the historical portfolio average and historical covariance matrix. To determine the Values at Risk of past periods, we refreshed the covariance matrix every 10 days. The stress period was the same as that used for individual shares.

The argument against applying a normal distribution is its too rapid falloff, meaning that the probability of the extreme values essential from the point of view of risk management – and thus the risk – is underestimated. Back-testing focuses on one side, examining the suitability of the model exclusively on the loss side. We therefore also examined the acceptability of our applied model with a two-sided test. The results of the Kupiec test[7] to check the significance of VaR overshootings are contained in *Table 1*.

Table 1
Testing the models on single shares

	Alpha	Number of observations (*n*)	Number of overshootings (*m*)	Proportion of overshootings (*m*/*n*)	Result of Kupiec test
MOL	0.99	250	1	0.40%	
RICHTER	0.99	250	5	2.00%	1.96
OTP	0.99	250	1	0.40%	
MTELEKOM	0.99	250	2	0.80%	
"A" portfolio	0.99	250	5	2.00%	1.96
"B" portfolio	0.99	250	3	1.20%	0.09

Source: own design, based on own calculations

The Kupiec test is a Chi-square distribution test, with one degree of freedom, where the critical value at a 95% significance level is 3.84. Given that the test statistic is smaller than the critical value for all examined instruments, the applied methodology can be accepted.

7 A description of the methodology can be found in Jorion (2007) and Hull (2012).

3.2 Results

Table 2 shows the results obtained for individual shares: the individual parameters; the internal model-based (IMB) value of the capital requirement calculated using these parameters in accordance with the previous Basel II regulations, which does not yet contain the surplus capital requirement induced by the Stressed Value at Risk; and the total capital requirement introduced by Basel 2.5, which does contain the latter surplus requirement. The percentage values are always to be understood as proportions of the portfolio value.

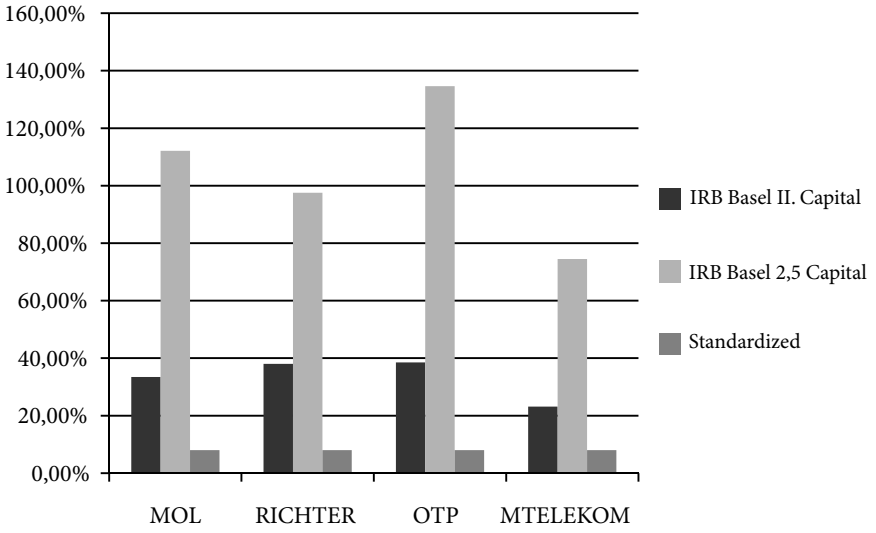
Table 2
Capital requirement for single equity positions

	MOL	RICHTER	OTP	MTELE-KOM
VAR_{t-1}	11.16%	11.25%	12.28%	7.06%
VAR_{avg}	11.15%	11.18%	12.85%	7.72%
$sVAR_{t-1}$	26.11%	19.89%	32.23%	17.16%
$sVAR_{avg}$	26.23%	19.83%	32.02%	17.12%
m_c	3.0	3.4	3.0	3.0
m_s	3.0	3.0	3.0	3.0
IRB Basel II capital	**33.45%**	**38.02%**	**38.55%**	**23.16%**
IRB Basel 2.5 capital	**112.15%**	**97.52%**	**134.62%**	**74.50%**

Source: own design, based on own calculations

We can see that for single asset portfolios, introduction of Stressed Value at Risk substantially increases the capital requirement for the general position risk on equities for institutions applying the internal model. *Figure 5* illustrates that for portfolios consisting of a single share, the capital requirement adjusted by the Stressed Value at Risk is 2.5–3.5 times greater than the value calculated without it under the earlier regulation. Moreover, if we compare the results to the 8% value prescribed under the standardized method, then internal models prescribe 9–17 times greater own capital, causing an unjustifiably large discrepancy.

