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# Stability of the Correlation Between Book and Market Value at Risk as a Measure of Banks' Information Transparency

**Hossein Abdoh Tabrizi**

Visiting Prof., Faculty of Management and Accounting, Sharif University of Technology, Tehran, Iran. (Email: abdoh@gsme.sharif.edu)

**Reza Tehrani**

Prof., Department of Financial engineering, Faculty of Accounting and Financial Sciences, College of Management, University of Tehran, Tehran, Iran. (Email: rtehrani@ut.ac.ir)

**Ali Baghani ***

*Corresponding Author, Assistant Prof., Department of Accounting and Finance, South Tehran Branch, Islamic Azad University, Tehran, Iran. (Email: ali.baghani.58@gmail.com)



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## Abstract

One of the main demands of investors (depositors and shareholders) of banks is transparency. However, in addition to the requirements for meeting this demand, measuring how to meet it has become challenging. So far, researchers have proposed different qualitative criteria for transparency. In this study, while introducing the correlation coefficient between book and market value at risk (VaRs) as a criterion of transparency, we seek to examine the stability of this criterion in different economic conditions. For this purpose, first, by using the e-garch model, the value at risk was estimated based on the balance sheet (book) information and also the market information of the banks' shares, then by calculating the correlation coefficients between book and market VaR's under normal conditions, we predict book and market VaR's using vector auto-regressive (VAR) models, along with defining three stress scenarios (Mild - Severe - hyper stress). We examined the significance of the difference between the calculated correlation coefficients in the three stress test modes. We thus tested the stability of the correlation coefficient of the defined scenarios. The findings showed that except for the correlation caused by the unemployment rate factor in mild and hyper-stress scenarios, in other cases, no evidence of H0 rejection was found, indicating the stability of the correlation coefficient between book and market VaRs as a measure of transparency.

**Keywords:** Information Transparency, Value at Risk (VaR), Vector Auto-Regressive Model (VAR), Correlation Coefficient, Stress Test

## Introduction

Banks, vital economic pillars, face the paramount challenge of risk management, particularly in the growing landscape of private banks (Rostamian and Haji Babaei, 2018). The pivotal role of banks in guiding a country's economy necessitates robust transparency for their health and stability. Financial transparency reduces transaction costs and enhances economic relations, with a crucial focus on transparency within the banking sector.

The transparency of financial information, a perpetual concern for investors and depositors, holds particular significance in banking, an inherently risk-laden sector. Public perception of a single bank can swiftly reverberate throughout the banking and economic system, underscoring the need for public trust, crisis prevention, and effective bank supervision. In today's world, information is the linchpin for societal development. Reliable, useful information is indispensable for informed decision-making on both micro and

macro scales (Haiderzadeh Henzaei et al., 2020). The transparency of financial information and risk measurement in banks is a focal point in financial literature, wielding substantial influence on public trust in a country's banking system.

Annual reports of companies reveal varying quality in disclosed information, reflecting management philosophies and discretion in disclosure for investment purposes (Kurdistan et al., 2011). Numerous approaches exist for measuring transparency, each examining different facets of the issue. The challenge lies in determining the transparency measure's adequacy and stability.

Existing models predominantly score and rank banks based on their adherence to Basel II's third pillar disclosure requirements. Value at Risk (VaR), a risk measure based on distribution parameters, is widely adopted for quantifying potential losses. Its simplicity in summarizing potential losses over a specific time horizon has made it popular in portfolio optimization and risk measurement since the early 1990s.

**Measuring Bank Transparency: A Multi-Faceted Approach**

The transparency of banks in information provision can be assessed through four key measures:

Interpreting Transparency through Stock Price Dynamics: This entails gauging transparency based on the speed of internal financial information transfer to stock prices.

Quantifying Maximum Expected Loss: Measurement involves determining market Value at Risk (VaR) based on stock prices and book VaR of net assets derived from the balance sheet.

Evaluating Mutual Relationships between VaRs: The correlation coefficient between market and book VaR indicates the mutual relationship between the two.

Quantitative Transparency Measure: A quantitative measure of transparency is derived from the provided information, contributing to an overall assessment of the country's banking system.

This study's central assumption is that share prices are more influenced by internal information rooted in a company's performance.

Traditionally, assessing the quality and transparency of financial information involved connecting elements of the income statement and cash

flow statement with stock market returns. While preparing balance sheets poses challenges, advancements in web-based accounting and online reporting are expected to ease accessibility.

This research explores the possibility of explaining transparency in bank share prices based on the relationship between VaRs (utilizing book and market information). It seeks to determine if the transparency of bank information can be judged based on risk criteria (VaR) in various conditions.

The critical focus is on the adequacy and capability of the correlation coefficient between book and market VaRs as a transparency interpretation criterion. Researchers investigate whether the values of this criterion significantly differ under diverse conditions. To achieve this, book and market VaRs are estimated under different economic scenarios using Vector Auto-Regression (VAR) models and the Gauss-Sidel problem-solving algorithm. Subsequently, the equality of correlation coefficients obtained in different scenarios is tested.

## Literature Review

Financial information transparency significantly influences investment decisions, offering benefits such as a lower cost of capital (Diamond & Vershea, 2001), reduced agency costs (Leftwich et al., 1981), improved stock prices (Gelb & Zarowin, 2002), and an increase in firm value. Adequate disclosure aids investors and creditors' inefficient capital utilization.

Public disclosure of banks' financial performance aligns with national rights, emphasizing the government's duty to raise public awareness (Iranian Constitution, Article 3). Iranian law underscores public access to information, emphasizing its use within legal bounds.

People's right to know banks' performance is vital, as deposits entrusted to banks legally belong to depositors, requiring transparent use in authorized banking operations. Bank transparency arises from the interaction of disclosure and incentives, posing empirical challenges. Financial accounting information is a powerful entry point for investigating bank transparency and economic consequences (Bushman, 2016).

Opacity and complexity impact governance, influencing the board-management and bank-regulator relationships. Boards' effective representation of shareholders hinges on understanding the bank's inner workings (Mehran et al., 2011). Banks must navigate strategic challenges, balancing shareholder demands with public interests.

