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COMPARISON OF CAPITAL REQUIREMENTS DEFINED BY INTERNAL (VAR) MODEL AND STANDARDIZED METHOD

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Abstract

The activities and different assets of commercial banks, investment funds and other financial institutions involve many risks, which have an effect on their profitability. One of the most important risks is called market risk, which is in connection with interest rate risk and price risk of held shares, bonds and derivatives. These effects have an impact as great as anywhere else for Hungarian financial institutions.

The Trading Book prescribes the capital charge against risky positions. It requires that the owners' equity must be sufficient to cover the calculated requirement. The Trading Book permits two alternatives (based on the recommendation of the Basle Committee) for financial institutions, defining the measurement method of market risk and the necessary capital charges against it. They can choose a statistical and mathematical approach called the Internal Model to define the capital requirement. The alternative is the Standardized Method which could be developed by an institution rather than the Internal Method.

In this article I compare these two alternatives and I argue to confirm that firms would be expected to choose the Standardized Methods in Hungary defining capital charges even though the other method applies superior tools and could explain the riskiness of a portfolio.

Keywords: financial risk, trading book, internal model, value at risk, standardized method.

1. Introduction

After the breakdown of the agreement of Bretton Woods and fixed exchange rates at the beginning of the 70's, financial processes regarding market risks became more important to financial institutions and those who participate in financial markets. These risks derive from the instability of the price of shares, foreign exchanges commodities and from the interest rate risk which cause the fluctuation in the present value of future cash flows of assets. The existence of these risks led to the appearance of new financial instruments called derivatives (like futures, swaps, options) which are able to hedge a risky position but which could involve additional market risk based on the price and interest rate risk of the base product.

Large losses by famous companies (JORION, 1997) like Baring PLC in the UK, Metallgesellschaft in Germany (this is an industrial corporation), and Daiwa Bank in the USA proved that market risks could have large effects on profitability and losses. Recognizing the importance of these effects inspired the Basle Committee to produce its recommendation about the Standardized Method in 1993. This document provides national governments and supervisory agencies with a way to regulate contracts of financial risks in financial institutions. It suggests that the risk of portfolios from products with an interest rate, a foreign exchange rate, or a share (or commodity) price risk should be calculated by a product of a standard value and the volume of the different types of products. It is easy to recognize that this kind of measurement technique gives a false illustration about the real risk of a portfolio because there are standardized values which do not take into consideration the individuality of each share, bonds, and other instruments and their potential to diversify unsystematic risk.

In 1995 the Basle Committee published a new recommendation to treat financial risk and to define capital charges called the Internal Model. This was based on the recognition that many financial institutions have developed quite sophisticated statistical models to define more accurately the risk of a portfolio. The Committee recommends that the risk of a portfolio and the level of consequent capital charge could be defined through a mathematical model with the main conditions below:

- the holding period is 10 days,
- the confidence interval (or the reliability) is 99%,
- the historical base of the statistical analysis (the length of the historical data row) must be at least 1 year,
- the mathematical model must be monitored quarterly.

The Hungarian regulation on the Trading Book is based on the recommendations of the Basle Committee from 1993 and 1995 in harmony with the Hungarian proposal to converge to the EU's requirements.

In the next chapter there is a short description of a VAR model; the so-called variance-covariance method which was used in the comparative analysis. It contains the definition of VAR, and a description of the application of VAR analysis for different products. In the third chapter we provide a short summary of the Standardized Method of the planned Trading Book and its specific allocation of capital charges to risky positions. After this there is a comparison of the VAR and the Standardized Method on two different portfolios with historical data rows from the Hungarian financial market. And finally, a conclusion from the calculated curves can be read.

