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Investigating the potentiality of various inflation-protected investments for investors in Iran

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***Abstract*---**This study aimed to investigate the potentiality of inflation-protected investments for investors in Iran. The objective of the present study was applied, and the methodology was correlational, which an ex-post facto research design was developed to explore the correlation between variables. Here in this study, the required data (e.g., time series pertaining to the total stock price index, housing, bond, gold, and coin prices as well as dollar prices in the unofficial market) were collected to distribute capital among asset groups and then econometric concepts and models were used to analyze these time series aiming to predict the returns and standard deviations as well as covariances of future periods. To determine the changes and relations between different assets and simulate the rate of return in the presence of macroeconomic factors, Burberry's (2000) and Campbell et al.'s (2003) methods were used. After static model variables were discovered, Schwartz-Bayesian (SC), Akaike (AIC), and Hannan Quinn (HQ) criteria were employed to determine the interrupt length. Eviews software was used to analyze the data to estimate the VAR model and Matlab software to resolve the mathematical programming problem. According to the results, the bond market was founded to have the highest yields compared to other markets. Also, according to the results from the Markowitz

model, investment in the stock market held the least risk and inflation protection.

***Keywords*---**Inflation protection, investment, Markowitz model.

Introduction

Economic activists have long grappled with various market risks. In recent years, political and economic risks in Iran have caused turmoil in the financial system and removed investor confidence in financial institutions, prompting researchers to investigate the existing risk management model for taking necessary measures. Risk protection or risk hedging is one of the most basic investment subjects to be examined from different views. Risk hedging, simply defined, is the act of protecting oneself against unpredictable events which may unfold at any moment. Risk hedging provides the necessary protection against sharp declines in markets such as the stock market downturns (Baur & McDermott, 2010). Risk hedging is one of the ways to diversify one's portfolio.

One of the critical issues in investment is the way resources are allocated to assets. In this connection, there are two decision-making views. In the first view, assets are allocated based on personal experiences when opportunities arise. The second view is a quantitative one based on which opportunity selection is made via detailed analysis and evaluation and applying such tools as mathematical equations, models, etc. (Levisauskaite, 2010). Investment portfolio is created to divide investment risk between several assets. A portfolio is a good combination of stocks or other assets an investor has bought. Theoretically speaking, a portfolio refers to one's diverse assets and investments; thus, instead of investing in a specific asset, the investor should create an investment risk portfolio to reduce risks (Lean, 2015).

Each asset incurs a different level of risk and return in the portfolio and thus has different mechanisms over time. Any investor expects a certain level of return (profit) from the investments, as there will also be a certain level of risk (failure to gain the desired return).

Any decision to invest in the market helps create a close relationship between risk and return from that investment. The extent to which an investor invests depends on the level of return and risk. It should be noted that the real world is affected by the effects of various overlapping economic factors. Thus, risk and return are the criteria that determine the desirability of the investor from selecting a set of investment assets. Now, the important issue is how people allocate resources to different assets when they make investments. In his study, Lee (2020) evaluated the selection of the securities portfolio and examined its relationship with inflation. The findings suggested that delayed indexing increased the number of state variables that could affect bond prices and the optimal stock portfolio. Heejin Yang et al. (2017) concluded in research that stock returns significantly depended on the different transactional behavior of investors (both domestic and foreign) in the wake of changing bond rates.

Antonakakis (2016) also investigated the impacts of inflation on the US stock market over the past two centuries and the correlation between stock price changes and inflation variations, suggesting that inflation could leave adverse effects on stock prices. There is a significant difference between inflation and stock prices (Shahbazi, 2013). In a study in Pakistan, the ability of gold to hedge against inflationary effects using the co-integration method in the presence of structural failures was investigated. The findings revealed that gold could create a good hedge against inflation both short and long term.

In Iran, scant studies are available on the allocation of assets between stock exchange companies, demonstrating that assets have been allocated without regard for the uncertain conditions arising from inflation. The present study aimed to optimally allocate assets considering the inflation-led uncertainty for investors in Iran. It can also be an example of an applied study to generalize to other developing countries in Asia and the Middle East.

Theoretical basics of the research
Risk hedging

Risk hedging helps diversify the portfolio. In this connection, investors create a portfolio which refers to any combination of financial assets such as stocks, bonds, and cash. Investors may hold portfolios or manage by financial professionals, hedge funds, banks, and other financial institutions. Portfolios usually have broader meanings. Portfolios are commonly used for listed companies, though they include non-listed companies and even non-listed investments (Lean, 2013). Another risk hedge issue that has gained much attention in recent years is that of safe capital or haven. This pertains to investors' behaviors during the crisis and amid a sharp financial markets downturn. If there is one asset that reduces losses in times of market stress or financial crisis more than other hedged and diversified assets, it is expected to reduce the severity and duration of radical market conditions to create profits and increase capital market stability. An asset with this characteristic is called a haven (Smiech & Papiz, 2017).