Market discipline, whether aiming for value maximization, stability, or innovation, can govern banks effectively (Mehran & Mollineaux, 2012). Financial transparency is a longstanding concern, and it aids in risk assessment, market discipline, and capital adequacy (Arjamandanjad, 2007).

In recent years, companies' financial information transparency has gained significance. Low transparency raises information risk premiums, complicating investor decision-making (Tehrani et al., 2014). Managers' tendency to mask weak performance fosters a lack of transparency (Fendersky et al., 2017).

Besides market discipline, transparency alleviates panic and risk for depositors and short-term lenders by reducing uncertainty. However, opinions differ on its impact; it may lead to inefficient bank operations due to coordination failure or inefficient investment decisions upon disclosure (Morris & Shin, 2002; Morrison & White, 2013).

Dong et al. (2014) explore the tension between positive and negative transparency effects, indicating that intermediate transparency levels are optimal. Increased transparency boosts adequate liquidity and heightens risk, prompting banks to take more risk. The compensatory effect suggests that optimal transparency levels exist, as decreased transparency increases information risk and expected investor returns (Moreno & Takalo, 2016).

## Previous Studies

Mohammadi et al. (2023) Investigate the link between banks' income transparency and economic policy uncertainty Using discretionary loan loss provisioning (DLLP) as a measure of bank income opacity, revealing a negative and significant relationship. During increased economic uncertainty, banks enhance income transparency to build trust and project a positive outlook.

Chen et al. (2022) Analyze a large sample of US banks from 1994-2019 Using critical accounting performance (accounting disclosures) as a measure of transparency, finding that transparent banks experience more sensitive uninsured depositor reactions to performance changes. This sensitivity impacts deposit rates, reliance on internal funds, and profitability, indicating a cost of bank transparency.

Shokoh et al. (2022) Defines transparency as the release of timely and reliable information (qualitative measures), revealing that improved banking system transparency reduces information gaps and enhances competition, leading to increased profitability.

Jin et al. (2021) Explore the negative relationship between financial literacy and bank earnings management Using absolute discretionary loan loss provisioning (ADLLP) as a measure of bank greater accounting discretion and lower transparency, demonstrating that financially literate depositors influence transparency, particularly in stable funding and fewer delinquencies.

Madanizadeh et al. (2020) Evaluate the impact of a supervisory transparency shock (as a severe transparency rule imposed by the central bank of the Islamic Republic of Iran after any banking scandal) on the lending channel, finding a significant adverse effect on involved banks' loans and off-balance sheet activities. Non-involved banks experience increased deposits and lending, affirming the role of supervision.

Chitsazan et al. (2019) Develop dimensions and components of information transparency in banks for evaluating and ranking Iranian banks' disclosure and transparency levels (qualitative measures). The model comprises 11 dimensions for assessment.

Ko et al. (2019) Investigate the impact of risk disclosure in financial reporting on investment efficiency (qualitative measures), concluding that risk disclosure improves the transparency of company information, positively affecting investment efficiency.

Valipour Pasha and Ahmadian (2019) The bank ownership type influences the relationship between equity returns and transparency (qualitative measures), with private banks being more transparent. Return on equity and the ratio of non-interest income to total income positively impact transparency.

Ghasemi and Sarlak (2018) Examine the financial crisis's impact on conservative accounting and transparency (earning transparency, which is calculated by dividing the profit before unrealized items, minus operating on net profit) of banks in Iran, revealing that the crisis influences transparency and emphasizes stakeholder interests.

Zopounidis et al. (2017) Compare Islamic and non-Islamic banks during the global crisis, measuring stability, transparency (qualitative measures), and competitiveness. Results suggest differences in financial reporting stability and competitiveness among the banks.

Bushman (2016) Highlights the influence of accounting policy choices on bank stability, revealing that capital adequacy concerns and high financing frictions can increase fragility (review research). Bank opacity supports regulatory forbearance and may lead to risk-shifting behavior.

Song (2015) Investigates the effects of firms' accounting disclosure policies on stock price synchronicity and crash risk, revealing that firms with superior accounting disclosure policies experience lower stock price synchronicity and crash risk.

### Research Questions and Hypotheses

Considering the primary research problem—whether the correlation coefficient of book and market VaRs, serving as a transparency measure, exhibits necessary stability—the research poses the following question: Are the correlation coefficients of book and market VaRs significantly different across various stress test scenarios reflecting other economic factors?

Aligned with the research problem, the formulated hypothesis is as follows: In diverse economic conditions, specifically stress test factors, the correlation coefficients of book and market VaRs within different scenarios demonstrate significant differences.

## Research Methodology

This research falls under the applied research category, aiming to enhance and refine methods, tools, and knowledge derived from primary research. Specifically, the study seeks to explore the meaningful relationship between VaRs using book and market data as indicators of information transparency.

The EGARCH model is employed to calculate VaR based on the extreme value (EV) distribution. Pearson's correlation coefficient between book and market VaRs is utilized to assess the significance of the relationship and rank banks in terms of information transparency.

Identifying variables influencing stock prices and balance sheet information, scenarios reflecting changes in economic conditions are developed. Using the VAR model and the Gauss-Sidel algorithm, VaRs are estimated under diverse economic conditions.

These calculated VaRs are the foundation for determining correlation coefficients in different conditions. To assess the adequacy and stability of the transparency criterion, the significance of differences in correlation coefficients is estimated using Student's t-test.

The study employs monthly data from Parsian, Saman, Sina, Pasargad, and Eghtesad-e-Novin (EN) banks, representing Iranian private banks listed on the Tehran Stock Exchange from March 2014 to March 2022 (Solar Hijri 1393-

1400). The correlation between book and market VaRs is assessed based on this data.

Using a simultaneous equations system and considering shocks in mild, severe, and hyper stress scenarios, the dependence structure of book and market VaRs with exogenous variables is explained. This framework simulates book and market VaRs for the 12 months spanning March 2022 to March 2023, facilitating scientific inferences on the correlation between book and market VaRs in diverse conditions.

