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Asset Quality, Firm Size and Volatility of Returns of Insurance Companies in Egypt

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Abstract

This article examines the hypotheses regarding the impact of asset quality and firm size on the volatility of returns (specifically, the standard deviation of return on assets and standard deviation of return on equity) of insurance companies in Egypt. The study utilizes the ARDL and GARCH models. The findings indicate that asset quality is related to the volatility of returns, as specified by the standard deviation of return on assets and the standard deviation of return on equity. The results reveal a positive relationship between asset quality and the volatility of returns. However, firm size (measured by the natural logarithm of total assets) demonstrates a negative relationship with the volatility of returns, as measured by both the standard deviation of return on equity and the standard deviation of return on assets. This paper focuses on investigating the relationship between asset quality and firm size with the volatility of returns, analyzing a sample of 23 Egyptian insurance firms over the period from 1999 to 2019.

Keywords: asset quality, volatility of return. firm size, GARCH model

1. Introduction

Financial institutions require compensation for systematic risk. Insurance firms in Egypt have diversified their portfolio of assets, including bonds, government securities, treasury bills, common stocks, and real estate. These firms use systematic risk to assess the risk-return trade-off. However, this paper utilizes the volatility of returns, specifically the standard deviation of assets and the standard deviation of equity, instead of measuring systematic risk. This is considered as risk-adjusted on asset and equity, similar to how Alistair Milne and Mario Onorato (2012) use risk-adjusted return on capital to assess portfolio decisions using asset pricing.

The paper sheds more light on the impact of asset quality on regulatory investment decisions for compliance with regulations, as highlighted in law 10 article (28), and firm size on the volatility of returns to measure risk performance. Gabriel Quiros and Allan Timmermann (2000) determined the effect of asset selection on risk performance. Etti Baranoff et al. (2007) explored the relationship between risk and firm size, while Jing Ai et al. (2016) conducted a study on the relationship between asset quality and financial performance.

The paper examines the hypothesis that the volatility of return is related to asset quality and firm size, aiming to explain the effect of independent variables on dependent variables. Asset quality and firm size may impact the relationships affecting the volatility of returns. Recent literature reviews conclude that firm size is negatively related to the volatility of return. For example, Ernesto Valeiras et al. (2016) found a significant negative effect of firm size on financial performance.

Nevertheless, some studies focus on small size, such as Moon Kim & David Burnie (2002), who concluded that small size has a significant relationship with portfolio earnings greater than large size in boom times but an insignificant relationship with small and large size in recession times. They also found that small-size firms grow faster than large-size firms, although they have higher volatility of return, as found by Chang Koo & Kyoung Chai (2017).

Besides other reasons, the epidemic crisis that gripped the world insurance market in 2019-2023 is a clear systematic event affecting risk, especially in the insurance market.