According to the portfolio theory, the individual is advised to allocate his investment to different assets to balance his risk and return on investment (Gholizadeh et al., 2015). Portfolio risk is reduced by adding new assets to an investor's portfolio. Investors need to optimally integrate investment assets according to their strategies. This integration should meet future needs of the investor and create peace of mind for them (Gholizadeh et al., 2015).

Under inflationary conditions, investors always seek to invest in assets that, which protect not only the value of their money but also provide good returns. Economic researchers now agree on the impact of high inflation on economic activity. High inflation rates in consequent periods are regarded as a crisis that could disrupt real financial activities, investment, and the economy as a whole. This issue was noted in the Iranian economy in recent years. Inflation appears to play a decisive role in the development of monetary and financial markets in developing countries, while lower inflation and moderate inflation in developed

nations could also have an adverse effect on the monetary and financial markets (Moghaddasi, 2017).

Investment portfolio

In modern economic literature, the bond is an instrument of indebtedness by which the debtor (usually a government or cooperative) borrows a sum from the bondholder and commits to pay interest to him/her within the contract period and to return the original sum after the contract period expires (Shahbazi, 2016). In finance, a bond is an instrument of indebtedness of the bond issuer to the holders. The most common types of bonds include municipal bonds and corporate bonds. Bonds can be in mutual funds or can be in private investing, where a person would give a loan to a company or the government. Bonds have a due date, and their yields are paid by the issuer when they are due. These bonds have an interesting document, and the pertinent interest is paid at regular intervals by the bank issuing the bonds. Bond issuance is one of the financing methods in the short and long terms. These bonds are also known as inflation-related bonds, which are calculated based on the positive or negative inflation rate under the nominal rate of the daily consumer index, also known as IIB for short. Therefore, these bonds are more appealing for risk-averting investors who are worried about losing the purchasing power of the invested sum, especially in countries like Iran, where high and persistent inflation has become commonplace.

Today, housing does not just mean a shelter; rather, it is a durable immovable commodity and a capital good, which investment on it is considered to be a household asset. In addition to households, housing is also appealing for business firms. Thus, housing is consumption and capital commodity (Chandra et al., 2015). In today's world, development programs emphasize expanding the housing sector as a tool to increase national production (Heydari & Souri, 2017). The housing market has characteristics, most of which pertain to inherent household characteristics, which are information inefficiency, high trading costs, slow regulation against shocks, and a broad connection with macroeconomics (Wang and Li, 2016). The housing market relationship with the monetary-credit sector at a macro level is also of high significance. High housing costs and the buyers' need for credits, on the one hand, and the allocation of a significant volume of bank credit to the housing sector, on the other hand, caused the housing sector to deeply depend on the credit sector (Wong & Jiang, 2016).

Investment in stock exchanges and securities is the best choice for the investors who can sustain more risks than equity holders and prefer to contribute to corporate profits and not to lose a higher stock growth potential. If the investor seeks to increase the profitability potentiality of his/her portfolio, s/he should give more weight to the stocks, thereby increasing the investment risk. Many studies, including Gupta et al. (2010) and Ray and Chatterjee (2003). have been conducted on the ability of stock prices to predict inflation. Goodheart et al. used seasonal data from 17 countries from 1970-1998 to conclude that stock prices could not predict inflation. In their study, Ray and Chatterjee presented evidence on the positive impacts of stocks on inflation in India.

As uncertainty in the financial markets increases, it will be highly critical to find assets that are potentially capable of reducing portfolio risk, as well as hedging. One of the assets often used for this purpose is gold. The hedging power of gold and other precious metals against the fluctuating stock markets of different countries is one of the subjects that has received much attention in recent years. Thus, one would argue that this precious metal, alongside other assets, greatly contribute to individuals' portfolio (Baur et al., 2010). One of the areas where gold is used as a substitute for other financial assets is inflationary conditions in the economy. Gold is one of the first monetary forms, which has traditionally been used by people to protect against rising public price levels (Beckman et al., 2015).

