Examining the Effect of Parallel Market Volatility and Deposit Breakage Rates on Long-Term Bank Deposits with the Aim of Estimating the Optimal Investment Portfolio

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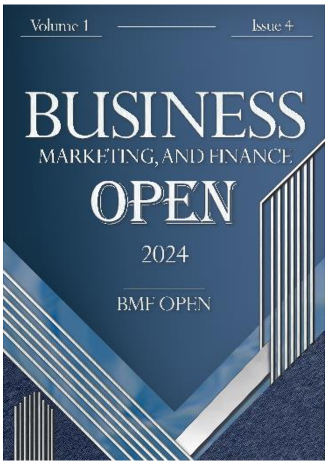

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Abstract: In recent decades, the role of the banking system in channeling financial resources toward productive activities and supporting the economic stability of countries has received increasing attention. One of the most important policy instruments in this regard is the breakage rate of long-term deposits, which reduces the interest payable to depositors when withdrawals occur before maturity. The main objective of this study is to examine the impact of bank deposit breakage rates on investor behavior in Iran, with an emphasis on the influence of parallel financial markets such as foreign exchange, gold, real estate, and the stock market. In this context, quarterly macroeconomic data of Iran for the period 2009 to 2019 were used, and the Conditional Value-at-Risk Vector Autoregressive (CVaR-VAR) model was employed to analyze the relationships among variables. To better understand dynamic interactions, variance decomposition analysis, impulse response functions, and the Granger causality test were applied. The findings indicate that changes in deposit breakage rates have a significant effect on the volume of bank deposits, and investors, when confronted with profitable opportunities in parallel markets, exhibit notable reactions to breakage rates. In addition, the results show that markets such as gold and foreign exchange exert a stronger influence in stimulating the withdrawal of long-term deposits compared with other markets, and their volatility can affect deposit levels. Based on the findings, implementing targeted and dynamic breakage rates—considering economic conditions and investors' risk tolerance—can serve as an effective tool for controlling liquidity and preventing turbulence in parallel markets.

Keywords: deposit breakage rate, investor risk tolerance, long-term deposits, parallel financial markets, CVaR model

1. Introduction

The stability and efficiency of the banking system hinge critically on the behavior of depositors and the resilience of deposit funding in the face of shocks to the real and financial sectors. Bank deposits remain the primary source of funding for both conventional and Islamic banks, shaping their capacity for maturity transformation, credit creation, and liquidity provision [1, 2]. The global financial crises of the past decades have shown that sudden shifts in depositors' expectations, combined with macro-financial instability, can trigger systemic stress and necessitate extraordinary central bank interventions [3-5]. In emerging and bank-based economies, where capital markets are less developed and households rely heavily on deposits as their main savings vehicle, understanding the determinants of deposit dynamics is therefore essential for both monetary policy design and financial stability analysis [2, 6].

A large body of research examines how competition, market structure, and risk-taking incentives shape the stability of deposit funding. Studies on the competition–stability nexus indicate that the relationship between bank competition and systemic risk is nuanced: while competitive pressure can reduce market power and deposit rates, it may also induce riskier portfolios and heighten fragility under stress [7-9]. Evidence from dual banking systems shows that the interplay between competition, diversification, and stability differs between Islamic and conventional banks, with deposit structures and risk-sharing mechanisms altering how shocks are transmitted [10-12]. In small open economies and commodity-dependent countries, systemic risk and fragility indices point to heightened vulnerability of banking systems when macroeconomic volatility and exchange-rate pressures erode depositor confidence [4, 6].

Parallel to the structural perspective, a growing literature documents how depositors react to crises, contagion, and market-wide uncertainty. Bank runs and collective withdrawal behavior can emerge even in the absence of fundamentals-based insolvency, driven instead by coordination problems and expectations about others' actions [3, 13]. Experimental and empirical studies show that line formation, observability of others' choices, and perceptions of institutional safety shape who withdraws first and how quickly liquidity leaves the banking system [13, 14]. During episodes of heightened systemic risk and financial contagion, deposit withdrawals and reallocation of savings into alternative assets, such as cash, foreign currency, or safe securities, become an important channel through which shocks propagate across markets [15-17]. This contagion dynamic is particularly salient in economies where currency, equity, and commodity markets offer easily accessible substitutes to bank deposits [18-20].

Household behavior in the face of liquidity needs, commitment frictions, and early withdrawal penalties has been another central theme in the recent literature. Early withdrawals from long-term savings and retirement accounts during crises illustrate how income shocks and perceived uncertainty erode commitment to illiquid saving arrangements [5, 21]. Field and experimental evidence shows that the design of commitment products and the level and structure of early withdrawal penalties can significantly influence deposit inflows and the durability of savings plans [22-24]. More recent work on "optimal illiquidity" argues that appropriately calibrated penalties and liquidity restrictions can help individuals overcome self-control problems, smooth consumption over time, and protect long-term savings against short-term temptations, while still allowing flexibility under genuine shocks [25, 26]. Evidence from early access to retirement savings further suggests that policy changes that relax illiquidity constraints can generate sizeable withdrawal and spending responses, with implications for long-term wealth accumulation and financial stability [21, 27].

In bank-based systems, depositor behavior is also tightly linked to the relative attractiveness and volatility of parallel financial markets such as foreign exchange, gold, real estate, and equities. Periods of high stock-market volatility and cross-asset spillovers have been shown to alter the portfolio choices of households and institutional investors, motivating rebalancing between deposits and market-based instruments [20, 28, 29]. The dynamic correlation of market connectivity and risk spillovers implies that shocks originating in one market—such as crude oil or global equities—can transmit to domestic stock indices and affect the perceived risk–return trade-off facing depositors [18, 19, 30]. In such an environment, long-term deposits compete not only with short-term alternatives but also with speculative positions in equity and derivative markets, especially when expected returns or valuation ratios suggest favorable entry points [31, 32].

The interaction between deposit markets and equity markets is further underscored by research on diversification, systemic risk, and deposit–loan efficiency. Bank diversification across income streams can reduce or amplify systemic risk, depending on the composition of assets and the correlation structure of returns [10, 33]. Studies that explicitly link stock-market conditions to deposit behavior find that movements in equity returns and volatility affect deposit flows, as households revise their expectations and shift between bank and market investments [34, 35]. Time-zone–based network models and entropy-based contagion analyses show that equity markets are tightly interconnected, implying that domestic depositors may be responding to both local and global signals when reallocating funds across banks and capital markets [19, 36]. In emerging markets, this interaction is often compounded by exchange-rate volatility and currency risk, which shape demand for foreign-currency assets and influence the relative appeal of domestic deposits [20, 37].

From a banking-industry perspective, micro-level characteristics such as ownership structure, market power, and bank-specific fundamentals also play a crucial role in determining deposit volumes and their sensitivity to shocks. Empirical analyses of Chinese and Ghanaian banks show that ownership structure, bank size, and capital adequacy influence the efficiency with which deposits are transformed into loans, and affect the stability of deposit funding [38, 39]. Competition and concentration in the banking industry can modify risk-taking incentives and the extent to which banks rely on aggressive deposit-rate strategies to attract funds [7-9]. In Islamic banking, the demand and supply of deposits are further shaped by profit-sharing contracts, Sharia-compliant instruments, and expectations around fixed versus variable returns, all of which can alter depositors' reaction to macroeconomic and policy shocks [2, 12, 40].

