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Applied-Research Paper

The Relationship between Risk and Return on Financial Assets (The Panel Vector Auto-Regression and Panel Cointegration Approaches)

Sorena Morovat, Afshin Baghfalaki *

Department of Economics, Kermanshah Branch, Islamic Azad University, Kermanshah, Iran.

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ABSTRACT

In this study, considering the necessity and importance of the relationship between risk and return on investment, some explanations were presented about the relationship between risk and return on the asset portfolio including gold, exchange, and stocks during the period 2001: 4 - 2018: 3 using panel vector auto-regression (PVAR) method and Kao and Pedroni panel cointegration approach and pooled mean group (PMG) method and Engel-Granger time series methods. The software used in this study involves EVIEWS 10 and STATA15. In this study, the multivariate GARCH (M-GARCH) approach (BEKK) was used to extract portfolio risk. The results showed a positive relationship between risk and return based on the PVAR approach. And also, given the beta coefficient of the CAPM equation, gold was the best inflation cover during the period under study, with a slight difference from the exchange rate.

1 Introduction

With the development of information technology in recent centuries, fluctuations in one market will affect other markets as well. Numerous studies show that financial variables transmit to each other between assets and markets over time and that it is important to know the transmission mechanisms in asset portfolio management because having information about the effect of transmission is quite useful in choosing the composition of the assets portfolio and reducing its risk [24,11]. The concept of risk is therefore a practical issue in the financial field. Of course, it seems that today Iranian investors do not pay enough attention to the risk variable along with the return variable or do not consider it as an important criterion for investment, as it should be, while both the risk and return variables should be considered together and based on the investment portfolio in which the new stock as its element makes the total return and specific stocks should be purchased after a comprehensive analysis. CAMP is one of the models that are useful in calculating the beta coefficient (systematic risk) [32]. With the introduction of the capital asset pricing model (CAPM) by Sharp [37] and Black [7], the first asset pricing theory in economics and finance emerged. Presently five decades have passed since the era of CAPM, and ac-

Corresponding author Tel.: +989183335018
E-mail address: *afshinbaghfalaki@yahoo.com*

cording to studies, today CAPM is the most widely used model in various areas of finance and investment, such as estimating the cost of corporate stocks, evaluating the performance of portfolios, and estimating the discount of long-term capital projects [32]. The evidence is a massive amount of valuable information for investing, which investors use in accordance with the capital asset pricing model, and expected re-turns from a common stock are determined by risk-free returns and risk-taking that is a function of beta [26]. Although early CAPM experimental tests emphasize its central importance in establishing a positive linear relationship between systematic risk (beta) and stock returns Black [7] and Fama & French [16], the results of recent studies suggest that, as a systematic risk indicator, beta coefficient is not capable of explaining the average difference in stock returns and other variables such as the company size [8], the price-to-earnings ratio Basu [5], the ratio of book value to market price [36], and the financial leverage [6] play important roles in explaining stock return differences[3]. Summarizing previous findings, Fama & French dealt with the experimental testing of the relationship between these variables and the expected return on stock in the US capital market and reported that beta, as a systematic risk indicator, alone does not have the power to explain the relationship between risk and stock returns during the period under study (1963-1990), and among the variables studied, two variables of the company size and the ratio of book value to market value are better capable of explaining the difference in stock returns.

Some researchers interpret these findings as evidence of the inefficiency of the capital market. According to these researchers, if stock returns can be predicted based on historical factors such as company size, the ratio of book value to market price, the ratio of income to price, and the like, it cannot be claimed that the market is efficient in terms of information. On the other hand, another assumption regarding CAPM is that market conditions are symmetrical, but the emergence of asymmetric market conditions can also affect the expected return on assets while affecting risk premium as well [31,16].Unlike various studies on the risk and return of stocks conducted in different countries (including developed and developing countries), the studies conducted on the three major assets including currency, stocks, and gold in the Iranian capital market have received less attention. Therefore, the main question of the present study is as follows: how is the relationship between risk and return on financial assets?

2 Theoretical Foundations

The basis for the development of the capital asset pricing model was established by [30]. Early theories identified the risk of single securities as a standard deviation from their returns and presented it as a measure of return instability, so that a higher standard deviation indicates a higher risk. According to [14, 11] were among the researchers who tried to use Markowitz' theory to the market securities pricing mechanism effectively. Their effort which is presently known as the capital asset pricing theory was flourished in the early 1960s. In the 1970s, when the balanced asset pricing models were presented with negative risk, the concept of negative (mitigating) risk was considered by financial experts in practice.

Nikoomaram [32] presented strong arguments that investors only pay attention to the (negative) mitigating risk and that the semi-variance measure should be used.

Hogan and Warren [19] proposed a kind of optimization logarithm for developing the expected return of efficient portfolios resulting from the semi-variance method below the target rate, known as ES [32]. Nikoomaram [32] developed the (negative) mitigating risk criteria and proposed a risk criterion called LPM. On the other hand, Hogan and Warren [19] presented a model similar to MSB variance, in which the criterion of asset sensitivity (beta) was placed against market fluctuations; this new measurement criterion was called the mitigating beta. Krausa & Litzenberger [28] tested this relationship as a CAPM test with a skewness factor and found that investors expect rewards for a positive skewness. Souri [38] examined the relationship between risk and return in different booming market conditions and believed that evaluating the relationship between beta and return needed to be adjusted and that traditional CAPM tests had already used real returns instead of expected returns, while according to the assumptions of the CAPM model, the expected return ratio with beta should be evaluated. Therefore, they developed a kind of conditional relationship between return and beta in which the beta and dependent returns relationship depended on whether the market excess return (risk premium) was positive or negative [32]. A conditional beta states that the negative beta is calculated for periods when the average market return is negative and below the market average return, and the positive beta should be used when the average market return is positive [2].

