ECONOMETRIC MODEL USABLE IN THE STUDY OF EMERGING MARKETS

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Abstract

Emerging markets can be studied in the sense of detaching the perspectives of their evolution and especially of the influence they will have on the Romanian market. The econometric model highlights the need to build such a technical mechanism, which would ensure an analysis of the efficiency of portfolio investment in domestic markets or in the nearby area.

As a member of the European Union, Romania also has additional possibilities, but also some difficulties to be able to ensure the placement of securities portfolios in always profitable conditions. Therefore, a study is absolutely necessary, a context in which action was taken to identify a mathematical, statistical-econometric model, to be used in the study of markets and primarily emerging markets.

Taking into account the Markowitz borders, the situation was based on indices from emerging markets in Central and Eastern Europe, respectively monthly yields and stock indices specific to countries such as Romania, Hungary, Bulgaria, Czech Republic, Poland, for a period of one year. Based on them and the conclusions resulting from the study, an extension can be made based on the parameters resulting from the econometric model used on the perspective and results that the investment of securities portfolios on the domestic capital market will have. The article presents a series of aspects that give meaning to the appreciations reached by the authors.

Keywords: emerging markets, portfolios, securities, investments, profitability, capital market, econometric models.

JEL classification: C13, G14.

Introduction

The article Econometric model usable in the study of emerging markets is based on a careful study carried out on some markets in the nearby area and with the same characteristics and evolutions as in Romania.

Aspects related to the uncertainty regarding the return on assets are defined and specified, aspects that have been carefully studied, thus establishing that the effective frontier consists of portfolios that this placement of securities portfolios has and this is highlighted in the returns obtained.

The basic idea is that a portfolio with an expected return on a border without constraints has a certain evolution, different from the one in which there are some constraints. The impact of adding a CVaR constraint to the issue of portfolio use is already analysed and defined, establishing the relationship as an econometric model, which we must consider. Any portfolio that lies on this frontier, of evolutionary limits, can lead to some results that can then be extended by forecasting studies, forecasting, in future periods.

We take certain variants of analysis we use the agreed model, the resulting parameters being those that are then used for a future forecast. There are a number of market constraints that have been exemplified, meaning that the conclusion that emerges from this analysis is to recommend practitioners be alone that a constraint can lead to the selection of inefficient portfolios, therefore investors and managers, of portfolio management contracts, to consider that in the presence of constraints there is a risk-based return, which is different depending on the influence of some of the factors we are discussing.

At the same level of expected profitability, an ever better portfolio can be built, which in the sense of the concept of medium-variance, refers to a portfolio with lower profitability variance, thus ensuring compliance with guaranteed confidence intervals.

Literature review

In the literature we find a series of works whose authors have focused on econometric models that can ensure an efficient analysis of portfolio investment in various markets. Thus, we recall the work of Andersen & Bollerslev (1998), which addresses some econometric methods of measuring volatility based on high frequency data, which are of interest in most financial applications. In the same vein, Anghelache C., Anghel M.G. (2015) addresses some econometric models usable in portfolio selection and uses these models to perform a complex analysis of the evolution of the Romanian capital market. Also, Anghelache C., Anghel M.G., Iacob Ș.V. (2020) addresses the possibility of expressing a model of asset accumulation at risk of inflation, taking into account the long-term structure and real returns. On the other hand, his work Belhaj, M. (2010) proposes a continuous time model usable in the analysis of capital expenditures for operational risk. Ding, Granger, and Engle (1993) address the issue of stock market returns, finding that not only is there a substantially higher correlation between absolute returns than yields per se, but the transformation of absolute yield power has a fairly high autocorrelation for long periods. Duan (1995) is concerned with the risk premium which should be a function of the systematic risk in the underlying asset and the effects on the values of the options. Engle (1982) considers that traditional econometric models involve a constant variation of the forecast over a period of time and to generalize this assumption introduces in his paper a new class of stochastic processes called autoregressive conditioned heteroskedastic processes (ARCH).

