

*Full Length Research Paper*

# **A new scheme for investigating any effects of credit and exchange risk on stock price returns**

**Omid Jalilian<sup>1</sup>, Mehrdad Ghanbari<sup>2</sup>, Hamid Jalilian<sup>3</sup>, Yousef Jalilian<sup>4</sup> and Naser Seifollahi<sup>5\*</sup>**

<sup>1</sup>Department of Accounting, Islamic Azad University, Kermanshah Branch, Kermanshah, Iran.

<sup>2</sup>Department of Accounting, Islamic Azad University, Science and Research Branch, Tehran, Iran.

<sup>3</sup>Department of Business Management, Islamic Azad University, Eslamabad-E-Gharb Branch, Eslamabad-E-Gharb, Iran.

<sup>4</sup>Young Researchers Club, Islamic Azad University, Kermanshah Branch, Kermanshah, Iran.

<sup>5</sup>Department of Management, Shahid Beheshti University, Tehran, Iran.

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**The main purpose of this research is to develop a localized model of credit risk management, exchange rate risk and price fluctuations in previous stock price by the use of GARCH approach as a family model. Then, we studied all effects of earlier mentioned variables on stock price return in order to find out any behavior of stock price as well. The mentioned procedure may enable us to have a clear understanding about fluctuation changes and reduce any cognitive limitations related to this variable and submission complete information for bank experts. According to the findings of this research, it was revealed that there is a significant relation between risk credit and exchange risk with the stock price return of banks based upon conditional variants of heteroskedasticity models. Then it is possible to find out any effects of credit risk and exchange risk on the stock price returns of banks completely separate from their predictability difference.**

**Key words:** Credit risk, return fluctuations, risk management, GARCH, ARCH, ARMA, GARCH-M, EGARCH, ARMA-GARCH.

## **INTRODUCTION**

Commercial banks always deal with three types of risks: 1) financial risks (credit risks), 2) operational, and 3) strategic. These risks leave different effects on the function of these banks. Credit risk has the most significant amount and level of loss of all. Recent years have witnessed the banks problems about the due date of the credit debt. Researchers have found many reasons regarding this issue. Credit problems, especially weak credit risk management, are one of the problems of such banks. Problems in the loan quality make problems for the banking industry. Weakness in the quality of loan originates from the data processing mechanism. Brown Bridge believes that this problem is more outstanding in developing countries. It starts from studying the loan request and when the loan is approved, it goes on in the

supervising stage.

Recent years have changes the market to a universal method through free and floating exchange rates. This method has opened a window for the beneficial businesses and has increased the exchange risks as well. Reducing exchange control and freeing invest movement of universal markets have led to a significant growth in international financial markets. Universal growth and volume of foreign businesses have increased international deals and invest flows which have resulted in more exchange rate fluctuations and exchange risks, too.

The point in this research is designing and identifying a localized model for risk management which can recognize the role of important and effective variables on the stock return fluctuations. One of the most important and effective variables on the price return of bank stock is credit risk and exchange rate risk.

\*Corresponding author. E-mail: [seifollahi\\_naser@yahoo.com](mailto:seifollahi_naser@yahoo.com).

ARCH was first used by Angel in 1982 for England inflation. He founded his ARCH model based on the remains of a simple model "winding-salary" related to 1977-185 in England. He used this model to approximate the mean and variance in inflation. The results indicated that his ARCH was meaningful. He understood that the SD had been doubled or more with the inflation rate prediction in England's economy in the 1960s in which the indicators was soft and predictable fluctuation compared to the 1970s which had more and unpredictable fluctuations.

Akgiray (1989) found out that the GARCH models from ARCH models, weight animation mean and historical mean models have been more of use in the predictions in the monthly US stock indicator.

Bollerslev (1986) compared the potential of the models GARCH, EGARCH, Markove's diet model, and three non-parametric models in the prediction of the US stock return monthly fluctuations. EGARCH and GARCH have been good predictors and the other models were weak.

Nelson (1991) found some shortcomings in GARCH model and then introduced power ARCH or PARCH. These pitfalls were disregarding negative correlation between present return and future fluctuations, binding functions of parameters which are almost always negated in predictions and limited the power of model to study the progress of conditional fluctuations and also that the interpretation of consistency or non-consistency of shocks to conditional variance in GARCH models are difficult. He used his model which lacked the weak points of GARCH model for CRSP value-weighted market index for the period of 1987-1992 and he announced satisfactory results. Day and Lewis (1992) studied the function of foreign predictor of sample models of GARCH and EGARCH in predicting the stock fluctuation indicators. The prediction of this model has been compared with the implied fluctuating model. The data included the weakly prices for the option indicator S&P100 and the basic option dated from March 11, 1983 to December 31, 1989. The results indicated that the sample model has some extra data which were not included in the EGARCH and GARCH model, however, outside the sample, the results showed that the predication was not an easy task and it could not lead to a general conclusion. Elyasiani and Mansur (1998) investigated the in advance predication of exchange rate. In this predication, GARCH had a better result, but when the period of predication increased, the function declined.

Brailsford and Faff (1996) found out that the GJR model and GARCH models had a better function than other models in the monthly fluctuation predictions of Australian stock indicator. The results of their studies showed that predication was not an easy task and the conditional variance models had a better outcome.

Lin and Yeh (2000) studied the nature of conditional heteroskedasticity and the type of distribution in the stock return in Taiwanese stock market. The used normal

distribution, normal compound, distribution and Poason to find out the stretch. In order to balance the serial correlation of the ARMA (1, 1) model and evaluate the conditional heteroskedasticity, they used GARCH (1, 1) model. The results mentioned that the GARCH (1, 1) model had a better return with normal compound distribution for the Taiwanese stock market.