The empirical performance is tested across a sample of 81 financial, energy, and other commodity markets for the period August 1999 –January 2018. The conditional regime-switching GARCH CAPM, with time-varying betas explaining both bull and bear markets, outperforms the unconditional (static) CAPM [17]. Among stocks, there are significant time variations in betas across our models and regimes. This empirical feature is even more pronounced in the USA, the UK, Germany, France, China, and Malaysia. Among energy and other commodities, we find similar variations in the market price of risk. The direction of the relation with market returns for Crude Oil, Gold, Copper, Tin, Rubber, Aluminum, and Platinum is the same across our nested models. This result also holds for aggregate markets indices [17]. One of the methods that helps investors to explain risk and return is the use of capital asset pricing model (CAPM). This model was introduced by Sharp [37]. In the Sharp model, the effect of systematic risk on investment portfolio is evaluated by a concept called beta coefficient, which is calculated by regression analysis of portfolio return and base portfolio return. Based on this model, we can determine the rate of return of any risk assets. The capital asset pricing model is a regression model as follows [12].

$$K_j = R_f + \beta\left(R_m - R_f\right) \tag{1}$$

Where R_f is the return rate, β is the sensitivity coefficient, and $R_m - R_f$ is the mere risk. Since other factors may affect stock returns, a y-intercept can also be added to the above equation. An important determinant in this regard is the beta coefficient, which is essential for measuring comparative power. The beta coefficient determines the sensitivity of the expected additional return on assets to the expected additional return on the market and, based on the Sharp model, is obtained by:

Therefore, the CAPM states that the return rate required by an asset is a function of two components:

$$Ki = Risk - Free\ Return + Risk\ Premium \tag{2}$$

The effect of a particular stock on the overall risk of a set of various stocks is measured by the beta of aforementioned stocks. The larger the stock beta, the greater will be its impact on the market and its fluctuations. Therefore, the beta factor is:

$$\beta = \frac{\operatorname{cov}\left(r_j, r_m\right)}{VAR\left(r_m\right)} \tag{3}$$

$$\operatorname{cov}_{(\mathrm{Ri,Rm})} = \mathrm{E}[(\mathrm{Ri} - \mu\mathrm{i})(\mathrm{Rm} - \mu\mathrm{m}] \tag{4}$$

$$\operatorname{var}_{(\mathrm{Rm})} = \mathrm{E}(\mathrm{Rm} - \mu\mathrm{m})^2 \tag{5}$$

The CAPM model helps to calculate investment risk and expected rate of return. The starting point of this model is the risk-free rate of return. Bonus will be added to this rate that investors expect to see as they take more risk. Beta is a systematic stock-related risk measurement unit that measures the degree of volatility sensitivity of share yields on volatility of market returns. This argument can be applied to any other assets as well, in order to relate the return of each asset to the general level of prices [18] which means that the price of an asset would change as compared to the general level of prices. In this case the following model can be introduced:

$$R_{it} - R_f = \alpha_i + \beta_i \left(\dot{P}_t - R_f \right) + \varepsilon_{it} \tag{6}$$

Where $\dot{P}_t$ is the inflation rate, and β_i is the beta coefficient of inflation. If this coefficient is equal to or greater than 1, it indicates that for a given increase in inflation, the return on asset *i* will grow more rapidly and will be able to fully cover inflation changes. In a particular case where the y-intercept of the equation is zero and the beta coefficient is one, the return on the asset will be proportional to inflation. But if the y-intercept is greater than one and the beta is equal to one, then the y-intercept component indicates an abnormal return, which means that the return on the i^{th} asset has on average been more than inflation. Therefore, the y-intercept component and the beta coefficient (the slope of the above equation) indicate the status of inflation cover of the asset in question [21]. It should be noted that the asset capital pricing model involves other types as the decreasing-unfavorable capital asset pricing model (D-CAPM), adjusted capital asset pricing model (A-CAPM), intertemporal capital asset pricing model (I-CAPM), conditional capital asset pricing model, revised capital asset pricing model (R-CAPM), consumption capital pricing model (C-CAPM), and the reward beta model (RBM).

3 Literature Review

Christian and Julien [11] in a study entitled" dynamic conditional regime-switching GARCH CAPM for energy and financial markets" This paper develops a methodology for estimating a time-varying conditional version of the CAPM with regime changes in conditional variance dynamics. They research goal is related to documenting the power of the beta when it is estimated dynamically. They result shed light on the supremacy of the market factor alone associated with time variation in risk premia across the energy and financial markets.

Fuzhong and et al [17] in a study entitled" Holding risky financial assets and subjective wellbeing: Empirical evidence from China" The purpose of this study is to investigate the relationships between the holding of risky financial assets and subjective wellbeing. Participation in financial markets with different risk levels of assets is divided into holding risk-free assets and holding risky assets. Holding risk-free assets is measured according to two sets of variables: having a demand deposit and having certificates of deposit. The results imply that to improve subjective wellbeing, financial policy-makers and investment institutions should develop effective policies and financial products to improve the efficiency of financial markets, and thereby provide more low-risk financial assets.

Laurent and et al [20] in a study entitled" Aggregation of heterogenous beliefs, asset pricing, and risk sharing in complete financial markets**"** Given a competitive equilibrium in complete asset markets, they propose a method that aggregates heterogeneous individual beliefs into a single “market probability,” which, if commonly shared by investors, generates the same marginal valuation of assets by the market as well as by each individual investor. As a result of the aggregation process, the market portfolio may have to be scalarly adjusted, upward or downward, a reflection of an aggregation bias due to the diversity of beliefs. From a dual viewpoint, the standard construction of an expected utility-maximizing aggregate investor designed to represent the economy in equilibrium, is shown to be also valid in the case of heterogeneous beliefs, modulo the above scalar adjustment of the market portfolio, thereby generating an Adjusted version of the Consumption based Capital Asset Pricing Model (ACCAPM). Botshekan and Farhadi [5] in a study entitled "the tradeoff between risk and return: evidence from a quantile regression model" using a linear and quantile regression model and the daily data of six stock indices, examined the linear relationship between surplus yield and risk.

Their findings showed that the tradeoff between risk and return is different along the distribution ranges and varies from the inverse relationship in the lower quartiles to the direct relation in the higher quartiles. Also, based on linear and quadratic models, the unexpected variance can explain the surplus yield at least as much as the expected variance. Rasekhi [35] in a study entitled dynamics of risk-return relationship in the Iranian stock market: new evidence using GARCH-JUMP model, relying on specific characteristics of financial assets including time-varying conditional fluctuations, examined the relationship between risk and return on financial assets in the Tehran Stock Exchange from September 28th, 1997 to February 21st, 2015. They used ARJI-GARCH, GARCH-M and GARCH-JUMP models in their research, and their findings suggest that the JUMP component, was significant in the period under study so that the risk in the Iranian stock market includes both components of mild changes and shock and JUMP events; and hence the traditional GARCH-M model alone is not suitable for examining the relationship between risk and return in the Iranian stock market. Also in the analysis of time-varying risk reward it was found that in the short term only the risk of JUMP is significant. Bagherzadeh and Salem [4] in a study on the relationship between intertemporal risk and return examined the intertemporal asset pricing model in the Tehran Stock Exchange in 2002-2012 using dynamic conditional correlations and beta time variations. The correlation between portfolio returns and market returns was estimated using dynamic conditional correlation and beta, which in the intertemporal model is a risk aversion coefficient and varies over time using the Kalman filtering method. Based on the findings of this study, the relative risk aversion coefficients in the intertemporal asset pricing model were estimated between 0.28 and 0.013 (mean 0.20); and given the meaninglessness of the y-intercept in most equations, it can be said that the Tehran Stock Exchange has an intertemporal pricing model of capital assets.