2. Literature Review

2.1 The Related Literature Review of Risk

As cascading the financial crises consequences lead to weakness of risk management practice, through the last three decade appears Value- at risk as standard risk measure, it became key technique for asset allocation David Cummins and Marry wises (2014) examines the potential to cause the systemic risk of insurance industry in US their conclusion was the core business don't create a systematic risk of insurance industry in US, beside that the life insurance are vulnerability more than property casualty , and Claudia Champagne& Stephane C. (2017) conducted that the relationship between pension funds freeze on systematic risk and abnormal return is insignificant, but in short term in financial crisis shareholder reduces the systematic risk, both of them investigated the effect of systemic risk on pension funds and insurance sector. Also Alistair Milne & Mario Onorato (2012) they present risk adjusted return on capital to assess investment decision instead of systematic risk to measure the performance in financial institutions to correct for deference the skewness But Itamar Drechsler & et al (2014) developed a model for risk prima and monetary policy, conducted that the low interest rate leads to low risk premia of insurance industry in US, when Christophe Boucher & et al (2013) used value – at risk to assess the effect of long term asset allocation and suggested a non-liner associated correction on value at risk and estimated with horizon considered also propose general approach to calculate the risk measure. However, Holder F. Mendonca & Vivian I. Barcelos (2021) revealed that the securitization of assets in Brazilian financial institutions increase insolvency risk that comes from real state receivable certificate operations higher that credit rights investment funds. And Yueyun Chen & et al (2014) conducted that the insolvency risk has a significant impact of the price of insurance using capital asset pricing model using data of property liability insurance, both of them investigated the effect of insolvency risk. Depend on statistical investigated on the operation risk. Chunguang Bai & el at (2021) indicate that the operational risk is negative effect of firm market performance also regulatory risk has a negative relationship with firm market performance. Rationale for revealing further investigate is that many literature review on the risk have been published by Tong Yu & et al (2008) indicates that tangible asset like firm size capitalization significant relationship with asset risk taking but intangible asset inverse relationship with asset risk taking in property – liability insurance firms. Rod Garratt& John Marshall (2003) proof the equity risk increases demand for insurance comes from an exogenous factors, the decision depend on lake of covariance between portfolio risk and insurable risk. Jesus Gonzalo & Jose Olmos (2019) conducted that in terms of risk aversion short term portfolio better than long term portfolio, there is significant empirical deference of presences of dynamic in risk aversion, also regarding to risk aversion coefficient has significant roll to determine optimal to fixed asset income. Martina Jasova & et al (2021) testing the impact of lender of last resort on bank interconnectedness which effecting systematic risk, used novel micro level dataset indicate that the lender of last resort policy incentive bank to increase bonds issued this sharing risk with others. Additionally, Alistair Milne & Mario Onorato (2012) presented risk-adjusted return on capital to assess investment decisions instead of using systematic risk to measure performance in financial institutions. They aimed to correct for the skewness. On the other hand, Itamar Drechsler & et al (2014) developed a model for risk premium and monetary policy, concluding that low-interest rates lead to low risk premia in the US insurance industry. Christophe Boucher & et al (2013) used value-at-risk to assess the effect of long-term asset allocation and suggested a non-linear associated correction on value at risk, proposing a general approach to calculate the risk measure. However, Holder F. Mendonca & Vivian I. Barcelos (2021) revealed that the securitization of assets in Brazilian financial institutions increases insolvency risk from real estate receivable certificate operations more than credit rights investment funds. Yueyun Chen & et al (2014) showed that insolvency risk has a significant effect on the price of insurance using the capital asset pricing model and data from property-liability insurance. Both studies investigated the effect of insolvency risk. Based on statistical investigations on operational risk, Chunguang Bai & et al (2021) indicated that operational risk negatively affects firm market performance. Regulatory risk also has a negative relationship with firm market performance. The rationale for further investigation is that many literature reviews on risk have been published. Tong Yu & et al (2008) indicated that tangible assets like firm size and capitalization have a significant relationship with asset risk-taking, while intangible assets have an inverse relationship with asset risk-taking in property-liability insurance firms. Rod Garratt & John Marshall (2003) proved that equity risk increases demand for insurance due to exogenous factors, with the decision depending on the lack of covariance between portfolio risk and insurable risk.

Jesus Gonzalo and Jose Olmos (2019) conducted research indicating that, in terms of risk aversion, short-term portfolios are better than long-term portfolios. There is a significant empirical difference in the presence of dynamics in risk aversion. Additionally, the risk aversion coefficient plays a significant role in determining the

optimal fixed asset income.

Martina Jasova & et al (2021) tested the impact of the lender of last resort on bank interconnectedness, affecting systematic risk. They used a novel micro-level dataset indicating that the lender of last resort policy incentivizes banks to increase bonds issued, thereby sharing risk with others.

Assaf Eisdorfer (2008) conducted a study indicating that the relationship between volatility and investment returns is negative. During uncertain times, investments become distressed, generating less value. Additionally, debt, growth options, regulation, and managerial incentives affect risk-shifting behaviour towards bondholders.

Francisco Gonzalez & Hayong Yun (2014) indicated that derivatives bring higher leverage overall and impact investment valuation. Risk management also has a real effect on firm outcomes.

Xin Che & et al (2018) conducted research revealing a positive relationship between market concentration and cash holding. There is also a significant relationship between cash holding policy and predation risk. According to these results, firms with external capital need to hold greater cash in US insurance firms.

Qian Song & et al (2017) found a significant relationship between decision support systems and risk performance.

Chih Hsiao & et al (2016) referred to the relationship between firm risk and leverage, asymmetric volatility, and volatility skew. Additionally, firm size has a relationship with firm risk.

Gabriel Quiros & Allan Timmermann (2000) found that small firms show asymmetry in returns distribution across recessions, and risk is most strongly affected by the credit market. They used volatility of returns as a measure of risk, which is highest during recessions.