Protection against inflation is one of the most important reasons to enter the foreign exchange market. When the investor learns that inflation is not affecting the asset s/he is investing in and that its value rises with increasing the rate of inflation, s/he is no longer worried about losing the value of the capital. A review of past statistics suggests that the value of foreign exchange has, in many cases, exceeded the inflation rate, bringing about returns on investment in the foreign exchange market while maintaining the value of assets and protecting against inflation. One more factor which makes the foreign exchange market be considered as one of the investment markets in Iran is its liquidity. One would argue that foreign exchange market liquidity is greater than in any other market, which may only be disrupted in some very specific cases within a short period of time. Because of its characteristics in Iran, the foreign exchange market can be a profitable investment market and help maintain the value of assets and capital.

Research Methods

The present study was an applied study from an objective point of view. The research method is correlational from a nature and content perspective as ex-post factor methods were used to discover the correlation between variables. Here in this study, the required data (e.g., time series pertaining to the total stock price index, housing price, bond price, gold and coin price, and dollar price in the unofficial market) were collected to distribute capital among asset groups and then econometric concepts and models were used to analyze these time series aiming to predict the returns and standard deviations as well as covariances of future periods.

The data used in this research were gathered on a yearly basis from the Iranian economy via a library method for the period from 2001 to 2006. The data from the stock price index in the stock exchange was collected from the Tehran Stock Exchange and the Central Bank databases, as well as the central bank, while the price index of bonds, housing prices, coin and dollar prices in the unofficial market from the Central Bank website. To determine the changes and relations between different assets and simulate the rate of return in the presence of macroeconomic factors, the Burberry (2000) and Campbell et al. (2003) methods were used. In this method, the dynamic rate of return for various classes of assets was determined using the vector-autoregressive (VAR) process and the inflation rate as a predictive factor. In this method, all assets are endogenous, and the reciprocal effects of each asset against each other are examined to measure the risk and return from the assets. At any stage, one of the assets is selected as an

output variable as the studied variables are used to predict this asset. To calculate the projected return and risk, the mean and standard deviation of the fitted values of the output variables within the selected period will be used. The following equation shows this situation.

(1)

RB=f{RC, RH ,RE,RG }
RC=f{RB, RH ,RE,RG }
RH=f{RC, RB ,RE,RG }
RE=f{RC, RH ,RB,RG }
RG=f{RC, RH ,RE,RB }

Where

RB = return on stock
RC = bond yields
RH = return on housing price
RE = return on dollars in the unofficial market
RG = return on the coin

If n interrupt is determined for the explanatory variables based on the selected criteria to determine the interrupt, the estimated model is as follows:

(2)

$$RB = \bar{C_1} + \sum_{i=1}^{n} (a_{1,i}RB(-i) + b_{1,i}\,RC(-i) + c_{1.i}RE(-i) + d_{1,i}RG(-i) + k_{1,i}RH(-i) + e_1)$$

(3)

$$RC = \bar{C_2} + \sum_{i=1}^{n} (a_{2,i}RB(-i) + b_{2,i}\,RC(-i) + c_{2.i}RE(-i) + d_{2,i}RG(-i) + k_{2,i}RH(-i) + e_2)$$

$$RE = \bar{C_3} + \sum_{i=1}^{n} (a_{3,i}RB(-i) + b_{3,i}\,RC(-i) + c_{3.i}RE(-i) + d_{3,i}RG(-i) + k_{3,i}RH(-i) + e_3)$$

(4)

$$RG = \bar{C_4} + \sum_{i=1}^{n} (a_{4,i}RB(-i) + b_{4,i}\,RC(-i) + c_{4.i}RE(-i) + d_{4,i}RG(-i) + k_{4,i}RH(-i) + e_4)$$

(5)

$$RH = \bar{C_5} + \sum_{i=1}^{n} (a_{5,i}RH(-i) + b_{5,i}\,RC(-i) + c_{5.i}RE(-i) + d_{5,i}RG(-i) + k_{5,i}RB(-i) + e_5)$$

(6)

$$\bar{C}\_5\ ((,C)\bar{}\_4, C)\bar{}\_3\ (,C)\bar{}\_2\ (,C)\bar{}\_1$$

As they are the intercept in Equations 2 to 6, respectively. RB (-i) is the return on stocks with the i interrupt, RC (-i) the bond yields with the i interrupt, RH (-i) return on housing with the i interrupt, RE (-i) return on the dollar with the i interrupt, RG (-i) return on the coins with the I interrupt, a, b, c, d, k, coefficients of variables, and e the random error of the models. The desired model is defined to identify the effects of variables on each other.

To invest in the foreign exchange market, the dollar rate was selected for the unofficial market because investors could have access to investment in foreign exchange only through the unofficial exchange market. As for the gold market, the coin price was selected as the main decision criterion because investment did not need to calculate the side costs, such as the fees paid for making gold, and so on.