Assets that are highly correlated with market conditional volatility have lower expected returns in the post-return period. Hung [19] developed the CCAPM model in examining the relationship between risk and return by separating the internal and external commodity markets. In their model, consumers can consume domestic and foreign goods, but only invest in the domestic market. In this model, the exchange rate of the ultimate utility channel affects the asset price, and the exchange rate fluctuates over time and has an anti-periodic behavior and can justify the anti-periodic behavior of the equity premium. Kim [21] in a study evaluated and compared the ability of different models of capital asset pricing in South Korea. In their research, they examined the CCAPM, ATP, CAPM models, and the three-factor and five-factor Fama-French models and the three-factor Chen models. Their findings indicated that three- and five-factor Fama-French models, three-factor models by Chen et al., and CAPM model, respectively, performed better than the other models. Chiang [7] in their study by dividing risk into two predicted and unexpected parts concluded that there is a direct relationship between expected risk and surplus return, and an indirect relationship between unexpected risk and surplus return. They also reported the relationship between risk and return on the partial range of returns differently. This means that the inverse relationship at the low domain and the direct relationship at the high domain were observed.

4 Research Methodologies

In terms of the objective type, this research is applied, and in terms of the nature, it is a correlational study. In terms of data type, it is quantitative, and in terms of performance location and time, it is a review. To conduct this research, the economic reports of the Central Bank and the databases affiliated with that institution, as well as the reports of the Securities and Stock Exchange Organization were used. The statistical population of this study involves Iran and it is in the form of monthly data gathered during the period of 2003:1-2019:4.

4.1 Models Specification

In this study, panel vector autoregressive (PVAR) and impulse response functions (IRF) as well as variance analysis (VA) are used to extract and identify how risk and asset return affect each other. Also, asset uncertainty and risk are modeled through MGARCH-BEEK models. In the panel vector autoegression model, all variables are considered as endogenous. In this research we have:

$$X_{it} = [rltepix_t \;\; rlgold_t \;\; rlexch_t \; seltepix_t \; selgold_t \; selexchange_t] \tag{7}$$

Where X_{it} is the vector of the return and risk portfolio variables that are examined in the panel model. The variables are included in the logarithmic form because in this case the estimated coefficients represent relative variations and are independent of the unit of measurement of the variables [13].

$$RLEXCHANGE_t = C(1) + C(4) \times RLEXCHANGE_{t-1} + C(5) \times RLGOLD_{t-1} + C(6) \times RLTEPIX_{t-1} + \varepsilon_{1t}$$

$$RLGOLD_t = C(2) + C(7) \times RLEXCHANGE_{t-1} + C(8) \times RLGOLD_{t-1} + C(9) \times RLTEPIX_{t-1} + \varepsilon_{2t}$$

$$RLTEPIX_t = C(3) + C(10) \times RLEXCHANGE_{t-1} + C(11) \times RLGOLD_{t-1} + C(12) \times RLTEPIX_{t-1} + \varepsilon_{3t}$$

The data and symbols used are as follows:

Coefficients C (1) to C (3) are the constant coefficients of the mean equation. In these equations the coefficients C (5) and C (6), for example, show the effects of overflow or volatility of gold and stock returns on currency returns. Likewise, the coefficients C (7) and C (9) show the return volatility of currency and stock returns on gold yields.

1- Growth rate logarithm of price index (Tepix) of Tehran Stock Exchange (with the symbol *rltepix*);

2- Growth rate logarithm of nominal exchange (Rial price of dollar exchange in nonformal market, with the symbol *rlexchange*);

3- Growth rate logarithm of liberty gold coin price (with the symbol *rgold*);

4- Bank deposit interest rate logarithm (lbs);

5- Inflation rate (growth rate logarithm of consumer price index with the symbol *linf*);

6- Currency risk rate (extracted based on MGARCH model with the symbol *selexch*);

7- Gold asset risk (extracted based on MGARCH model with the symbol *selgold*);

8- Equity risk (extracted based on MGARCH model with the symbol *seltepix*).

4.2 Estimation of the MGARCH-BEKK Model to Extract Asset Uncertainty

In this study, multivariate autoregressive conditional heteroskedasticity (ARCH) family is used to model uncertainty. Accordingly, the model used in this study is the MGARCH model with the asymmetric stipulation method BEKK. In this approach, we will be able to incorporate the asymmetric and non-diagonal effects of one variable upon another in the model using the asymmetric variance-covariance matrix. In order to estimate the VAR-BEKK-GARCH model, a vector autoregressive model (VAR) as the conditional mean equation of the model must first be formulated. The optimal number of interruptions of this model is determined based on the information criteria such as Akaike, Schwarz-Bayesian, Hannan-Quinn and likelihood ratio. After determining the optimal model interval, it is estimated with various statements as ARCH, GARCH and TARCH and the results are reported in the following Table. Also, since bank deposits were directorially determined and lacked market and clustering behavior, they were eliminated from the model and the model was estimated with three assets: return on currency, return on gold, and return on stock. Another important point is that the MGARCH-BEKK models will not achieve the desired results for more than three time series.

4.3 Investigation of Uncertainty (Cluster Behavior in Time Series)

In the first step of the model estimation, the Engle proposed approach and Lagrangian coefficient test are used to ensure the variance heterogeneity behavior. In this test, after estimating a conditional mean equation for each equation, two F statistics and $nR^2 \sim \chi_q^2$ are used to investigate the effects of ARCH. The null hypothesis in this test is the absence of ARCH effects (either the model variance stability or the uncertainty). The results of this test are reported in the following Table:

Table 1: Arch Test on Asset Portfolio

Series Name	Stock Returns	Currency Returns	Gold Returns
F (Prob)	14.21 (0.006)	14.82 (0.0000)	3.26 (0.0403)
nR^2 (Prob)	21.44 (0.0003)	26.1 (0.0000)	6.41 (0.0405)

Source: Research Findings

Based on the results of the above tests it can be said that the null hypothesis is rejected in all the relevant time series and in fact the effects of ARCH (uncertainty) exist in all equations.