Brooks et al. (2000) used PARCH models to study the returns of stick markets in 10 countries and one universal indicator. They figured out that including leverage effects and GARCH makes PARCH models more accessible in these countries and the power inversions required for these models are the same in these countries.

Miyakoshi (2002) studied the effects of ARCH and central data in conditional variance in stock returns with the application of individual stock prices in Tokyo stock market and their price indicators. The results illustrated that involving the volume of deals in the formations of GARCH and EGARCH wipes out the effect of ARCH in the individual stock and price indicator. He mentioned the reasons for this behavior and showed that data centered variance models had a better potential in this regard.

Friedmann and Sanddorf (2002) studied the Chinese dynamics stock markets compared to EGARCH and GJR GARCH models. The results indicated that different dynamics regarding the various market divisions is as internal and external stocks. In respect to the internal stock returns, they found out that the days that there was no dealing had large effects on the fluctuations, and inserting price limitations would reduce the fluctuations significantly. A traditional graph showed the effects that when the fluctuation periods were high, there would be more suitable conditions to accelerate the effects of the news on GJR and GARCH models while the effects of news on EGARCH model were untouched.

Awartani and Corrad (2005) investigated the price fluctuation predictions with GARCH models, foreign journal prediction (167 to 183) and compared the prediction potential out of the sample models emphasizing the asymmetric feature. Their findings showed that regarding the in advance prediction, asymmetric GARCH model had a better function than GARCH (1, 1) model. The some steps in advance predictions share the same results, however, the power of asymmetric GARCH models decrease as the period of prediction increases. While the asymmetric GARCH models are not accounted for, the function of GARCH (1, 1) model was the best of all.

Flannery (2000) used the following multi-variant regression to evaluate the sensitivity of exchange rate and stock price of 152 accepted companies (86 exporting and 66 non-exporting companies) in the stock market between 2000 and 2002.

$$R_{it} = a_i + \beta_{1i}e_t + \beta_{2i}R_{mt} + e_{it}$$

$a_i$  -fixed amount i-the stock return for the entrepreneur;

$e_t$ - percentage change in exchange rate;  $R_{mt}$ -market return;  $B_t$ -sensitivity indicator of the stock return of company  $i$  related to exchange rate changes.

This research applied two analyses. The first was the economic risk of Turkish companies by the regression slope of stock return on the exchange rates. The developed model for this analysis focused on the value of individual entrepreneur and the estimates of regression of the least squares. The real exchange rate coefficient was used in this research. These researchers measured the sensitivity of exporting and non-exporting companies regarding the exchange rates (Simwaka, 2011).

The findings showed that 11.8% of sample companies had positive economic risks in the case period. The risk mean coefficient of exporting companies was higher than the risk mean coefficient of the non-exporting companies. While the coefficient was 60%, was meaningful for the exporting companies, only two non-exporting companies had a meaningful coefficient. The results indicated that the risk pattern of exporting and non-exporting companies were different. In the meantime, the  $B_t$  coefficient was positive (Albaity and Ahmad, 2011).

Sensarma and Jayadev (2009) studied the data of financial bills on the risk management potentials in banks and determined banks stock sensitivity compared to risk management. The results of the data related to Indian banks showed that risk management has increased in recent years except for 2 years. Banking returns are sensitive regarding the bank risk management potentials.

The results showed that the banks which could increase the wealth of their stock holders emphasized the main risk managements. The implied results were for the shareholders who were seeking long-term benefits on bank stocks and they were better risk managers. These results were useful for the inspectors to develop the quality indicators of banking systems (Chang and Jiun-Tze, 2011).

Richard et al. (2008) investigated a development of an interpretive model for more functions in perceiving credit risk management of commercial banks in one economy with less financial division.

In this research, at first the research method are mentioned and the data are categorized by the research method. The time and place are identified and the data collection method is distinguished. At the end of this paper, the test of first and second hypotheses regarding the effects of exchange risk fluctuations and credit risks on price risk returns of bank stocks related to the studied period is investigated and they are based on the models of ARMA-GARCH, ARAMGARCH-M, ARAM-GARCH with the outcome of Eviews software.

### The conceptual research model

In this model, the process of the effect of credit risk as an exogenous variable and price return of bank stocks on the return risk of bank stocks based on the mean and variance equations

have been shown.

In this conceptual model, it is assumed that the price return of bank stocks has been affected by the credit risk, exchange risk and delay amounts of the variable and animated mean (ARMA). The variance equation shows the effects of the credit risk, exchange risk, wastes, SD of credit and exchange risk (with one delay based on their innate behavior) on the variance equation and mean equation which demonstrate the price return relationship of the past periods with the stock price and also the waste. This model can also be used to study the periodical data series. In this model, ARMA has two parts.

In the GARCH model, the effects of credit and exchange risks through using wastes and considering the variance equation on the return risk of stock prices have been shown indirectly. In GARCH-M model, credit and exchange risks have been entered the mean equation directly and the effects of the mentioned risks on the return prices of the bank stocks have been shown (Figure 1).