2.2 The Related Literature Review of Asset Quality

Asset quality plays a crucial role in the revenue generation of Egyptian insurance firms. However, the ability of insurance firms to select their assets under quality conditions is constrained by financial authority regulations in Egypt, as per the law 10 of the year 1981. The question arises: Do insurance firms in Egypt have the ability to select their assets with quality, and does it affect their risk performance? To answer this question, several prior studies have been published. Atanu Saha (2007) found that risk preferences and ignoring risk may significantly overestimate input demand elasticity and output supply. Firm size also has an effect on risk preference.

Yunting Ling, Zihan Jiang, and Shiyu Liu (2023) suggested that asset allocation can effectively signal assets when reducing high-risk degrees. Effective foresight is an impacting factor to reduce risk and maximize returns based on this model.

Roy Hoevenaars et al. (2014) studied the effect of uncertainty parameters on asset allocation and found that returns on stocks and bonds show limited mean reversion at medium and short-term investments. In the long term, there is no mean reversion, and the correlation between asset returns with informative priors remains stable.

Etti Baranoff et al. (2007) conducted a study indicating that regulatory asset risk and opportunity asset risk affect capital structure decisions in large insurance firms. In small firms, opportunity asset risk is positively significant on capital structure decisions, while regulatory asset risk is insignificant in life insurance.

Steven Dennis and Ian Sharpe (2005) provided variables such as firm size, firm risk, asset maturity, and leverage, significantly affecting loans maturity, except for leverage, which is negative. Large size gives the ability to diversify and set loans maturity.

Barbara Casu et al. (2016) investigated the associated diversification and size on risk, finding that firm size affects risk, but there is no relationship between diversification and the risk of bank activities. Mergers and acquisitions between banks and securities firms pose higher risk than with insurance firms.

Cheekiat Low, Dessislava, et al. (2012) presented a skewness-aware asset allocation new theoretical framework, equivalent to the capital asset pricing model, showing a positive and significant relationship between asset allocation, firm size, and risk-based capital on investment returns of insurance firms. The results support the Mean-Variance portfolio selection theory to allocate their assets. However, the relationship between risk-based capital and investment returns is intervened by asset allocation.

Salah Eladly (2022) analysed the relationship between sources allocation and risk performance using GARCH and ARCH, indicating the relationship between asset structure and risk performance of insurance firms in Egypt.

Consistent with this paper, Joe Brocato and Steve Steed (1998) showed that asset quality is strongly positively associated with equity, including foreign stocks, but less strongly positive with debt instruments. Real estate

return is higher than common stocks, but precious metals have an insignificant correlation with common stocks and a negative correlation with other assets. To manage assets, Carl Wallnerström et al. (2013) prepared a framework for asset management based on cost efficiency and risk. Arnold Polanski and Evarist Stoja (2010) prepared a model to show the relationship between asset returns and volatility. Rakesh Arrawatia et al. (2019) examined the commercial banking sector, finding that expository monetary policy and high real interest rates affect asset quality. Equity capital and diversification are important factors determining asset quality.