The literature on systemic crises and contagion also highlights the importance of macroprudential perspectives when analyzing deposit behavior. Systemic banking crisis databases and cross-country case studies document the conditions under which liquidity shortages and asset-price collapses propagate across institutions and borders [4, 5]. Research on systemic risk spillovers between oil markets and stock indices, as well as between stock markets and banking deposits, underscores that shocks in global commodity and equity markets can have pronounced effects on domestic financial stability, particularly when regulatory frameworks and safety nets are weak [17, 18, 35]. Experimental and network-based evidence emphasizes that financial contagion operates not only through balance-sheet linkages but also through the wealth effects and behavioral responses of households and firms, including deposit withdrawals and reallocation of savings [14, 16, 29].

In the specific context of Iran, several studies have examined systemic risk, contagion between monetary and financial markets, and the fragility of the banking system, highlighting the importance of deposits as both a stabilizing and potentially destabilizing force [6, 16, 17]. The behavior of legal and corporate bank customers, the introduction of deposit profit taxes, and ongoing debates about fixed-profit payment mechanisms and deposit insurance in Islamic banks all suggest that the institutional design of deposit contracts and policy instruments can substantially alter the volume and composition of deposits [40-42]. In parallel, households and firms are exposed to alternative investment opportunities in foreign currency, gold, real estate, and the stock market; fluctuations in these parallel markets can significantly change the opportunity cost of holding long-term deposits and motivate shifts in portfolio allocation [18, 20, 28].

Against this backdrop, the introduction and calibration of "deposit breakage rates"—that is, penalties applied when depositors withdraw funds before maturity—emerge as a potentially powerful instrument for influencing depositor behavior and mitigating destabilizing flows. Theoretical and empirical work on commitment savings accounts and early withdrawal penalties indicates that the structure of such breakage rates can attract deposits, shape the horizon of savings, and modulate the responsiveness of depositors to shocks in parallel markets [22, 25, 26]. At the same time, experimental evidence on financial contagion, bank runs, and line formation suggests that poorly designed penalties may backfire if they interact with expectations of bank fragility or macroeconomic stress [13, 14, 24]. Consequently, there is a need for integrated frameworks that combine portfolio choice under risk—such as Conditional Value-at-Risk (CVaR) approaches—with behavioral and systemic considerations when evaluating the impact of deposit breakage rates on long-term deposit volumes and the allocation of savings across competing markets [18, 19, 35, 36].

However, there is still limited evidence on how changes in deposit breakage rates interact with volatility and return dynamics in parallel financial markets—such as foreign exchange, gold, and equities—to shape the volume of long-term bank deposits in a bank-based emerging economy. Accordingly, the aim of the present study is to investigate the impact of deposit breakage rates and the volatility of parallel financial markets on long-term bank deposits, using a CVaR-based portfolio framework to estimate the optimal allocation of savings across deposits and alternative assets.

2. Methodology

This study is applied in terms of purpose and analytical–descriptive in terms of methodology within the framework of model utilization. To specify the model accurately, the Conditional Value-at-Risk (CVaR) method and the Option Pricing method (binomial Black–Scholes model) are employed. For calculations related to the CVaR method, the variance–covariance approach is used.

The research model is as follows:

$$SB_t = f(R_t, i_t, Ex_t, Ph_t, Ps_t, Pg_t)$$

In this model, SB_t is the growth rate of long-term bank deposits, R_t is the bank interest rate, i_t is the inflation rate, Ex_t is the exchange rate, Ph_t is the housing price index, Ps_t is stock market returns, and Pg_t is gold market returns.

Research Data and Information

The statistical information used in this study consists of time-series data. Time-series data are observations collected over a specific time interval. Such data may be gathered daily, weekly, monthly, annually, or at any interval required by the researcher. In this study, the required data were collected on a quarterly basis. These data consist of:

- Rate of return of the total index of the stock exchange
- Growth rate of land and housing prices
- Growth rate of the free-market dollar price
- Growth rate of the price of the full Bahar Azadi gold coin
- Growth rate of long-term bank deposits (entered into the CVaR model as the dependent variable)

All quarterly data were extracted from the beginning of the second quarter of **2009** to the end of the third quarter of **2019**.

In the research method, in the first stage, using the Conditional Value-at-Risk (CVaR) method, the optimal portfolio consisting of the five aforementioned assets is selected based on return and risk. In the second stage, after applying a 10% shock to the rate of return on long-term deposits as the breakage rate, the second portfolio is selected. Likewise, shocks of 15%, 20%, and 25% are applied, and in each stage, an optimal portfolio is selected. After completing these stages, the effect of these changes in the breakage rate on deposit volume is estimated.

Subsequently, in a separate model, the effect of other variables on the growth of long-term bank deposit volume is examined using the vector autoregression approach.

Statistical Tests and Methods Used in the Study

CVaR Method

In recent years, a percentile-based risk measurement criterion known as Conditional Value-at-Risk has been developed due to its attractive computational properties. This criterion measures the expected loss when the loss exceeds the specified VaR. For example, CVaR with a 99% confidence level and a 10-day holding period represents the average amount expected to be lost over a 10-day period, assuming that the worst-case scenario occurs with a one-percent probability. This criterion was proposed by Artzner et al. (1999) to address the shortcomings and weaknesses of the Value-at-Risk method. This model and criterion, also known as Expected Shortfall or tail variance, successfully incorporate all the properties that posed limitations in VaR (Artzner et al., 1999). This criterion is defined along with VaR as illustrated in the figure below:

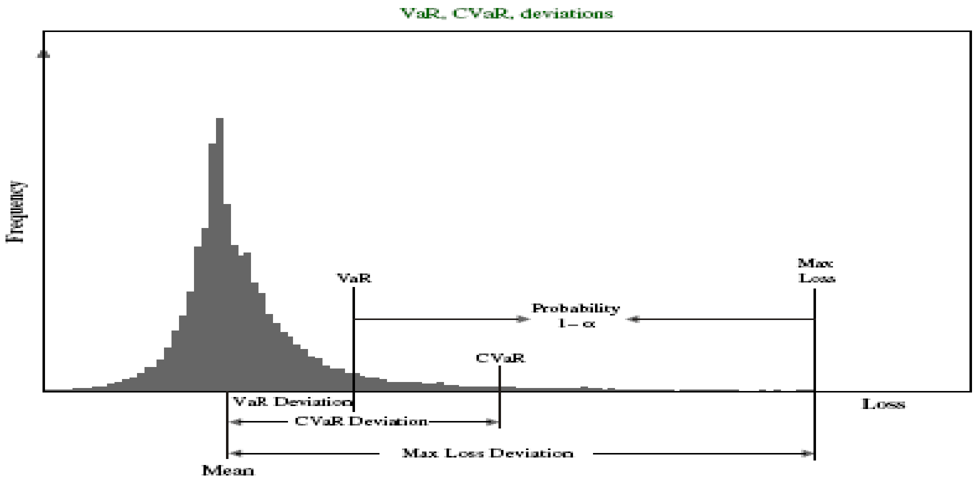

Figure 1. Conditional Value-at-Risk (CVaR)

As clearly shown in this figure, CVaR represents the mean of losses that are greater than and exceed the Value-at-Risk threshold (Yamai & Yoshiba, 2002). Methods for calculating Conditional Value-at-Risk include the variance–covariance method, historical simulation, and Monte Carlo simulation. In this study, the first method is used; therefore, it is explained below.