Research Variables: In this study, the research variables are summarized in Table 1:

**Table 1. Summary of research variables**

| Name | Type | Abbreviation |
|---|---|---|
| Bank i's debts for period t | Independent | $debts_{it}$ |
| Bank i's deposits for period t | Independent | $deposits_{it}$ |
| Bank i's current assets for period t | Independent | $current\_assets_{it}$ |
| Bank i's long-term assets for period t | Independent | $Fixed\_assets_{it}$ |
| Bank i's stock price for period t | Independent | $stock_{it}$ |
| Bank i's market VaR for period t | Dependent | VaR-stock $_{it}$ |
| Bank i's book VaR for period t | Dependent | VaR-Balance $_{it}$ |

**Source: Research Findings**

Value at Risk (VaR): VaR is a risk assessment method that measures the maximum expected loss within a given time horizon at a specific confidence level. For example, a bank might state that its daily VaR for the trading portfolio is $35 million at a 99% confidence level. This means that in about 1 out of 100 daily trades, losses exceeding $35 million may occur. VaR concisely summarizes the bank's market risk exposure, quantifying it in dollars.

Calculating VaR encounters difficulties despite its simple and comprehensible concept. VaR calculation involves finding the critical value for a desired probability level α. However, VaR calculation faces challenges due to the non-constant nature of the probability distribution of returns over time. Various methods have been proposed to calculate VaR. In this study, we employ the EGARCH (exponential generalized autoregressive conditional heteroscedasticity) model on the EV (extreme value) distribution to compute VaR.

Generalized Autoregressive Conditional Heterogeneity Model (GARCH): The ARCH (autoregressive conditional heteroscedasticity) model, introduced by Robert Engle in 1982, and its generalization, the GARCH (generalized

autoregressive conditional heteroscedasticity) model, proposed by Tim Bollerslev, one of Engle's notable students, in 1986, capture time-varying uncertainty. These models enable researchers to capture and calculate conditional heteroscedasticity as it changes over time.

ht is defined as equation 1

$$h_t = \alpha_0 + \sum_{j=1}^{q} \alpha_1 \varepsilon_{t-j}^2 \quad (1)$$

which is shown as ARCH(q). Bollerslev (1986) extended the determination of the conditional heteroscedasticity by inserting the discrete values of ht in the right side of the above equation. Bollerslev stated ht as follows:

$$h_t = \alpha_0 + \sum_{j=1}^{q} \alpha_{1j} \varepsilon_{t-j}^2 + \sum_{j=1}^{p} \alpha_{2j} h_{t-j} \quad (2)$$

For the GARCH model to be determined and in order to satisfy the stationarity condition, the equation = $\sum_{j=1}^{q} \alpha_{1j} + \sum_{j=1}^{p} \alpha_{2j}$ must be less than one and all $\alpha_{1j}$ $\alpha_{2j}$ and must have the condition of being non-negative (Nelson, 1991).

Exponential generalized autoregressive conditional heteroscedasticity (EGARCH) model: One of the primary restrictions of GARCH models is that they enforce a symmetric response of volatility to positive and negative shocks. This arises since the conditional variance in equations such as (Eq.2) is a function of the magnitudes of the lagged residuals and not their signs (in other words, by squaring the lagged error in (Eq.2), the sign is lost). However, it has been argued that a negative shock to financial time series will likely cause volatility to rise more than a positive shock of the same magnitude (Brooks, 2008). Pp130

GARCH models, such as the EGARCH model, were developed to address the symmetric effects of positive and negative shocks. These models allow for the consideration of asymmetrical effects of shocks, such as the impact of increasing and decreasing stock returns or oil prices on an economy. The recognition is that there is no inherent reason for the effects of these shocks to be symmetrical. Hence, GARCH models, including the EGARCH model, incorporate asymmetry to capture the differential impact of positive and negative shocks. For the first time, Nelson (1991) defined the EGarch model as equation 3

$$\ln\left(\delta_t^2\right)=\alpha_0+\sum_{i=1}^{p}\alpha_i\left|\frac{\varepsilon_{t-1}}{\delta_{t-i}}\right|+\sum_{j=1}^{q}\beta_j\ln\left(\delta_{t-j}^2\right)+\sum_{i=1}^{p}\gamma_t\left[\frac{\varepsilon_{t-i}}{\delta_{t-i}}\right] \quad (3)$$

The model has several advantages over the pure GARCH specification. First, since log ($\delta_t^2$) is modelled, it will be positive even if the parameters are negative $\delta_t^2$. Thus, there is no need to artificially impose nonnegativity constraints on the model parameters. Second, asymmetries are allowed under the EGARCH formulation (Brooks, 2008). Pp130

Calculate VaR using Extreme Value Theory: In this section, we demonstrate the calculation of VaR using the traditional approach based on extreme value (EV) theory. This method uses maximum likelihood estimation to estimate the three parameters of the generalized extreme value (GEV) distribution. Subsequently, VaR is determined based on the estimated parameters.

Suppose we have a sample of T returns from an asset. We divide this sample into a g subsample consisting of n members. If $T \neq n\,g$ so, then we will consider making the final subsample smaller. Then, we determine the maximum of each sub-sample and use the resulting set of maximums as a sample to estimate the parameters ($\alpha_n$ , $\beta_n$ , $\xi_n$) using the maximum likelihood method. By considering $X=(r-\beta_n)/\alpha_n$ and placing it in the GEV distribution function, the quantile of this distribution is obtained at the desired confidence level. Suppose that $P^*$ is the probable error value and $r_n^*\,(1-P^*)$ the maximum subsample's quantile under the GEV distribution. By inserting X in the GEV distribution function, we have:

$$1-P^*=\begin{cases}\exp\left(-\left[1+\dfrac{\xi_n(r_n^*-\beta_n)}{\alpha_n}\right]^{\frac{-1}{\xi_n}}\right) & , \quad \xi\neq 0\\ \exp\left(-\exp\left(-\dfrac{r_n^*-\beta_n}{\alpha_n}\right)\right) & , \quad \xi=0\end{cases} \quad (4)$$