Figure 5
Capital requirement for general position risk on single shares



Source: own design, based on own calculations

In the case of single shares, the capital requirement for general position risk may exceed even the value of the entire position. The application of internal models was already unattractive since it is generally not in the interests of credit institutions to adopt rules that result in a higher capital requirement, and the introduction of the Stressed Value at Risk counted even more against methods resulting in a more advanced measurement of risk.

The advantage of internal models in being able to capture the diversification effect among various instruments cannot be felt in the case of single shares. To examine this effect, we calculated the capital requirement for the general position risk on portfolios. *Table 3* shows the results for the four-equity "A" and eight-equity "B" portfolios, in price-weighted and minimum variance compositions.

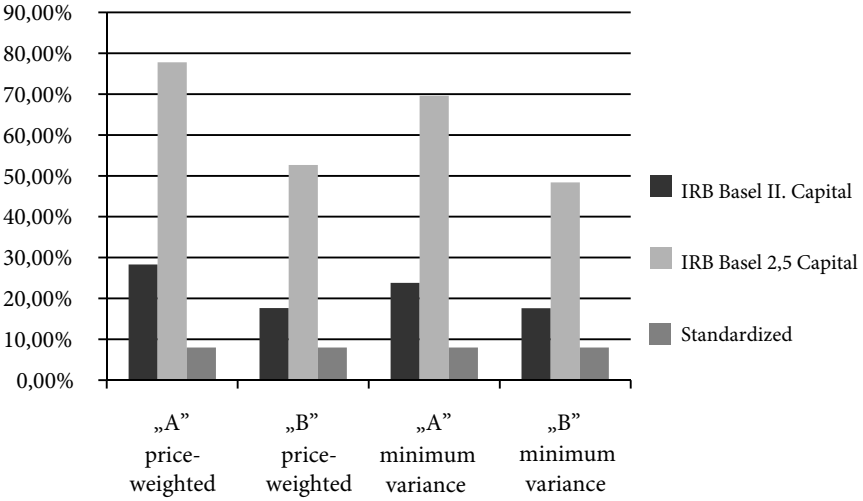
Table 3
Capital requirement for equity portfolios

	"A" price-weighted	"B" price-weighted	"A" minimum variance	"B" minimum variance
VAR_{t-1}	9.28%	6.41%	6.47%	4.01%
VAR_{avg}	8.33%	5.88%	6.80%	4.40%
$sVAR_{t-1}$	18.60%	12.73%	15.26%	10.33%
$sVAR_{avg}$	16.49%	11.67%	15.27%	10.27%
m_c	3.40	3.00	3.50	4.00
m_s	3.00	3.00	3.00	3.00
IRB Basel II capital	**28.31%**	**17.65%**	**23.81%**	**17.59%**
IRB Basel 2.5 capital	**77.79%**	**52.65%**	**69.62%**	**48.40%**

Source: own design, based on own calculations

Although diversification mitigates the disadvantage of internal models, the capital requirement is still six times the standardized method even in the case of the most favourable eight-equity "B" portfolio at minimum variance. *Figure 6* shows the result of calculations carried out for the individual portfolios and the proportion of capital required by the various methods compared to the value of the portfolio.

Figure 6
Capital requirement for general position risk on equity portfolios



Source: own design, based on own calculations

Further nuance to the analysis could be provided by supplementing the portfolios with foreign shares, but Hungarian banks typically do not hold such assets. It is clear that, although internal models would be well suited to measuring institution-specific risk and determining the appropriate capital requirement, the size of the capital requirement according to the standardized method is so much more favourable that there is no incentive for institutions to calculate according to the more advanced method. Naturally individual institutions do employ Value at Risk-based models; however, these serve internal information goals and are not tools for calculating capital requirements.

4. THE FUTURE OF REGULATION

As we have shown, the management of market risk is in need of change, and in this light a consultation process between banks and the Basel Committee was launched in 2012. Based on three consultative documents affecting the trading book,[8] the committee's latest set of standards pertaining to market risk appeared in January 2016 under the title "Minimum capital requirements for market risk" (BCBS, 2016). The most important changes are set down in the document under the following five points:

(1) A revised internal models approach (IMA).
(2) A revised standardized approach (SA).
(3) A shift from Value at Risk (VaR) to Expected Shortfall (ES), the new measure of risk in risk management.
(4) Incorporation of the risk of market illiquidity into the regulatory capital requirement.
(5) A revised boundary between the trading book and the banking book.