Methodology, data, results and discussions

Uncertainty about asset returns is characterized by a finite set of states with equal probabilities $\Omega = \{1,2, \ldots S\}$, where *S*>*J* . Asset returns are given by a matrix *R* of size *J*x*S*. Whether $\overline{R}$ size vector *J* x 1 of expected returns and *V* the dimension matrix *J*x*J* of the variance-covariance associated with *R*. Whether $R_s = \left[R_{1s} \ldots R_{js}\right]^T$, where R_{sj} is the return on asset *j* in condition *s*. It is assumed that there are no opportunities for arbitrage; rank (*V*) = *J*, so that there are no redundant assets or assets without risk and rank (1 $\overline{R}\, R_{1s} \ldots R_{js}$) = *J* for any set of *J* - 2 distinct states where $\{s_1 \ldots . s_{j-2}\}$ is the vector of dimension *J* x 1, of the form $[1 \ldots I]^T$. A portfolio is a vector *w* of size *J* x 1 with $w^T I$ = 1. Missing sales are also allowed. Whether $\tilde{R}_w$ its random profitability *w*. Expected profitability and variance for *w,* are denoted by $\bar{R}_w$, and respectively σ_w^2.

A portfolio is on the border without constraints if it satisfies the following optimization problem:

$$\min_{w \in \{\hat{w} \in R^J \,;\, \hat{w}^T I = 1\}} \sigma_w^2 \text{, with } \bar{R}_w = E \tag{1}$$

For a certain level of expected profitability *E*, we will consider:

$$a = I^T V^{-1} \overline{R},\ b = \overline{R}^T V^{-1} R^T,\ c = I^T V^{-1} I$$

The portfolio located on this border, with the expected profitability *E*, is given by, the relationship:

$$w_E = \beta w_\sigma + (1 - \beta) w_\alpha$$
$$\beta = \frac{E - b/a}{a/c - b/a};\ w_\sigma = \frac{y^{-1} I}{c} \ and\ w_\alpha = \frac{V^{-1}\overline{R}}{a} \tag{2}$$

Which represents the minimum variance portfolio and the portfolio located on the border with an expected return of b / a. Using equation (2) borderless portfolios can be written as a linear combination of two funds. Their representation in space $(\overline{R}_w, \sigma_w^2)$, is give n by the hyperbola:

$$\sigma_w^2 = \frac{I^*}{c} + \frac{\left(\bar{R}_w - a/c\right)^2}{d/c} \tag{3}$$

where d = bc - a^2

The efficient frontier consists of portfolios on this curve, with expected returns greater than or equal to a / c.

Next we will analyse the impact of adding a VaR constraint to the portfolio optimization issue. In defining VaR, some authors establish a level of confidence α, such that α = s / S for an integer s, with S/2 < s < S. Whether $z_{1,w} < z_{2w} < .... < z_{nw}$, the ordered values for which $\tilde{z}_w = -\tilde{R}_w$, where $N_w <$ S is the number of these values. It is defined $n_{\alpha,w}$ the unique index with the property:

$$\sum_{n=1}^{n_{\alpha,w}} p_{n,w} \geq \alpha > \sum_{n=1}^{n_{\alpha,w}-1} p_{n,w} \tag{4}$$

where: $p_{n,w} = P[\tilde{z}_w = z_{n,w}]$

VaR for portfolio w for a confidence level $\alpha = 100$ % is given by:

$$V_{\alpha,w} = z_{n_{\alpha,w}} \tag{5}$$

$$P\left[\tilde{R}_w \geq -V_{\alpha,w}\right] = P\left[\tilde{z}_w \leq z_{n,w}\right] \geq \alpha$$

$$P\left[\tilde{R}_w > -V_{\alpha,w}\right] = P\left[\tilde{z}_w < z_{n,w}\right] < \alpha \tag{6}$$

We will consider the VaR constraint $V_{\alpha,w} < V$, where V is the assumed threshold for VaR. A portfolio is on the border with VaR constraint, if:

$$\min_{w \in \{\hat{w} \in R^J ;\, \hat{w}^T I = 1\}} \sigma_w^2 \text{, with } \bar{R}_w = E \text{ and } V_{\alpha,w} \leq V \tag{7}$$