Note that if $1+\xi_n(r_{n,i}-\beta_n)/\alpha_n>0$ , $\xi\neq 0$, then by Taking the logarithm of the above relationship, we have:

$$ln(1-P^*)=\begin{cases}-\left[1+\dfrac{\xi_n(r_n^*-\beta_n)}{\alpha_n}\right]^{\frac{-1}{\xi_n}} & , \quad \xi\neq 0\\ -\exp\left(-\dfrac{r_n^*-\beta_n}{\alpha_n}\right)) & , \quad \xi=0\end{cases} \tag{5}$$

which, after simplifying, $r_n^*$ is obtained as follows:

$$r_n^*=\begin{cases}\beta_n-\dfrac{\alpha_n}{\xi_n}\left\{1-\left[-ln(1-P^*\right]^{-\xi_n}\right\} & , \quad \xi\neq 0\\ \beta_n-\alpha_n\, ln\left[-ln(1-P^*\right] & , \quad \xi=0\end{cases} \tag{6}$$

$r_n^*$ The above equation is the VaR of the maximum subsample at the $(1-p^*)$ percent confidence level. The VaR of the logarithmic return $(r_t)$ of the financial asset at the $(1-p^*)$ percent confidence level is calculated as follows:

$$VaR=\begin{cases}\beta_n-\dfrac{\alpha_n}{\xi_n}\left\{1-\left[-n\, ln\,(1-P^*\right]^{-\xi_n}\right\} & , \quad \xi\neq 0\\ \beta_n-\alpha_n\, ln\left[-n\, ln\,(1-P^*\right] & , \quad \xi=0\end{cases} \tag{7}$$

Vector autoregression (VAR): Sims introduced the VAR (Vector Autoregression) approach in the 1980s as an alternative to macroeconomic models. VAR models are based on empirical relationships between data and are considered a reduced form of a system of simultaneous equations. Each endogenous variable in the system is estimated based on the lagged values of other variables in the system (Noferesti, Mohammad, 1999).

In VAR models, there is no requirement to specify short-term structural relationships or have prior knowledge of causal relationships between the variables. This makes VAR models particularly useful when detailed information about the underlying processes or determinants of the variables is lacking. In this approach, the researcher's theory and previous knowledge are primarily used to determine the variables included in the model. The mathematical representation of a VAR system is as follows:

$$y_t = A_1 y_{t-1} + ... + A_p y_{t-p} + u_t \qquad u_t \approx N(o,\Sigma) \tag{8}$$

where yt and its intervals and ut are k×1 vectors and Ati's (i=1,...,p) is the k×k matrix of model coefficients. Ut is a vector of residual terms that may be simultaneously correlated but are uncorrelated with their interval values and variables on the right side of the equation.

Significance test of correlation coefficient difference: This test examines whether there is a significant difference in the correlation coefficients between two samples from the same population. The test requires the satisfaction of the following three conditions:

Variables x and y have normal distribution

The variance of variable y is independent of x

The relationship between x and y is linear

Assuming that n2 and n1 are the volumes of the first and second samples and r2 and r1 are the correlation coefficients in the two samples, First, $r'_i$ should be calculated according to the correlation coefficient of two samples and using Fisher's correction as follows:

$$r'_i = \frac{1}{2}\ln\left(\frac{1+r_i}{1-r_i}\right) \qquad i = 1 \tag{9}$$

It should be noted that r1 and r2 are calculated based on two independent samples, and it is assumed that $\rho_1 = \rho_2$. Then, the z test statistic is defined as follows:

$$Z = \frac{r'_1 - r'_2}{s} \ , \sim N(0,1) \tag{10}$$

In which

$$s = \sqrt{\frac{1}{n_1 - 3} + \frac{1}{n_2 - 3}} \tag{11}$$

The significance of the relationship between the correlation coefficients is determined by comparing the calculated test statistic with the critical value from the standard normal distribution table. At the five percent error level, the critical value is 1.96.

## Results

The descriptive statistics of the research data are presented in Table 2. The skewness and kurtosis analyses revealed that none of the examined time series followed a normal distribution. Consequently, we applied data normalization and standardization in this study before conducting further analyses.

**Table 2. Descriptive Statistics**

| Bank's name | Series name | Average | Midian | Min | Max | St-d | Skewness | Kurtosis |
|---|---|---|---|---|---|---|---|---|
| Eghtesad-e- Novin | current_assets | 70,464 | 63,516 | 17,213 | 140,938 | 31,521 | 0.268 | 0.894- |
| | Fixed_assets | 362,257 | 338,826 | 115,936 | 1,417,754 | 237,137 | 2.571 | 7.848 |
| | Deposits | 343,008 | 331,250 | 112,611 | 1,358,213 | 205,802 | 2.646 | 9.665 |
| | Debts | 71,932 | 65,938 | 15,500 | 245,483 | 46,398 | 1.605 | 3.439 |
| | Stock | 2,822 | 2,414 | 1,097 | 9,347 | 1,264 | 1.658 | 5.22 |
| Parsian | current_assets | 163,845 | 131,666 | 36,315 | 394,600 | 101,340 | 0.864 | 0.401- |
| | Fixed_assets | 689,548 | 607,166 | 242,891 | 1,925,285 | 387,368 | 0.892 | 0.261 |
| | Deposits | 636,688 | 580,188 | 238,649 | 1,553,187 | 314,986 | 0.805 | 0.123- |
| | Debts | 180,742 | 119,785 | 20,553 | 654,762 | 151,813 | 0.822 | 0.173- |
| | Stock | 2,305 | 2,161 | 926 | 5,943 | 1,162 | 0.93 | 0.528 |
| Pasargad | current_assets | 153,250 | 116,445 | 42,125 | 442,754 | 107,066 | 1.317 | 0.652 |
| | Fixed_assets | 588,561 | 483,118 | 151,753 | 2,111,060 | 424,469 | 1.256 | 1.291 |
| | Deposits | 562,983 | 453,987 | 147,030 | 1,812,463 | 385,573 | 1.199 | 0.808 |
| | Debts | 109,003 | 63,786 | 5,003 | 472,556 | 114,652 | 1.171 | 0.607 |
| | Stock | 2,537 | 1,603 | 999 | 13,970 | 2,933 | 2.751 | 6.361 |
| Saman | current_assets | 78,936 | 65,988 | 13,484 | 198,578 | 50,553 | 0.941 | 0.073- |
| | Fixed_assets | 263,042 | 281,129 | 75,224 | 695,561 | 145,007 | 0.343 | 0.616- |
| | Deposits | 254,925 | 232,033 | 72,101 | 705,496 | 146,146 | 1.098 | 0.941 |
| | Debts | 74,375 | 48,518 | 6,329 | 227,906 | 71,067 | 0.699 | 1.128- |
| | Stock | 2,558 | 1,202 | 607 | 23,642 | 3,782 | 3.196 | 10.947 |
| Sina | current_assets | 35,057 | 34,439 | 5,420 | 79,879 | 15,530 | 0.47 | 0.905 |
| | Fixed_assets | 135,211 | 137,022 | 50,334 | 267,423 | 54,248 | 0.492 | 0.103- |
| | Deposits | 141,508 | 140,679 | 41,079 | 328,738 | 63,426 | 0.683 | 0.408 |
| | Debts | 16,109 | 13,113 | 5,839 | 38,375 | 8,203 | 1.188 | 0.642 |
| | Stock | 2,666 | 1,609 | 915 | 20,880 | 3,102 | 3.54 | 13.745 |