In this research, risk return of the bank stocks has been defined as the following equation:

Mean equation:

$$SPR_{2F3} = c(1) * SPR(-1) + C(2) * SPR(-2) + \epsilon$$

Variance equation:

$$GARCH = C(3) + C(4) * RESID(-1)^2 + C(5) * GARCH(-1) + C(6) * 3F4CRR(-1) + C(7) * EU RR(-1) + C(8) * CRR\_S(-1) + C(9) * EU RR\_S(-1)$$

The variables in the mean equation are as the following:  $SPR$  is the stock price return risk in  $t$  time,  $C_1$  is the sensitivity of the stock price return related to one lag period and parameters ( $C_2$ ) is the sensitivity of the stock price return related to two lag periods,  $C_3$  is the coefficient of intercept and  $C_4$  is the power coefficient of the waste,  $C_5$  coefficient is the stock fluctuations or stock risks with one period delay and  $C_6$  coefficient is the stock price return sensitivity compared to the credit risk with one delay period,  $C_7$  coefficient is the stock price return risk compared to the  $EU RR$  risk with one lag period,  $C_8$  coefficient is the SD of credit risk and  $C_9$  coefficient is the SD coefficient of the exchange (Euro) risk. ARCH conditional variance follows the defined process in equation which is determined by the second power of the waste  $\epsilon^2_{t-i}$  and the earlier behavior of the variance (ARCH). The waste  $\epsilon^2_{t-1}$  has a normal distribution with zero mean and  $h_t$  variance which is defined through the equation.

### The development process of GARCH and ARCH

The main purpose of econometric in investigation of time series of financial return is how to use the existing data to predict the mean (the expected value) and return variance while various models have been developed to describe the return formation and expected return measuring. Before introducing conditional self-regression on variance heteroskedasticity, there was no exact method to predict variance. One simple tool is rolling SD. This tool is a method to calculate the SD based on fixed numbers of the newest data and it assumes that the return fluctuations in the future period are the previous harmonic mean. This tool was described as the simple moving mean. The assumption of the equal weights is not absorbing because it can be assumed that the recent events are the most important so that they should be devoted more weights. Therefore, rolling SD was introduced by weight system. The only difference between this method and the rolling SD is that the newest data are given more weights for SD calculation. In both tools, the previous observations of the rolling window are devoted zero weight and that is one important shortcoming of both models because some parts of data are wasted out.

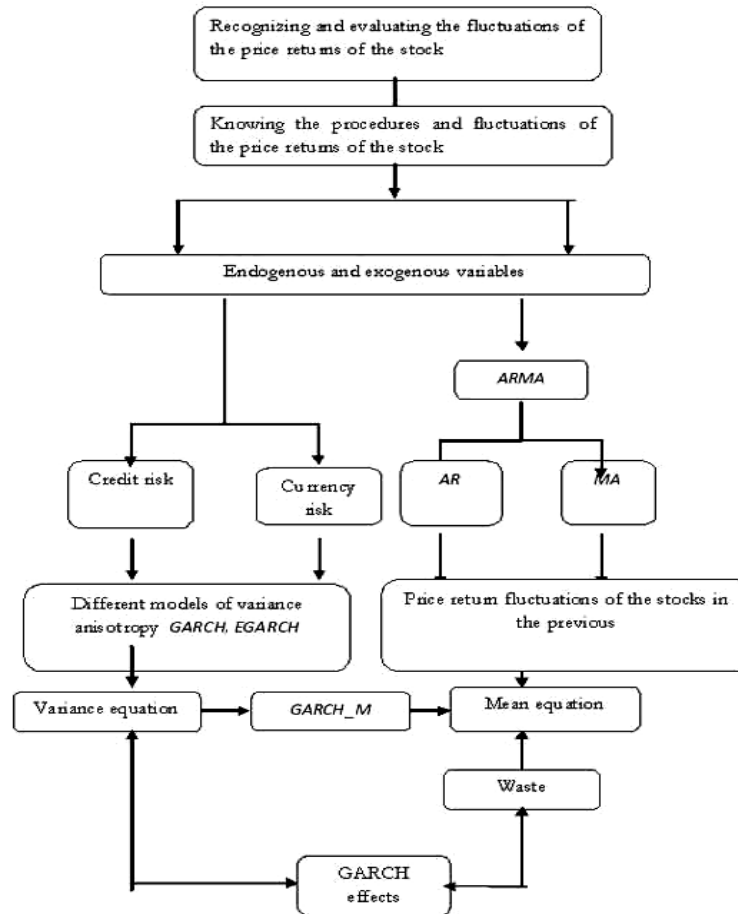


Figure 1. The conceptual research model.

Conditional self-regression model on heteroskedasticity was eventually introduced by Angel in 1982. This model considers the existing weights in variance calculation as passive parameters and it takes their estimate into account so that regarding the data, the best weights are estimated to predict the variance.

The conditional self-regression model on heteroskedasticity was generalized to developed conditional self-regression model on heteroskedasticity in 1986 by Boloself. These models, like moving mean models (simple and exponential), are the squared mean of the previous period remains, but they have some weights that are reducing all the time; however, they never meet zero. It means that the size of sampling window increases by the historical data and all historical observations are used in fluctuation predictions. In the meantime, these models are cheap to launch and parameter predictions are rather easy and they are interestingly successful in predicting conditional variances.

Developing GARCH and ARCH models has revolutionized the accidental fluctuation modeling procedure and these models have granted economy Nobel Prize to Angel in 2003.

## RESULTS

Here, different issues of the designed GARCH models are reported to three banks according to collected data

and extracted data from the Eviews outcome. The hypotheses are tested and the results are interpreted.