To estimate the desired model, the static variables were first examined; then, the root unit of the Dickey-Fuller test was used to determine the mean stationarity of the variable time series. After static model variables were discovered, Schwartz-Bayesian (SC), Akaike (AIC), and Hannan Quinn (HQ) criteria were employed to determine the interrupt length. The results obtained from this method can be used to measure inflation protection for each class. To obtain the minimum variance portfolio, the following equation needs to be solved for a certain level of the real rate of return (Bauer & Sagnori, 2013):

(7)

$$Min_w\, w' \sum w$$

$$\sum_{i=1}^{n} w_i R_{iT} = \bar{R}$$

$$\sum_{i=1}^{n} w_i = 1$$

$$w_i \geq 0$$

R_{iT} is the annual real rate of return of n assets in an investment portfolio, w_i the weights of each asset, $\bar{R}$ target (expected) real rate of return and $\sum$ covariance matrix of the real rate of return simulated through time-series return rate analyses (VAR model). This equation indicates an optimal combination of minimum risk and a portfolio with the target rate of return for each investment.

Also, the average return on assets over previous years was considered to be a criterion for the expected return. Therefore, the expected return on each asset is obtained from the following equation.

(8)

$$\bar{R}_i = \frac{\sum_{t=1}^{n} R_{it}}{n}$$

In fact, $\bar{R}_i$is the expected return estimated or E (R_i). In this equation, the return on each asset is in the i^{th} year and shows the profitability of the asset in a year, which includes changing the price of the asset in a year along with other returns on each asset. E (R_i) is also the expected return on i^{th} assets. Because the future return on assets is not clear, the Markowitz model was used to gain the average return on each asset over the years under study and was also determined as a criterion for the expected return on that asset. Eviews software was used to analyze the data to estimate the VAR model and Matlab software to resolve the mathematical programming problem. According to the results, the bond market was founded to have the highest yields as compared to other markets. Also,

according to the results from the Markowitz model, investment in the stock market had the least risk and inflation protection.

Findings

Study variables include; RB =return on stocks; RC = bond yields; RH = return on housing prices; RE =return on the dollar in the unofficial market and RG =return on coins. Before estimating the model, it is required to test the stationarity of all variables used in the research model. According to Table (1), all variables were stationary except for the variable of bond yield. In other words, they held zero accumulation. On the other hand, the variable of bond yield was not stationary but became stationary after first-order differencing. In other words, the degree of accumulation was 1.

Table 1
Generalized Dickey-Fuller unit root test

Variable	Level		First-order differencing		Status
	Value	Sig.	Value	Sig.	
RB	-4.544	0.001	-----	-----	I(0)
RC	0.513	0.983	-7.762	0.000	I(1)
RE	-4.229	0.003	-----	-----	I(0)
RG	-4.201	0.003	-----	-----	I(0)
RH	-4.739	0.001	-----	-----	I(0)
P	-4.787	0.000	-----	-----	I(0)

Source: research findings

After investigating the stationarity of the model variables, the next step to estimate the VAR models is to determine the optimal interrupt for the model. According to Table (2), considering Akaike and Hannan-Quinn, interrupt three was regarded as the optimal interrupt.

Table 2
Results from determining the optimal model interrupt

Interrupt	AIC	SC	HQ
0	5.564	6.057*	5.688
1	5.708	7.436	6.143
2	5.938	8.901	6.683
3	4.588*	8.785	5.644*

Sources: research findings

After the optimal interrupt was determined in the previous step, the study model is estimated by interrupt 3. The results of Table (3) are described below:

Table 3
VAR model estimation

Variable	RB	RC	RE	RG	RH
RB(-1)	0.196	-0.764	-0.020	0.100	0.042
	0.431	2.691	0.181	0.195	0.111
	0.455	-0.284	-0.114	0.514	0.376
RB(-2)	-0.153	-1.559	0.020	0.031	-0.030
	0.442	2.760	0.186	0.200	0.114
	-0.346	-0.579	0.111	0.158	-0.263
RB(-3)	0.007	-2.853	0.136	0.028	0.099
	0.399	2.488	0.168	0.181	0.103
	0.019	-1.146	0.814	0.156	0.963
RC(-1)	-0.021	-0.103	0.009	0.0007	-0.007
	0.041	0.261	0.017	0.018	0.018
	-0.509	-0.398	0.529	0.039	-0.732
RC(-2)	0.004	0.209	0.020	0.007	-0.008
	0.004	0.270	0.018	0.019	0.011
	0.105	0.773	1.102	0.385	-0.751
RC(-3)	0.032	0.134	0.044	0.043	0.003
	0.046	0.290	0.019	0.021	0.012
	0.270	0.462	2.273	2.041	0.323
RE(-1)	0.822	-4.744	-0.983	-0.808	-0.280
	1.588	9.715	0.656	0.706	0.404
	0.527	-0.4888	-1.498	-1.144	-0.694
RE(-2)	-0.969	-9.481	0.592	0.175	-0.048
	1.378	8.589	0.580	0.624	0.357
	-0.703	-1.103	1.021	0.281	-0.134
RE(-3)	-0.205	23.169	0.015	-0.427	0.290
	1.433	8.936	0.603	0.649	0.371
	-0.143	2.592	0.025	-0.657	0.781
RG(-1)	-0.510	9.832	0.638	0.480	0.183
	1.699	10.593	0.715	0.770	0.440
	-0.300	0.928	0.891	0.623	0.415
RG(-2)	-0.039	12.393	-0.595	-0.483	0.115
	1.471	9.173	0.619	0.667	0.381
	-0.026	1.351	-0.960	-0.724	0.301
RG(-3)	0.268	-11.086	-0.180	0.124	-0.184
	1.410	8.789	0.593	0.639	0.369
	0.190	-1.261	-0.304	0.194	-0.505
RH(-1)	-0.369	-3.232	-0.191	-0.379	0.063
	1.385	8.631	0.583	0.627	0.359
	-0.266	1.932	-0.329	-0.603	0.176
RH(-2)	0.297	16.34116/	0.415	-0.023	-0.311
	1.357	8.457	0.571	0.615	0.351
	0.219	1.932	0.726	-0.037	-0.886
	-0.371	12.551	-0.018	0.210	-0.311

RH (-3)	1.652	10.298	0.695	0.749	0.428
	-0.225	1.218	-0.026	0.280	-0.726
Intercept	0.485	-8.232	-0.657	-0.178	0.118
	1.078	6.723	0.454	0.488	0.279
	0.449	-1.224	-1.448	-0.364	0.425
P	-0.0005	0.052	0.040	0.026	0.013
	0.037	0.234	0.015	0.017	0.009
	-0.0.14	0.224	2.528	1.562	1.357
Coefficient of determination	0.520	0.838	0.882	0.855	0.871

Sources: research findings

Table 4
Stock market analysis of variance

Period	Error	Stocks market	Bond market	Foreign exchange market	Gold Market	Housing market
1	0.577	100	0	0	0	0
2	0.607	92.413	3.006	3.195	0.870	0.514
3	0.690	74.340	3.703	20.506	0.776	0.672
4	0.707	72.635	3.927	20.413	2.356	0.666
5	0.759	63.440	5.582	18.672	10.427	1.875
6	0.797	580.27	10.259	19.080	9.971	2.919
7	0.813	56.379	10.332	20.848	9.573	2.865
8	0.826	56.601	10.355	20.198	9.949	2.895
9	0.872	53.248	14.013	19.563	10.306	2.286
10	0.939	45.925	16.362	25.958	9.275	2.479

Sources: research findings

According to Table (4), in the first period, the total changes of the variable are explained by the variable itself. Over time and in subsequent periods, the variable contributes less while other variables contribute more. The findings suggested that foreign exchange and bond markets contributed most to explaining stock market behavior. Concerning the dependence of the entire economy on the foreign exchange rates, one would say that the foreign exchange market causes fluctuations in the stock market. Of course, this fluctuation can entail two different impacts. The first group involves companies whose sales are based on the dollar, with the fluctuating exchange rates directly affecting their profitability. However, the second category includes companies whose sales are not dependent on the dollar, and one cannot provide a true estimate of their profitability. On the other hand, the bond market can also be a competitor to the capital market as it does not have operational risks and provides relatively good returns.

Table 5
Analysis of variance of foreign exchange market

Period	Error	Stocks market	Bond market	Foreign exchange market	Gold Market	Housing market
1	0.577	2.370	4.186	93.442	0	0
2	0.607	2.212	12.977	75.659	8.501	0.648
3	0.690	11.185	10.789	57.929	18.165	1.929
4	0.707	11.720	26.013	44.019	16.562	1.612
5	0.759	14.520	24.292	41.068	13.947	5.543
6	0.797	13.955	26.063	38.694	15.821	4.925
7	0.813	14.141	29.051	38.263	15.536	4.007
8	0.826	9.758	32.161	39.435	14.932	3.711
9	0.872	8.219	30.850	40.331	17.179	3.418
10	0.939	6.491	33.167	36.887	20.210	3.242

Sources: research findings

According to Table (5), in the first period, 93% of the changes of the variable are explained by the variable itself. Over time and in subsequent periods, the variable contributes less while adding to the contribution of other variables in the model. Accordingly, it is said that gold and bond markets contribute most to explaining the foreign exchange market behavior. The gold market is seen by investors as the safest market. If the economy comes under a shock, the government needs to regulate the liquidity directly. Under uncertain conditions, investors tend to buy gold and foreign exchange. On the other hand, the bond market can compete with the foreign exchange market and attract liquidity in the market as it does not have operational risk while providing good returns.