**Source: Research findings**

Additionally, we performed the Augmented Dickey-Fuller test statistic to assess the stationarity of the selected banks' return time series. The results, presented in Tables 3 and 4, indicate that for all-time series, the test statistic values exceed the critical value at all three confidence levels, and the p-values for each series are below 5%. Therefore, based on the obtained p-values, we accept the assumption of stationarity for the series.

**Table 3. Unit Root Test Results (Augmented Dickey-Fuller)**

| Bank's name | Series name | Augmented Dickey-Fuller | | |
|---|---|---|---|---|
| | | Sstatistics | P-value | Result |
| Eghtesad-e-Novin | Debts | 9.92831- | 0.0000 | stationar |
| | Deposits | 5.95437- | 0.0000 | stationar |
| | current_assets | 8.19789- | 0.0000 | stationar |
| | Fixed_assets | 4.42483- | 0.0000 | stationar |
| | Stock | 10.55145- | 0.0000 | stationar |
| Parsian | Debts | 11.82215- | 0.0000 | stationar |
| | Deposits | 9.14511- | 0.0000 | stationar |
| | current_assets | 11.39818- | 0.0000 | stationar |
| | Fixed_assets | 9.29569- | 0.0000 | stationar |
| | Stock | 14.44647- | 0.0000 | stationar |
| Pasargad | Debts | 12.82446- | 0.0000 | stationar |
| | Deposits | 9.17130- | 0.0000 | stationar |
| | current_assets | 9.45476- | 0.0000 | stationar |
| | Fixed_assets | 9.13474- | 0.0000 | stationar |
| | Stock | 5.76047- | 0.0000 | stationar |
| Saman | Debts | 0.18888- | 0.0000 | stationar |
| | Deposits | 10.87031- | 0.0000 | stationar |
| | current_assets | 9.67242- | 0.0000 | stationar |
| | Fixed_assets | 8.55899- | 0.0000 | stationar |
| | Stock | 10.02846- | 0.0000 | stationar |
| Sina | Debts | 11.87872- | 0.0000 | stationar |
| | Deposits | 12.90418- | 0.0000 | stationar |
| | current_assets | 5.28822- | 0.0000 | stationar |
| | Fixed_assets | 10.76520- | 0.0000 | stationar |
| | Stock | 11.81348- | 0.0000 | stationar |

**Source: Research findings**

**Table 4. Critical values of the Augmented Dickey-Fuller test**

| critical value at the 1% prob | critical value at the 5% prob | critical value at the 10% prob |
|---|---|---|
| -2.567299 | -2.862449 | -3.432666 |

**Source: Research findings**

This study calculated VaRs using the EV distribution and the EGARCH model. To examine the presence of autocorrelation in the residual terms of the EGARCH model, the Breusch-Pagan (LM) Lagrange multiplier test was employed.

**Table 5. Breusch-Pagan Lagrange multiplier (LM) test**

| ARCH test | | VaR_Balance | | VaR-Stock | |
|---|---|---|---|---|---|
| | | F-statistic | Obs*R-squared | F-statistic | Obs*R-squared |
| Eghtesad-e- Novin | Sstatistics | 13.6620 | 12.2979 | 36.9825 | 33.8856 |
| | Prob. | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Parsian | Sstatistics | 15.6732 | 13.3697 | 33.0322 | 31.3522 |
| | Prob. | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Pasargad | Sstatistics | 15.3682 | 15.3682 | 28.1287 | 26.0826 |
| | Prob. | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Saman | Sstatistics | 12.6943 | 11.7690 | 29.8942 | 27.0721 |
| | Prob. | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Sina | Sstatistics | 13.9740 | 12.7631 | 24.3679 | 29.3731 |
| | Prob. | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

**Source: Research findings**

Table 5 shows that the probability value is less than 5%, indicating the presence of heteroscedasticity effects in the model residuals. Figures 1 to 5 present the VaRs based on each bank's balance sheet data and market data.