4.4 Determining the Optimal Model Interval

Before estimating the multivariate GARCH model, the number of optimal intervals of the model to specify the conditional mean equation is determined based on a VAR equation. Hannan-Quinn (HQ), Schwarz-Bayesian criterion (SBC) and Akaike information criterion (AIC) are used for this purpose. The relevant results are presented in Table 2. According to the results of Table 2, based on two criteria, a model with one interval, and based on three criteria, a model with six intervals, are proposed. Accordingly, the model with one interval is ultimately applied to a multivariate GARCH approach, since the model stability condition (having the roots of the characteristic equation of the model within a single circle) is satisfied in this interval.

Table 2: Determining the Optimal Interval of Conditional Mean Model in the Var-Mgarchbekk Equation

Lags	Likelihood Log	Likelihood method Log	Prediction error	Akaike	Schwarz	HQC criterion
0	2404.62	------	4.57 E-15	-24.50633	-24.45616	-24.4860
1	2461.499	111.4353	2.80 E- 15	-24.99489	-24.79419	-24.9136
2	2467.047	10.6998	2.90 E- 15	-24.95966	-24.60844	-24.8174
3	2482.493	29.3159	2.72 E -15	-25.02543	-24.52368	-24.8223
4	2491.422	16.6745	2.72 E -15	-25.02472	-24.37244	-24.7606
5	2502.612	20.5525	2.66 E -15	-25.04706	-24.16631	-247230
6	2518.724	29.10086	2.48 E -15	-25.11963	-24.01039	-24.7336
7	2527.196	15.04101	2.49 E -15	-25.11424	-24.45616	-246673
8	2530.352	5.50725	2.65 E -15	-25.05461	-2380023	-24.5467

Source: Research Findings

4.5 MGARCH-BEEK Model Estimation

Here, before estimating the model, the optimal multivariate GARCH model, MGARCH, must be selected. Accordingly, the model, despite various statements, is estimated as ARCH, GARCH and TARCH and the results are reported in the following Table. Also, since bank deposits were directorially determined and lacked market and clustering behavior, they were eliminated from the model and the model was estimated with three assets: return on currency, return on gold, and return on stock.

Table 3: Determining the Optimal MGARCH Model

The number of sentences in a conditional variance equation	(ARCH,GARCH,TARC)	(0,1,1)	(1,1,1)	(1,2,2)	(2,1,2)	(2,1,1)	(2,2,1)	(2,2,2)
Data criteria for selecting optimal model	AIC criterion	-26.025	-22.238	-22/077	-25.997	-24.754	-24.028	-24.16
	SBC criterion	-25.617	-22.57	-23.512	-24.432	-25.267	-25.463	-24.80
	HQC criterion	-25.86	-22.44	-23.84	-25.767	-24.267	-24.798	-24.42

Source: Research Findings

Based on Table 3, the MGARCH model with an ARCH statement, GARCH is selected. It should be noted that the preferred model is the one possessing minimum values of Akaike (AIC), Schwarz-Bayesian (SBC), and Hannan-Quinn (HQ) criteria. In other words, the absolute value of each value of these information criteria is the highest possible. The software used here was EVIEWS 10 and the estimation method was the maximum likelihood. It should be noted that for the models estimation the t-student distribution was used, since the yield distribution was not normal and better results could be achieved in this way. The estimation results of the selected model MGARCHVAR (1) - with BEKK approach are as Table 4. In the Tables above, the results of the mean and variance equations are presented. The equation coefficients of the average Table above actually express the following equations. Coefficients C (1) to C (3) are the constant coefficients of the mean equation. In these equations the coefficients C (5) and C (6), for example, show the effects of overflow or volatility of gold and stock returns on currency returns. Likewise, the coefficients C (7) and C (9) show the return volatility of currency and stock returns on gold yields.

Table 4: Summary of the Results of the Conditional Mean Equation

Average Equation				
	Coefficient	**Standard Deviation**	**Z statistic**	**P-value**
C(1)	0.000824	8.53E-0.5	9.669447	0.0000
C(4)	0.378742	0.074186	5.105301	0.0000
C(5)	-0.166767	0.025647	-6.502303	0.0000
C(6)	-0.046564	0.012371	-3.764068	0.0002
C(2)	0.000612	0.000179	3.411363	-0.0006
C(7)	0.453135	0.036287	12.48761	0.0000
C(8)	0.035847	0.058646	0.611244	0.541
C(9)	0.040979	0.026653	0.537498	0.1242
C(3)	0.001089	0.000353	8.085561	0.002
C(10)	0.020696	0.077575	0.266795	0.7896
C(11)	-0.10521	0.101933	-1.032145	0.3020
C(12)	0.433498	0.061893	7.003993	0.0000

Source: Research Findings

Table 5: MGARCH Model Estimation Results

$$GARCH_t = M + A_1 U_{t-1} U'_{t-1} A_1 + B_1 GARCH_{t-1} B_1$$

$$M = \begin{bmatrix} \underset{(0.1138)}{5.74E-08} & \underset{(0.0021)}{2.33E-07} & \underset{(0.0041)}{2.96E-07} \\ 0 & \underset{(0.0008)}{9.43E-07} & \underset{(0.0004)}{1.20E-06} \\ 0 & 0 & \underset{(0.0674)}{1.53E-06} \end{bmatrix} A_1 = \begin{bmatrix} \underset{(0.0000)}{0.5484} & 0 & 0 \\ 0 & \underset{(0.0000)}{0.5538} & 0 \\ 0 & 0 & \underset{(0.0000)}{0.3744} \end{bmatrix} B_1 = \begin{bmatrix} \underset{(0.0000)}{0.8769} & 0 & 0 \\ 0 & \underset{(0.0000)}{0.7765} & 0 \\ 0 & 0 & \underset{(0.0000)}{0.8966} \end{bmatrix}$$

Source: Research Findings - The numbers in parentheses are the significance level 0.95

Here the matrix A_1 shows the transfer of shocks generated between the two series and the matrix B_1 shows the fluctuations overflow among the time series return on asset portfolio. Now using the estimated model above the risk (conditional variance) of the triple asset portfolio is extracted. It should be noted that the square root of the conditional variance obtained will be considered as the risk index of each asset. At the bottom of the chart the conditional variance and risk (standard deviation) of the asset portfolio are presented. The sharp fluctuations in the graphs above can be attributed to the expansion and intensification of uncertainty in that year. For example, in 2012, the effects of the sharp fluctuations of exchange rate can clearly be seen in its conditional standard deviation graph. The same is true for gold. In fact, each of these fluctuations corresponds to the specific economic and political situation in the country. The following diagrams show the conditional covariance of the three assets. Using these graphs, we can investigate the uncertainty relationship between the variables. For example, in the graph below, the conditional covariance between gold and currency is positive and relatively high in 2012 and 2013, and until recently the correlation between the two variables has been relatively stable.

