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Evaluating the efficiency of GARCH models in estimating the conditional risk value in Tehran Stock Exchange Accounting data approach

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ABSTRACT

Predictions are extremely important for a better decision-making. Uncertainty in decision making makes investors always seek to assess and estimate risk to minimize potential losses. Conditional risk value (CvaR) is considered as a comprehensive measure of risk that has been considered a useful tool in recent years. Due to the characteristics of capital market data, not all models will be able to make accurate predictions, and among the multitude of models, only the models which make predictions can correctly explain this market.

In this study, according to the existing theoretical foundations and using Delphi model and analysis and review of experts, first the accounting variables in the financial statements are effective in predicting the conditional risk value, then the data of accepted companies are used. In Tehran Stock Exchange during 2012-2018, we evaluated the capability of GARCH and Markov index models in predicting conditional risk value as a criterion for predicting coherent risk. The results showed that the estimates made with the GARCH model (1, 1) are closer to reality with the distribution of T-Student.

Keywords:

Accounting Data, Cohesive Risk, Conditional Risk Value, Markov Switching, GARCH

1. Introduction

In recent years, Iranian Stock Exchange has developed significantly with government`s support and measures such as the liberalization of justice stocks, both in terms of volume and value of transactions and the number of listed companies, and in terms of inflow liquidity and number of shareholders. Now it has an important position in the country's economy and today many people are active in the stock market, hence the stock market became a very large and complex market, hence in this situation one of the best ways is to predict the market. Prediction is a precondition for a decision, and different individuals and groups rely on prediction in their decisions. Uncertainty in predictions is inevitable, but that does not mean that predictions are worthless. The more accurate the forecasts, the more reliable they can be and may provide investors a great perspective. Investors make a great effort to invest their financial resources in markets with the highest return and the least risk. Return is a quantitative variable and risk is a qualitative variable. Because quantitative variables are much easier to measure than qualitative variables, much effort has been made to quantify risk and provide mathematical models. (*Sadeghi and Shams*, 2014). One of the most important components of risk is risk measurement. Risk is divided into two sections of favorable and undesirable. What is important in financial theories about risk and its measurement is adverse risks and their measurement. (*Shahiki Tash et a.l*, 2013)

The value that is at risk is from unfavorable risk criteria family which is a new way to measure potential risk in the capital market. (*Sadeghi et al.*, 2014) VAR is a simple and concise statistical measurement criterion for potential portfolio losses due to market risk, which measures risk quantitatively and conceptually, first proposed by *Bamol* in 1963. But it has been widely used since the early 1990s as a tool for measuring risk. Although VAR is a common risk criterion, it also has undesirable characteristics and is not satisfactory as a risk measurement. (*Demirchi*, 2010) Conditional risk value is considered as an attractive criterion of risk (coherent risk criterion) that has been welcomed in recent years and gradually emerged as a useful tool for risk measurement and management, which is denoted by the symbol CvaR. (*Fallahpour* and *Baghban*, 2014)

CvaR, first introduced by *Oriasev* and *Rockefeller*, is a measure that is more credible and more cohesive than VAR. Conditional value at risk tells us what to expect in bad situations. In other words, this criterion states how bad the bad conditions can be and shows the damage if it exceeds the VAR. (*Mohajeri*, 2011) To predict the risk, various models have been presented so far, each of which has its strengths and weaknesses. Some of them are weak in terms of lack of appropriate theoretical foundations and others have not shown proper efficiency in practice despite using appropriate theoretical foundations. Therefore, the purpose of this study is to evaluate the efficiency of GARCH models and comparative comparison of Markov switching model and GARCH family models in predicting conditional risk value as a criterion for coherent risk. In this regard the main focus is on the use of accounting data.