### Modeling the price return risks of the private banks stocks based on different issues of mean and variance equations (ARMA-GARCH)

The effects of credit risk and exchange risk on stock return fluctuations of private banks have been investigated from July 15th, 2009 to April 22nd, 2011 with 648 observations based on different issues of GARCH models. Of all, the issues of ARMA (2, 0)\_GARCH(0,1), ARMA (2,0)\_GARCH (1,1), ARMA(2,0)\_GARCH-M\_EGARCH(0,1), ARMA(2,0)\_EGARCH(1,1), ARMA(2,0)\_GARCH-M\_EGARCH(0,1) were meaningful with acceptable coefficients, and the issues of ARMA(2,0)\_PGARCH ARMA(2,0)\_IGARCH were not meaningful based on Z-test and some regression coefficients. It should be added that the stock related data, stock price SD, debts, debt changes and debt SD, exchange rate, exchange rate changes, and Tejarat

bank, Eghtesad-e-Nouvin nad Kar Afarin exchange rate SD have been accounted for in the enclosures. As explained in details in chapter two, GARCH family model is used to figure out the estimates of variable relationships when the variance of the waste is a function of the second power of the waste in the previous periods. If the least number of estimate squares is used due to variance heteroskedasticity, the estimated coefficients will not be reliable any more. In the model estimate, all GARCH models have been investigated in order to determine the most appropriate issue which can describe the dependent variable behavior well. The fluctuations of the stock price returns of the banks based on the mean and variance equations have been illustrated as the following:

1. First of all through the mean equation which indicates the direct relationship of the dependent variable, that is, the return risk of the stock price compared to previous amounts and also the amount of the animated mean (earlier shocks) in the form of ARMA.
2. Secondly, through the variance equation in which the endogenous variables of the credit risk and exchange risk were effective through the variance equation on the risk returns of stock price of the mentioned banks and the related coefficients are highly meaningful. It should be noted that in the EGARCH model, because the variance logarithm is inserted into the model and also because the changes in the stock price returns and related changes in the exchange risk and credit risks appear in a logarithm form, the obtained coefficients are notably larger than the ordinary GARCH model. The effects of the exchange rate changes and credit risk on the risk of the stock price returns are different in the models of GARCH and EGARCH in three banks. Some parts of this can be due to debt differences in the model and some other parts are due to some other reasons such as the policies, and different functions of these banks regarding credit and exchange. The next point is that in most of the used models, maximum two lags have been injected that is because of short-term relationship between risk of the stock price returns with the descriptive variables. These results are fully matched with the accidental behaviors of the market variables.

In this research, different issues of GARCH model have been tested and most of them have had meaningful and acceptable results. PGARCH and IGARCH have revealed weaker results than the other ones.

### **ARMA (2, 0)-GARCH (1, 1) MODEL**

In this model, the price return risk has been framed within ARMA\_GARCH mode. Different models have been tested and two following models have had better results regarding the determining coefficient and meaningfulness.

In the preceding phrase, ARMA (p, q) is the self-regression model of the animated mean with the power of the p self-regression and q animated mean. ARMA (1, 1) is commonly used in the financial return time series. The phrase of GARCH (p, q) means a conditional self-regression on the variance heteroskedasticity in which p shows the ARCH (the waste of the previous period) and q shows the GARCH (the previous variance).

### **The first study: ARMA (2, 0)-GARCH (1, 1) model**

Mean equation:

$$SPR = C(1)* SPR(-1)+ C(2)*SPR(-2)+\varepsilon$$

Variance equation:

$$GARCH = C(3) + C(4)* RESID(-1)^2 + C(5)* GARCH(-1) + C(6)*CRR(-1) + C(7)* EURR(-1) + C(8)*CRR_S(-1) + C(9)* EURR_S(-1)$$

Where  $C_3$  is the fixed number,  $C_s$  the related variable coefficient, \* multiplication sign,  $SPR(1)$  is the bank stock price return in the last period,  $SPR(2)$  bank stock price return in the two last periods,  $\varepsilon$  is the interrupting sentence,  $RESID(1)^2$  is the second power of the interrupting sentence in the last period,  $GARCH(-1)$  is the credit risk SD for one week ago,  $EURR(1-)$  is the exchange rate for one week ago,  $EURR_S(1-)$  is the exchange risk rate SD for one week ago.

The preceding model is the standard version of ARMA-GARCH model. According to this model, the mean fluctuations of the return prices of the bank stocks in the form of ARMA (2) are related to two previous periods and its fluctuations which are price return risk of the bank stock are defined in the form of GARCH (1, 1) and the depend on the exogenous variables of the exchange rate risk, credit risk, second power of the error sentence with one lag, the last period variance  $GARCH(-1)$ , SD of the credit risk and exchange of the last period (Table 1).

The horizontal axis shows the number of observations and the vertical one shows the stock prices. One other feature is related to investigations of the time series of the changes or general changes of the conditional variance in one period. The purpose of studying the effects of GARCH is to choose a suitable model to estimate the related parameters to the designed model. Figure 2 to 5 shows that the conditional variance changes over time. Choosing the best model is the waste sentence with variance heteroskedasticity as the Figure 2 shows.

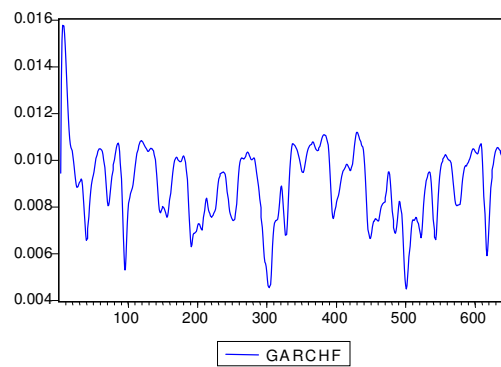
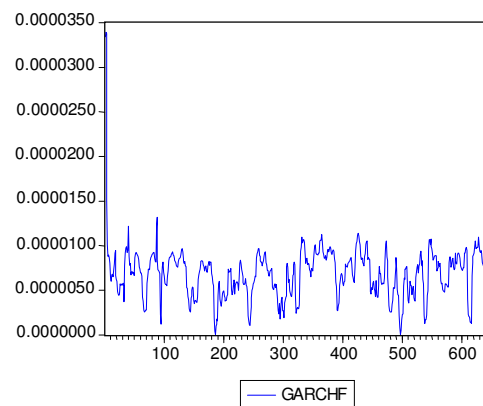
### **Interpreting the data of the estimated model table (ARMA (2, 0)\_GARCH (1, 1)**