Table 6
Analysis of variance of the gold market

Period	Error	Stocks market	Bond market	Foreign exchange market	Gold Market	Housing market
1	0.577	0.631	0.256	76.926	22.186	0
2	0.607	2.083	3.920	67.498	24.031	2.465
3	0.690	6.541	5.177	55.096	30.966	2.188
4	0.707	4.669	21.363	49.965	22.251	1.749
5	0.759	9.661	20.403	45.638	20.053	4.243
6	0.797	8.905	19.623	42.238	25.342	3.890
7	0.813	7.297	27.370	38.854	23.650	2.827
8	0.826	5.951	28.145	41.848	20.096	3.957
9	0.872	5.723	27.198	40.303	23.047	3.726
10	0.989	5.119	29.750	35.851	25.322	3.956

Sources: research findings

According to Table (6), in the first period, 77% of variables are explained by the foreign exchange market. Over time and in subsequent periods, the market

contributes most to changes in the gold market. Accordingly, it is suggested that the foreign exchange market greatly contributes to explaining the gold market behavior. The gold market, which is the safest market for investors, is completely dependent on the exchange rate. Thus, one would say that the exchange rate and gold fluctuations are the same.

Table 7
Analysis of variance of the housing market

Period	Error	Stocks market	Bond market	Foreign exchange market	Gold Market	Housing market
1	0.577	0.465	1.126	34.956	1.301	62.150
2	0.607	0.458	1.346	36.464	3.156	58.574
3	0.690	1.310	5.828	37.047	2.633	53.180
4	0.707	8.964	4.374	31.254	4.314	51.091
5	0.759	8.902	4.297	30.757	5.292	50.749
6	0.797	7.368	8.188	35.282	4.642	44.517
7	0.813	7.225	8.671	35.066	4.560	44.477
8	0.826	8.730	8.175	33.128	8.024	41.940
9	0.872	7.716	12.280	32.049	10.868	37.085
10	0.939	7.553	14.075	31.593	10.130	36.644

Sources: research findings

According to Table (7), in the first period, 62% of changes of the variable are explained by the variable itself. Over time and in subsequent periods, the variable contributes less while adding to the contribution of other variables in the model. Accordingly, it is suggested that the foreign exchange market most explains the behavior of the housing market. Fluctuating rates in the country are associated with the impact on most macroeconomic variables. One of the markets which are affected by exchange rate fluctuations is the housing market. As the price of a currency rises and the national currency values plummets, people holding liquidity tend to convert it into commodities, and housing is a highly lucrative commodity over time. Despite a sharp rise in the currency price, construction companies sometimes suffer from inflationary recession.

Table 8
Analysis of variance of the bond market

Period	Error	Stocks market	Bond market	Foreign exchange market	Gold Market	Housing market
1	0.577	31.478	68.521	0	0	0
2	0.607	26.231	51.697	11.877	9.346	0.846
3	0.690	18.477	42.485	13.311	14.038	11.686
4	0.707	14.146	40.033	17.046	17.548	11.225
5	0.759	15.812	33.792	21.620	21.082	7.692
6	0.797	16.984	29.088	23.495	23.740	6.690
7	0.813	15.076	29.685	19.726	25.269	10.241

8	0.826	15.629	30.260	18.082	23.477	12.250
9	0.872	16.486	31.484	20.935	20.196	10.539
10	0.939	17.390	31.945	23.496	17.792	9.375

Source: research findings

According to Table (8), in the first period, 68% of the variables are explained by the variable itself. Over time and in subsequent periods, the variable contributes less while adding to the contribution of other variables in the model. According to the results, the foreign exchange market is said to contribute most to explaining the behavior of the bond market. The exchange rate fluctuations in the country are associated with the impact on most macroeconomic variables. The bond market is one of the markets exposed to exchange rate fluctuations.

The first step to use the heterogeneity of variance models is that the condition of heterogeneity of variance in the research variables is met. According to the F values and R2 observations, the null hypothesis stating variance heterogeneity for all variables is rejected. It can be said that the condition of heterogeneity of variance is met.