2.3 The Related Literature Review of Firm Size

In previous studies, an enduring theme attempts to answer the important question: What is the role of firm size in creating knowledge, and how does it become an important source of innovation, in addition to the advantages of diversification? The literature review creates a sophisticated situation in terms of firm size (small or large) over the last two decades, making the ongoing literature review interesting. Rudolf Ember (2001) indicates that firm size has a negative effect of layoff risk, but firm size is a positive associated with wages, implying employment stability. Linda Hooks (2003) conducted research revealing that medium-sized firms have a significant negative relationship with bank debt usage, but information asymmetry plays an important role in this issue. Shai Bernstein et al. (2019) conducted a study on the long-term utilization of assets in reorganized firms, finding that it is higher relative to assets of liquidated firms. These impacts affect the market and reduce access to finance, indicating that liquidation has effects on the efficiency of asset allocation in bankruptcy in the US. However, there is no effect of firm size, as indicated by Ivo Arnold & Evert Vrugt (2004), who found no relationship between firm size and monetary policy. Tomasz Piskorski et al. (2015) indicated that there is no relationship between growth rate and firm size. Furthermore, older firms grow slower than younger firms, and to grow faster, they should minimize input costs. Firm growth is positively associated with the economies of scope. Several studies have presented a negative association of firm size with financial performance and volatility of return. Ming Leon & Nen Hwang (2011) show that firm size has a negative association with return on equity, but the relationship is positive when below average return. Financial leverage has a significant positive relationship with ROE. Ernesto Valeiras et al. (2016) found a significant negative effect of firm size on financial performance, but indebtedness as a moderator variable has a significant positive relationship with financial performance. Dennis and Sharpe (2005) tested firm size dependence on loans mutuality in banks, finding a negative relationship between firm size and loans maturity, with lower risk for middle-market loans. Bruce Hearn & Jenifer Piesse (2015) found a negatively significant relationship between firm sizes and liquidity based on the CAPM model – as size increases, earnings decrease. Olan Henry & John Sharma (1999) used a multivariate GARCH model to analyze asymmetric conditional volatility with firm size, finding a negative relationship between volatility of returns and large-sized firms and a negative association with prices. On the other hand, several literature reviews have indicated positive effects of firm size. Jing Ai et al. (2009) found that enterprise risk management and diversification of product lines (asset quality) have a significant positive association with insurance firm performance. Daye Li et al. (2022) indicated that firm size measured by market value has a significant effect on profitability. Lakshman Alles and George A. (2006) found that time has an effect on investment in the Canadian stock market, with short-term investment outcomes better than long-term investment outcomes in terms of risk-return payoffs. Robert Connelly and Mark Hirschey (2006) found that research and development have a significant positive effect on firm value, and R&D has a positive effect on firm size in the long term. Hung Ngoc Dang et al. (2019) detected that profitability and size are significantly positively associated with the value of the enterprise, but the capital structure has a negative relationship with the value of the enterprise. Growth has no effect on the value of the enterprise. Thorsten Beck et al. (2008) indicate that small firms grow faster, and financial development has a positive effect on small firms. However, other prior studies have presented firm size in models and other analyses. Jerry Tsai & Jessica Wachter (2015) provided a model to explain the effect of external risk expectations on asset pricing and volatility of returns hypotheses on option pricing, aiming to understand the puzzle of asset pricing. Kenton K. Yee (2020) revealed that when interest rates are higher, poor earning quality increases the risk from equity. Risks created by poor earnings are systematic risk and diversifiable risk, affecting capitalization factors. Salah Eladly (2021) tested the relationship between earning assets and working capital management of the insurance firms in Egypt, indicating a positive relationship between working capital and earning assets. Clemens Sialm & Hanjang Zhang (2019) conducted research indicating that mutual funds with higher burdens on investors are irreplaceable, and those tax costs lead mutual funds to avoid destroying value for investors. They should manage their investment tax efficiently. Moon Kim & David Burnie (2002) concluded that small size has a significant relationship with portfolio earnings greater than large size in boom times, but there is an insignificant relationship with small and large size in recession times. In adverse economic conditions, small companies are more vulnerable because they depend on financial leverage and low productivity. Byeongyong P. Choi (2010) indicated that firm size is independent of growth, with a

negative relationship between firm age and growth – younger firms grow more than old ones. Industry mix has a significant negative relationship with growth. Chang Koo & Kyoung Chai (2017) showed that the imperfect problem causes the moral hazard problem, leading to an inefficient level. Also, large firm size is vulnerable to overinvestment. Byeongyong P. Choi (2010) tested the size on value, showing that the smallest firms have a strongly significant relationship with value in the China stock market, accounting for 30% of the smallest firms from the sample.

2.4 The Related Literature Review of Firm Size and Risk

In terms of the related literature review of firm size and risk this paper shed light on this discussion by literature review investigated this relationship as for Rudolf Ember (2001) indicates that firm size has a negative effect of layoff risk. But Chih Hsiao et al (2016) firm size has a relationship with firm risk. Tong Yu & et al (2008) indicates that tangible asset like firm size capitalization significant relationship with asset risk taking but intangible asset inverse relationship with asset risk taking in property – liability insurance firms. Gabriel Quiros and Allan Timmermann (2000) found that small firms and risk is most strongly affected by the credit market. Tong Yu & et al (2008) indicated that tangible assets like firm size and capitalization have a significant relationship with asset risk-taking, while intangible assets have an inverse relationship with asset risk-taking in property-liability insurance firms. Awad E. A. Ibrahim and Ahmed Aboud (2016) found firm has a positive associated with risk