2. Theoretical foundations and research background review

One of the important questions about risk criteria is which criteria are more appropriate for measuring risk? *Artzner et al*. (1999) provided a criterion for this purpose. For economic reasons, they concluded that each measurement of risk must apply to four principles of the subject called “the principles of coherence” in order to be considered an appropriate risk measurement. These four principles are positive about transfer reliability, uniformity, sub-aggregation, and positive homogeneity. In addition to the cohesiveness feature, risk managers, brokers, and economists have considered other features in selecting a criterion for measuring risk. The most important features are simplicity of estimation, high flexibility, the ability to properly assess risk in critical market conditions and also good efficiency in normal market conditions. Based on the above features, the VaR criterion is easily estimated and in normal market conditions, the risk is measured with appropriate accuracy. But this criterion does not perform well in critical market conditions. In addition, one of the most important disadvantages of this criterion is lack of coherence characteristics. (*Artzner et al*., 1999)

In traditional econometric models, the constant variance of perturbation has always been one of the main and classical assumptions. In order remove this limiting assumption, *Engel* established a new method called *ARCH*. One of the reasons for using ARCH models is the existence of small and large prediction

errors in different clusters of a series; so that a series can show different behaviors in different years. In such cases, it is expected that the variance is not constant over time and is a function of behavior of an error in a sentence. In fact, the advantage of ARCH models is that it can explain the trend of conditional variance based on its past information.

Table 1 Summary of the background of the most important foreign (international) research

Topic and results	Year	Researcher(s)	Number
They employs a GARCH-Copula-CoVaR approach to address the debate on the extreme risk spillovers from commodity market to maritime market. the results provide new evidence regarding risk transmission from oil and ex-energy sector to the maritime markets, as well as the interactions between different sub-sectors of maritime market. It is also found that commodity markets exert different spillover effects on global and Chinese domestic maritime markets. In additional, the risk spillovers in oil-freight index pairs after global financial crisis is different from the before. Results enrich the knowledge of risk spillovers between commodity and maritime market, which help stakeholders improve portfolio optimization	2020	*Xiaolei Sun et el*	1
This paper proposes a hybrid credit risk model, in closed form, to price vulnerable options with stochastic volatility. The distinctive features of the model are threefold. First, both the underlying and the option issuer's assets follow the Heston–Nandi GARCH model with their conditional variance being readily estimated and implemented solely on the basis of the observable prices in the market. Second, the model incorporates both idiosyncratic and systematic risks into the asset dynamics of the underlying and the option issuer, as well as the intensity process. Finally, the explicit pricing formula of vulnerable options enables us to undertake the comparative statistics analysis.	2021	Gechun Liang & Xingchun Wang	2
Using neural networks, fuzzy logic and autoregressive, they presented a hybrid model for predicting the TAIEX stock index.	2017	*Chang et al*	3
They presented a study entitled "Stock market risk forecasting model" through a combination of rotational, fuzzy and GARCH regimes. To do this, first the fluctuations of three stock market indices were predicted using different GARCH models. Then, using Markov switching, the status of factors or macroeconomic variables affecting stock market indices were identified and combined with the fuzzy inference system model (ANFIS) to determine the effect on each index. The results showed that the proposed model is able to increase the forecasting power in the MAPE and RMSE GARCH models and provides a more accurate estimate of stock market volatility.	2018	*Crijanpoleri* and *Michelle*	4

In Iran, in connection with the calculation of risk value and *Garch* and *Markov* models, studies have been conducted using various methods, some of which are mentioned.

Table 2 summarizes the most important background of domestic research

Topic and results	Year	Researcher(s)	Number
They examined the possibility of using the risk value in the stock market and estimated the risk value and the metal ore industry index. The results showed that using the risk value criterion, the market risk of the metal ore industry is predictable and manageable.	2013	*Golarzi et al*	1
They introduced a new model for predicting sharp fluctuations in Tehran stock market returns. For this purpose, stock returns fluctuations were modeled by estimating Markov Garch switching model. By estimating this model, the matrix of probability for transfer of two volatile and low volatile conditions in Tehran stock market returns was calculated. According to the criteria for selecting the AIC and BIC models, the Markov rotational model with GED distribution is the best model for predicting fluctuations in the Tehran stock market.	2015	Nademi et al	2
Financial efficiency was modeled using the "variable-time-Markov combination model with normal time" results.	2018	*Alipour et al*	3

Topic and results	Year	Researcher(s)	Number
The output of the Dow ranking method, however, has been very similar to one another According to Dow ranking method, the GEV model has had the lowest loss function at 5% level of significance, and at 1% level of significance, the HS model has demonstrated the least loss function. ES calculations have also been carried out for the four models with ARIMA-GARCH-COPULA model showing the least loss.	2021	Alizadeh & Fallah	4