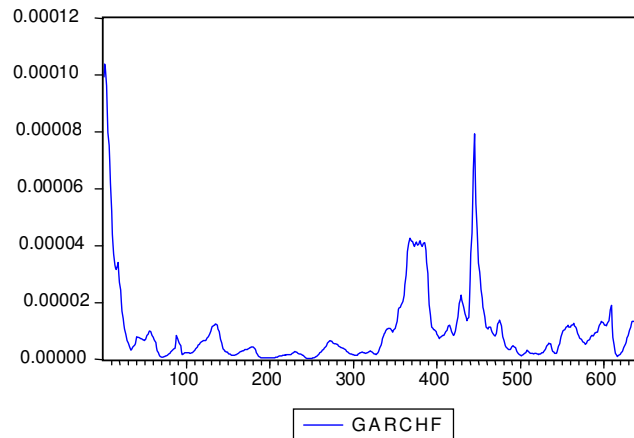
#### ***Coefficient of determination ( $R^2$ )***

As the results in Table 1 show, all the coefficients are

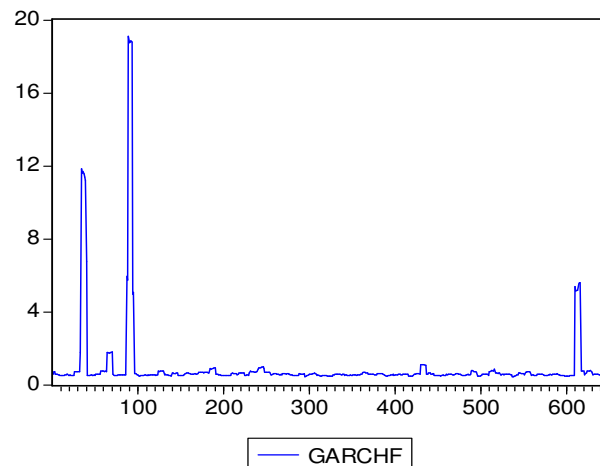
**Table 1.** The results of the first study: ARMA (2, 0)-GARCH (1, 1).

Variable	Coefficient	Std. error	Z-statistic	Prob.
SPR (-1)	1.085498	0.099929	10.86269	0
SPR (-2)	-0.2156	0.09584	-2.2496	0.0245
<b>Variance equation</b>				
C	6.19E-06	6.70E-07	9.246737	0
RESID (-1)^2	0.149718	0.048074	3.114315	0.0018
GARCH (-1)	0.598085	0.041964	14.25239	0
CRR (-1)	5.64E-05	1.45E-05	3.886344	0.0001
EURR (-1)	0.000675	7.77E-05	8.693641	0
CRR_S (-1)	-7.42E-05	7.49E-06	-9.90771	0
EURR_S (-1)	-0.00044	5.65E-05	-7.68986	0
R-squared	0.803035	Mean dependent var		0.000666
Adjusted R-squared	0.800562	S.D. dependent var		0.006201
S.E. of regression	0.002769	Akaike info criterion		-9.07668
Sum squared resid	0.004886	Schwarz criterion		-9.01439
Log likelihood	2940.768	Durbin-Watson stat		2.025103

**Figure 2.** The estimated variance of the GARCH (1, 1) model.**Figure 3.** Estimate model of the ARMA (2, 0)-GARCH (0, 1).



**Figure 4.** Variance estimated model ARMA (2, 0)-EGARCH (1, 1).



**Figure 5.** Variance of the estimated model ARMA (2, 0)-GARCH-M-EGARCH (0, 1).

statistically meaningful. The coefficient of determination is a reliable benchmark to provide an estimation line for the statistical data of the sample period so that it can be a powerful regression description. The amount of the coefficient of determination shows the behavior of the dependent variable which has been explained by the independent sample variables and that is 80%. Therefore, approximately 80% of the dependent variable behavior in this model has been explained by two variables of the credit risk and exchange risk. In other words, this benchmark shows the percentage or ratio of all dependent variable changes (price return of the bank stock) which are related to the changes of all independent sample variables. The bigger the  $R^2$ , the better the relationship between independent and dependant variables will be.

**Durbin-Watson test**

The self-correlation can be defined as the correlation between all the elements one set of all time series data or temporary data. Regarding regression, the linear regression assumes that there is no such thing as self-correlation in interruptive sentences. Durbin-Watson test is an easy test which has been designed for the first degree self-correlation. In fully positive correlation case, the amount of Durbin-Watson is almost zero. In fully negative correlation, this amount will be around 4 and in non-self-correlation case, the amount will be close to 2. In estimate model, the statistical amount of Durbin-Watson is almost 2 which will show there is no self-correlation in one sample. In case there is self-correlation, the obtained results of the estimate model will be unreliable. One

reason for the existence of self-correlation in waste sentence is that this designed model is not complete. Considering that in all estimate models, the Durbin-Watson data is near 2, it can be concluded that there is no self-correlation in the designed model of the waste sentence.

### **Z statistic: An indicator to test regression meaningfulness**

If there is a meaningful relationship between dependent and independent variables, it can be tested by z-test. The amount is obtained from the result of the division of the estimate coefficient (the explained changes by regression) by the SD error. As much bigger the numerator of the z than the denominator, the regression distribution will be bigger; which means that the regression is meaningful. Therefore, the bigger the z than 2 is, the bigger the meaningfulness of the amount of the related coefficient. Since all the estimate models have a number bigger than 2, the estimated regression will be meaningful.