3. Methodology and Hypotheses

This paper focuses on asset quality and is constructed by computing for two categories of assets (free assets and regulatory assets), covering a 21-year period from 1999 to 2019. The data depend on financial statements reports produced by the Egyptian Financial Authority. The overall sample consists of 19 firms (48%). This paper requires every sample company to have complete data throughout the study period, with non-missing observations and assets risk measured. The dependent variables, as shown by Salah Eladly (2022), are the standard deviation of return on assets and the standard deviation of return on equity considered as externality risk. The independent variables are asset quality and firm size, as shown by Alistair Milne and Mario Onorato (2012), using ARDL evaluate the both contemporaneous as long as time lag spillover impact and as shown by Olan Henry & John Sharma (1999), the GARCH type model is also employed to evaluate the spillover impact between the financial series which used in this paper. It is desirable to analyze the relationship between asset quality, firm size, and the volatility of returns."

Equation (1):

$$y_t = \alpha + \sum_{i=1}^{p} \gamma_i y_{t-1} + \sum_{j=1}^{k} \sum_{i=0}^{q_j} X_{j,t-i'} \beta_{j,i} + \varepsilon_t$$

in terms of hypothesis there are many papers investigated the relating between asset quality Chang Koo &Kyoung Chai (2017) presented a model for testing the relationship between asset quality and risk, also Yunting Ling & Zihan Jiang & Shiyu Liu (2023) tests the relationship between asset allocation on risk and risks also firm size and risks the relationship test with the volatility of returns on financial performance by Salah Eladly (2022), while analysing the below hypothesis this paper control the other possible impact such as firm size as control variable

H1: The relationships among asset quality and firm size are insignificant with standard deviation of return on equity

H2: the relationships among asset quality and firm size are insignificant with standard deviation of return on asset

4. Empirical Results and Discussion

Table 1. Descriptive statistics for variables

constructs	Y1	Y2	X1	X2	LNX3
Jarque-Bera	38.09069	23.98791	29.01699	24.78154	5.797972
Std. Dev.	0.010886	0.035582	0.225925	0.131956	1.507681
Skewness	0.737088	0.491196	-0.603496	0.381279	0.240858
Maximum	0.042087	0.141620	0.986386	0.496168	16.62014
Minimum	4.67E-05	0.000747	0.003465	0.003624	9.472166
Median	0.012432	0.047220	0.549062	0.201883	13.09981
Mean	0.015046	0.053698	0.502464	0.228967	13.17006
Kurtosis	2.656522	2.308778	2.462830	2i.046519	2.658386
Probability	0.000000	0.000006	0.000001	0.000004	0.055079

Notes. The total observation 399; *** Significant at ≥ (0.001).

Table 1 displays the algorithm's maximum total assets, which is 13.17006, and the minimum, which is 9.472166. The table also presents variables related to asset quality (X1), firm size (X2), standard deviation of return on equity (Y1), and standard deviation of return on assets (Y2). It is observed that the variables Y1 and Y2 have lower risk, while the skewness of Y2 is also lower, indicating a non-normal distribution. This is supported by the Jarque-Bera statistic, which is significant at a level less than 0.05.

On the other hand, the natural logarithm of total assets (LNX3) follows a normal distribution, as the Jarque-Bera statistic is insignificant (greater than 0.05). This normality property is essential for Dennis and Sharpe's (2005) test, which examines the dependence of firm size on loans mutuality in banks.

Additionally, the Pearson skewness coefficient (PSC) is within the range of -1 to 1 for most variables, indicating no significant skewness. However, the natural algorithm of total assets has a skewness greater than 1, as noted by Alistair Milne and Mario Onorato (2012), suggesting some skewness in this particular variable.

Furthermore, concerning standard deviation, variables Y1 and Y2 show significantly lower risk, but the volatility of return may be higher than the dependent variables. This outcome could be attributed to a lack of diversification, given the heavily regulated nature of Egyptian insurance firms.

Moving on to the second point, a group unit root test is employed to assess the stationary of time series. In this paper, the Im, Pesaran, and Shin W-stat (IPSW) test, along with the Augmented Dickey-Fuller (ADF) test, is used to ensure that the mean and variance remain constant over time, and the covariance between two time periods depends only on their distance rather than the actual time at which the covariance is computed for variables.