2. The Variance-Covariance VAR Model (as a Possible Internal Model)

2.1. Definition of the VAR of a Portfolio

The VAR symbol came from the expression of 'Value at Risk'. This value describes the potential loss in the value of a portfolio with predefined conditions. The mathematical approach of defining the risk of a portfolio is based on the assumption that the value of a portfolio is a probability variable. By knowing the probability density function (or distribution diagram) of this variable, the maximum potential change can be defined as basic to calculate the maximum potential loss as the VAR. This value describes the risk of a portfolio with the conditions of holding it for certain days (on a certain horizon) at a given probability level.

The main task is to determine the probability density function of the potential values of a portfolio. The VAR analysis uses the historical data of and the correlation between basic financial products like individual shares, commodities, bonds and their potential value in the future is considered to be elementary probability variables. The variance-covariance method computes the total probability density function from these elementary data series.

2.2. Probability Distribution of Portfolios

The random walk model is the fundamental model of price dynamics of products and portfolios. If P_t is the value of an asset at time t and $p_t = \ln(P_t)$ the price dynamics is:

$$P_t = P_{t-1} + \mu' P_{t-1}\Delta t + \sigma P_{t-1}\varepsilon_t\sqrt{\Delta t} \quad \text{and} \quad p_t = p_{t-1} + \mu\Delta t + \sigma\varepsilon_t\sqrt{\Delta t}^{1}, \tag{1}$$

where $\varepsilon \sim$ IID $N(0, 1)$ and $\mu = \mu' - \sigma^2/2$. IID means that 'identically and independently distributed' and $N(0, 1)$ is the normal distribution with mean of 0 and variance of 1.

It could be assumed that the probability variable of $r_t = \ln\left(\frac{P_t}{P_{t-1}}\right)$ for a period has normal distribution[2], $E(r_t) = \mu$ (mean value of r_t) and $E(r_t^2)^{1/2} = \sigma$ (volatility of r_t). The distributions of logarithmic relative changes of elementary products and the total portfolio are normal (an elementary product's density function is $f(r_t)$). By VAR analysis we have a data series for elementary financial products whose volatility could be calculated and if we compose a portfolio from them with different weights, their total volatility could be defined.

Its expected value and volatility exactly describe a normal distribution. The summarized distribution (R_s) of normal distributions (r_i, with weight of w_i and volatility of σ_i) could be calculated with the help of the variance-covariance matrix of the aggregated distribution[3]:

$$\sigma^2(R_S) = \sum_{i=1}^{N} w_i^2\sigma_i^2 + \sum_{i=1}^{N}\sum_{j=1, i\neq j}^{N} w_i w_j \sigma_{ij}^2, \tag{2}$$

[1] The price dynamics of p_t could be derived from the random walk model for P_t using Ito's lemma (HULL, 1999).

[2] $r_t = \ln\left(\frac{P_t}{P_{t-1}}\right) = \ln(P_t) - \ln(P_{t-1}) = p_t - p_{t-1}$

[3] The mean value of the cumulative distributions (μ_S) could be calculated simply by summarizing the means of the elementary distributions.

where $\sigma_i^2 = E\,(r_i - E\,(r_i))^2$, and $\sigma_{ij}^2 = E\left((r_i - E(r_i))\left(r_j - E(r_j)\right)\right)$ is the covariance of r_i and r_j. The VAR could be calculated at a certain confidence interval or probability level (CI):

$$\text{Probability}\ (R_{CI} < R_S) = CI \ \text{or} \ \int_{R_{CI}}^{\infty} f(R_S, \mu_S, \sigma_S)^* \,\mathrm{d}R_S = CI, \tag{3}$$

$$\text{VAR}\ R_s\,(\mu_S, \sigma_S, CI) = |R_{CI}|, \tag{4}$$

where $f(R_s, \mu_s, \sigma_s)$ is the summarized probability density function with mean of μ_s and volatility of σ_s.