### **Akaike info criterion and Schwarz criterion**

In Table 1, Akaike info criterion and Schwarz criterion show the data in the desirable time series. Therefore, positive indicators confirm the requirement for other variable describers which can be inserted into the regression equation. On the other hand, the low amount of these data indicates that the number of variable describers have been able to explain the changes of the dependent variable. Specifically, when the data are negative, shown by negative sign in Table 1, it indicates that the model has high explanation and it does not need other variable describers. When the parameters are reliable, it shows there is a thorough match between the econometric and data.

Regarding the obtained results and specifically the z amounts, it indicates the meaningful and positive relationship between two variables of credit risk and exchange risk with the price returns of the bank stocks.

Based on the estimated statistics, it can be concluded that two hypotheses of this research paper which indicated that there is a meaningful relationship between credit risk and exchange risk with the fluctuations of the price returns of the bank stock can be accepted. In other words, the changes of two variables of credit risk and exchange risk have been able to study the behavior of the price return of the bank stock well on the confident level.

In the mean equation,  $C_1$  coefficient is positive which indicates the positive relationship between price return of the bank stock of one period before.  $C_2$  coefficient is negative which shows the negative relationship between

the stock price return with the return of two previous periods. In the variance equation, credit risk coefficient (with one lag), exchange risk coefficient (with one lag) and variance (with one lag) are all positive. It means that there is a positive relationship between the credit risk, exchange risk and variance (all three with one lag) with the fluctuations of the stock returns. Increasing the credit risk, exchange risk and variance can lead to an increase in the return risk of the bank stock and decrease of the credit risk, exchange risk and variance makes the bank stock price risk return decrease.

In the variance equation, the risk credit SD coefficient (with one lag), and exchange risk SD coefficient (with one lag) are both negative. It means that there is a negative relationship between the credit risk SD and exchange risk SD with the fluctuations of the stock returns.

Since the results of the estimated data in all versions of ARMA-GARCH are almost the same, their interpretations will be the same as well. In order to avoid repetitive interpretations, a brief explanation of each version has been presented (Table 2).

### **The second study: ARMA (2, 0)-GARCH (0, 1)**

#### **Mean equation**

In this mode, the element of ARCH, in other words, RESID variable or waste sentence do not exist (Figure 3).

### **Second version: ARMA (2,0)\_EGARCH (1,1)**

In this model, the risk of the price returns are modeled in a variance logarithm framework (better to say GARCH), for this purpose, EGARCH has been used and after testing different models, the best regarding their description and meaningfulness have been determined as the following:

The first investigation: ARMA (2, 0)- EGARCH (1, 1)

Mean equation:

$$SPR = C(1) * SPR(-1) + C(2) * SPR(-2) + \varepsilon_t$$

Variance equation:

$$\begin{aligned} \text{LOG (GARCH)} &= C(3) + C(4) * \text{ABS}(\text{RESID}(-1) / @\text{SQRT}(\text{GARCH}(-1))) + C(5) * \text{RESID}(-1) / @\text{SQRT}(\text{GARCH}(-1)) + C(6) * \text{LOG}(\text{GARCH}(-1)) + \\ &C(7) * \text{CRR}(-1) + C(8) * \text{EURR}(-1) + C(9) * \text{CRR}_S(-1) + C(10) * \text{EURR}_S(-1) \end{aligned}$$

In the preceding equation, @SQRT shows the second root of radical. In this model all the coefficients are meaningful especially the coefficient of determination which is 80%. The Durbin-Watson statistic is near 2 as well (Table 3 and Figure 4).



**Table 2.** Second version: ARMA (2, 0)-GARCH (0, 1).

Variable	Coefficient	Std. error	Z-statistic	Prob.
SPR (-1)	1.098457	0.033917	32.3867	0
SPR (-2)	-0.237105	0.032933	-7.19966	0
<b>Variance equation</b>				
C	6.41E-06	3.59E-07	17.84829	0
GARCH (-1)	0.241542	0.018512	13.04794	0
CRR (-1)	0.000227	1.99E-05	11.39435	0
EURR (-1)	8.88E-04	6.41E-05	13.86307	0
CRR_S (-1)	-1.62E-05	8.10E-06	-2.00497	0.045
EURR_S (-1)	-2.91E-04	7.28E-05	-3.99588	0.0001
R-squared	0.802884	Mean dependent var		0.000666
Adjusted R-squared	0.800722	S.D. dependent var		0.006201
S.E. of regression	0.002768	Akaike info criterion		-9.12442
Sum squared resid	0.004889	Schwarz criterion		-9.06906
Log likelihood	2955.188	Durbin-Watson stat		2.053307

**Table 3.** The results of the first investigation: ARMA (2, 0)-EGARCH (1, 1).

Variable	Coefficient	Std. error	Z-statistic	Prob.
SPR (-1)	1.142983	0.04476	25.53572	0
SPR (-2)	-0.265972	0.046213	-5.75535	0
<b>Variance equation</b>				
C (3)	-6.68E-01	4.12E-02	-16.2393	0
C (4)	0.121715	0.010637	11.44214	0
C (5)	0.031755	9.96E-03	3.187914	0.0014
C (6)	9.50E-01	3.12E-03	304.5284	0
C (7)	2.10E+01	1.60E+00	13.10208	0
C (8)	5.14E+01	2.78E+00	18.4795	0
C (9)	-2.278852	8.23E-01	-2.76879	0.0056
C (10)	-6.179021	2.022845	-3.05462	0.0023
R-squared	0.802371	Mean dependent var		0.000666
Adjusted R-squared	0.799574	S.D. dependent var		0.006201
S.E. of regression	0.002776	Akaike info criterion		-9.69732
Sum squared resid	0.004902	Schwarz criterion		-9.62812
Log likelihood	3142.235	Durbin-Watson stat		2.145477