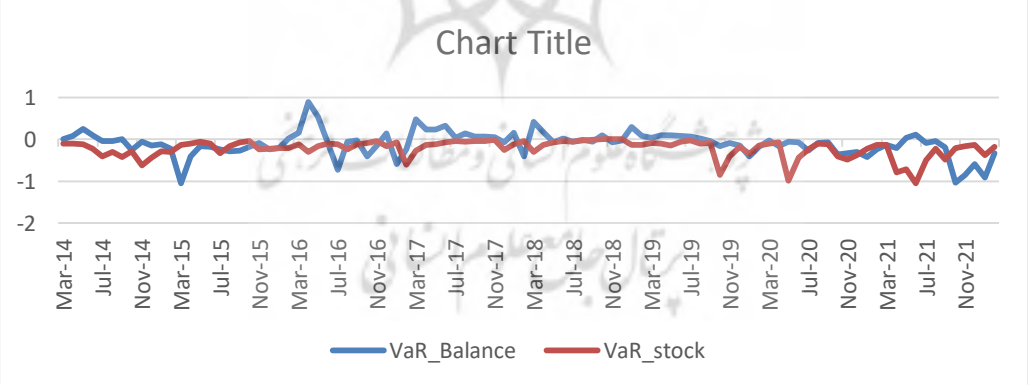


**Figure 1. book and market VaRs of Eghtesad-e- Novin Bank**

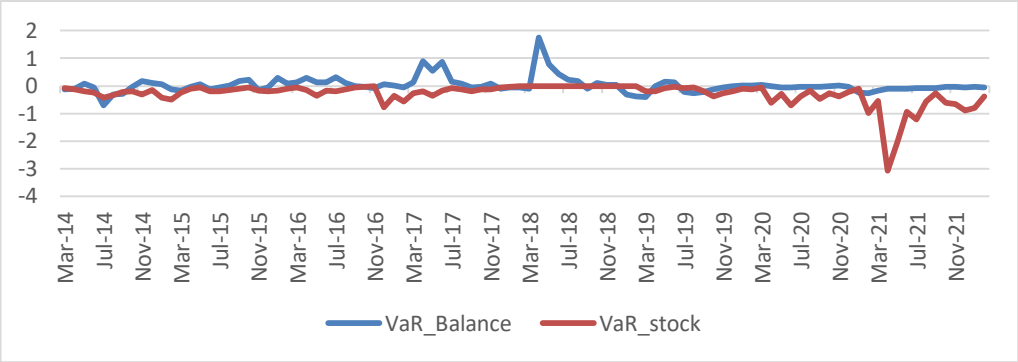


**Figure 2. book and market VaRs of Parsian Bank**

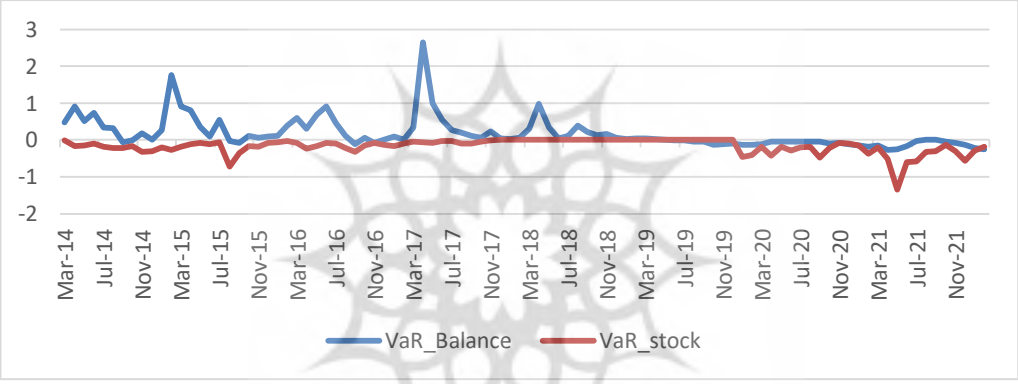


**Figure 3. book and market VaRs of Pasargad Bank**

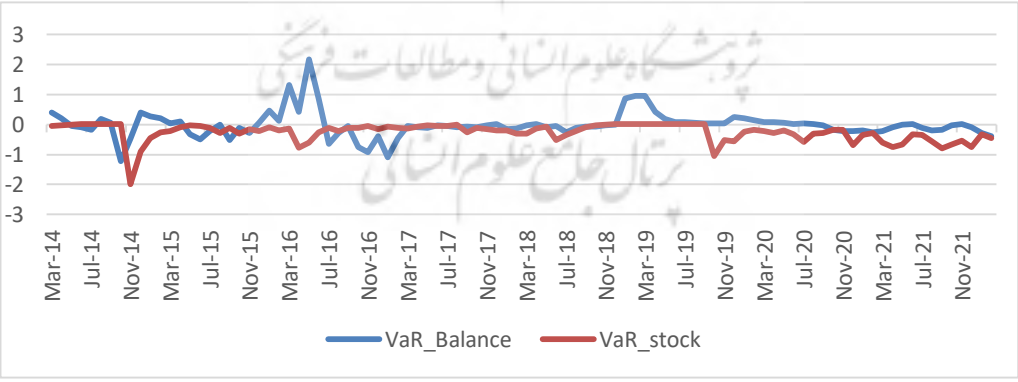


**Figure 4. book and market VaRs of Saman Bank**

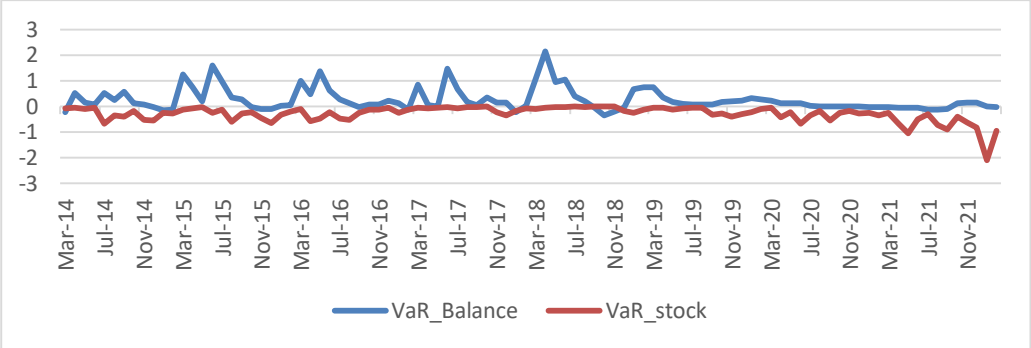


**Figure 5. book and market VaRs of Sina Bank**

**Table 6. Pearson correlation test results for research variables without lag**

| Variable name | Eghtesad-e-Novin market VaR | Parsian market VaR | Pasargad market VaR | Saman market VaR | Sina market VaR |
|---|---|---|---|---|---|
| Eghtesad-e-Novin book VaR | 0.049 | - | - | - | - |
| Parsian book VaR | - | 0.173 | - | - | - |
| Pasargad book VaR | - | - | 0.230 * | - | - |
| Saman book VaR | - | - | - | -0.014 | - |
| Sina book VaR | - | - | - | - | 0.2230 * |

*** Significant at the 95% confidence level ** Significant at the 99% confidence level**
**Source: Research findings**

In Table 6, the coefficients representing the relationship between book and market VaRs in the simultaneous data dimension (without time lag) are as follows: Eghtesad-e-Novin (0.049), Parsian (0.173), Pasargad (0.23), Saman (-0.014), and Sina (0.223) banks. A correlation value below 0.2 does not indicate a significant correlation relationship. Only the correlation coefficients between the book and market VaRs of Pasargad and Sina banks are statistically significant at the 95% confidence level. Therefore, based on this analysis, the transparency ranking of banks is as follows: Pasargad, Sina, Parsian, Eghtesad-e-Novin, and Saman banks.