Variance–Covariance Method for Calculating CVaR

Conditional Value-at-Risk for short-term periods can be calculated using the following equation:

$$CVaR = \frac{e^{-\frac{Z_\alpha^2}{2}}}{\alpha\sqrt{2\pi}}\delta_p - \bar{r}_p$$

For long-term periods, the following formula is used:

$$CVaR = \frac{e^{-\frac{Z_\alpha^2}{2}}}{\alpha\sqrt{2\pi}}\delta_p - \mu w_i$$

In this case, $\mu \neq 0$is considered.

According to this criterion, the probability that the loss exceeds the conditional value-at-risk in a T-day period is α% (Yamai et al., 2002). If the return distribution is normal, we can write:

$$\min\,(CVaR_\alpha)[-f(x,\zeta)] \Leftrightarrow \min\; k_1(\alpha)\sigma(\alpha) - R$$

Or more simply (as used in this study):

$$\text{Min } Z = \frac{e^{-\frac{Z_{\alpha}^{2}}{2}}}{\alpha\sqrt{2\pi}}\delta_p - \bar{r}_p$$

Subject to:

$$\bar{r}_p = \sum_{j=1}^{M} x_j \bar{r}_j$$

$$\sum_{j=1}^{M} x_j = 1, x_j \geq 0$$

Characteristics of Conditional Value-at-Risk

The Conditional Value-at-Risk criterion possesses the properties of a coherent measure (Burka, 2005) and is therefore considered a desirable risk metric (Kourwieser & Schranner, 2005). A coherent measure has the following characteristics:

a) Monotonicity

If $X \in V, X \geq 0 \Rightarrow \rho(X) \leq 0$

b) Sub-additivity

If $X, Y, X + Y \in V \Rightarrow \rho(X + Y) \leq \rho(X) + \rho(Y)$

c) Positive homogeneity

If $X \in V, h \geq 0, hX \in V \Rightarrow \rho(hX) = h\rho(X)$

d) Translation invariance

If $X \in V, a \in \mathbb{R} \Rightarrow \rho(X + a) = \rho(X) - a$

Optimal Model Selection in the CVaR Approach

The approach used in this study for calculating Conditional Value-at-Risk does not impose any assumption on the distribution of asset returns. In other words, CVaR is estimated using the empirical distribution of returns rather than a theoretical distribution. CVaR can be computed by minimizing a more tractable function without the need to determine the VaR beforehand. Additionally, because this approach does not require calculation of the variance–covariance matrix, it does not encounter computational difficulties when dealing with high-dimensional problems. The method is as follows:

$$\min\{a + \frac{1}{1-\alpha}\sum_{j=1}^{n} Z_j\}$$

Subject to:

$$Z_j \geq f(x, y) - a, Z_j \geq 0$$

$$E(R_p) = \sum_{i=1}^{n} E(R_i)$$

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

Cointegrated Vector Autoregression Method (C-VAR)

The C-VAR (cointegrated VAR) model belongs to the family of unrestricted VAR models. The null hypothesis in this model is the absence of cointegration. The main objective of the C-VAR technique is to pool the data to examine long-term relationships while simultaneously allowing short-term fixed and random effects among variables to be analyzed. For this purpose, the following system is considered:

$$y_{it} = \alpha_{it} + X_{it}\beta + \varepsilon_{it}$$
$$x_{it} = \sigma x_{it-1} + \varepsilon_{it}$$

The general form of the equation for estimating the parameters is:

$$\hat{\beta}_{FM} - \beta = [\sum_{i=1}^{N} \hat{\Omega}_{i22}^{-2} \sum_{t=1}^{T} (x_{it} - \bar{X})]^{-1} \sum_{i=1}^{N} \hat{\Omega}_{i11}^{-1}\hat{\Omega}_{i22}^{-1}[\sum_{t=1}^{T} (x_{it} - \bar{x})\varepsilon_{it}^{*} - T\hat{Y}_{it}]$$

Where:

$$\varepsilon_{it}^{*} = \hat{\Omega}_{i22}^{-1}\hat{\Omega}_{i21}^{-1}$$
$$\gamma_{it} = \hat{\tau}_{i21}\hat{\Omega}_{i21}^{0} - \hat{\Omega}_{i22}^{-1}\hat{\Omega}_{i21}(\tau_{i22} + \hat{\Omega}_{i22}^{0})$$

Implicitly, the variance–covariance matrix can be expressed in two parts as:

$$\Omega_i = \Omega_i^0 + \tau_i$$

where $\tau_i$is the weighted sum of variances and $\Omega_i^0$is the contemporaneous variance. Both groups of statistics are based on the null hypothesis of no cointegration; therefore, $\sigma_i = 1$for all values of i, which is the cointegration coefficient on the residuals estimated from the cointegration equation under different assumptions.

3. Findings and Results

In order to plot the efficient frontier, both portfolio optimization models are implemented in MATLAB for different levels of expected return. The output of both models is the set of optimal portfolio combinations from the perspective of the relevant risk criterion. Given the portfolio weights, the expected return matrix of each portfolio and its expected risk are calculated as follows:

$$R_p = W \times ExpReturn$$

where $R_p$represents the matrix of expected returns, $W$is the vector of asset weights in the portfolio, and $ExpReturn$is the matrix of expected returns of the assets in the portfolio. In the following charts, the Mean–CVaR efficient frontier is presented for five different breakage-rate scenarios at a 95% confidence level. It should be noted that in these charts the horizontal axis represents the value of CVaR and the vertical axis represents the expected portfolio return.