For a certain level of expected profitability E and for anything:

$$s \in Q, or\ w_s = \frac{V^{-1}R_s}{c_s}, where\ c_s = I^T V^{-1} R_s$$

Portfolios $\{w_s\}_{s \subset Q}$ are used in the characterization of the boundary with VaR constraint. To show that the portfolios on the border with VaR constraint we will use from the combinations a K + 2 portfolios: w_σ, w_α și $w_{s_1}, \dots, w_{s_{k+2}}$.

The basic idea is that if the portfolio with an expected yield on the border without constraints does not satisfy the VaR constraint, then the constraint is reached in the case of a portfolio that has the same expected return, but on the border with constraints.

Next, the impact of adding a CVaR constraint to the portfolio optimization problem is analyzed, in defining that the CVaR is followed according to which the CVaR level of the portfolio w for a confidence level of α =100% is given by the relationship:

$$C_{\alpha,w} = \frac{1}{1-\alpha}\left[\left(\sum_{n=1}^{n_{\alpha,w}} p_{n,w} - \alpha\right) z_{n_{\alpha,w}} + \sum_{n=n_{\alpha,w}+1}^{N_w} p_{n,w} z_{n,w}\right] \quad (8)$$

We will consider the CVaR constraint, provided $C_{\alpha,w} \leq C$ with *C* is the threshold for CVaR level. A portfolio is on the border with CVaR constraint, only if:

$$\min_{w\in\{\hat{w}\in R^J;\, \hat{w}^T I=1\}} \sigma_w^2 \text{, with } \bar{R}_w = E \text{ și } C_{\alpha,w} \leq C \text{ ,} \quad (9)$$

reaching a certain level of expected profitability *E*.

It can be shown that the funds needed to create a portfolio located on the border with CVaR constraints depend on the set of states for which the portfolio suffers higher losses than VaR. The main element refers to the fact that if the portfolio with a given expected return, located on the border without restrictions, does not satisfy the CVaR constraint, then the constraint is reached in the case of a portfolio that has the same expected return, but located on the border with constraints.

The maximum interim reduction in the case of a portfolio is the largest loss that a portfolio can suffer in a given period of time. Formally, MD (maximum drawdown) for a portfolio *w* is $D[R_w] = -min_{s\in\{1,\dots,S\}} w^T R_s$.

Considering the constraint MD: DD [R_w] < DD (DD represents the level threshold MD). A portfolio is on the border with constraint if it respects the constraint and no other portfolio can be identified that satisfies the constraint characterized by the same expected return, but with a smaller variance.

We can conclude that any portfolio on this border, for which the constraint is respected, does not belong to the medium-variance border. However, in general, the number and composition of inefficient funds depend on E.

We will build the Markowitz borders with and without constraints for a sample of indices from emerging markets in Central and Eastern Europe, respectively the monthly returns of the stock indices BET (Romania), BUX (Hungary), PX50 (Czech Republic), WIG20 (Poland) and SOFIX (Bulgaria), for the period January - December 2019. The analysed framework will be in conditions *J* = 5 and *S* = 132.

Table 1 summarizes the descriptive statistics for the series of monthly yields. These include the media. The statistics defined by Jarque-Bera reject the hypothesis of normality. The abnormal behaviour of the distribution can be induced by the temporal dependencies between the returns, especially by the temporal moment of second order dependence. The presence of such a dependency is tested by the Ljung-Box statistics established for ten lags.