3. Research methodology

The research method in this research has been mixed (a combination of qualitative and quantitative) and is experimental in terms of time and in terms of development-applied purpose and post-event studies based on the analysis of observational data. After reviewing the research literature and initial identification of variables by fuzzy Delphi model, the inputs of Garch and Markov models are considered. Therefore, first the data is classified in Excel environment, then *Eviews* and *Matlab* software are used to achieve the optimal model. The statistical population and research period of all companies listed in Tehran Stock Exchange during 2012-2018 and the adjusted population (selected sample) is 91 companies.

Basic research steps

The process of conducting this research can be briefly described as follows:

1) Reviewing and studying the existing theoretical foundations (systematic review method) and extracting appropriate criteria
2) Preparing a questionnaire and distributing it among experts to reach agreement on indicators
3) Receiving experts` opinions, analyzing, classifying the answers and determining the final indicators of the research
4) Reviewing of descriptive statistics of data
5) Extracting the statistical features of the time series of the variables used and performing tests accuracy and LM test
6) Estimation of research variables by Garch regression to calculate coherent risk
7) Estimation of research variables by Markov switching regression to calculate coherent risk
8) Evaluating two fitted models with two normal distributions and t-student and selecting the best one

Execution of Fuzzy Delphi Method (Fuzzy Delphi Method) FDM

In the fuzzy Delphi algorithm and for screening at first a suitable fuzzy spectrum must be developed to fuzzy the verbal expressions of the respondents. Conventional fuzzy spectra can be used for this purpose. In this research, a triangular fuzzy spectrum of five degrees including Likert scale has been used. After identifying 142 effective variables in the qualitative phase, these components were presented to 30 people in the form of a questionnaire with the aim of obtaining experts` opinion and according to the proposed options and language variables, the results of the answers were listed. The questionnaire was analyzed to obtain the fuzzy mean of the components. The experts participating in this study were faculty members and university professors in the accounting and finance department who were active in the capital market and risk management. As it can be seen in the table below, for 11 variables, the difference between the first and second stages is less than 0.1. Therefore, it can be said that for these 11 variables, experts reached a consensus. Therefore, the poll for the identified variables is stopped. The validation of 11 variables out of 142 identified variables derived from financial statements which was approved by the consensus of experts and the fuzzy Delphi method.

Table 3- Triangular fuzzy mean and definite mean of categories (second stage)

No.	The difference between the first and second stages	De-fuzzy mean (definite)	Triangular fuzzy mean			Categories
			M	α	β	
1	0.025	0.6165	۰,٦٤١	۰,١٥٦	۰,۰٥٨	Cash and balances with banks
2	0.00725	0.60035	۰,٦٤٢	۰,٢٤٥	۰,۰٧٨٤	Short-term investments
3	0.0884	0.4616	۰,٥١٢	۰,٢١٢	۰,۰١۰٤	Accounts receivable and commercial documents

No.	The difference between the first and second stages	De-fuzzy mean (definite)	Triangular fuzzy mean			Categories
			M	α	β	
4	0.08	0.47	۰,٤۹۱	۰,۱۳۱	۰,۰٤۷	Other accounts receivable and business receivables
5	0.02	0.517	۰,٥٦٥	۰,۲٦۸	۰,۰۷٦	Inventories
6	0.06	0.519	۰,٥٦۷	۰,۲٦۱	۰,۰٦۹	Total current assets
7	-0.0475	0.62	۰,٦٦٥	۰,۲٥۷	۰,۰۷۷	Long-term investments
8	0.015	0.5315	۰,٥۷۸	۰,۲٦۱	۰,۰۷٥	Other assets
9	0.095	0.513	۰,٥٦۱	۰,۲٦٦	۰,۰۷٤	Investments and other assets
10	-0.0925	0.629	۰,٦۷٥	۰,۲٦۸	۰,۰۸٤	Net fixed assets
11	0.018	0.5165	۰,٥٥٦	۰,۲٥٤	۰,۰۹٦	Total non-current assets

Source: Research calculations

4. Descriptive statistics of variables

After performing the fuzzy Delphi method and selecting the research variables, the descriptive statistics of the variables have been studied to evaluate the central indicators and dispersion. Descriptive statistics parameters include information about central indicators such as mean, mean, maximum, minimum, as well as information about scatter indicators such as standard deviation, skewness coefficient and elongation coefficient according to the table below.