**Third version ARMA(2,0)-GARCH-M-EGARCH (0, 1)**

Mean equation:

$$SPR = C (1)* SPR (-1) + C (2)*SPR (-2) + C(3) LOG(GARCH) + \epsilon_t$$

Variance equation:

$$LOG(GARCH) = C(4) + C(5)* RESID(-1) /@SQRT(GARCH(-1)) + C(6)*LOG(GARCH (-1) + C(7)*CRR(-1) + C(8)*EURR(-1) + C(9)*CRR_S(-1) + C(10)*EURR_S(-1)$$

The preceding model has this characteristic that in the mean equation, stock price return has a relationship with the risk along with the amounts of two previous periods. Therefore, the C(3) coefficient is the effect of risk on the

**Table 4.** The results of the third version: ARMA (2, 0)-GARCH-M-EGARCH (0, 1).

Variable	Coefficient	Std. error	Z-statistic	Prob.
LOG (GARCH)	-1.38E-05	5.73E-06	-2.41122	0.0159
SPR (-1)	1.11E+00	3.69E-02	30.09326	0
SPR (-2)	-0.214189	0.036355	-5.89154	0
<b>Variance equation</b>				
C (4)	-6.90E-01	5.04E-02	-13.6933	0
C (5)	-0.015059	0.006345	-2.37359	0.0176
C (6)	0.938424	3.89E-03	241.1352	0
C (7)	2.44E+01	1.76E+00	13.8376	0
C (8)	4.55E+01	3.09E+00	14.73134	0
C (9)	-3.51E+00	6.69E-01	-5.23697	0
C (10)	-12.99471	1.63E+00	-7.96007	0
R-squared	0.802174	Mean dependent var		0.000666
Adjusted R-squared	0.799375	S.D. dependent var		0.006201
S.E. of regression	0.002778	Akaike info criterion		-9.44888
Sum squared resid	0.004907	Schwarz criterion		-9.37967
Log likelihood	3061.987	Durbin-Watson stat		2.066701

bank stock price return and when it increases, that stock return decreases. It means that increasing the credit risk and exchange risk leaves a negative effect on the stock return and decreasing the credit risk and exchange risk has positive effects on the stock returns. The results of this model show the meaningfulness of the model coefficients (Table 4 and Figure 5).

In this model, all the z statistics are meaningful. According to ARMA (2, 0)-ARCH-M-GARCH (2, 2), the behavior of the dependant variable of the bank stock price return has been directly estimated by the behavior of the endogenous variables of the credit risk and exchange risk. Two variables of the credit risk and exchange risk, waste sentence and variance have been able to explain 78% of the changes in bank stock price returns.

#### Fourth version: ARMA (2, 0)-PGARCH

Mean equation:

$$SPR = C(1) * SPR(-1) + C(2) * SPR(-2) + \varepsilon_t$$

Variance equation:

$$\begin{aligned} @SQRT(GARCH)^{C(11)} = & C(3) + C(4) * (ABS(RESID(-1))) \\ & C(5) * RESID(-1)^{C(11)} + C(6) * @SQRT(GARCH(- \\ & 1))^{C(11)} + C(7) * CRR(-1) + C(8) * CRR(-2) + C(9) * EURR(- \\ & 1) + C(10) * EURR(-2) \end{aligned}$$

In this study, the model of ARMA (2, 0)-PGARCH has been tested, if the coefficient of determination is high and

it is 80%, but most of coefficients are not meaningful (Table 5).

#### Fifth version: ARMA (2, 0)-IGARCH

Mean equation:

$$SPR = C(1) * SPR(-1) + C(2) * SPR(-2)$$

Variance equation:

$$\begin{aligned} GARCH = & C(3) * RESID(-1)^2 + (1 - C(3)) * GARCH(-1) + \\ & C(4) * CRR(-1) + C(5) * CRR(-2) + C(6) * EURR(-1) + \\ & C(7) * EURR(-2) \end{aligned}$$

In this study, the model of ARMA (2, 0)-PGARCH has been tested. If the coefficient of determination is high and it is 80%, but most of coefficients are not meaningful (Table 6).

#### CONCLUSION AND SUGGESTIONS

The results of the research in Tables 1 to 6 for three banks show that the behavior of fluctuations of bank stock price returns by the designed model have a high descriptive ability in the frame of conditional variance heteroskedasticity in that in the designed models of the private banks, the credit risk and exchange risk have been able to explain the behavior of the dependant variable with high  $R^2$  around 80%, Eghtesad-e-Nouvin bank with 79%, in Kar Afarin bank with  $R^2$  around 64%.