Profitability study data

Table 1

	BET	BUX	PX	WIG	SOFIX
Nr. Remarks	132	132	132	132	132
Expected profitability (annualized)	0.1886	0.0701	0.0585	0.0151	0.1004
Volatility (annualized)	0.3420	0.2532	0.2406	0.2603	0.3580
Skewness	-0.6401***	-0.8716***	-1.1155***	-0.3001	-0.6617***
Excess of kurtosis	2.6790***	2.5199***	3.5012***	0.6960*	4.1754***
Maximum intermediate loss	0.3958	0.3344	0.3164	0.2668	0.4763
Maximum profitability	0.2976	0.1671	0.1711	0.1890	0.3504
JB	48.49 (0.0000)	51.63 (0.0000)	94.79 (0.0000)	4.64 (0.0979)	105.52 (0.0000)
0.(10)	**16.32 (0.0079)**	**10.17 (0.4255)**	**19.27 (0.0368)**	**7.47 (0.6804)**	**23.64 (0.0085)**
LM(5)	**2.37 (0.0430)**	**0.42 (0.8333)**	**5.02 (0.0003)**	**2.08 (0.0714)**	**3.64 (0.0041)**
Correlation matrix	BET	BUX	PX	WIG	SOFIX
BET	**1.0000**	**0.6191**	**0.6688**	**0.4841**	**0.5764**
BUX		**1.0000**	**0.7821**	**0.7809**	**0.5109**
PX			**1.0000**	**0.7586**	**0.5649**
WIG				**1.0000**	**0.3696**
SOFIX					**1.0000**

Source: own calculations

*, **, and *** show statistical significance at a level of 10%, 5%, and 1%, respectively;

p-values are presented in round brackets;

JB is the Jarque-Bera test statistic for normal distribution;

0. (10) is the statistic of the Ljung-Box test for autocorrelation up to 10 lags;

LM (5) is the Engle LM test statistic for GARCH effects up to 5 lags.

The data in figure 1 illustrate the medium-variance boundaries with constraints (dotted line) and without constraints (solid line) in the absence of a risk-free asset. Panels (a) - (f) show the impact of the DD reduction (from 35% to 25%) on the constraint middle-variance boundary.

There are four main results. First, for a low level of DD, the medium-variance border with constraints consists exclusively of portfolios that are not on the border without constraints. If the DD is large enough, the border with constraints includes portfolios on the border without constraints. The second situation shows that the distance between the two borders is greater for lower and higher expected returns than in the case of moderate ones. Also, the third situation shows that the mean-variance boundary with constraints is placed further away from the mean-variance boundary without constraints once DD decreases. The last situation shows that the range of expected returns for which the two borders have common areas, which decreases once DD decreases.