As it can be seen, the difference between the mean and the mean in all variables except the stock index as well as the skewness and Kurtosis is very high, which indicates the absence of a normal distribution among these variables. Therefore, based on the above fluctuations among the variables, the pattern can be estimated using Markov switching regression and different regimes can be obtained.

Table 4- Descriptive statistics of research variables

Variable name	Kurtosis	Skewness coefficient	standard deviation	Minimum	Maximum	Median	Mean
Total Index (INDEX)	۱/۸٥۲	۰/٤٥٦	۲۷۹۲۳/۰۷	۱۰۷۷٦۸	۱۹٦٦۲٤	۱۳٦۷٥٤/۷	۱٤۱٦٦۹/۹
Cash and balances with banks (Cash)	۲۳٤/۰۸۸	۱۳/٥۳۹	٦٤٤٦۸۰۸	۰/۰۰	۱۳۸۰۰۰۰۰۰۰	۲٥۷۷۱/٥	۹۹۹٦۲۷/٦
Short-term investments (SI)	۷۸/٤۳۲	۸/۰۷۱	۱۲۰۳٤٦۹	۰/۰۰	۱٤٦٤۱۱۰۷	۰/۰۰	۲٤۸٤٦٤/۲
Accounts Receivable (BA)	۲٥۰/٥۱۷	۱۳/۸٥۸	٦۷۹۹۸۰۰	۰/۰۰	۱٤۹۰۰۰۰۰۰۰	٥۲۷٥۲/٥	۱۱٤۸۲٥٥
Other Accounts Receivable (BAA)	۸۲/٤۰۰	۸/۱۳٤	۱۰۳۱۳۷۲۷	۰/۰۰	۱٤٦۰۰۰۰۰۰۰	۱۱۰٤۸/٥	۲۰۲۸۱٥۰
Material Inventory (GM)	٦٥/۸۹٤	۷/۱۸۳	۱۹٤۱۰۸۰	۰/۰۰	۲٥٥.۳٥٥.	٤۳۰٤۳	٥۱۲٤۱۸/٦
Current Assets (CA)	٥۸/۸٦۲	٦/۷۷۷	۱۳٤۰۰۰۰۰۰۰	۱۷۷۲	۱٥۷۰۰۰۰۰۰۰۰	٦۰٥٥۰۲	۳۳۲۲۷۲۳۳
Long-term investments (LI)	٦۹/۱۱٤	۷/۲۱۹	۱۹۸۹٥۸۱	۰/۰۰	۲۹۱۰۹۸۱٦	۷٤۸۰/٥	٤۹۲۱۱۲/۸
Other Assets (RA)	۱۰۰/۸۷۷	۸/۸٥٤	۱۲٥۳۹۰۷۱	۰/۰۰	۱۹۷۰۰۰۰۰۰۰	۳۰۰۰	۲٤٦۱٤۰۸
Investments and other assets (IRA)	۹۱/۱۹۸	۸/۲٦۹	۱۲۸۲٥٤۰۳	۰/۰۰	۱۹۷۰۰۰۰۰۰۰	٤۲٦٤٦	۳۰۱۹۹۲۸
Net Fixed Assets (FR)	۱۷۱/۱۱۷	۱۱/۰٦۰	٤۸۱٥۹۲۷	۰/۰۰	۹۰٦٦۷۲۸٥	٤۳۹۷٦/٥	۱۰۳۷۲۳۰
Total non-current assets (NR)	٤۸/۷۲٤	٦/۰٦۳	۱۸٦۷۸۲۰۷	٥۲٤	۲۰۸۰۰۰۰۰۰۰	۲۳٥۷٤٦/٥	٥٦۸٤۹۹۹

Source: Research calculations

Markov-Switching Regression (MS)

In this section, the following regression is estimated by the Markov-Switching (1989) model.