By VAR analysis daily logarithmic relative changes are modelled from which logarithm relative changes could be calculated. These calculations would take the form for n periods:

$$r_{t,n} = \ln\left(\frac{P_t}{P_{t-n}}\right) = \ln\left(\prod_{l=t-n}^{t-1} \frac{P_{l+1}}{P_l}\right) = \sum_{l=t-n}^{t-1} \ln\left(\frac{P_{l+1}}{P_l}\right) = \sum_{l=t-n+1}^{t} r_l. \tag{5}$$

This means that the log relative changes for more than one period are a sum probability variable of n daily log relative changes. If we assume that the daily relative changes are independent probability variables we can calculate the variance of the aggregated distribution function for a period of n days:

$$\sigma^2(r_{t,n}) = \sigma^2(r_t) + \sigma^2(r_{t-1}) + \ldots + \sigma^2(r_{t-n+1}) = n^*\sigma^2(r). \tag{6}$$

This equation is valid for the variance of the portfolio as well: $\sigma^2(R_{S,n}) = n^*\sigma^2(R_S)$.

At this point we are able to calculate the aggregated distribution of a portfolio from financial products for a period if we have the data series of the basic instruments and if we assume that:

- log relative changes of values have normal distribution,
- and these relative changes are independent on a time horizon.

2.3. Calculating VAR for Different Financial Instruments

The method to calculate VAR depends on the type of the financial product which could be relatively easy for shares but could be quite difficult for options, or other derivatives. In the next chapters different types of VAR calculating methods are presented for instruments used in the portfolios for comparison.

2.3.1. Shares

The value change of a share position could be characterized by its price change because the profit of an equity position in a period is equal with the change of its market price (supposing there is no dividend payment). The VAR could be calculated with the normal distribution defined by the log relative changes of equity prices in the past.

2.3.2. Bonds

It is more sophisticated to calculate the VAR for bonds for two reasons:

- the types of bonds are defined by their maturity which means that the types of bonds change every day because of the decrease of their maturity,
- some bonds contain many basic bonds (or zero coupon bonds with one cash flow in the future) so they have many cash flows in the future.

The present value (or market value) of a zero coupon bond (or a fixed income product at time t with maturity of M and face value of FV) defines its yield to maturity (y_t):

$$P_t = FV^* e^{-y_t(M-t)}. \tag{7}$$

If the yield changes, the relative change of P_t could be written in second order approximation:

$$\frac{\Delta P_t}{P_t} = -y_t(M-t)^* \left(\frac{\Delta y_t}{y_t}\right) + \frac{1}{2}\left(y_t(M-t)\right)^2 \left(\frac{\Delta y_t}{y_t}\right)^2. \tag{8}$$

In practice this equation is measured in the first order which supports calculating the relative changes linearly and produces aggregated volatility with variance and covariance values.

We have two equivalent quantities – price and yield; therefore we must decide which is to be modelled. Bonds have the important feature that they converge to their face value as they approach their maturity. This involves that bond price volatility converges to zero approaching its expiration. That is the reason why the bond yields are modelled with random walk theory.

It is a complex mathematical problem to define the zero coupon yield curve for bonds with the same risk. The difficulties are:

- bonds could have many cash flow points; there could be more than the number of bonds (the equation system is unsolvable because there are more variables than equations),
- the payment days of bonds are generally not equal for different bonds,
- there are not enough data for a continuous curve.

The Spline interpolation of a yield curve helps to solve this problem as it is presented by JORION (1997), MAKARA and BRONSTEJN (1987). In *Fig. 1* there is a typical yield curve for Hungarian treasury bonds on May 24, 2000. The market prices of Treasury Bonds were supplied by the Hungarian State Treasury, Government Debt Management Agency.