The meaning of coefficient of determination for the

**Table 5.** The results of the fourth version ARMA (2, 0)-PGARCH.

Variable	Coefficient	Std. error	Z-statistic	Prob.
SPR(-1)	1.085012	0.138829	7.815474	0
SPR(-2)	-0.216083	0.136665	-1.581123	0.1138
<b>Variance equation</b>				
C(3)	5.07E-06	9.65E-06	0.525021	0.5996
C(4)	0.149615	0.083995	1.781236	0.0749
C(5)	0.050086	0.25511	0.196331	0.8444
C(6)	0.598185	0.05681	10.52948	0
C(7)	0.000151	0.000358	0.423286	0.6721
C(8)	0.000165	0.000289	0.570851	0.5681
C(9)	0.000429	0.00088	0.487924	0.6256
C(10)	0.000456	0.001167	0.390732	0.696
C(11)	1.994364	0.352859	5.65201	0
R-squared	0.803033	Mean dependent var	0.000666	
Adjusted R-squared	0.802727	S.D. dependent var	0.006201	
S.E. of regression	0.002754	Akaike info criterion	-8.968948	
Sum squared resid	0.004886	Schwarz criterion	-8.89282	
Log likelihood	2907.97	Durbin-Watson stat	2.02419	

**Table 6.** The results of the fifth version ARMA (2, 0)-IGARCH.

Variable	Coefficient	Std. error	Z-statistic	Prob.
SPR(-1)	1.099433	0.169548	6.484506	0
SPR(-2)	-0.20663	0.165963	-1.24504	0.2131
<b>Variance equation</b>				
RESID(-1)^2	0.000942	0.000359	2.625158	0.0087
GARCH(-1)	0.999058	0.000359	2783.815	0
CRR(-1)	0.000129	0.000126	1.028257	0.3038
CRR(-2)	0.000129	0.000135	0.952131	0.341
EURR(-1)	5.95E-05	9.96E-04	0.059707	0.9524
EURR(-2)	3.84E-05	0.000968	0.039663	0.9684
R-squared	0.802579	Mean dependent var	0.000666	
Adjusted R-squared	0.802273	S.D. dependent var	0.006201	
S.E. of regression	0.002757	Akaike info criterion	-7.958643	
Sum squared resid	0.004897	Schwarz criterion	-7.910198	
Log likelihood	2577.642	Hannan-Quinn criter.	-7.939847	
Durbin-Watson stat	2.046897			

private banks in different estimated models is that 80% of the behavior of the stock price return has been explained by independent variables and 20% of the behavior of the dependent variable is related to other elements. Therefore, the first and second hypotheses which claimed that there was a meaningful relationship between independent variables of credit risk and exchange risk

with the dependent variable, that is, fluctuations of the bank stock returns could be confirmed and accepted.

Based on the coefficients of Akaike info criterion and Schwarz criterion in Tables 1 to 6, it can be concluded that two variables of credit risk and exchange risk have been able to explain the fluctuations of the bank stock price returns (dependent variable) well. Small and

negative features of these coefficients (mentioned in the tables are shown by negative sign and they are about 9.7) confirm that these variables are enough in the model to explain the behavior of the dependent variable behavior and there is no need to add other descriptive variables.

The amount of Akaike and Schwarz are estimated to be 9.7 in different models. It means that the behavior of the stock price return by independent variable is enough in the model to explain the behavior of the dependent variables and there is no need to add other variables. Therefore, two variables of credit risk and exchange risk are appropriate to explain the behavior of the stock price return risk. As a result, the first and second hypotheses which claimed that there was a meaningful relationship between independent variables of credit risk and exchange risk with the dependent variable, that is, bank stock return risk could be confirmed and accepted.

The amount of  $z$  is a benchmark to test the meaningfulness of regression. The calculated amount of this statistics in Tables 1 to 6 shows that in all versions of GARCH family, the amount of  $z$  is meaningful for all three banks. Except Tables 4 and 5, as much bigger  $z$  is than 2, it shows the meaningfulness of coefficient regression. In all tables which show the results of the estimated models, the statistics is bigger than 10. Based on  $z$ , the first and second hypotheses which claimed that there was a meaningful relationship between independent variables of credit risk and exchange risk with the dependent variable that is the bank stock return risk could be confirmed and accepted.

As mentioned earlier, if  $z$  is bigger than 2, the related coefficients will have higher meaningfulness and the obtained results confirm this idea. In general, reliability of parameters indicates the match of econometric pattern with the data.

### Durbin-Watson test

If there is no serial correlation, DW will be near to 2. If there is no serial correlation in the amounts of wastes, self-correlation in all lags will be close to zero. In all models of GARCH family, the statistics of DW (Durbin-Watson) will be near to 2 (except for Table 4 which is 2.3 and in Table 5, the number will be 2.4) so that in the period that the variables have been studied, there is no self-correlation.

The results from Tables 4 to 6 indicate that the descriptive feature of different versions of conditional models are different from each other (the comparison between the models of ARMA-PGARCH and ARMA-IGARCH with other models).

Credit risk and exchange risk are two main and effective elements to explain the behavior of the fluctuations of the bank stock price returns in that the extracted statistics from this model in a high level have been able to explain the behavior of the dependent

variable based on the changes in the independent variable with around 80%.

Based on model ARMA (2, 0)-ARCH-M-EGARCH (0, 1), the increase in credit risk and exchange risk decreases the bank stock price return.

It has been estimated that in all GARCH patterns, the credit risk and exchange risk coefficient have been positive with one lag period. These positive coefficients indicate that there is a positive relationship between credit risk and exchange risk with stock price return risk. It means that increasing or decreasing the credit risk or exchange risk makes an increase or decrease in the bank stock price return risk.

In all equations, the C1 mean coefficient is positive which indicates the positive relationship between stock price return and the last return. In the meantime, C2 coefficients are negative which means there is a negative relationship between stock price return and the returns of two previous periods.

In variance equation, the coefficient of credit risk, exchange risk and variance are all positive. It means that there is a positive relationship between credit risk, exchange risk and variance with the fluctuations of stock return. Increasing the credit risk, exchange risk and variance increases the stock price risk and decreasing them makes a decrease in the stock price return. In the variance equation, credit risk SD coefficient and the exchange risk SD coefficient are positive. It means that there is a positive relationship between credit risk SD and exchange risk SD with the stock return fluctuations.

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