INDEX = β0 + β1CASH + β2SI + β3BA + β4BAA + β5GM + β6CA + β7LI + β8RA + β9IRA + β10FR + β11NR + εit

where in; INDEX is a dependent variable equal to the total stock price index and 11 independent variables are the one identified in the fuzzy Delphi method. Markov switching model is to examine the existence of different regimes in predicting risk and stock market fluctuations.

Determining the optimal delay degrees and selecting the model

In this section, the optimal delay degrees and the selection of the appropriate model are presented by the *Akaike* criterion and the maximum likelihood test. Table 5 shows the results.

Table 5 - Determining the optimal delay degrees and model selection

	MSI(2) AR(4)	MSM(2) AR(2)	MSMA(2) AR(2)	MSMH(3) AR(4)	MSMH(3) AR(5)	MSMH(3) AR(4)
Akaike	١٤/٩٨٥	١٤/٨٧٥	١٤/٧١١ *	١٥/٤٧٨	١٥/٩٤٥	١٤/٨٢١
Maximum accuracy	/٢٣٦٥ -٨٩٦٥	/٩٦٨ -٩٥٨٢	/٢٧٣ *-٨٠٧٣	/٧٤١ -٨٨٩٦	/١٢٣٩ -٨٤٥٦	/٢٣١٠ -٩٦٠١

Source: Research Calculations

According to the above table, to determine the optimal interrupt degrees, each of the variables in the model are selected by considering maximum 5 interrupts, minimum value for the Akaike criterion, maximum value for the maximum likelihood, statistical comparison of probability ratios and, most importantly, models that can be justified for the structure of the Iranian stock market. According to the structure of the Iranian stock market and diagnostic tests, among the above models, the MSMH (2) -AR (2) model was selected as the optimal model.

Selecting the number of modes in the Markov switching model

The likelihood ratio test was used to select the number of diets. Table 6 shows the probability ratio test results.

Table 6 - Selection of regimes in the Markov switching model

Probability level	Akaike statistic	Number of regimes
٠/٠٠	-٨٠٧٣/٢٧٣	Two regimes
٠/٠٠	-٨٨٠٨/٦٩	Three regimes

Source: Research Calculations

According to the probability ratio test and considering that the value of this statistic is more than two regimes, it is more appropriate to use the Markov switching method with two modes to extract the present model.

Markov switching model estimation

As mentioned, the model of choice for the effect of accounting variables on the stock price index is the model MSMA (2) -AR (2). The model estimation results are shown in Table 7.

Table 7 - Markov switching model estimation

Probability level	T statistic	Coefficient	Variable	Regime
0.8296	-0.215168	-1.87E-07	CASH	First (high regime)
0.0461	1.994794	1.28E-05	SI	
0.0461	-1.994844	-1.95E-06	BA	
0.3402	-0.953692	-6.46E-07	BAA	
0.1203	1.553713	9.16E-06	GM	
0.2198	-1.227137	-1.48E-07	CA	
0.0000	-49.46658	-0.001107	LI	
0.0000	-49.88300	-0.001101	RA	
0.0000	49.75101	0.001097	IRA	
0.1587	-1.409383	-2.75E-06	FR	
0.0220	2.289855	4.54E-06	NR	
0.9544	0.057252	4.46E-07	CASH	Second (low regime)

Probability level	T statistic	Coefficient	Variable	Regime
0.4473	-0.760142	-1.80E-05	SI	
0.8687	0.165316	1.55E-06	BA	
0.9303	-0.087472	-5.89E-07	BAA	
0.7817	0.277149	1.24E-05	GM	
0.9876	-0.015570	-2.07E-08	CA	
0.9388	-0.076790	-6.81E-06	LI	
0.9710	0.036315	3.07E-06	RA	
0.9913	-0.010901	-9.23E-07	IRA	
0.9351	0.081446	1.59E-06	FR	
0.9804	-0.024571	-2.83E-07	NR	
0.0000	539.0802	0.825867	AR(1)	
0.0000	82.16766	0.313129	AR(2)	
0.0000	-34.75516	-0.138873	Sigma(0)	
Log-Likelihood	-8073.273			
AIC	14.71141			
HQ	14.34658			

Source: Research Calculations

According to the results presented in the table above, the results of estimating the parameters related to the model to evaluate the two high and low regimes show that in the first regime, the variables SI, BA, LI, RA, IRA and NR at the level of probability 5 percentages affect the stock index; but in the second regime, none of the independent variables can affect the stock index. This result shows that in the second regime, the fluctuations of accounting variables were much more severe than the first regime, which led to accounting variables and could not affect the stock index. Probably during this period, due to sharp exchange rate fluctuations, the stock index was often affected by exchange rate fluctuations or other parameters.