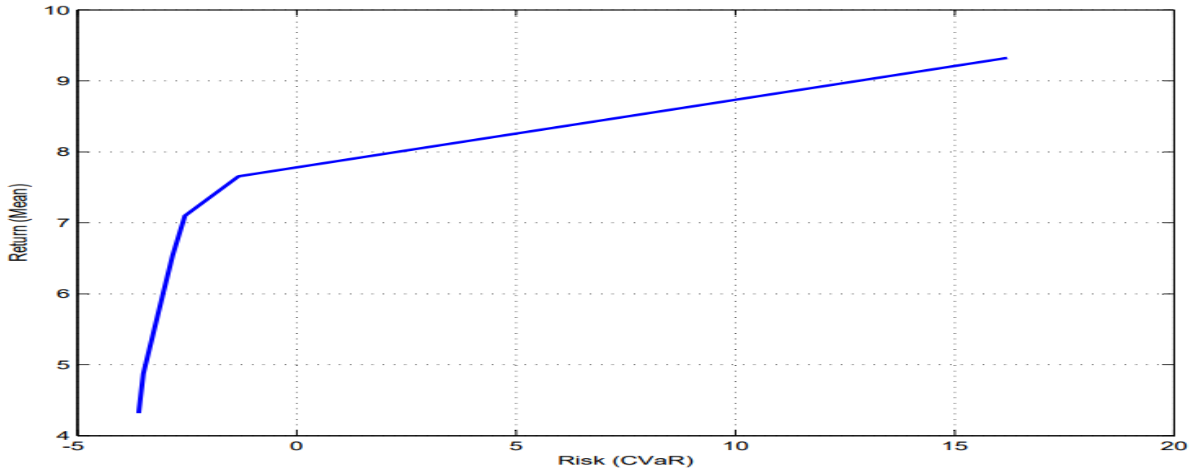

Figure 2. CVaR Efficient Frontier without Breakage Rate

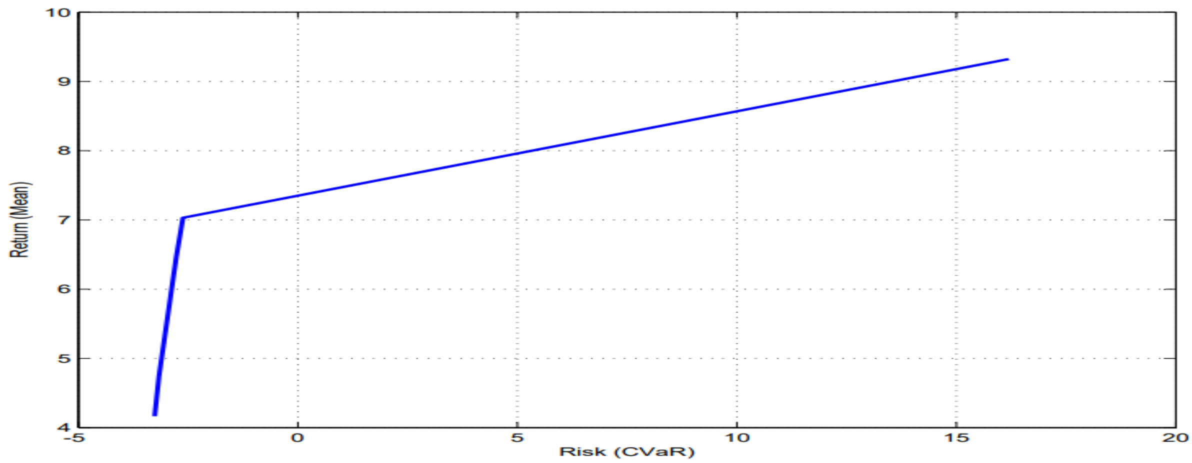

Figure 3. CVaR Efficient Frontier with a Breakage Rate Equal to 10 Percent of the Deposit Interest Rate

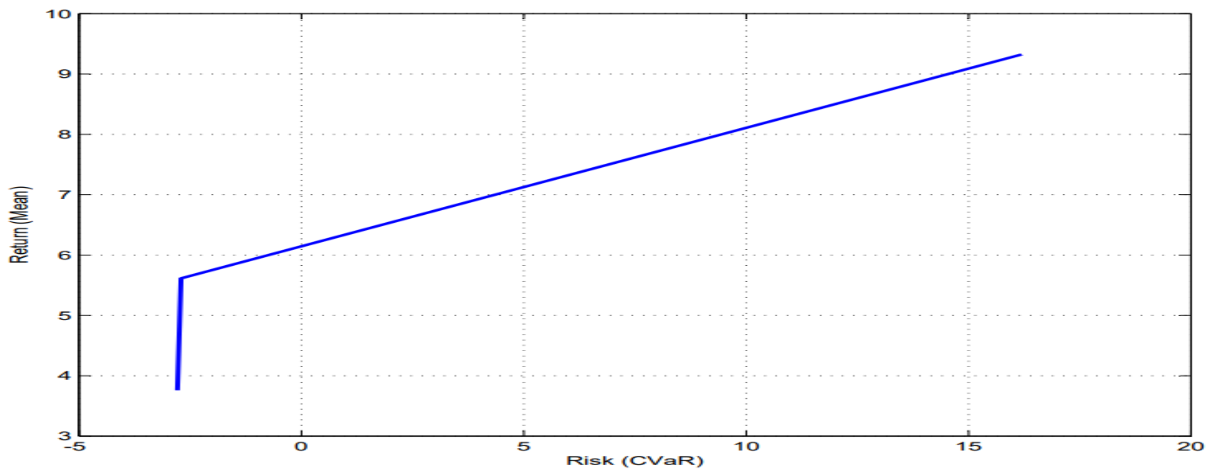

Figure 4. CVaR Efficient Frontier with a Breakage Rate Equal to 15 Percent of the Deposit Interest Rate

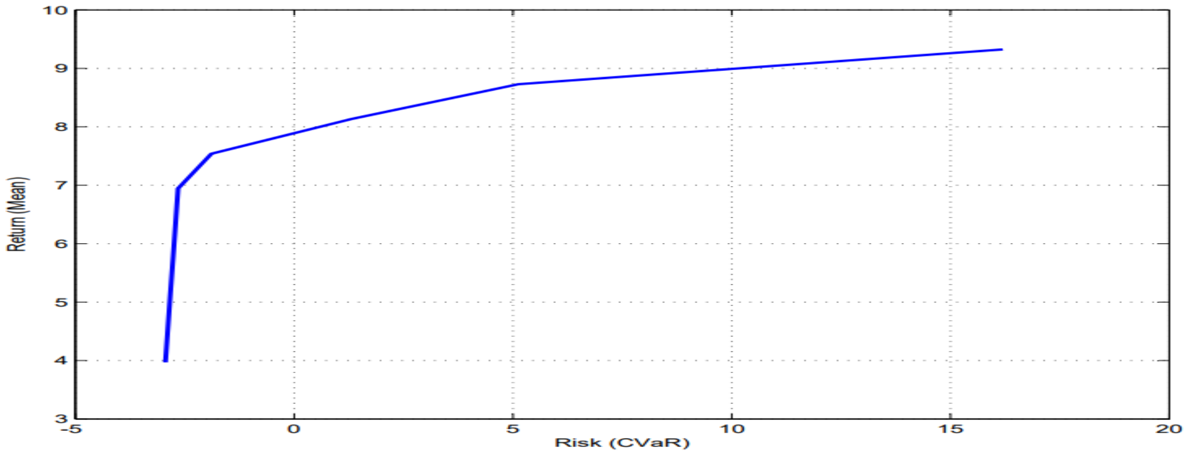

Figure 5. CVaR Efficient Frontier with a Breakage Rate Equal to 20 Percent of the Deposit Interest Rate