Besides placing great emphasis on the expansion of the supervisory authorities' licence to act, and on limiting regulatory arbitrage opportunities, the new regulations radically transform the rules for calculating capital. The changes aim to remedy the huge difference, contained in the current regulations, between the calculation of capital by the internal models-based approach and calculation by the standardized method, on the one hand by strengthening the connection between the two methods, and on the other hand by improving the standardized method.

8 Fundamental review of the trading book, May 2012.
Fundamental review of the trading book: A revised market risk framework, October 2013.
Fundamental review of the trading book: Outstanding issues, December 2014.

4.1 Changes to the internal models approach

The most important change in the internal models-based approach is that, recognising the limitations of the VaR measure of risk applied thus far, the regulations switch to calculating based on Expected Shortfall (ES). The new risk measure, which is also recommended by *Acerbi* and *Tasche* (2002), is basically the expected value of the given percentage worst outcome. The Expected Shortfall is therefore likewise loss-based, but suitable for quantifying losses beyond the threshold value, while also meeting all requirements expected of a coherent risk measure (*Artzner* et al., 1999), and see also *Csóka* (2003) and *Csóka* et al. (2007) on the same topic). A similarly important beneficial feature is that it is much harder to manipulate (*Kondor*, 2014). In the event of a continuous distribution, it corresponds to the Conditional Value at Risk (CVaR), which is the expected value of losses beyond the amount of VaR; however, if the likelihood of occurrence of the threshold value (VaR) deviates from zero, then the weight of the threshold value is determined by calculating the expected value for precisely a given percentage of the distribution. Instead of the 99% reliability level determined in the case of VaR, the prescribed threshold with respect to ES is 97.5%, so that the basis for the calculation is the expected value of the worst 2.5% of losses. The minimum value of the corrective multiplier factor applied in internal models is 1.5, which may rise to 2 depending on the outcome of back-testing of the 99% Value at Risk.

Based on all this, a significant shift has occurred in the philosophy of regulation, since there is a need for much more accurate prediction of extreme occurrences (tail losses), and thus of risks. However, it is important to note that if we assume the normality of the return distribution, then Expected Shortfall, as a new risk measure, differs from the hitherto applied Value at Risk merely in its use of a constant multiplier. The threshold value incorporated into the regulations also reflects precisely this conversion ratio, as the 99% percentile VaR corresponds to the expected value of the worst 2.5%, so that even this more advanced risk measure does not provide us with any more information.

In addition, it is also worth noting that even the Expected Shortfall does not resolve the problem of portfolio selection and risk management whereby multidimensional statistical models that serve to manage a typically large number of bank instruments – due to the relatively small number of usable data – contain a huge estimation error (*Kondor*, 2014).

Another significant new element of the regulation is that, instead of the uniform 10-day liquidity period, risk type-dependent time horizons of 10–120 days are to be applied.[9]

9 An alternative method of handling market liquidity might have been to apply some kind of liquidity-adjusted risk measure, which is recommended by Madar et al. (2016).

4.2 Changes to the standardized method

Changes affecting the standardized method, which has remained unchanged almost since its introduction, fundamentally transform the system of capital calculation. The BCBS outlined two paths to the expansion of the standardized method: the cash flow-based and the sensitivity-based approaches (BCBS, 2014). The essence of the cash flow-based method is breaking down instruments into cash flows which then serve as inputs for further calculations. In the sensitivity-based approach, on the other hand, banks must supplement their calculations with a sensitivity analysis pertaining to prices and returns. The BCBS judged that the latter method is simpler and more cost-saving to introduce, so that the new regulation has been created based on this principle. The new standardized method presupposes that the bank pricing models serving to calculate the outcome can adequately handle all market risks, and consequently are suitable as the foundations of risk management as well.

Capital according to the standardized method is comprised of three components: sensitivity-based capital charges, default risk charge, and residual risk add-on. Items in the trading book are to be assigned to 7 risk classes: general interest rate risk; credit spread risk non-securitization; credit spread risk securitization (not correlation trading portfolio); credit spread risk securitization (correlation trading portfolio); equity risk; commodity risk; and foreign exchange risk. The three elements of sensitivity-based risk capital are capital calculated for delta and vega risks, supplemented – in the event of instruments with option features – with capital to be calculated on risk deriving from curvature. The delta and vega risks are prescribed by the regulations dependent on risk factors and sensitivities that impact individual risk classes. No risk reduction due to diversification can be taken into account among the individual risk classes, while it is necessary to prepare for the possibility of changing correlations within the risk classes, so that capital must be calculated based on the one of three different scenarios (high, medium and low correlation) that results in the highest capital requirement.