**Table 7. Pearson correlation test results for research variables with a lag**

| Variable name | Eghtesad-e-Novin market VaR | Parsian market VaR | Pasargad market VaR | Saman market VaR | Sina market VaR |
|---|---|---|---|---|---|
| Eghtesad-e-Novin book VaR | 0.124 | - | - | - | - |
| Parsian book VaR | - | 0.499 ** | - | - | - |
| Pasargad book VaR | - | - | 0.197 | - | - |
| Saman book VaR | - | - | - | -0.210 * | - |
| Sina book VaR | - | - | - | - | 0.208 * |

*** Significant at the 95% confidence level ** Significant at the 99% confidence level**
**Source: Research findings**

In Table 7, considering the speed of information dissemination in the market and the concept of information efficiency, we examine the correlation coefficients between book and market risk values with a one-lag time interval. The correlation coefficients for Eghtesad-e-Novin, Parsian, Pasargad, Saman, and Sina Banks are 0.124, 0.499, 0.197, 0.210, and 0.208, respectively. The correlation coefficient between the book and market data of Parsian Bank is significant at the 99% confidence level. This coefficient is significant at the 95% confidence level for Saman and Sina banks. The coefficient for Pasargad Bank is very close to the critical value of the 95% confidence level. Therefore, the transparency ranking of banks in this case is as follows: Parsian, Saman, Sina, Pasargad, and Eghtesad-e-Novin banks.

In the subsequent phase, we identify the key variables that significantly influence the dependent variable: coronavirus disease (COVID-19), exchange rate changes, economic growth (GDP), inflation, stock market fluctuations, and unemployment. We also determine the maximum magnitude of virtual shocks that can be applied to these variables. Subsequently, various stress scenarios are formulated to simulate the behavior of the correlation coefficient between book and market VaRs under these stress scenarios.

In the mild stress scenario, the influential variables are subjected to shocks equivalent to 30% of the maximum shock magnitude determined in the previous analysis. The behavior of the correlation coefficient between book and market VaRs is then predicted for 12 months, from March 2022 to March 2023. The changes in the dependent variable are examined based on the intensities applied to each variable, which include a 23% increase in Corona, a 222% increase in the exchange rate, a 108% decrease in economic growth, a 46% increase in the inflation rate, a 288% decrease in stock index fluctuations,

and a 29% increase in the exchange rate.

In the severe stress scenario, a shock of 60% of the maximum allowable magnitude is applied to the influential variables. This scenario aims to assess the changes in the behavior of the correlation coefficient between book and market VaRs in 2022-2023, considering a 30% increase in the shock volume compared to the previous scenario.

The third scenario, known as the hyper-stress scenario, involves applying the maximum possible shock to the dependent variable in the future.

**Table 8. The amount of shocks to each of the exogenous variables of the model in different scenarios**

| Stress scenario | Covid 19 | exchange rate | economic growth | inflation | stock market fluctuations | unemployment |
|---|---|---|---|---|---|---|
| mild | 23% | 222% | -108% | 46% | -288% | 29% |
| severe | 45% | 444% | -216% | 91% | -577% | 58% |
| hyper | 75% | 740% | -360% | 152% | -961% | 97% |

**Source: Research findings**

**Table 9. Equality test of correlation coefficients in different scenarios using synchronous data**

| The estimated correlation coefficients between the book and market VaRs according to the exogenous factor | | Type of stress | | | Differences in correlation coefficients | | |
|---|---|---|---|---|---|---|---|
| | | Mild * | Severe * | Hyper * | mild – severe ** | mild – hyper ** | severe – hyper ** |
| VARS_ BASELINE | Correlation | 0.1910 | 0.1910 | 0.1910 | 0.0000 | 0.0000 | 0.0000 |
| | t-Statistic (z-Statistic) | 4.5020 | 4.5020 | 4.5020 | 0.0000 | 0.0000 | 0.0000 |
| | Probability | 0.0000 | 0.0000 | 0.0000 | | | |
| VARS_ COVID | Correlation | 0.1880 | 0.1850 | 0.1810 | 0.0030 | 0.0065 | 0.0034 |
| | t-Statistic (z-Statistic) | 4.4300 | 4.3550 | 4.2720 | 0.0516 | 0.1096 | 0.0580 |
| | Probability | 0.0000 | 0.0000 | 0.0000 | | | |
| VARS_ ER | Correlation | 0.1910 | 0.1880 | 0.1790 | 0.0031 | 0.0124 | 0.0092 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | t-Statistic (z-Statistic) | 4.5210 | 4.4440 | 4.2190 | 0.0530 | 0.2098 | 0.1568 |
| | Probability | 0.0000 | 0.0000 | 0.0000 | | | |
| VARS_GDP | Correlation | 0.1930 | 0.1950 | 0.1980 | -0.0021 | -0.0053 | -0.0032 |
| | t-Statistic (z-Statistic) | 4.5650 | 4.6180 | 4.6970 | -0.0365 | -0.0912 | -0.0546 |
| | Probability | 0.0000 | 0.0000 | 0.0000 | | | |
| VARS_INF | Correlation | 0.1850 | 0.1760 | 0.1610 | 0.0089 | 0.0244 | 0.0156 |
| | t-Statistic (z-Statistic) | 4.3680 | 4.1520 | 3.7750 | 0.1502 | 0.4129 | 0.2627 |
| | Probability | 0.0000 | 0.0000 | 0.0000 | | | |
| VARS_STKMF | Correlation | 0.1850 | 0.1730 | 0.1530 | 0.0120 | 0.0315 | 0.0196 |
| | t-Statistic (z-Statistic) | 4.3540 | 4.0630 | 3.5900 | 0.2026 | 0.5321 | 0.3296 |
| | Probability | 0.0000 | 0.0000 | 0.0000 | | | |
| VARS_UR | Correlation | 0.1910 | 0.2390 | 0.3200 | -0.0488 | -0.1294 | -0.0806 |
| | t-Statistic (z-Statistic) | 4.5050 | 5.7210 | 7.8360 | -0.8391 | -2.2728 | -1.4337 |
| | Probability | 0.0000 | 0.0000 | 0.0000 | | | |