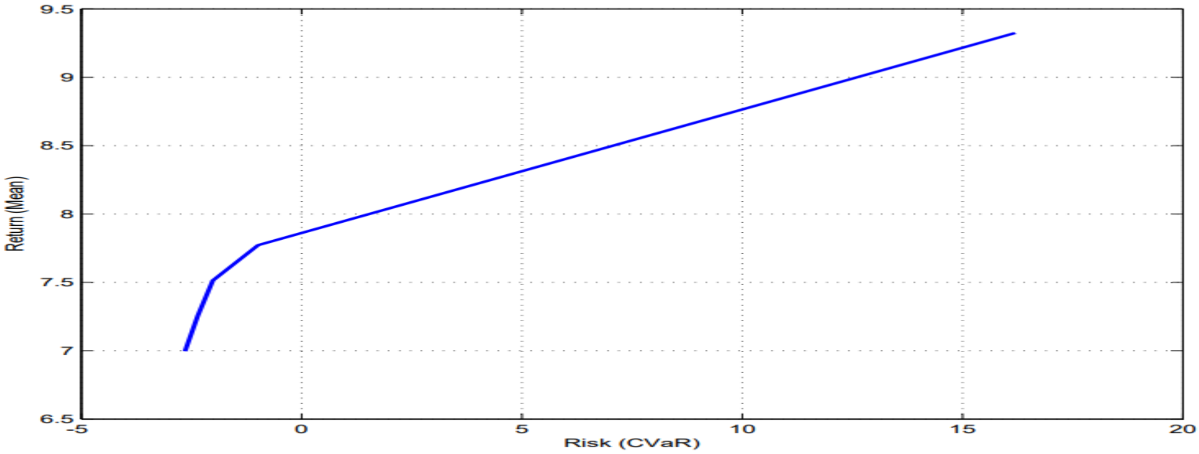

Figure 6. CVaR Efficient Frontier with a Breakage Rate Equal to 25 Percent of the Deposit Interest Rate

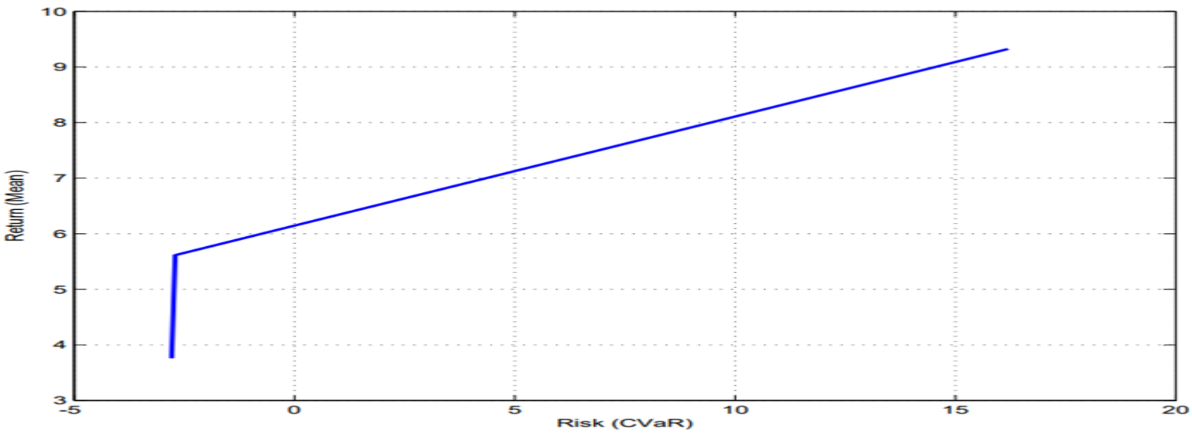

Figure 7. CVaR Efficient Frontier with a Breakage Rate Equal to 30 Percent of the Deposit Interest Rate

What is clear from these charts is as follows:

1. In the graphical representation of return versus risk, the optimal portfolios, for identical levels of return or identical levels of risk (CVaR), lie in the upper-left part of the graph, and points below the minimum-variance point do not belong to the efficient frontier. Here, the points located on the curve constitute the efficient frontier, representing all the portfolios that an investor can choose to obtain the highest possible return for a given level of risk.

2. If an investor seeks to achieve a higher return, then by accepting a higher level of CVaR (i.e., by increasing their risk tolerance), which in fact indicates the degree of riskiness of the portfolio, the investor reduces diversification across the stocks in the portfolio in order to reach the desired level of return, and tilts the portfolio toward stocks with higher expected returns. In this situation, as the return of the selected portfolio increases, the corresponding risk also increases.

In the following, given different levels of risk tolerance among individuals, the optimal level of the breakage rate of time deposits is examined. The results of this analysis are reported in the table below.

Table 1. Share of Deposits in Investors' Portfolios at Different Breakage-Rate Levels for Bank Deposits

Scenario	Low Risk	Medium Risk	High Risk
Without Breakage Rate	95%	57%	37%
Breakage Rate = 10% of Deposit Interest	88%	53%	36%
Breakage Rate = 15% of Deposit Interest	85%	52%	36%
Breakage Rate = 20% of Deposit Interest	84%	51%	34%
Breakage Rate = 25% of Deposit Interest	84%	36%	36%
Breakage Rate = 30% of Deposit Interest	0%	0%	0%

As can be seen in the above table, if no breakage rate is defined for time (long-term) deposits, low-risk individuals allocate 95 percent of their investment portfolio to these deposits, while medium-risk and high-risk individuals allocate 57 percent and 36 percent, respectively. Now, if the breakage rate is equal to 10 percent of the total deposit interest, in this case low-risk, medium-risk, and high-risk individuals allocate 88, 53, and 36 percent of their capital, respectively, to deposits, and compared to the previous case, they reduce the volume of their investment in long-term deposits. Subsequently, increasing the breakage rate up to 25 percent of the deposit interest leads to a reduction in the share of long-term deposits in individuals' investment portfolios. After the imposition of a 30 percent breakage rate, individuals with different risk profiles no longer include any deposits in their asset portfolios.

Before conducting any further tests, the stationarity or non-stationarity of the variables is examined. For this purpose, in this section the Augmented Dickey–Fuller (ADF) unit root test is employed. The results of this test are reported in the table below.

Table 2. Results of the ADF Unit Root Test

Variables	t-statistic	Probability	Result
Growth rate of deposits	-7.18	0.000	Stationary at level
Return on exchange rate	-5.09	0.000	Stationary at level
Return on Bahar Azadi gold coin	-3.52	0.000	Stationary at level
Deposit interest rate	-0.25	0.581	Non-stationary at level
Return on stock price index	-1.14	0.22	Non-stationary at level

Here, the null hypothesis of the test is based on non-stationarity. As can be seen, for the variables growth rate of deposits, return on the exchange rate, and return on the Bahar Azadi gold coin, the null hypothesis is rejected at the 5 percent level, and it can be concluded that these variables are stationary at level. For the variables deposit interest rate and return on the stock index, since the null hypothesis is not rejected, these variables are non-stationary at level. Therefore, in the following, stationarity in the first difference of the variables is investigated.