According to Table (9), the estimated model is based on ARCH (2) and GARCH (1). According to this model, gold and housing prices represent a significant impact on the stock price index.

Table 9
Estimation of conditional heterogeneity of variance model of stock price index

Variable	Coefficient	Standard error	T value	Sig.
Bonds	-0.044	0.061	-0.728	0.466
Exchange rate	-0.103	0.178	-0.579	0.562
Gold price	4.591	1.011	4.450	0.000
House price	373.749	146.693	2.547	0.010
Inflation rate	-15.865	17.856	-0.888	0.374
Intercept	119.208	159.922	0.745	0.456
)1(ARCH	0.615	0.767	0.801	0.422
(2)ARCH	-1.681	0.206	-8.131	0.000
GARCH (1)	1.845	0.770	2.396	0.016

Source: research findings

Based on the results of Table (10), the estimated model is GARCH (1).
Within this model, none of the variables show a significant effect on the price of gold.

Table 10
Estimation of the conditional heterogeneity of variance model of gold price

Variable	Coefficient	Standard error	T value	Sig.
Stocks price index	0.058	0.060	0.962	0.335
Bonds	0.0034	0.0093	0.368	0.712

Currency rate	0.0070	0.070	0.099	0.920
Housing rate	61.497	64.359	0.955	0.339
Inflation	4.417	22.774	0.193	0.846
Intercept	-15.039	93.80	-1.603	0.108
GARCH (1)	1.560	0.221	7.054	0.000

According to Table (11), the estimated model is based on ARCH (2) and GARCH (1). According to this model, gold and housing prices represent significant impacts on the exchange rate.

Table 11
Estimation of conditional heterogeneity of variance model of the exchange rate

Variable	Coefficient	Standard error	T value	Sig.
Stocks price index	0.025	0.038	0.659	0.509
Bonds	0.0035	0.021	-0.161	0.871
Currency rate	2.256	0.313	7.198	0.000
Housing rate	105.587	34.331	3.075	0.002
Inflation	39.266	36.340	1.080	0.279
Intercept	267.421	256.210	1.043	0.296
)1**(**ARCH	0.832	0.591	1.407	0.159
(2)ARCH	-0.754	0.440	-1.711	0.087
GARCH (1)	0.654	0.482	1.356	0.174

Sources: research findings

According to Table (12), the estimated model is based on ARCH (2) and GARCH (2). According to this model, the stock price index and gold price represent a significant impact on housing prices.

Table 12
Estimation of the conditional heterogeneity of variance model of the housing prices

Variable	Coefficient	Standard error	T value	Sig.
Stocks price index	0.00064	0.00019	3.352	0.000
Bonds	2.69*10.5	5.12*10-6	0.525	0.599
Currency rate	0.00010	0.00036	0.295	0.767
Housing rate	0.0025	1.61*10-5	15.74	0.000
Inflation	-0.014	0.119	-0.120	0.904
Intercept	-0.894	1.166	-0.766	0.443
(1)ARCH	0.825	0.254	3.241	0.001
(2)ARCH	-1.638	0.566	-2.893	0.003
GARCH (1)	1.202	0.571	2.105	0.035
GARCH (2)	1.011	0.910	1.110	0.266

According to Table (13), the estimated model is based on ARCH (1) and GARCH (1). According to this model, gold and housing prices show a significant impact on bonds.

Table 13
Estimation of the conditional heterogeneity of variance model of bonds

Variable	Coefficient	Standard error	T value	Sig.
Stocks price index	-1.625	1.263	-1.286	0.198
Bonds	-2.535	3.866	-0.655	0.512
Currency rate	12.600	7.096	1.776	0.075
Housing rate	12.54	424	2.954	0.003
Inflation	252.600	385	0.655	0.511
Intercept	2737.1801	1.29*105	0.212	0.831
)1(ARCH	-0.133	0.064	-2.054	0.039
GARCH (1)	1.189	0.322	3.688	0.000

To obtain the optimal capital portfolio, the Markowitz method was used, which yields the minimum variance of a certain level of return; for this, we have a linear programming model with the following equation:
(9)

$$Min\ z = \sigma_p^2$$

$$st: \quad \overline{r_p} = \sum_{j=1}^{n} w_j . \overline{r_j}$$

$$\sum_{j=1}^{n} w_j = 1$$

$$w_{j\geq 0}$$

Where w_i is the weight of the i^{th} variable in the capital portfolio, $\overline{r_p}$ ،the expected return on the capital portfolio, $\overline{r_j}$ the return on the i^{th} variable, and σ_p^2 ، the variance of the return on the portfolio defined as the following equation:
(10)

$$\sigma_p^2 = \sum_{i=1}^{n}\sum_{j=1}^{n} w_i w_j \operatorname{cov}(\overline{r_i}, \overline{r_j})$$

The constraints are as follows:
Constraint 1: The intended return on the stock portfolio is determined by the investor.
Constraint 2: It refers to the weight constraint, which considers the total weight of the stocks in the portfolio to equal one.