DD boundary for the covariance average

Figure 1

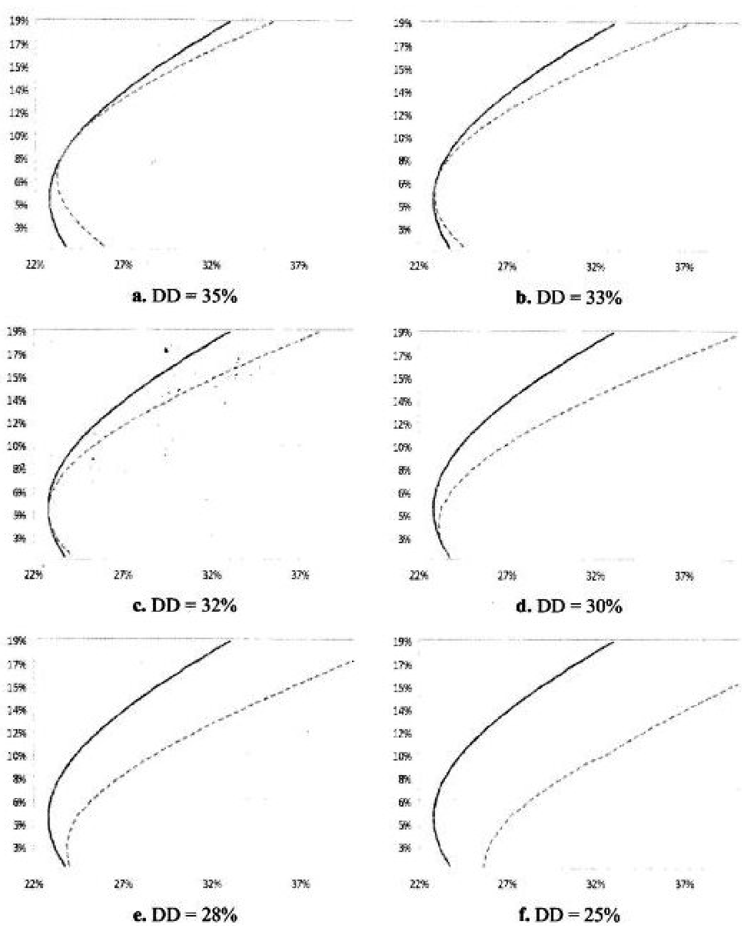


Figure number 2 shows the mean-variance boundary with VaR constraints when we have different values of the value constraint at risk. We specify that only the portfolios on the border without constraints, with moderate expected returns, satisfy the constraint. Under these conditions, the medium-variance border with VaR constraints consists of portfolios with moderate expected returns on the border without constraints and portfolios with high or low returns, which are not on this border. A portfolio at a distance from the border without constraints is the difference between its standard deviation and that of the portfolio located at the border without constraints, with the same expected return.

From those presented in figure number 2 it results that the distance between the portfolios located on the border with VaR constraint and those located on the border without constraints increases for expected lower or higher returns.

Mean-variance of boundaries

Figure 2

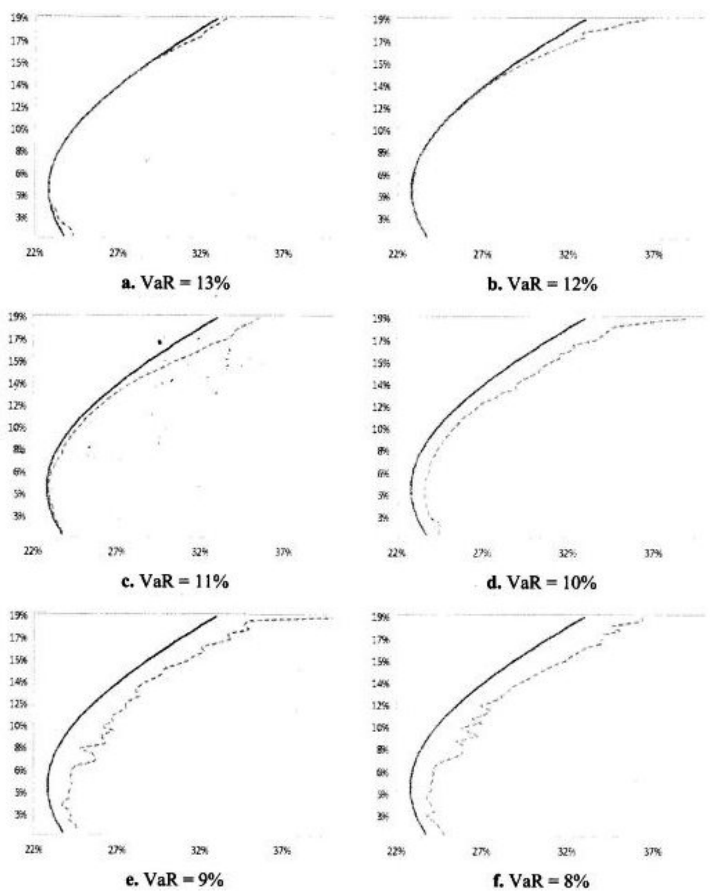
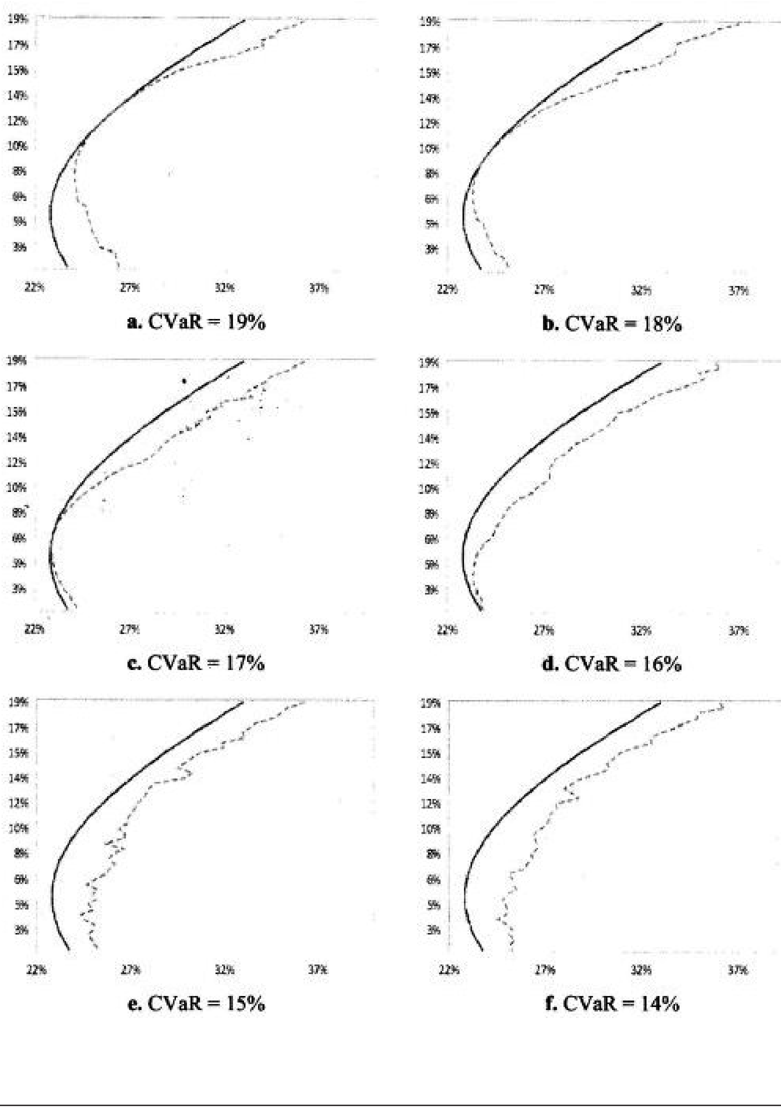