4.1 The Test of Group Unit Root Test

Table 2. The test of Group unit root for variables

Method	Cross-sections	Prob.**	Statistic	Obs
Null: Unit root (assumes individual unit root process)				
PP - Fisher Chi-square	5	0.001***	162.887	1990
Im, Pesaran and Shin W-stat	5	0.001***	-10.7615	1986
ADF - Fisher Chi-square	5	0.001***	137.623	1986
Null: Unit root (assumes common unit root process)				
Levin, Lin & Chu t*	5	0.001***	-8.51875	1986

Table 2 presents the estimated time series of the variables, including the standard deviation of return on equity (Y1) and the standard deviation of return on assets (Y2). These variables are associated with free asset investments (X1), regulatory asset investments (X2), and the natural algorithm of total assets (lnx3), all of which are stationary at level 1 (0). This is based on the constant level and meets the following criteria: LLC, IPSW

showed -8.51875, PP showed 162.997, and ADF showed -10.7615at a significance level less than (0.001)."

4.2 Co-integrating equation Model

Table 3. The model of Co integrating for variables

Variables	Z-statistic	Prob.*	T-statistic	Prob.*
Y1	-131.9188	0.001***	-8.879061	0.001***
Y2	-121.2515	0.001***	-8.448820	0.001***
X1	-101.6486	0.001***	-7.216085	0.001***
X2	-105.6182	0.001***	-7.803602	0.001***
LNX3	-71.34175	0.001***	-6.289347	0.001***

Note. significant level at a 0.001***.

Involves fitting a line to the data points, The Engle-Granger Co-integration test is employed to examine the non-stationary time series variables mentioned above, determining whether they exhibit long-term equilibrium connections. These variables include the standard deviation of return on equity, standard deviation of return on assets, free asset, regulatory asset, and the nature of the algorithm of total asset lnx3. This result consistent with Consistent with Ivo Arnold & Evert Vrugt (2004), the z-statistic and Tau-statistic are utilized at a P ≥ (0.001). Table (3) reveals the existence of long-term equilibrium linkages between asset quality (free asset and regulatory assets), firm size, standard deviation of return on equity, and standard deviation of return on assets from 1999 to 2019.

4.3 Pearson Correlation Test

Table 4. The matrix of Pearson correlation to the ARDL model

Constructs	Y1	Y2	X1	X2
Standard deviation of return on equity Y1	1			
Standard deviation of return on asset Y2	0.515***	1		
Free asset X1	0.566***	0.268***	1	
Regulatory asset X2	0.433***	0.436***	-0.673***	1
Nature algorithm of total asset LNX3	-0.242***	-0.344***	0.523***	-0.295***

Note. *** Significant at ≥ (0.001).

From Table 4, the researcher revealed the following: this model employs a linear relationship between the asset quality, and firm size on volatility of retunes. It assumes that the relationship between the variables can be represented

- Consistent with the majority of the literature reviewed, this paper's results indicate significant positive linear relationships between independent variables (free assets and regulatory assets) and the volatility of returns specifically standard deviations of return on assets and return on equity , The associated p-values are less than 0.05, the table reports Pearson correlations: 0.51 between the standard deviation of return on equity and free asset investment, 0.43 with regulatory asset, and 0.24 with the natural algorithm of total assets. Additionally, the correlation between the standard deviation of return on assets is 0.27 with free asset investment, 0.44 with regulatory asset, and 0.34 with the natural algorithm of total assets.
- Also consistent with the literature, this paper's results indicate significant negative linear relationships between firm size measured by (the natural algorithm of total assets, lnx3), and standard deviation of return on assets and standard deviation of return on equity. The associated p-values are ≥ 0.001.

4.4 ARCH and ARDL Model

The study employed the ARDL model, as reported in Table 5, to investigate the existence of a long-term equilibrium associated with the variables. The analysis builds on the work of Pesaran and Shin, as well as Pesaran, Shin, and Smith, using the bound testing approach for cointegration and error correction models within the ARDL framework.