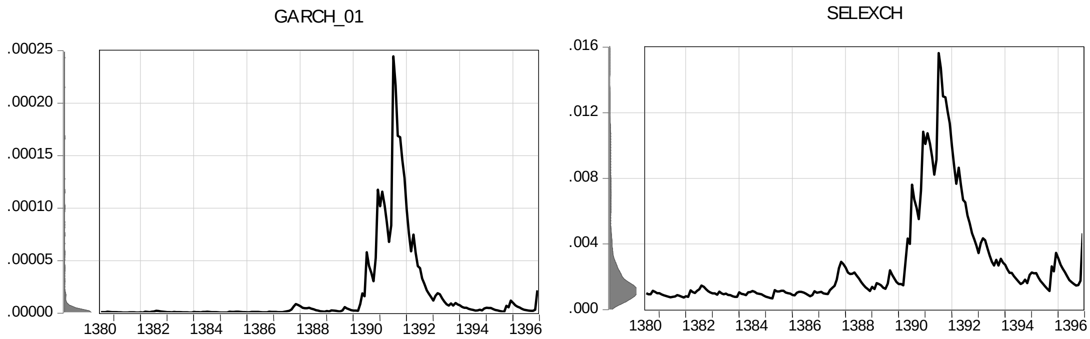

Fig. 1: Conditional Variance and Conditional Standard Deviation of Currency- Source: Research Findings

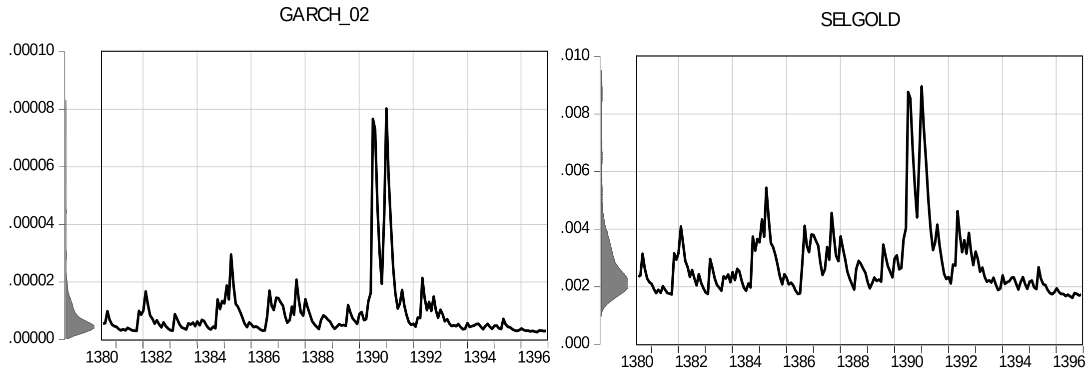

Fig. 2: Conditional Variance and Standard Deviation of Gold- Source: Research Findings

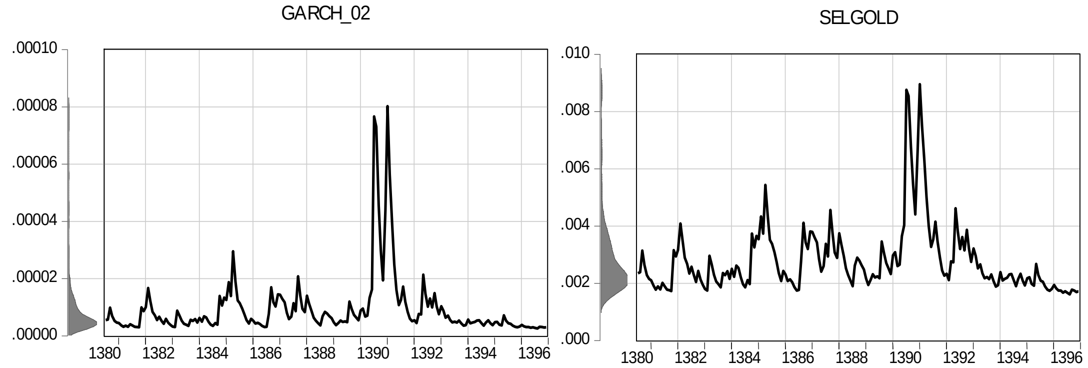

Fig. 3: Conditional Variance and Standard Deviation of Stocks- Source: Research Findings

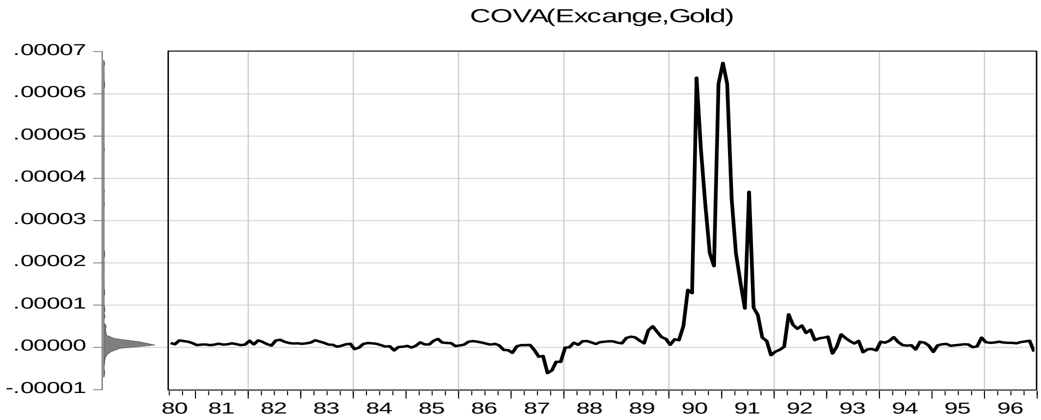

Fig. 4: Conditional Covariance Between Currency and Gold- Source: Research Findings

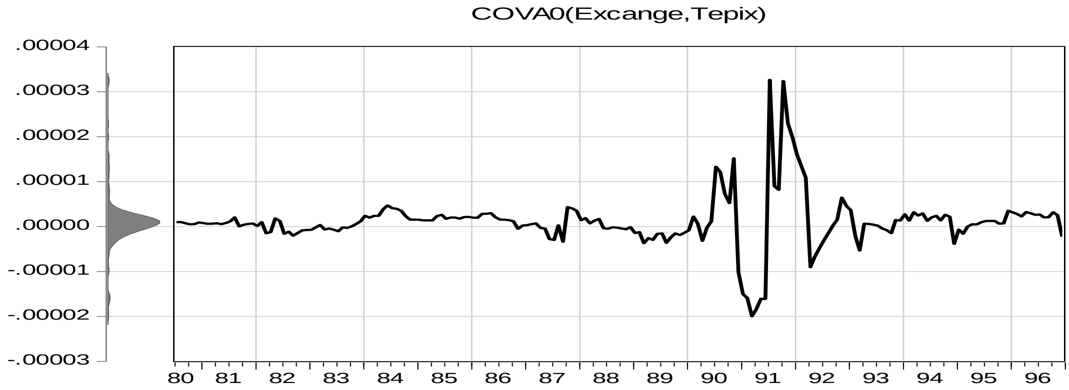

Fig. 5: Conditional Covariance Between Currency and Stock- Source: Research Findings