Table 3. Results of the ADF Unit Root Test for Non-Stationary Variables at Level

Variables	t-statistic	Significance Level	Result
Deposit interest rate	-3.61	0.000	Stationary
Return on stock price index	-8.02	0.000	Stationary

In the above table, which examines stationarity in the first difference of the variables, it is observed that after taking the first difference of the two non-stationary variables in the previous table, these variables become stationary. Therefore, these two variables are of the I(1) type. Given that all variables in the study are either I(0) or I(1) and that there is no I(2) variable among them, econometric models for these variables yield optimal results and no substantial information is lost. Accordingly, the C-VAR model can be used for these variables.

In the model introduced in this study, the growth of deposit volume is specified as a function of the deposit interest rate, stock price growth rate, exchange rate growth, and gold coin price growth. Before estimating this specified equation using the C-VAR framework, as in the standard VAR approach, it is necessary to determine the optimal lag length. For this purpose, the Akaike Information Criterion (AIC), the Schwarz Bayesian Criterion (SBC/BIC), the Hannan–Quinn criterion (HQ), and the likelihood ratio (LR) test and final prediction error (FPE) test are used. The results of each of these criteria are shown in the table below.

Table 4. Examining the Optimal Lag Length of the Research Model

Lag Order	Likelihood Ratio	Final Prediction Error	Akaike	Schwarz	Hannan–Quinn
Lag 0	–	52,077,226	31.95	32.17	32.03
Lag 1	*111.51	*5,591,902	29.71	*31.07	*30.17
Lag 2	28.04	7,942,444	29.98	32.37	30.83
Lag 3	30.40	8,916,640	29.88	33.37	31.11
Lag 4	23.77	12,335,383	29.75	34.32	31.36
Lag 5	25.13	12,359,446	*28.81	34.48	30.81

*An asterisk indicates the optimal lag length according to each criterion.

Based on the results of these tests, the Schwarz Bayesian criterion, the Hannan–Quinn criterion, and the likelihood ratio and final prediction error tests all suggest an optimal lag length of 1, whereas the Akaike criterion suggests an optimal lag length of 5. Since the VAR model tends to include more parameters and avoid the loss of information, and considering the available number of observations for estimation as well as the diagnostic tests conducted on the residuals, a lag length of 1 is chosen as the optimal lag in this model.

Given that some variables of the model are stationary in their first differences, the Johansen–Juselius cointegration test is used to determine the cointegration vectors. Based on the selection of one optimal lag for the model, the number of cointegration vectors and the cointegration rank—or the number of long-run equilibrium relationships—is determined using the trace statistic and the maximum eigenvalue statistic. It should be noted that Johansen and Juselius state that if there is a contradiction between the results of the two tests in determining the number of cointegration vectors, the maximum eigenvalue test is preferred, since its alternative hypothesis is more restrictive.

Table 5. Results of the Trace Test

Null Hypothesis	Alternative Hypothesis	Test Statistic	Probability
$r = 0$	$r = 1$	97.17	0.0001
$r \leq 1$	$r = 2$	48.07	0.0477
$r \leq 2$	$r = 3$	22.29	0.2823
$r \leq 3$	$r = 4$	12.14	0.1503
$r \leq 4$	$r = 5$	3.56	0.0589

Based on the results of the trace test, at the 5% and 10% significance levels, the existence of two cointegration vectors among the model variables in the long run is confirmed.

Table 6. Results of the Maximum Eigenvalue Test

Null Hypothesis	Alternative Hypothesis	Test Statistic	Significance Level
r = 0	r = 1	49.09	0.0004
r ≤ 1	r = 2	25.77	0.0836
r ≤ 2	r = 3	10.15	0.7299
r ≤ 3	r = 4	8.57	0.3234
r ≤ 4	r = 5	3.56	0.0589

Based on the results of the maximum eigenvalue test, at the 10% significance level, the existence of two cointegration vectors among the model variables in the long run is confirmed. Moreover, given the presence of two cointegration vectors indicating long-run relationships, there is no need to include I(1) variables in differenced form, and all variables can be entered into the model at level.

After estimating the vector autoregression model with the optimal lag and conducting the cointegration test, impulse response functions and forecast error variance decomposition are analyzed. To forecast the impact of each asset's return share on deposit-volume changes over time, the impulse response functions are studied. These functions apply a shock to one variable while keeping the others constant and allow the researcher to observe the extent to which each variable responds to the shock. Accordingly, the nature, magnitude, and short-run or long-run effects of the shock can be interpreted.

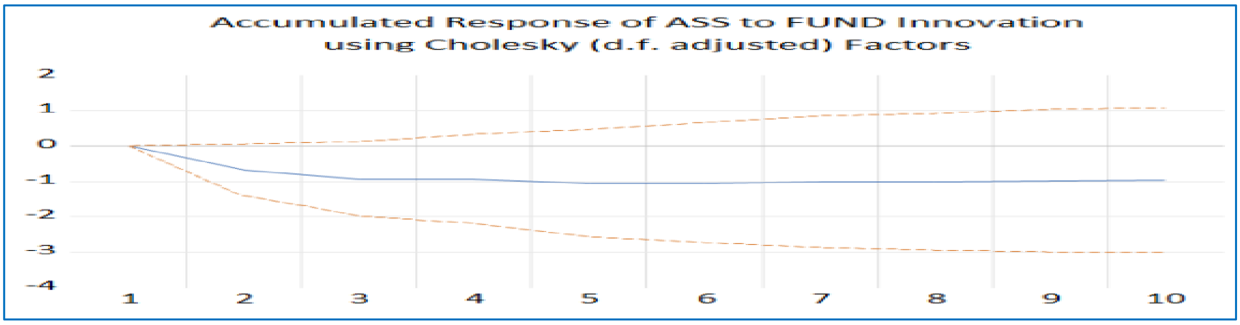

Figure 8. Results of a Negative Shock to the Interest Rate on Long-Term Bank Deposit Volume

As can be observed, a negative shock to the interest rate decreases the volume of bank deposits for up to three periods, and after that—from the third period onward—stabilizes at a constant trend. However, it never returns to its initial level. Thus, a negative shock to the interest rate results in a one-percent decline in deposit volume over three years and stabilizes thereafter, indicating the persistence of this shock's effect on deposit volume.

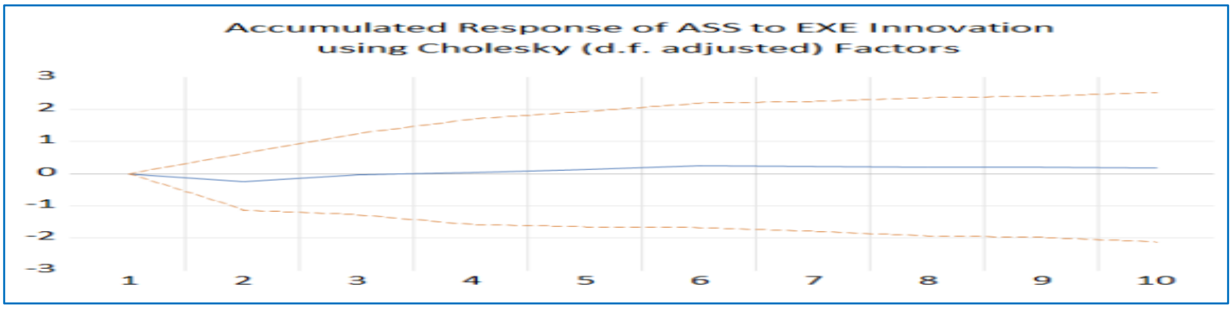

Figure 9. Results of a Positive Shock to the Exchange Rate on the Rate of Return of Long-Term Bank Deposits

Based on the above graph, a positive shock to the exchange rate slightly reduces the volume of deposits for up to two periods, but in the third period this decline is reversed, and ultimately the deposit volume exceeds its initial level. From the fourth period onward, the system reaches a positive equilibrium trend.