Equation (2):

$$y_t = \alpha + \sum_{i=1}^{p} \gamma_i y_{t-1} + \sum_{j=1}^{k} \sum_{i=0}^{q_j} X_{j,t-i'} \beta_{j,i} + \varepsilon_t$$

Table 5. The model of the ARDL

Variable	Coefficient	Std. Error	t-Statistic	Prob.	VIF
Y1(-1)	0.561368	0.049637	11.30959	0.001***	2.063905
Y1(-2)	0.164519	0.049970	3.292348	0.0011**	2.091662
X1	0.006274	0.002634	2.382022	0.0177*	2.494046
X2	0.004753	0.003894	1.220600	0.2230	1.866358
LNX3	-0.000779	0.000320	-2.435601	0.0153*	1.626937
C	0.010139	0.004137	2.450848	0.0147	-

The results presented in table 5 to estimate the R^2=53.3% to explain the effect of free asset investment X1, regulatory asset investment x2 and size of the firm lnx3 on standard deviation of return on equity sued the auto regressive distributed lag model reported that ARDL Bounds Test F test=9.39 CVB 1%=(3.65, 4.66) BGSC F test=1.10 sig=0.333 Heteroskedasticity where the standard error is + 0.0101393064583, but regarding to the table reported estimating ARCH model F test =1.793 sig=0.0681 Ramsey RESET Test t-teat=0.920 sig=0.358. Where ML ARCH model tests results were Sig=0.001*** AIC =-6.93 SC=-6.87 HQC=-6.91 RMSE=0.0075 U=0.209 DW=1.98JB=142.98 Sig=0.001***

In addition the equation of the model of the ARDL which explain the relationship between standard deviation of ROE with asset quality and firm size

Equation (3):

*Y1 = 0.561368365666*Y1 (-1) + 0.164518843986*Y1 (-2) + 0.00627355137949*X1 + 0.00475304816901*X2 - 0.000779420760542*LNX3 + 0.0101393064583*

Equation (4): The equation of Co integrating:

D (Y1) = -0.274112790348(Y1 (-1) - (0.02288675*X1 + 0.01733975*X2 -0.00284343*LNX3 + 0.03698954))*

Table 6. ARDL for the second dependent variable

Variable	Coefficient	Std. Error	t-Statistic	Prob.	VIF
Y2(-1)	0.573336	0.075849	7.558948	0.001***	4.085566
Y2(-2)	0.219945	0.088721	2.479061	0.0136*	6.084064
Y2(-3)	-0.072230	0.050757	-1.423039	0.1555	2.807378
X1	0.002910	0.011222	0.259260	0.7956	4.838880
X1(-1)	0.018581	0.009468	1.962449	0.0504*	4.408170
X2	0.016362	0.004108	3.982572	0.001***	2.233960
LNX3	-0.011965	0.002012	-5.946819	0.001***	1.442318
C	0.011226	0.012942	0.867419	0.3862	---

The results reported an estimated (R^2 = 55.2%) from the model to explain the effect of free asset investment ((X_1)), regulatory asset investment ((X_2)), and firm size ((\ln X_3)) on the standard deviation of return on assets using the autoregressive distributed lag (ARDL) model. The ARDL Bounds Test reported an F-test value of 9.894 with critical value bounds (CVB) at 1% = (3.65, 4.66). The Breusch-Godfrey Serial Correlation (BGSC) F-test value was 0.458 with a significance level of 0.633. The Heteroskedasticity Test reported a standard error of 0.0112261109561.

The ARCH model presented an F-test value of 1.648 with a significance level of 0.120. The Ramsey RESET Test reported a t-value of 1.061 with a significance level of 0.289 and a standard error of 0.0112261109561. The Maximum Likelihood (ML) ARCH test reported a significance level of 0.001***, with the following information

criteria: AIC = -4.61, SC = -4.53, HQC = -4.58. The Root Mean Square Error (RMSE) was 0.023, Theil's U statistic was 0.191, Durbin-Watson (DW) statistic was 1.99, and the Jarque-Bera (JB) test reported a value of 82.10 with a significance level of 0.001***.