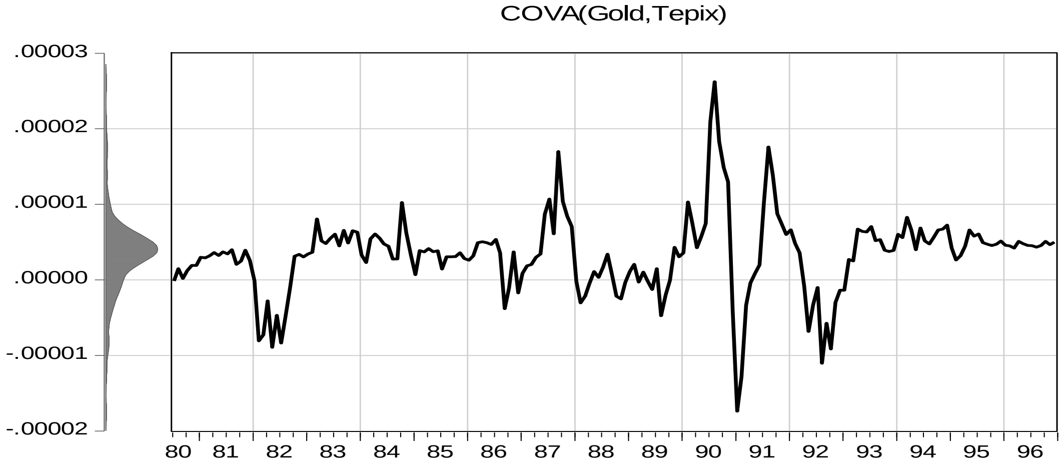

Fig. 6: Conditional Covariance Between Gold and Stock- Source: Research Findings

Table 6: Optimal Interval Determination Test of the (PVAR) Model Based on GMM Approach

Lag	CD	J	J-P value	MBIC	MAIC	MQIC
1	0.9364485	26.78463	0.1414328	-100.8517	-13.21537	-47.35348
2	0.9369251	19.86657	0.2262907	-82.24249	-12.13343	-39.44392
3	0.938127	10.93706	0.53432	-65.64473	-13.06294	-33.5458
4	0.9401448	5.001131	0.7574552	-46.0534	-10.99887	-24.65411
5	0.9352509	1.848575	0.7635844	-23.67869	-6.151425	-12.97905

Source: Research Findings

5 Estimating Panel Vector Auto-Regression Model (PANEL-VAR)

5.1 Model Estimation Based on Helmert Transformation

The first step in estimating the auto-regression models is to determine the optimal interval of the model; as shown in the following Table, all information criteria propose interval one as the optimal interval (three criteria of MBIC, MAIC, and MQIC are minimum at this interval). In empirical studies, the coefficients of the PVAR model are rarely used and interpreted, and instead the effect of changes in exogenous variables on each of the endogenous variables of the PVAR system of equations is analyzed. These analyses are performed on the basis of two tools of the impact reaction functions and variance analysis. The reliability of the results of the PVAR model depends on the stability of the system of equations. The stability condition in the PVAR model is that the roots of the companion matrix are embedded in a single circle. The results of the investigation of the roots of the mentioned matrix indicate the stability of the PVAR system of equations and this is shown in Chart 1. A key point in the analysis of vector auto-regression models is to provide stability, since the goal in this framework is not to extract coefficients so that there is a concern about the existence of a single root.

6 Analysis of Instantaneous Reaction Functions

In this section, based on the estimated PVAR model, we analyze the effects of interactions of the variables. It should be noted that in the estimation of the PVAR model the Helmert transformation is used to eliminate the fixed effects. Also the GMM estimation approach was based on [1] program and implemented in Statata 15 software environment. The estimation results show that the Hansen's J statistic (stipulation of over-identifying restrictions of the system of equations) is $\chi^2_{(12)} = 22.62$ and, at the acceptable level (0.031), it indicates the validity of the instrument variable (lack of correlation with the error component) in model estimation.

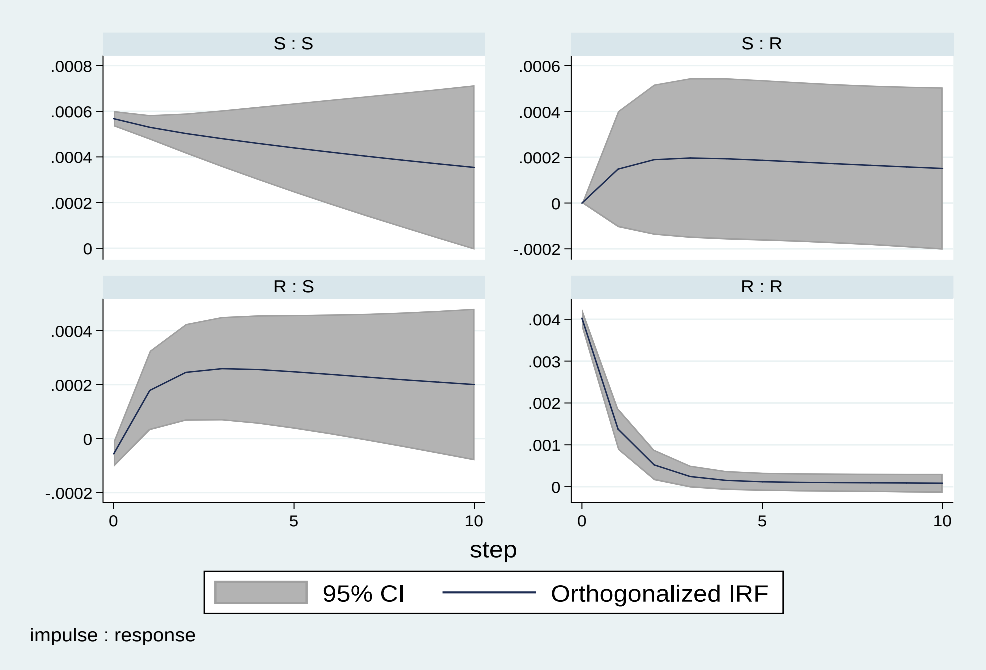

Fig. 7: Immediate Reaction Functions- Source: Research Findings

Based on the chart above, the risk (S) (derived from the MGARCH model from the previous section) increases in the response to the shocks caused by the return and the shock from the return increases the portfolio risk at the end of the period. On the other hand, in response to shocks caused by asset risk, the return increases at the beginning of the period, and the effects of shocks do not disappear at the end of the period; in other words, on the whole, the effects of mutual shocks caused by the risk of return are quite lasting and do not disappear at the end of the period.