Constraint 3: It considers the minimum weight of each stock in the capital portfolio to be greater than zero while rejecting negative numbers.

The Markowitz model was implemented on each of the obtained clusters in MATLAB software. With each implementation, the risk and return values of the portfolio were obtained. The output of the Markowitz code is given in Tables (14) and (15).

According to Table (14), concerning different markets, the bond market with a yield of 17.783 held the highest rate of return. Ranking second place was the housing market, with a return of 16.588. In the third rank stood the foreign exchange market with a return of 14.863. The gold market with a return of 13.918 ranked fourth, while the stock market stood at fifth with a return of 12.438.

Table 14
Returns from the stock portfolio using the Markowitz model

Markets	Stocks market	Gold market	Foreign exchange market	Housing market	Bond market
Return	12.438	13.918	14.863	16.588	17.783

Sources: research findings

According to Table (15), concerning different markets, the stock market with a risk of 3.026 held the lowest level of risk. The foreign exchange market held the second rank with a risk of 4.183. The housing market stood at the third rank with a risk of 3.226. The bond market was in fourth place with a risk of 3.461, and finally, the gold market ranked last with a risk of 3.262.

Table 15
Stock portfolio risk in the Markowitz model

Markets	Stocks market	Gold market	Foreign exchange market	Housing market	Bond market
Risk	3.026	3.262	3.183	3.226	3.461

Sources: research findings

Two questions were raised in this research as follows:
Question 1: How do Iranian investors allocate resources to different assets, taking into account the risk of inflation?

According to the Markowitz model, the bond market held the highest returns as compared to other markets. The Markowitz model uses two main factors of risk and return for optimization. Thus, a market based on this model can take precedence, with less risk fluctuation and a high return over time. According to this model, investors can allocate their assets to such markets as bonds, stocks, gold, currency, and housing, respectively.

Question 2: Which investments do contribute to protecting investments from inflation?

According to the Markowitz model, investment in the stock market yielded the least risk and inflation hedging. Following the stock market, the foreign exchange market, the housing market, gold market, and bond market were in the next ranks.

Conclusion

Making decisions about investment is one of the basic issues in financial and economic domains that has been studied from different angles. One of these issues is inflation hedging. An inflation hedge is an investment that is made for the purpose of protecting the investor against decreased purchasing power of money due to the rising prices of goods and services. The ideal investments for hedging against inflation include those that maintain their value during inflation or that increase in value over a specified period of time. How resources are allocated and the type of investment is elected important. This optimal allocation, especially in the financial markets which drive growth, is key. The two most important elements in investment are risk and return. Investors always seek to increase their return at a certain level of risk or reduce their risk at a certain level of return. Markowitz provided his own model on the portfolio to discuss reducing risk at a certain level of return. Therefore, investors tend to maximize their expected returns and minimize their risk by selecting the optimal integration of financial assets in their portfolio. This study aimed to investigate the potentiality of inflation-protected investments for investors in Iran. Accordingly, the ADF unit root test was first used. Then the optimal interrupt was calculated. Then, the VAR model with an optimal interrupt 3 was calculated. After the VAR model was calculated, instantaneous reaction functions and analysis of variance of the research model variables were performed. Finally, the Markowitz model was employed for optimization. The VAR model demonstrated that the financial markets including the stock market, the foreign exchange market, the housing market, the bonds and the gold market were closely related to each other. The Markowitz model also showed that the bond, stock, gold, currency and housing markets held the highest returns within the study period, respectively. As the results showed, investors are advised to take into account the impacts of such variables in their own decisions. Similarly, economic policymakers should consider the impacts of their decisions in the society when developing monetary policies. Also, strengthening the stock market and developing non-evident investment culture through making medium and long-term profits in this sector could help attract and direct capital to this market, thereby reducing the speculation and investment motives in non-productive sectors which finally drive the economic growth. Considering the country's inflationary environment, on the one hand, and the stagnation in recent years, on the other hand, it is recommended that the central bank develop policies to reduce the liquidity in the country through issuing bonds, pre-selling coins, etc.

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