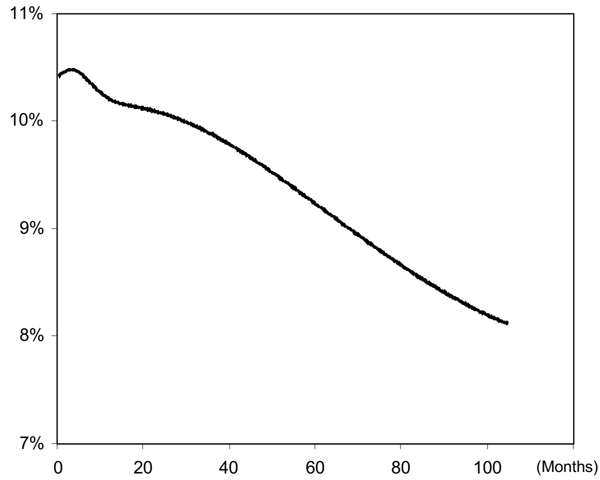

Fig. 1. Yield curve for Hungarian treasury and zero coupon bonds

If we have a yield curve series, yield volatility could be estimated. The VAR model distributes bonds for zero coupons because a complex bond is a portfolio of elementary cash flows for which we have statistical information from zero coupon yield curves.

If we liked to model the risk of a bond with VAR we should have a variance-covariance matrix for each possible maturity day. This would result in a matrix of thousands of elements, which is quite difficult to analyze. The cash flow mapping technology offered by MORGAN–REUTERS (1996) helps to simplify this problem.

Cash flow mapping fixes vertex points (v_i) to a certain maturity (m_i) on which yield curve values are measured and which are involved in the variance-covariance matrix. If the maturity of measured cash flows (C_t) is between two vertexes (v_{i-1}, v_i; $m_{i-1} < t < m_i$) the yield value and the standard deviation are interpolated linearly:

$$y_t = \left(\frac{m_i - t}{m_i - m_{i-1}}\right) y(v_{i-1}) + \left(\frac{t - m_{i-1}}{m_i - m_{i-1}}\right) y(v_i), \tag{9}$$

$$\sigma_t = \left(\frac{m_i - t}{m_i - m_{i-1}}\right) \sigma(v_{i-1}) + \left(\frac{t - m_{i-1}}{m_i - m_{i-1}}\right) \sigma(v_i). \tag{10}$$

The cash flow mapping splits the actual cash flow into two cash flows whose maturity is equal with the maturity of the two nearest vertexes (splitting an α portion of C_t into v_{i-1} and a $(1-\alpha)$ portion into v_i). The condition of splitting is that the cumulative variance of split cash flows must be equal with the interpolated variance:

$$\sigma_t^2 = \alpha^2 \sigma_{i-1}^2 + 2\alpha(1-\alpha)\sigma_{i-1,i}^2 + (1-\alpha)^2 \sigma_i^2. \tag{11}$$

This second ordered equation contains only α as a variable. Solving this equation for α, we can receive the weights of vertex $i-1$ and i after splitting.

This process must be followed for every cash flow of the portfolio and finally we receive the aggregated positions at all vertex points to be considered. (There is an example in the Footnotes illustrating the mechanism of this method.[4])

2.3.3. Futures

Futures contracts have a certain maturity (τ_m) and a future or a delivery price (K) on a financial product like shares or stock indexes. On the day of maturity and for the delivery price the investor to the long position must buy the financial product, or he must pay the difference between the fixed price of futures and the spot price of the financial product. The theoretical value of futures could be given at a certain time from the comparison of two equivalent portfolios and with the assumption of non-arbitrage:

1. buy a financial product on the spot price (S_t),
2. buy a futures contract with fixed price of F_t and save $F_t e^{-r\tau m}$ in a risk-free investment.

These two portfolios will be equal at the maturity therefore we can define the relationship between the spot and the theoretically future price at any time to calculate the present value of the value of portfolios at maturity:

$$F_t e^{-r\tau_m} = S_t - pv(\text{yield}\ (S_t, \tau)) = S_t e^{-y\tau_m} \tag{12}$$

which describes the correlation between spot and futures prices. Therefore, the futures price could be written as follows:

$$F_t = S_t e^{(r-y)\tau_m}. \tag{13}$$

[4]The illustrating of the mechanism of the mapping technique considers a treasury bond with 10 months maturity. Cash payments will be in $4m$ (C_{4m}) and $10m$ (C_{10m}). Suppose a model that uses the following vertices for cash flow mapping: $1m$, $3m$, $6m$, $12m$, $2y$, $3y$. The mapping of C_{4m} involves the splitting of this cash flow into two components: a $3m$ and a $6m$ cash flow. The yield of C_{4m} could be calculated by the linear interpolation of the $3m$ and $6m$ yield: (using *Eq.* (9), $y_{3m} = 10.2\%$ and $y_{6m} = 10\%$)

$$y_{4m} = \frac{2}{3}^* 10.2\% + \frac{1}{3}^* 10\% = 10.13\%.$$

The linear interpolation of standard deviation for the $4m$ yield is (using *Eq.* (10), $\sigma_{3m} = 0.5\%$, $\sigma_{6m} = 0.56\%$, $\rho_{3m,\,6m} = 0.97$)

$$\sigma_{4m} = \frac{2}{3}^* 0.5\% + \frac{1}{3}^* 0.56\% = 0.52\%.$$

The cash flow components could be calculated by solving *Eq.* (11) for α. The result for α is 60%. This means that 60% of C_{4m} should be split into a $3m$ and 40% into a $6m$ component. C_{10m} could be mapped into a $6m$ and a $12m$ component in the same way. The advantage of this method is that we should calculate the statistical parameters only for the vertices.

The change in the value of a futures contract at a certain time equals the change in the futures price (F_t) because of the daily clearing. Using Ito's lemma and supposing that $y = 0$, it could be shown that the total difference of $F_t(S, r)$ has the following stochastic process (HULL, 1999):

$$\begin{aligned} F_t &= F_{t-1} + (\mu' - r)F_{t-1}\Delta t + \sigma F_{t-1}\varepsilon_t\sqrt{\Delta t} \\ &= F_{t-1} + \mu' F_{t-1}\Delta t + \sigma F_{t-1}\varepsilon_t\sqrt{\Delta t} - rF_{t-1}\Delta t. \end{aligned} \tag{14}$$

Analyzing this formula it can be concluded that a long futures position could be substituted with two basic positions:

1. hold the underlying asset,
2. borrow cash with the maturity of the futures.

These positions could be measured by methods described in 2.3.1 and 2.3.2.

2.3.4. Total Capital Charges Defined by the Trading Book

The Trading Book prescribes that the VAR must be calculated for 10 days at a confidence level of 99%. This value must be multiplied by a protecting factor whose minimum value is 3 which gives the total capital charges for general risks of the portfolio. (This factor increases if the number of default values of VAR model is more than 5 for 250 days determined by backtesting.)

2.4. Measuring and Forecasting Standard Deviation (σ_i) and Covariance (σ_{ij}^2) from Historical Data Series

There are many alternatives to estimate standard deviation and covariance of probability variables from historical data series. A convenient way to estimate these parameters used for our analysis is called the Exponentially Weighted Moving Average Model (EWMA). It calculates the variance and covariance at t according to the following equation:

$$\hat{\sigma}_{i,t}^2 = \lambda\hat{\sigma}_{i,t-1}^2 + (1-\lambda)r_{i,t-1}^2 \quad \text{and} \quad \hat{\sigma}_{ij,t}^2 = \lambda\hat{\sigma}_{ij,t-1}^2 + (1-\lambda)r_{i,t-1}r_{j,t-1}, \tag{15}$$

where $r_{t,i}$ is the value of the variable r_i at t and λ is a constant between 0 and 1. The advantage of this model is that it can handle the phenomenon of stochastic volatility.

The EWMA depends on the value of λ. A smaller λ means that the weights of the latest values are larger; therefore the reaction time of estimation is shorter for changes but the estimation is less stable.

MORGAN–REUTERS (1996) calculated the optimal λ for many markets with the condition that the root mean squared error would be the smallest. From these values they calculated a weighted average which resulted a λ (decay) factor of 0.94 for daily data set.