Figure 3 shows the average-variance boundary with CVaR constraints for different values of conditional risk value constraints. Qualitatively, the results are similar to those obtained when a VaR constraint was imposed. The properties of the portfolios located on the border with CVaR constraints are presented. It can be seen that the results are similar to those obtained for portfolios located on the medium-variance border with VaR constraint.

Limits of mean-variance without constraints and with CVaR constraint

Figure 3



The conclusions based on this analysis recommend that practitioners be sure that a constraint can lead to the selection of inefficient portfolios. Also, institutional investors and portfolio managers, who are considering the conclusion of a portfolio management contract with an MD constraint, must consider that in the presence of this constraint the profitability-risk trade-off is substantially different.

The main results of the paper, regarding the medium-variance boundary with VaR constraints are as follows: expected profitability, standard deviation, VaR and CVaR for an economic agent whose optimal portfolio is subject to a VaR constraint are lower than those obtained in the case of an optimal portfolio without restrictions and the distance of the optimal portfolio with VaR constraint from the boundary without constraints is greater for borders with lower VaR constraints. Therefore, this result suggests that in order to reduce large losses in the medium-variance model, a CVaR constraint is more effective than a VaR constraint.

We specify that risk management is an elegant framework, which combines the concept of risk with the process of building portfolios. Agencies aim to optimally select efficient mid-variance portfolios. To facilitate this process, a number of new tools have been created, which have emerged with the evolution of the financial market. The most commonly used tool is value at risk. On the other hand, studies have led to the emergence of new tools, as different approaches to VaR. Thus, conditional risk value is used as an alternative, being a coherent risk measure.