Results of variance homogeneity test

First, the variance homogeneity test is used to prove the use of the GARCH method. If the error components in the model have variance inequality, the GARCH model can be estimated with confidence. The null hypothesis of this test is homogeneity of variance. Therefore, if the probability level is less than 5%, the null hypothesis is accepted and the model has variance inequality. Table 8 shows the results of the LM Arch test to detect variance heterogeneity in the model.

Table 8 Results of Arch LM test

Result	Probability level	Statistics F
Variance inequality	۰/۰٤	٤/۱۷٥

Source: Research Calculations

Due to the fact that the probability level of the test statistic is less than 0.05, the results of the Arch LM test at the 5% probability level indicate the existence of variance inequality in the model residues. Therefore, the GARCH method can be used to estimate the model with confidence.

Investigation of different patterns of GARCH model

To accurately determine the GARCH model, different GARCH patterns with different degrees should be tested. The lower the Akaike and Schwartz criteria, the better the model will be. The test results of different models of GARCH model are described in Table 9.

Table 9 GARCH model estimation results

Criterion	CARCH (0,1)	CARCH (2,1)	CARCH (1,1)
Akaike	۲۳/۳۰۹	۲۲/۳۲٦	۲۲/۰۳۱
Schwartz	۲۳/۳۷۲	۲۲/۳۹۹	۲۲/۱۰٤

Source: Research Calculations

According to Akaik and Schwartz criteria, the best GARCH regression model is the GARCH model (1, 1).

GARCH Model Estimation (1, 1)

In this section, regression is estimated based on the selection of the best model, which is GARCH (1, 1). Table 10 shows the results of regression estimates.

Table 10 GARCH regression estimation results (1, 1)

Probability level	T statistic	Coefficient	Variable
0.0000	648.8936	136459.2	Width of origin
0.2826	1.074487	1.78E-05	CASH
0.0000	8.577632	0.001812	SI
0.0000	-4.881812	-0.000321	BA
0.0000	-5.556400	-7.04E-05	BAA
0.0000	6.477564	0.001489	GM
0.0027	2.997197	6.49E-06	CA
0.0000	6.527120	0.002482	LI
0.0000	6.959496	0.002870	RA
0.0000	-6.895655	-0.002843	IRA
0.0752	-1.778970	-0.000323	FR
0.3749	-0.887262	-4.65E-05	NR
0.0000	4.098513	0.128941	AR(1)
R^2= 0.23			
DW= 2.02			

Also, the mean and conditional variance results are as follows:

Table 11 - Mean and conditional variance in GARCH regression

Probability level	T statistic	Coefficient	Variable
0.0730	1.792986	433929.6	Width of origin
0.0003	2.964360	0.432346	ε_{t-1}^2
0.0000	8.992673	0.556239	GARCH(-1)

The coefficient of all variables related to the mean and conditional variance is significant. Therefore, the conditional variance equation is as follows:

$$GARCH = 433929 + 0.432\ \varepsilon 2t\text{-}1 + 0.556GARCH\ (-1)$$

The proposed model is a GARCH model (1, 1). GARCH is the conditional variance of the error process, which is considered as model uncertainty. The values of 1α and β in the simple case of GARCH model are equal to 0.432 and 0.556, respectively. Since 1> β + 1α, the unconditional variance of the error sentences can be defined. Thus the error squares depend on both the conditional mean and the conditional variance. Accordingly, the conditional variance of the error components in the GARCH regression is as follows:

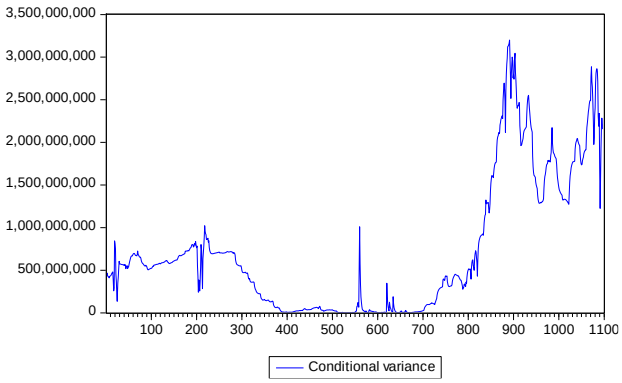

Figure 1. Conditional variance in GARCH regression

Conditional Risk Estimation or Cohesive Risk Estimation (CVaR)

In this section, the AVaR model is used to assess the coherent risk. The results of Markov switching and GARCH models obtained in the previous section are compared with each other and the best model for integrated risk assessment is selected. Therefore, to examine the best model, the coherent risk is calculated by two distributions, normal and t-student. Then, by comparing these two distributions, the best model is selected. The results are shown in the table below.

Table 12 - Calculation of Value at Risk Average (CVaR)

T-student	Normal	Model
0274/0	0265/0	Markov Switching
0269/0	0269/0	GARCH(1,1)

As can be seen, the estimates made with the GARCH model (1, 1) with the t-student distribution are closer to reality; therefore, conditional heterogeneity or GARCH models can be used to estimate the CVaR risk value.

5. Conclusions

Accuracy of forecasting is one of the most important factors in choosing the method of forecasting. Today, despite the existence of various forecasting methods, accurate financial forecasting is still not an easy task and most researchers are trying to use a combination of different methods and use different information in order to achieve more accurate results. The main approach in this model has been coherent risk forecasting using accounting information as basic information and input data. The financial crises that

took place in the world made the world aware of the need to re-evaluate the risk management system and the tools used by it. Therefore, the approach of this research can be summarized in two parts:

The first part is a systematic review, identification of accounting variables and data affecting risk. The second part indicates that using a comparative model based on Garch and Markov models and accounting data, it can be stated that to predict the conditional risk value as a measure of integrated risk assessment of multivariate GARC models, other models should be used and investors should pay attention to them as the outputs of the network also increase the forecast accuracy. Therefore, it is recommended that investors, taking the accounting data into account in the financial statements, seek to assess the coherent risk resulting from the Garch model and consider these issues in the companies under review, and financial institutions also seek to identify sources.

6. Suggestions from research results

This research allows not only investors but also company managers to have a more accurate planning for the resources of the business unit by studying and estimating coherent risk more carefully. Due to the success of the model based on accounting data in practical tests, it can be considered as an efficient tool for investors according to the conditions of Tehran Stock Exchange in terms of efficiency and also the availability of accounting information compared to other information. Therefore, the following items that arise from the results of this study are recommended:

- It is recommended that investors invest in the companies under consideration due to the cohesive risk.
- It is recommended to use ANFIS method to optimize risk and stock portfolio.
- It is recommended that many financial institutions seek to identify sources of risk and then control and manage it.
- According to the capabilities of the conditional risk value criterion as a cohesive risk, it is suggested that portfolio managers measure the portfolio risk according to the advantages of the ANFIS model using this criterion and finally measure the financial assets. Identify the risk increases and redistribute assets optimally to minimize portfolio risk.
- The need for special attention of organizations and companies to the category of coherent risk and the use of accurate tools to estimate it
- Using a coherent risk assessment model in banks for credit rating of customers

7. Suggestions for future researchers

Based on the studies conducted in this study and in order to complete the research in this field, the following items are suggested to researchers for future studies:

- It is suggested that in a comprehensive and simultaneous study, the impact of macroeconomic variables such as exchange rates, gold, oil, commodities and accounting variables on cohesive risk be investigated.
- It is suggested that in future research, other multi-objective optimization algorithms such as multi-objective genetic algorithm based on faulty sorting or other evolutionary multi-objective optimization algorithms be used.
- It is suggested that other risk criteria be considered in future research. Consistent risk can be estimated from other methods such as AVaR.
- Coherent risk assessment in various industries, including insurance, banking and investment companies, metals and petrochemicals, etc.
- Investigate the use of the above model in the field of evaluating the performance of the portfolio and determining the optimal portfolio

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