3. Standardized Method

The recommendation of the Basle Committee from 1993 and the Hungarian Trading Book contain standard factors for elementary groups of financial instruments like shares, bonds, futures, and options. This plan classifies the risk of products into two groups: general and individual risk. The general yield and price risk could be substituted by Internal Model therefore their regulation is described in this article.

3.1. Shares

The Trading Book generally prescribes 8 percent capital of the value of a net share position as compensation of general risk.

3.2. Bonds

The capital requirement of general risk could be defined by the Standardized Method through the maturity-based approach. This method classifies yield positions into maturity levels and these maturity levels into zones. Capital charges could be defined by calculating balanced and non-balanced values inside maturity levels, among maturity levels and zones. The products of different weights and balanced or non-balanced position give the total capital charges. (The difference between the absolute values of long and short position in a level or in a zone gives the non-balanced position of a level or a zone, while the smaller value of the long and the short position provides the balanced position.)

3.3. Futures Contracts

Futures have to be split into two positions; a position of the instrument the futures are based on and a loan or a debt. For example a long futures on a share have to be split into:

- a debt with the maturity of the futures and the amount of the delivery price,
- a long share position.

Therefore a futures could be substituted with elementary instruments in the Standardized Method as well.

Table 1. Content of the portfolios

	Portfolio 1	Portfolio 2
Bonds (Treasury & zero coupon)	82.4%	14.4%
Average maturity	12/19/2000	5/26/2006
Number of bonds (different types)	6	4
Shares	17.6%	85.6%
Number of shares (different types)	5	10

4. Capital Charges from the Internal Model and the Standardized Method

For the comparison of the Internal Model and the Standardized Method, two portfolios[5] of bonds and shares were defined representing two different types of investors. The first portfolio contains mostly (nearly 80%) treasury bonds with a shorter maturity and only 20% of shares. The proposal is that this kind of portfolio represents an investment of lower risk.

The second portfolio has nearly 85% of shares and 15% of treasury bonds with long maturity. Shares and bonds with longer maturity represent a higher risk level which was experienced through the historical VAR analysis as well. The contents of the portfolios and their relative weights[6] are shown in *Table 1*.

The capital requirements for both portfolios were defined from January 4, 2000 to April 28, 2000 based on one year data series using the Varitron risk management system[7]. The results were provided by the Postbank and Savingsbank Ltd.

In *Fig. 2* there is a comparison of the capital charges from the Internal and the Standardized Methods for the observed period. It can be seen that the capital charges are larger by the Internal Model for the safety portfolio.

The average difference between the two methods is 4.58% in the value of the portfolio which is 1.6 times larger than the average charge defined by the Standardized Method. This means that the user of the Internal Model is fined with a 160% extra charge. The main component of the charge defined by the Internal and Standardized Method comes from share positions (price risk) and bond positions (yield risk). The Standardized Method defines a capital charge of 8% for shares

[5] Portfolio 1 contains: A000615B95, A000724J98, A010212D98, A020412H99, D000614, D001227 (treasury bonds) and BORSODCHEM, MATAV, MOL, OTP, RABA (shares). Portfolio 2 contains: A021231D92, A040701A89, A070812C98, A090212B99 (treasury bonds) and BORSODCHEM, EGIS, GARDÉNIA, GRABOPLAST, MATÁV, MOL, OTP, RABA, RICHTER GEDEON, TVK (shares).

[6] The weights are based on the assets' market value on January 04, 2000.