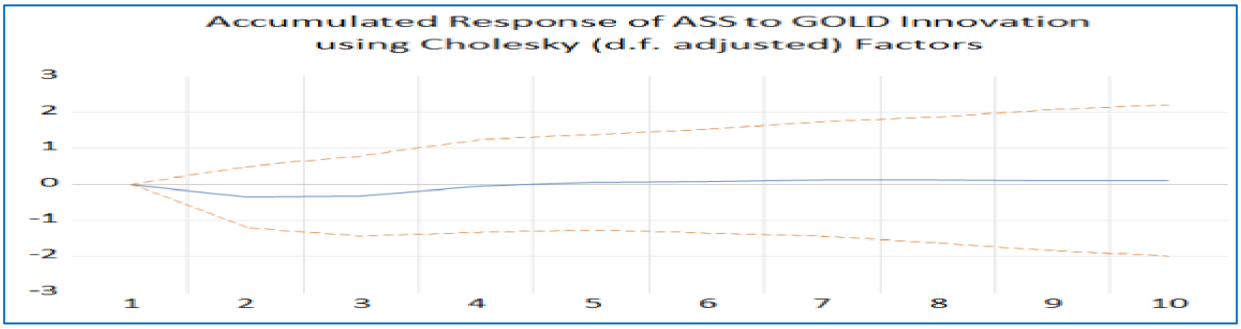

Figure 10. Results of a Positive Shock to the Gold-Coin Price Growth Rate on the Return of Long-Term Bank Deposits

In the above graph, it is observed that a positive shock to the gold-coin price reduces investment in long-term deposits for approximately four periods, but in the long run, the effect becomes positive (although small), and the shock does not dissipate completely.

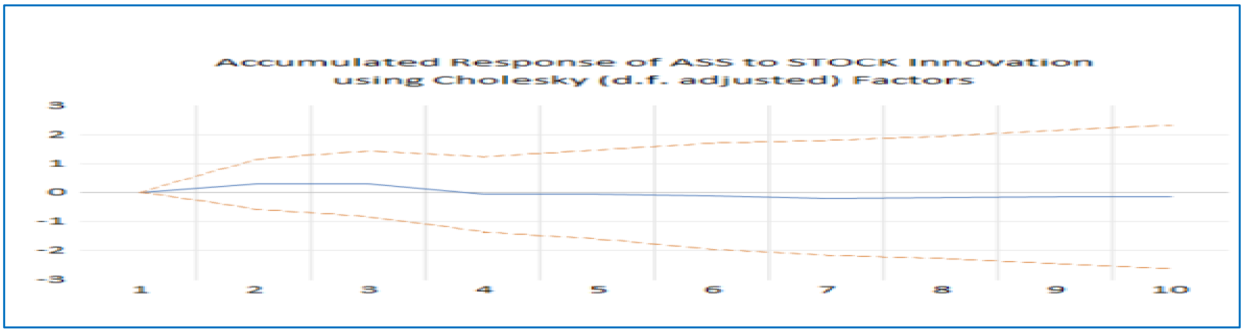

Figure 11. Results of a Positive Shock to Stock-Market Returns on the Return of Long-Term Bank Deposits

The above graph shows that a positive shock to stock-market returns has a completely opposite effect compared to shocks in gold and exchange-rate returns. Here, applying a shock to stock-market returns increases deposit volume in the initial period, but in the long run, the cumulative effect of this shock on deposit volume becomes negative.

At this stage, given that the existence of cointegration vectors is confirmed, the long-run relationship among the model variables must be estimated, and the normalized vector must be selected relative to the first endogenous variable. In selecting the long-run vector, it is necessary that the normalized vector with respect to the first endogenous variable has coefficient signs consistent with economic theory and that the coefficients are statistically significant. The optimal vector selected in this study is as follows:

$$ASS_t = -0.01EXE_t + 1.21FUND_t - 0.01GOLD_t - 0.04STOCK_t$$

where ASS represents the growth rate of long-term deposit volume in the banking sector, EXE is the exchange-rate growth (U.S. dollar), FUND is the bank deposit interest rate, GOLD is the gold-coin price growth rate, and STOCK is the stock-market return. Because of strong multicollinearity between the housing price index and the exchange rate, and between housing prices and gold returns, one of these variables had to be removed in order to obtain unbiased estimates; therefore, the housing market variable was excluded from the model. This vector can be regarded as representing a long-run financial relationship. The vector is normalized on deposit volume so that it reflects the long-run equilibrium relationship between deposit volume and returns in various financial markets. The interest rate has a positive and significant effect on deposit volume, indicating that higher interest rates increase the growth rate of long-term bank deposits. Regarding other variables—stock-market return, exchange-rate return, and gold-coin return—the results show that in the long run, their effects on deposit volume are negative. As returns in these markets rise, the volume of bank deposits declines.

Table 7. Software Output for Cointegration Vectors

Variable Type	Variable	Coefficient	Probability
Dependent	ASS	–	–
Independent	EXE	-0.0131	0.0173
	FUND	1.2118	0.0947
	GOLD	-0.0171	0.0243
	STOCK	-0.0417	0.0258

Given the results in the above table, it is clear that all variables included in the model have significant and interpretable long-run effects at the 10% level on the growth rate of long-term bank deposits. This indicates that the effects of these variables on long-term deposit volume persist not only in the short run but also in the long run. This finding is also consistent with the impulse response analysis.

4. Discussion and Conclusion

The purpose of this study was to examine how changes in deposit breakage rates and volatility in parallel financial markets—specifically foreign exchange, gold, and equities—affect long-term bank deposits, using a CVaR-based portfolio optimization model integrated with econometric analyses of cointegration, impulse responses, and variance decomposition. The results across multiple analytical layers provide consistent evidence that depositors in Iran respond sensitively to breakage-rate adjustments, and that their reactions are amplified or dampened depending on conditions in competing financial markets. Taken together, the findings confirm the behavioral, structural, and systemic dimensions of depositor decision-making documented in previous global and Iranian studies, while also contributing empirical evidence on an underexamined instrument—deposit breakage rates—as an important policy lever.

The first major finding relates to the role of deposit breakage rates in shaping portfolio allocation. The CVaR efficiency frontiers indicate that as breakage rates increase, the share of long-term deposits in an optimal portfolio declines noticeably, especially among low-risk depositors. This is consistent with experimental and field evidence showing that penalty structures and commitment frictions meaningfully influence savings behavior [22-24]. The finding aligns with the theory of “optimal illiquidity,” which posits that while moderate penalties can incentivize long-term saving by supporting self-control, excessively high penalties deter participation altogether [25, 26]. In this study, depositors eliminated long-term deposits completely when the breakage rate reached 30%, suggesting the existence of a behavioral threshold beyond which commitments are viewed as unattractive or punitive. Similar behavioral discontinuities were observed in retirement and savings-access reforms, where liquidity shocks triggered strong withdrawal responses [21, 27].