7 Results of the Cointegration Approach and Model Estimation

In the following, the discussion of the cointegration relationships among the variables is examined based on the panel approach. First of all, the panel data unit root test for the variables used in the model is implemented.

Table 7: Return Variable Panel Root Unit Test (R)

Number of Views	Number of cross section	P value	Test statistic value	Test –method
zero hypothesis: the existence unit root(common unit root test)				
597	3	0.0029	-2.756	Levin , Lin & Chui
594	3	0.0001	-3.785	Breitung (t- statistics)
zero hypothesis: the existence unit root(single unit root test)				
597	3	0.0000	-6.548	Im , Pesaran & Shin(W test)
597	3	0.0000	52.191	ADF Fishers (Chi-square)
609	3	0.0000	207.503	PP Fishers (Chi-square)

Source: Research Findings

Table 8: Risk Variable Panel Root Unit Test (S)

Number of views	Number of cross section	P- value	Test statistic value	Test method
zero hypothesis: the existence unit root(common unit root test)				
609	3	0.0459	-1.685	Levin , Lin & Chui
609	3	0.0038	-2.667	Breitung (t- statistics)
zero hypothesis: the existence unit root(single unit root test)				
609	3	0.0175	-2.1	Im , Pesaran & Shin(W test)
609	3	0.0151	15.762	ADF Fishers (Chi-square)
609	3	0.012	16.354	PP Fishers(Chi-square)

Source: Research Findings

Table 9: Pedroni Panel Cointegration Test between Risk and Return

H0: There is no coexistence relationship		
Panel test	**Statistics**	**P-value**
Panel v-Statistic (Weighted)	12.29159 (6.22979)	0.0000 (0.0000)
Panel rho-Statistic (Weighted)	-44.4250 (-43.1907)	0.0000 (0.0000)
Panel PP-Statistic (Weighted)	-12.67168 (-12.3398)	0.0000 (0.0000)
Panel ADF-Statistic (Weighted)	-11.664 (-10.9429)	0.0000 (0.0000)
Intergroup test		
Group rho-Statistic	-44.25179	0.0000
Group PP-Statistic	-17.6754	0.0000
Group ADF-Statistic	-16.5068	0.0000

Source: Research Findings

Table 10: KAO Cointegration Test

Ho: There is no Coexistence Relationship		
ADF- test	**t- statistics**	**P- value**
	-3.7781	0.0001

Source: Research Findings

Based on the results of unit root tests, two variables used in the study lack the unit root. It should be noted that these tests are calculated for all possible situations and are included in the appendix to the thesis. Also, based on the results of the cointegration approach (Pedroni's seven statistics) and the Kao test, it can be concluded that there is a long-run relationship between the research variables (risk and return). In the following Tables, the estimation results of this model are based on the fully modified ordinary least squares (FMOLS) and dynamic ordinary least squares (DOLS) method.

Table 11: The Long-Term Panel Cointegration Relationship between Risk and Asset Portfolio Returns (Panel Approach)

Dependent Variable- Risk						
Variable Name	**DOLS Method**			**FMOLS Method**		
	coefficient	t	P value	coefficient	t	P value
Return	0.1784	4.149	0.0000	0.34509	7.377	0.0000
R^2	.38			-.10		
$\bar{R}^2$	.36			-.11		

Source: Research Findings - Note: Determination Coefficients Are Negative Due to Lack of Y-intercept.

Based on the results, there is a positive long-term panel cointegration relationship between risk and return. In other words, as the asset portfolio return increases, the risk will increase too. Then, the relationship between risk and return will be estimated for each asset based on the cointegrative approach to determine the risk-return relationship for each asset separately.

Table 12: Long-Term Cointegration Relationship between Currency Risk and Currency Return

Dependent Variable-Currency Risk									
Variable	**DOLS Method**			**FMOLS Method**			**CCR Method**		
	CF	t	P	CF	t	p	CF	t	p
Currency	1.86	16.26	0.000	0.315	0.975	0.330	0.432	3.47	0.0006
Intercept	0.0011	5.94	0.000	0.002	1.9	0.057	0.0022	5.27	0.0000
R^2	0.88			0.51			0.68		
$\bar{R}^2$	0.86			0.50			0.67		

Source: Research Findings

It should be noted that in estimating the equations for each asset, the Engle-Granger cointegration test was performed and the existence of a long-term relationship between the variables was confirmed. As it can be seen from the Tables above, there is a positive relationship between risk and return among the sections (for each asset), and accepting more risk is only possible in exchange for accepting higher returns. In the following, to evaluate the status of inflation cover by each asset, first the CAPM equation is estimated within the framework of the panel approach and based on the cointegration methods for the asset portfolio and then, this equation is estimated separately for each asset and the results are reviewed.

Table 13: The Long-Term Cointegration Relationship between Risk and Gold Return

Dependent Variable- Gold Risk									
Variable	**DOLS Method**			**FMOLS Method**			**CCR Method**		
	coeffi-cient	t	p	CF	t	p	CF	t	p
Gold Return	0.66	7.2	0.00	0.108	1.1	0.23	0.1	1.0	0.304
Intercept	0.00	16.	0.00	0.00	8.0	0.000	0.0	8.4	0.000
R^2	0.42			0.42			0.21		
$\bar{R}^2$	0.31			0.41			0.20		

Source: Research Findings

Table 14: The Long-Term Cointegration Relationship between Risk and Stock Return

Dependent Variable: Stock Risk									
Variable	**DOLS Method**			**FMOLS Method**			**CCR Method**		
	coefficient	t	p	coefficient	t	P	coefficien	t	P
Stock	0.143	3.2	0.00	0.0901	1.54	0.123	0.047	1.66	0.09
Intercep	0.00	31.14	0.00	0.0048	14.1	0.0000	0.004	32.6	0.00
R^2	0.21			0.23			0.23		
$\bar{R}^2$	0.18			0.23			0.23		

Source: Research Findings

Table 15: Estimating the CAPM Equation of Asset Portfolio Inflation (Panel Approach)

Dependent Variable: Risk						
Variable name	**DOLS Method**			**FMOLS Method**		
	Coefficient	t	P val	Coefficient	t	P val
Returns	1.096	20.541	0.0000	1.00899	2.0465	0.0411
R^2	-12.23			-0.103		
$\bar{R}^2$	-12.43			-0.108		

Source: Research Findings

As it can be seen from the results of the Table above, during the period under study the asset portfolio inflation has generally been a good cover against inflation. In the following, the CAPM equation is examined for each asset separately.