[7] The Varitron risk management system calculates the capital requirement using both the VAR model and the Standardized Method. (http://www.ramasoft.hu/english/varitron_e.html)

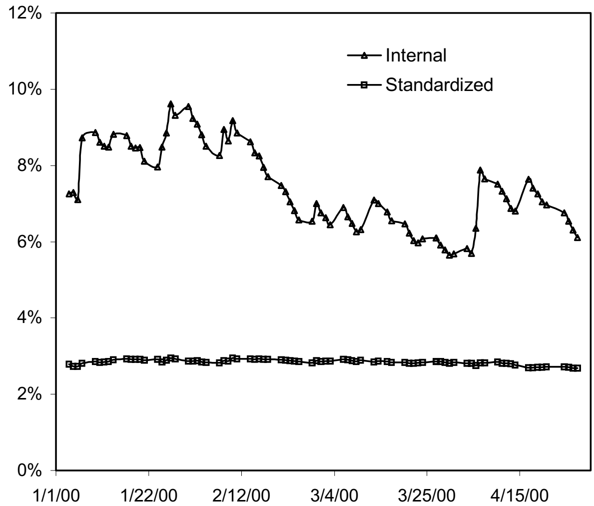

Fig. 2. Capital charges defined by internal and standardized method for portfolio 1

compensating general price risk and an 0.71% average charge for bonds. By the Internal Model there are extra capital charges of 29.3% for shares and 2% for bonds (ignoring the diversification between bonds and shares).

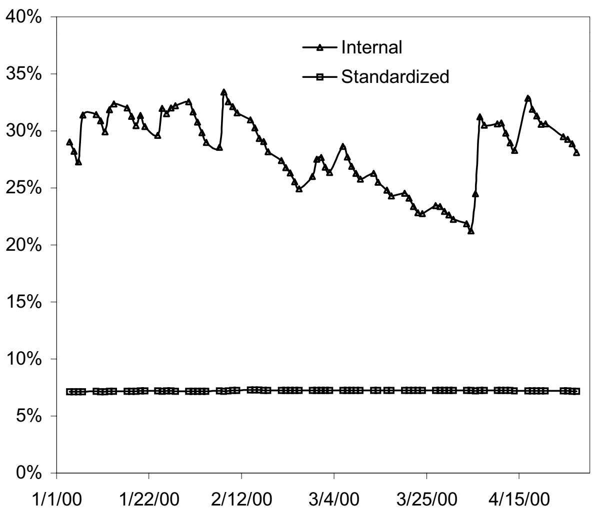

Fig. 3. Capital charges defined by internal and standardized method for portfolio 2

The difference is larger by the other portfolio (assumed to be riskier) as can be seen in *Fig. 3*. The average difference between the capital charges from the Internal and Standardized Method for the whole portfolio is 21.2% which is nearly 3 times larger than the average standard capital requirement.

The total capital charges of the compared two methods and their difference are larger for the second portfolio. The main reason of this experience is that instruments with higher risk (shares) have large weight. But there is another phenomenon explaining the larger capital charge which is in connection with the volatility of bonds in a case of long maturity.

The Standardized Method prescribes a larger capital charge for bonds with longer maturity. This results in an extra capital charge of 1.3% for bonds by standard calculation compared to the safer portfolio. The Internal Model results in a higher charge for the bonds of the second portfolio, too, but the difference is 24% which is larger than the difference of 1.3% by the Standardized Method. This extreme increase of charges by bonds could be explained by the increased volatility of bonds with long maturity. This increase derives from the long distance until maturity and the maturity structure of reference bonds used to determine yield curve. There are fewer cash points as the maturity increases, therefore mistakes contained by market data are balanced worse by longer maturity. The effects are that the summarized volatility of bonds (with shorter maturity than 2 and a half years) contained by the first portfolio is just 0.12% but for the bonds of the other portfolio with the longest maturity of almost 10 years is 1.21%. This volatility means an order increase in the capital charge for longer maturity although charges defined by the Standardized Method increased only 3 times.