Given that VaR and CVaR are the most commonly used risk measures in risk management, the study focuses on the optimal way of allocating resources, by imposing VaR or CVaR constraints. The conclusions express that while the VaR for the optimal portfolio located on the medium-variance boundary with CVaR constraint is close to that of the optimal portfolio located on the border with VaR constraint, the CVaR in the case of the first portfolio is lower than in the case of the second.

To use a VaR or CVaR constraint in building the optimal portfolio, investors can directly optimize the risk effect. The implications of imposing a restriction on maximum intermediate loss in a portfolio selection case are analyzed and compared with those of imposing a VaR or CVaR constraint.

Optimal portfolios are not effective when constraints on VaR, CVaR or maximum intermediate loss are imposed. Consideration of such restrictions, which lead to risk limitation, is also accompanied by an additional cost represented by the fact that the built portfolio is not efficient from the point of view of the medium-variance approach. At the same level of expected profitability, a better portfolio could be built, which in the sense of the medium-variance paradigm refers to a portfolio with a lower return on profitability. This portfolio may exceed the limits imposed by internal or external regulations regarding VaR, CVaR or maximum intermediate loss.

Regarding the quantification of market risk, the most used method is VaR, defined as the maximum loss that can be registered with a specified level of confidence, in a period of time.

Given that most of the models presented did not prove to be sufficiently satisfactory to measure risk, some adjustments were necessary to obtain a higher degree of accuracy and efficiency. The obstacles of these techniques aim primarily at the characteristic features of the processes that determine the evolution of exchange rates, as well as the impact of the use of historical data.

Regarding the dynamics of volatility and the implications of the phenomenon of volatility clustering using daily returns in the case of eight stock market indices for emerging countries (Romania, Hungary, Czech Republic, Poland, Slovenia, Bulgaria, Slovakia, and Croatia), several types of volatility can be estimated. GARCH models to test the zero residue hypotheses Ud.

The study shows that the GARCH model (1.1) or the GJR-GARCH model (1.1) are not adequate to express the volatility dynamics in the case of the eight countries in Central and Eastern Europe, thus recommending the FIGARCH model (1, d, 1), because it better captures the dynamics of volatility with a high degree of occurrence. The fractional differentiation parameters of the estimated ARFIMA-FIGARCH models are statistically significant for all countries, which implies the presence of the phenomenon of long memory, both in profitability and in volatility. Regarding the dynamics of volatility, the value of the long memory specific parameter is decreasing in Bulgaria, increasing in Hungary, and for the rest of the countries it is relatively stable during the analysed period.

The results obtained illustrate that while the VaR for the optimal portfolio located on the medium-variance border with CVaR constraint is close to that of the optimal portfolio located on the border with VaR constraint, CVaR. By integrating a VaR or CVaR constraint into building the optimal portfolio, risk diversification can be directly optimized.

At the same level of expected return, a better portfolio can be built, which in the sense of the medium-variance concept refers to a portfolio with a lower return on variance. However, this portfolio may exceed the limits imposed by internal or external regulations in terms of VaR, CVaR or maximum intermediate loss.

Conclusions

In this article, the authors aim to analyse risk management issues, studies and estimates focusing on market risk quantification models, which represent the risk of loss arising from unexpected changes in stock prices, interest rates or exchange rate.

Establishing an adequate level of capital volume, covering the minimum adequacy requirements, must be done taking into account the level of amounts invested, currency used, duration of an investment, safety and return on investment, so that income is sufficient to produce the liquidity needed to meet current obligations.

Market risk is distinguished from other forms of financial risk, in particular credit risk and operational risk, the management of which is significant for capital market investors.

One variable that contributed to the rapid development of market risk management was the high level of instability in the economic environment. Thus, the volatility of the economic environment is reflected in various factors such as: capital market volatility, exchange rate volatility and interest rate volatility.

Investors in financial markets must accept that a diversity of market participants, with different investment strategies, different time horizons and different risk management strategies, will lead to greater market stability.

As a final conclusion, it can be appreciated that both VaR and CVaR are useful market risk management measures, stimulating the development of new methods for identifying risk sources, defining risk limits, reporting risks and improving investment strategies.

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