Based on the findings of the study, this hypothesis is rejected because the beta coefficient of the CAPM equation of inflation for the stock market under all estimation methods was less than 1 and the capital market was not a good cover against inflation. In fact, this market alone has not been a good shield against inflation compared to the gold and currency markets. Given the growing decline in the country's production structure and the dominance of the unproductive sector over the productive sector this result does not seem far-fetched. In fact, instead of being the safest and most profitable asset market, the

Iranian capital market has become a zero-sum game, and investors have suffered enormous losses in the long term despite cross-sectional profits. This is in contrast to the results of [8, 16, 25].

Table 16: CAPM Equation for Currency Returns

Dependent Variable:Currency Returns, Deposit Output Average									
Variable	**DOLS Method**			**FMOLS Method**			**CCR Method**		
	Coefficien	t	p	Coefficient	t	p	Coefficie	t	p
Deposit output average	1.002	1.3	0.108	1.005	2.1	0.03	0.001	1.98	0.049
Intercept	0.109	54.4	0.000	0.112	42.8	0.000	0.109	94.9	0.000
R^2	0.126			0.621			0.54		
$\bar{R}^2$	0.124			0.62			0.50		

Source: Research Findings

Table 17: CAPM Equation for Gold Returns

Dependent Variable:Gold Returns, Deposit Output Average									
Variable	**DOLS Method**			**FMOLS Method**			**CCR Method**		
	Coefficien	t	p	Coefficient	t	p	Coefficien	t	p
	1.002	1.5	0.129	1.002	1.79	0.074	1.002	2.48	0.012
Intercept	0.104	65.9	0.000	0.10	57.5	0.000	0.104	93.9	0.000
R^2	0.11			0.59			0.41		
$\bar{R}^2$	0.101			0.54			0.40		

Source: Research Findings

Table 18: CAPM Equation for Stock Returns

Dependent Variable:Stock Returns, Deposit Output Average									
Variable	**DOLS Method**			**FMOLS Method**			**CCR Method**		
	Coefficien	t	p	Coefficient	t	p	Coefficien	t	p
	0.008	2.3	0.022	0.0033	1.19	0.351	0.001	2.17	0.03
Intercept	0.115	28.	0.000	0.109	27.9	0.000	0.108	91.4	0.00
R^2	0.88			0.12			0.57		
$\bar{R}^2$	0.88			0.12			0.56		

Source: Research Findings

Also, during the period under review, gold and exchange were almost similarly able to act as a good cover against inflation, with a very little difference between them, given the beta coefficient of the CAPM equation of inflation. But overall, gold, with a very small difference, has been able to cover inflation more than currency and therefore, the research hypothesis is rejected. The reason for this may have been to some extent keeping the country's exchange rate stable by injecting foreign exchange rates into the market. The result of this hypothesis is in line with the study by [6, 9, 10, 21].

Table 19: Estimation of CAPM Equation by PMG and MG Methods

Dependent Variable: Risk						
	Long Run Model				**Hausman MG-PMG**	
Independent Variable	**PMG**		**MG**			
	Coefficient	P value	coefficient	P value	$\chi^2_{(2)}$	P value
Returns	1.4577	0.0000	1.7377	0.0000	0.002	0.803
Short run model					Test Result PMG Model Gives a More Efficient Estimate As Opposed to MG Model	
Error Correction Model						
Gold Returns	-0.0767	0.000	-0.0670	0.000		
Currency Returns	-0.0321	0.000	-0.1464	0.000		
Stock Returns	-.00202	0.000	-0.118	0.000		
Intercept						
Gold	0.0001	0.0000	0.0009	0.082		
Currency	0.0001	0.0000	0.0003	0.001		
Stock	0.0003	0.0000	0.0002	0.001		
Number of Sections =3	Number of =609 View		Number of Lag =1	PMG: Loglikelihood **=3726.4**		

Source: Research Findings - TATA15 Software

As shown in the Table above, based on the pooled mean group (PMG) approach, there is a positive relationship between risk and return, and also based on the Hausman test, the PMG model is more efficient than the MG intergroup model (because the probability value of the test at confidence level is greater than 0.95). Also, the short-term error correction model based on the PMG and MG approaches illustrates the speed of models adjustment to long-term equilibrium and all have the expected sign and value (between -1 and zero).

9 Conclusion

In this paper, the relationship between risk and return on financial assets was studied. Based on the results, there is a positive relationship between risk and return, and accepting more risk is only possible in exchange for higher returns. In other words, as the return on asset portfolio increases, the risk will also be increased. In estimating the equations for each asset, the Engle-Granger cointegration test was performed and the results showed that there is a long-term relationship between the relevant variables. The results showed that there is a positive and significant relationship between the risk variable and returns on investment in gold, and between risk and currency returns.

Due to the affirmation of the positive relationship between risk and return on investment in gold and foreign exchange assets, any investor who is able to bear more risk can expect to receive a higher return on investment in this area. The results are consistent with the studies by [17, 8 and 35] are inconsistent with the study by [26 and 32]. Then, the status of inflation coverage by each asset was tested through the CAPAM equation in the framework of the panel approach and based on aggregation methods for the asset portfolio, and the results showed that the asset portfolio, in general, was a good coverage against inflation. The CAPAM equation for each asset was examined separately. The results showed that the beta coefficient of the CAPM inflation equation for the stock market based on all estimation methods was less than 1 and basically the capital market was not a good coverage against inflation. This result does not seem far-fetched given the increasing decline in the production structure of the country and the dominance of the unproductive sector over the productive sector. The results are inconsistent with the study by [11, 14, 23 and 38]. The beta coefficient of the CAPM inflation equation, for gold and foreign exchange, was greater than 1, and gold was capable to cover the inflation more than the foreign exchange, the reason of which might be keeping the exchange rate constant in the country to some extent by injecting the exchange rate into the market. The results are consistent with the study by [38 and 24]. Also, the short-term error correction model (ECM) based on the PMG and MG approaches indicates the speed of model adjustment towards long-term equilibrium and all of them have the expected sign and value (from -1 to zero).

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