Table 2. Summary of the comprised capital charges (CC) and volatility values by Standardized Method (SM) and Internal Model (IM)

	Portfolio 1	Portfolio 2
Average CC for shares by SM	8.0%	8.0%
Average CC for bonds by SM	0.71%	2.0%
Average CC for portfolio by SM	2.84%	7.2%
Average CC for shares by IM	37.34%	32.1%
Average CC for bonds by IM	2.72%	26.7%
Average CC for portfolio by IM	7.42%	28.4%
Average diversification benefit by IM	5.25%	24.09%
Average volatility for shares	1.7%	1.46%
Average volatility for bonds	0.12%	1.21%

For shares there is an average volatility of 1.7% by the first portfolio and 1.46% by the second portfolio. These volatility rates were calculated for the aggregated share portfolios and they represent diversified values. The second portfolio contained more types of shares therefore the higher level of diversification contributed to the lower volatility for shares. That is the reason why capital charges defined by Internal Method are lower for the second portfolio related to shares. *Table 2* summarizes the earlier mentioned data for both portfolios.

5. Conclusion

Introducing Trading Book the proposal is to regulate transactions of financial institution regarding financial risk by the capital charge prescription for risky financial instruments. The Standardized Method prescribes standard factors for financial products. The proposal permits one to calculate capital charges with the Internal Model so as to give a refined alternative method for financial institutions because standard factors mean a rude methodology of localizing financial risk. The refinement derives from the individual analysis of each instrument by a statistical approach and calculating of diversification through covariance. Although an Internal Model offers a sophisticated definition of financial risk, its usage has many disadvantages in Hungary as the analysis of the earlier portfolios shows. The implementation of an Internal Model involves many technological investments to get up to date information about the position of financial instruments and to build up a statistical model. This could involve large costs for institutions, however, their investments are not compensated with lower capital charges because the tests of earlier portfolios show there are larger capital charges by the Internal Model. Although the average diversification benefits are 5.25% by the first portfolio and 24.09% by the other portfolio and the Internal Model observes individual instruments with their historic data series, the resultant capital charges are larger than charges defined by the Standardized Method. Therefore it could be concluded that financial institutions will not use the Internal Method to calculate the capital charge because of its large extra charges and costs compared to the Standardized Method.

The other conclusion is in connection with the VAR calculation of bonds. It was emphasized that longer maturity means larger financial risk as it appears in the Standardized Method through larger factors for longer maturity. We have the same result by the Internal Model but the rate of increase is larger than the Standardized Method. (This observation also confirms the earlier conclusion that it is not worth for financial institutions to calculate capital charges by the Internal Model.)

The large difference between capital charges determined by the Internal and Standardized Model derives from the fact that the quite young Hungarian market, with a new economic system, is riskier than in developed countries. According to Jorion (1997) and Smith, Smithson and Wilford (1990) the volatility for shares and bonds is smaller on the US market. On the Hungarian market the typical volatility of shares contained by the test portfolios was between 2% and 5% which is much larger than share volatility on the US market. This extreme difference could be observed for bonds with long maturity as well but the prescription of Standardized Method was built up by the recommendation of the Basle Committee. These conditions should be considered by the Hungarian regulatory agencies so that Internal Models would be attractive for financial institutions. Therefore, the prescriptions of the Trading Book should be adjusted taking these results into consideration. Theoretically, this could be accomplished in two ways. The first possibility is by reducing the holding period or the protecting factor by the Internal Method so the calculated capital requirement would be smaller. The second way is by adjusting the Standardized Method and choosing larger percentages for shares and longer maturity levels of cash flow positions so that the capital requirement defined by the Internal and Standardized Method would be similar and it would not be so unbalanced for more risky portfolios. However, only the latter way is acceptable, because the Internal Method is a better description of the current market and it is better to adjust the Standard Method to the current conditions so that the capital charge of certain risk levels could be similar in different markets. On the other hand, it is inappropriate for a country intending to join the European Union to establish a lower standard than the EU's regulation.

Although an Internal Model defines a larger capital charge it is expected that financial institutions will use the Internal Model to analyze their positions. As it was described earlier, an Internal Model is able to consider the individuality of different financial instruments and their diversification. This involves a more proper description of a portfolio and the variance-covariance values of its instruments which supports the capability of its analysis in different facets and the localization of its main risk factors.

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