The second significant finding concerns the strong negative effect of alternative market returns—particularly exchange-rate and gold-price movements—on deposit volumes. The impulse response functions showed that positive shocks in foreign exchange and gold prices depress bank deposit growth in the short run, while long-run cointegration results confirm a persistent negative effect. These results are well aligned with the literature documenting cross-market contagion, the wealth effect, and volatility spillovers across asset classes [14, 17, 29]. In contexts where currency depreciation is perceived as likely or asset price inflation is rapid, households tend to reallocate savings toward assets that hedge against macroeconomic instability [20, 28]. Prior evidence from energy and equity markets also supports the idea that rising global or sectoral volatility shifts investors toward speculative or inflation-protective assets and away from liquid banking instruments [18, 19]. In Iran's case, where exchange-rate movements carry significant informational content about inflation expectations, capital controls, and macroeconomic uncertainty, such reallocation patterns are even more pronounced.

The behavior documented in this study is consistent with research showing that deposit outflows often originate not only from liquidity needs but also from comparative asset evaluation in highly volatile environments. Households and firms systematically adjust their portfolios in response to market cycles and valuation ratios, as observed in empirical finance studies on stock return predictability and valuation metrics [30-32]. Similarly, cross-asset network studies emphasize that rising global and regional volatility spills over into domestic stock and commodity markets, encouraging a shift from deposits into assets perceived as offering higher or more stable returns [19, 36]. These alignment patterns reinforce the finding that Iranian depositors behave similarly to global investors in responding to expected returns and risk spillovers.

A third important finding is that shocks to the interest rate—represented here through the breakage-rate mechanism—produce persistent rather than temporary effects on deposit volume. A negative shock to the interest rate leads to a three-period decline in deposit growth, after which the level stabilizes but does not return to its initial value. This persistence mirrors findings in research on banking crises and systemic liquidity shortages, where even temporary rate adjustments or shocks have long-lasting effects on depositor trust and liquidity preferences [3, 4]. The durability of interest-rate effects in deposit markets is also consistent with behavioral studies demonstrating that initial negative experiences with savings products—such as high penalties or loss scenarios—can permanently alter saving trajectories and participation rates [22, 23]. These patterns underscore the sensitivity of depositors to both policy design and market conditions.

A fourth major insight emerges from the cointegration results. The long-run equilibrium relationship demonstrates that interest rates have a positive, statistically significant effect on long-term deposits, whereas exchange-rate growth, gold-price growth, and stock returns have significant negative long-term effects. These results reinforce previous evidence from both developed and emerging markets. For example, studies on Asian and GCC banking systems similarly highlight that deposit flows are sensitive to competition across asset markets and to macroeconomic shocks [8, 9, 11, 43]. Furthermore, research on diversification and systemic risk shows that households assess the relative risk-adjusted performance of banking versus non-banking investment opportunities when reallocating funds [10, 33]. The results also align with studies on the sensitivity of deposits to ownership structure and bank fundamentals, suggesting that deposits are not only passive funding sources but active components of household portfolio decisions [38, 39].

Iran-specific studies have similarly demonstrated that systemic risk spillovers between currency, stock, and money markets can significantly alter deposit flows [16, 17]. Furthermore, research on monetary–financial contagion shows that speculative pressures in parallel markets can accelerate deposit withdrawals even without changes in bank fundamentals [6, 42]. The present findings substantiate these concerns by quantifying how volatility and returns in parallel markets interact with policy instruments such as breakage rates to shape portfolio choices.

Finally, the results of the CVaR portfolio analysis illustrate that breakage rates act not only as behavioral constraints but also as financial parameters influencing optimal portfolio construction. Under lower breakage rates, long-term deposits constitute a high share of the optimal portfolio for low-risk individuals, consistent with studies documenting the attractiveness of deposit instruments for conservative investors in uncertain environments [2, 12]. However, at higher breakage rates, deposits lose their comparative appeal. These patterns mirror the global literature on commitment savings and illiquidity structures: depositors are willing to tolerate moderate illiquidity but respond adversely to excessive penalties or perceived unfairness [25, 26]. The disappearance of deposits in the optimal portfolio at a 30% penalty illustrates the practical boundaries of commitment-based policy tools.

Overall, the findings of this study confirm and extend the existing body of literature on depositor behavior, market competition, risk spillovers, financial contagion, and commitment products. They show that deposit breakage rates significantly influence long-term deposit volumes and amplify depositor sensitivity to volatility in parallel markets. The patterns also highlight the need for calibrated policy interventions that balance stability objectives with the behavioral realities of depositor decision-making.

This study has several limitations that should be acknowledged. First, the analysis relies on quarterly macroeconomic and market-level data, which may obscure short-term behavioral fluctuations or intra-quarter episodes of stress. Second, while the CVaR model captures risk under tail conditions, it does not fully incorporate potential structural breaks, regulatory changes, or extreme events that could alter depositor behavior abruptly. Third, the econometric framework focuses on linear long-run relationships, which may not capture nonlinear behavioral dynamics such as threshold effects, panic-driven withdrawals, or herding during crises. Fourth, institutional factors such as deposit insurance credibility, bank reputation, and political risk were not explicitly modeled despite their importance for depositor confidence. Finally, the absence of high-frequency behavioral data on individual households or firms limits the ability to analyze heterogeneity in depositor preferences.

Future studies could extend this work by incorporating micro-level data on household saving behavior, allowing for richer modeling of heterogeneity in risk tolerance and deposit sensitivity. Additional research could explore nonlinear or regime-switching econometric models to capture crisis-specific dynamics or behavioral thresholds in withdrawal patterns. Investigating the interaction between deposit breakage rates and digital banking adoption would also be valuable, as fintech platforms may alter how savers respond to penalties and return differentials. Comparative studies between Iran and other emerging markets could help identify structural versus country-specific drivers of depositor behavior. Finally, incorporating measures of trust, financial literacy, and institutional quality would deepen the understanding of how depositor expectations interact with policy design.

Policymakers should consider calibrating deposit breakage rates carefully to avoid discouraging long-term saving while still promoting financial discipline. Banks may benefit from designing deposit products with flexible yet predictable penalty structures that support commitment without imposing excessive costs on depositors. Regulators should monitor volatility in parallel markets closely, as rapid shifts in exchange rates or gold prices can trigger deposit outflows even in otherwise stable conditions. Clear communication about deposit safety, insurance mechanisms, and long-term profitability can help maintain depositor confidence, particularly during periods of macroeconomic uncertainty. Banks can also diversify their product offerings to compete more effectively with alternative assets, thereby stabilizing deposit funding over time.

Authors' Contributions

Authors equally contributed to this article.

Ethical Considerations

All procedures performed in this study were under the ethical standards.

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Conflict of Interest

The authors report no conflict of interest.

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