*** T statistic ** Z statistic**

**Source: Research findings**

**Table 10. Equality test of correlation coefficients in different scenarios using lagged data**

| The estimated correlation coefficients between the book and market VaRs according to the exogenous factor | | Type of stress | | | Differences in correlation coefficients | | |
|---|---|---|---|---|---|---|---|
| | | Mild * | Severe* | Hyper * | mild – severe ** | mild – hyper ** | severe – hyper ** |
| VARS_ BASELINE | Correlation | 0.201 40 | 0.201 40 | 0.201 40 | 0.0000 0 | 0.000 00 | 0.0000 0 |
| | t-Statistic (z-Statistic) | 4.765 20 | 4.765 20 | 4.765 20 | 0.0000 0 | 0.000 00 | 0.0000 0 |
| | Probability | 0.0 00 00 | 0.0 00 00 | 0.0 00 00 | | | |
| VARS_ COVID | Correlation | 0.198 80 | 0.196 10 | 0.193 10 | 0.0027 0 | 0.005 70 | 0.0030 0 |
| | t-Statistic (z-Statistic) | 4.699 70 | 4.633 90 | 4.559 70 | 0.0456 0 | 0.097 00 | 0.0514 0 |
| | Probability | 0.0 00 00 | 0.0 00 00 | 0.0 00 00 | | | |
| VARS_ ER | Correlation | 0.201 40 | 0.197 50 | 0.187 20 | 0.0039 0 | 0.014 20 | 0.0103 0 |
| | t-Statistic (z-Statistic) | 4.763 80 | 4.668 90 | 4.415 90 | 0.0658 0 | 0.241 40 | 0.1756 0 |
| | Probability | 0.0 00 00 | 0.0 00 00 | 0.0 00 00 | | | |
| VARS_ GDP | Correlation | 0.204 90 | 0.208 00 | 0.212 30 | -0.0031 0 | -0.007 40 | -0.0043 0 |
| | t-Statistic (z-Statistic) | 4.850 40 | 4.927 00 | 5.034 70 | -0.0530 0 | -0.127 40 | -0.0744 0 |
| | Probability | 0.0 00 00 | 0.0 00 00 | 0.0 00 00 | | | |
| VARS_ INF | Correlation | 0.197 | 0.189 | 0.175 | 0.0077 0 | 0.021 90 | 0.0142 0 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | 00 | 20 | 10 | | | |
| | t-Statistic (z-Statistic) | 4.656 10 | 4.466 00 | 4.120 10 | 0.1319 0 | 0.372 40 | 0.2405 0 |
| | Probability | 0.000 000 | 0.000 000 | 0.000 000 | | | |
| VARS_STKMF | Correlation | 0.196 50 | 0.184 20 | 0.162 20 | 0.0123 0 | 0.034 30 | 0.0221 0 |
| | t-Statistic (z-Statistic) | 4.644 50 | 4.343 80 | 3.808 80 | 0.2088 0 | 0.581 30 | 0.3725 0 |
| | Probability | 0.000 000 | 0.000 000 | 0.000 020 | | | |
| VARS_UR | Correlation | 0.211 60 | 0.262 60 | 0.337 10 | -0.0509 0 | -0.125 50 | -0.0745 0 |
| | t-Statistic (z-Statistic) | 5.018 10 | 6.305 60 | 8.297 60 | -0.8843 0 | -2.227 40 | -1.3432 0 |
| | Probability | 0.000 000 | 0.000 000 | 0.000 000 | | | |

*** T statistic ** Z statistic**

**Source: Research findings**

## Discussion and Conclusion

This study examined the significant relationship between book value at risk and the market as an indicator of transparency and information quality. The stability criterion of the obtained correlation coefficient was tested to assess its adequacy.

The value at risk (VaR) was initially computed using the EGARCH model on the EV distribution, considering both balance sheet and market data. The time series of the data exhibited stationarity, and the results of the Breusch-Pagan (LM) Lagrange multiplier test confirmed the presence of arch effects and variance heterogeneity in the model. We conducted a Pearson correlation test on the computed VaRs to assess their stability. To evaluate the stability of the coefficients, we performed stress tests and utilized the Vector Autoregression (VAR) approach to obtain VaR vectors under different scenarios, considering various sources of stress. By calculating the correlations

between these VaR vectors, we examined the stability of the coefficients.

Using Fisher's correction and the correlation coefficient test of paired samples, we assessed the significance of differences in these coefficients across different scenarios. The results indicated a weak relationship between book and market VaRs when considering synchronous data. Specifically, the coefficients for Eghtesad-e-Novin, Parsian, Pasargad, Saman, and Sina banks were 0.049, 0.173, 0.23, -0.014, and 0.223, respectively. Only the correlation coefficients between the book and market VaRs of Pasargad and Sina banks were statistically significant at the 95% confidence levelIf. We consider the speed of information dissemination in the market and the concept of information efficiency, assuming a one-lag time interval for the dissemination of internal information of companies in the market, the correlation coefficients between book and market risk values for Parsian, Eghtesad-e-Novin, Pasargad, Saman, and Sina Banks are 0.124, 0.499, 0.197, 0.210, and 0.208, respectively.

Table 7 demonstrates that the correlation coefficient is significant for Parsian Bank at the 99% confidence level and for Saman and Sina banks at the 95% confidence level. In the case of Pasargad Bank, the confidence level of this coefficient is very close to 95%.

Moreover, the stability analysis revealed that the correlation between book and market VaRs in different strategies, except for the correlation between mild stress and hyperstress data resulting from changes in the unemployment rate, did not exhibit significant differences in both synchronous and lagged dimensions. This finding indicates the relative stability of the selected criterion. Based on the research findings and considering the primary users of this research (such as the Central Bank of the Islamic Republic of Iran and other banking sector regulators), it is recommended to assess the quality of banks' information transparency based on the convergence and strength of the correlation between book and market VaRs. This criterion can serve as an indicator for measuring the transparency of bank information. Other users, including shareholders and stakeholders, may also find this criterion useful in evaluating the quality of information disclosed by banks.

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