Default risk capital, which corresponds to an individual risk under the present regulation, is to be calculated for every instrument exposed to default risk, and in accordance with the default risk of instruments on the banking book, so that the possibility of different capital requirements for similar exposures is eliminated.

Given that the standardized method contains explicit rules for capital requirements for various individual instruments, other sources of risk may be omitted from any detailed description. For this reason, the residual risk add-on is introduced as a third risk charge element, the goal of which is to provide adequate protection against potential further risks. The regulations distinguish two types: risks associated with exotic basic products, and other residual risks.

4.3 The impact of the new regulations

To assess the impact of the new rules, the Basel Committee carried out an impact analysis, questioning 78 banks based on data from the end of 2014 (BCBS, 2015b). The answers of 44 banks proved suitable for analysis, from which the following conclusions were drawn:

- As a consequence of the planned changes, the entire capital requirement would increase by 4.7%.
- The growth in the capital requirement for market risk would be 74% with respect to the weighted average, and 41% based on the simple average (weighting based on market risk-weighted assets).
- In the case of internal models, the growth would be 54% (simple average, containing not only the impact of introduction of the ES methodology, but other factors as well).
- In the case of the standardized method, the growth would be 128% (simple average).
- Based on a significantly smaller sample (9 banks), the capital requirement according to the standardized method would be 8.91 times that calculated by the internal model.

In interpreting these results, it should be noted, on the one hand, that major discrepancies appear among the individual banks; and on the other hand that, prior to the appearance of the new rules, the value of the multiplier used in internal models was not yet known, so that it was assumed for some questions as 1, and for others as the current 3.

All this being given, it can be seen that the capital requirement according to the standardized method can be expected to grow (to about double the amount), for which the bulk of credit institutions that calculate using this method must prepare.

Individual legislatures must implement the modified standards for managing market risks by January 2019, while credit institutions must report under the new rules from the end of 2019.

5. SUMMARY

Although capital for the coverage of market risk makes up a comparatively small proportion of the capital requirement under Pillar 1 (on average 5% among the examined Hungarian banks in 2014, 4.06% nationwide in 2013, and 2.78% in Europe as a whole), this area of banking activity carries significant risk, and consequently

it is important to quantify and manage this risk appropriately and accurately.

In this article we have presented the evolution of regulation of market risk, as well as the currently valid methodology. The bulk of credit institutions calculate their capital requirement for market risk based on the less advanced standardized method that does not require risk modelling, bolstered by the annual reports of major Hungarian banks and data from the European Banking Authority. The reason for this is clearly that the capital requirement calculated in this way is but a fraction of the capital requirement according to internal model-based capital calculations, a discrepancy that was further deepened by modifications in the wake of the crisis, which introduced Stressed Value at Risk into capital calculations.

To illustrate this, we carried out Value at Risk-based calculations for individual shares and equity portfolios, comparing the Pillar 1 capital requirement for the general position risk on equities according to the various methods. In the case of a single stock holding, the introduction of the Stressed Value at Risk resulted in a regulatory capital requirement as much as twice or three times as great, leading to a capital requirement for general position risk calculated via internal models of 75%–135% of the entire position in the case of individual shares, as compared to 8% under the standardized method. This discrepancy decreases in the case of equity portfolios, depending on their degree of diversification; however, even in the most favourable case we examined, the capital requirement was around half of the value of the position, which is still six times the capital calculated by the standardized method.

As the result of a four-year process of consultation, a new Basel recommendation emerged in January 2016 for the calculation of the capital requirement for market risk, which is leading to significant changes in capital calculation according to both the standardized and internal models-based methods. The most important change is that the standardized method also becomes risk-sensitive, building on the bank's internal risk assessment, while capital is to be calculated according to internal models based not on Value at Risk but on another measure, namely the Expected Shortfall. The advantage of the new risk measure is that it demands a more accurate measurement of the tail of the loss distribution, i.e. the worst outcomes, and thus the risk. However, if models continue to assume a normal distribution of returns, the new, more advanced risk measure will differ from the older version merely in its use of a constant multiplier. Based on preliminary impact analyses, the new rules to be introduced from 2019 narrow the gulf between the two methods, providing a better incentive for capital calculation based on institution-specific, more accurate assessment of risks.

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