In addition the equation of the model of the ARDL which explain the relationship between standard deviation of ROA with asset quality and firm size

Equation (5):

$$Y2 = 0.573335594462*Y2\ (-1) + 0.219945129478*Y2\ (-2) - 0.0722298704596*Y2\ (-3) + 0.00290952638363*X1 + 0.0185812726853*X1(-1) + 0.01636181340754*X2 - 0.011665965*LNX3 + 0.0112261109561$$

Equation (6): Co integrating Equation:

$$D\ (Y2) = -0.278949146519*(Y2\ (-1) - (0.07704200*X1(-1) + 0.02280636*X2 - 0.00238452*LNX3 + 0.04024429$$

First Observation - ML ARCH Technique and ARDL Models

The initial observation of employing the ML ARCH technique, ARDL (2, 0, 0, 0), and the (3, 1, 0, 0) model aligns with the theoretical literature review. The results support the Mean-Variance portfolio selection theory. Previous studies, such as Olan Henry & John Sharma (1999) volatility of returns specifically by standard deviation of return on assets and return on equity, utilizing models by Gabriel Quiros and Allan Timmermann (2000) and Tong Yu et al (2008). Further insights from Daye Li & et al (2022), Hung Ngoc Dang & et al (2019), and Ming Leon and Nen Hwang (2011) provide a comprehensive understanding of the complex relationships explored in this paper.

Second Observation - Coefficient of Determination (R^2) and Model Evaluation

The second observation concerns the coefficient of determination (R^2) for the ARDL (2, 0, 0, 0) and the (3, 1, 0, 0) models. The variables (free assets investment, regulatory assets investment, and firm size) explain 55-53% respectively, of the total variation in the standard deviation of return on equity (Y1), and standard deviation of return on assets (dependent variables). This aligns with the findings of Dennis and Sharpe (2005) who utilized F-tests, indicating the significant impact of independent variables on the standard deviations of return on equity and return on assets further insights from this result finding a correlation between risks come from equity with assets quality, this result consistence with theory of agency cost for Jensen and Meckling (1976)

Moreover, T-tests reveal the most significant independent variables accepted in the models, such as Y1 (-1), Y1 (-2), X1, and LNX3 for ARDL (2, 0, 0, 0), and Y2 (-1), Y2 (-2), X1, X2, and LNX3 for ARDL (3, 1, 0, 0), all at a significance level less than 0.05. Various statistical tests, including the Variance Inflation Factors (VIF), 13-Ramsey RESET Test, Jarque-Bera Test, and Theil's inequality coefficient U, assess the models' goodness of fit, multicollinearity, normality of residuals, and accuracy.

In conclusion, the Akaike Information Criteria (AIC) analysis identifies the ARDL (2, 0, 0, 0) and (3, 1, 0, 0) models as the best fit for demonstrating the behavior of the volatility of returns as dependent variables. The auto regressive distributed lag (ARDL) Bounds Test confirms the existence of long-term relationships between variables. Heteroskedasticity Test, the Durbin-Watson test and Breusch-Godfrey Serial Correlation LM Test, support the model's validity and reliability, indicating the absence of autocorrelation and heteroskedasticity.

5. Conclusions

This paper sought to analyze the relationship between asset quality, firm size, and volatility of returns of insurance firms in Egypt. Asset quality is expected to be related to the volatility of return (standard deviation of return on assets and standard deviation of return on equity). The results indicate a positive relationship between them, but firm size (LNx3) has a negative relationship with volatility of return.

The paper focuses on the relationship between asset investment and firm size with volatility of return, examining a sample of 23 insurance firms over the 1999 to 2019 period. The paper's results confirm the investment theory that the relationship between asset quality and volatility of returns is positive, but firm size has a negative relationship with volatility of returns. This is consistent with much of the literature review and unrelated firm size dependency to volatility of return, as mentioned in the literature review section when testing the relationship between firm size and financial performance. However, it contrasts with previous studies that find a negative relationship between firm size and volatility of returns. On the other hand, this paper suggests an advantage for diversification.

The paper's results provide that:

- Consistent with most of the literature review, this paper's results indicate significant positive linear relationships between the independent free asset and regulatory asset with the standard deviation of return on assets and standard deviation of return on equity at a significant level ≥ 0.05. This is consistent with mean-variance theory.
- Consistent with most of the literature review, this paper's results indicate significant negative linear relationships between the independent variable firm size measured by the natural logarithm of total assets (LNx3) and the dependent variable; standard deviation of return on equity and standard deviation of return on assets at a significant level less than 0.001.

This paper has focused on asset quality and firm size on the volatility of returns, where the researcher believes insurance firms' problems stem from heavy regulation in terms of investment channels. Although the financial authority regulation in Egypt raised the insurance firms' equity to 100 million, the results show the relationship between firm size and volatility of returns is negative. This result is consistent with results that show a negative relationship with financial performance (ROE and ROA), while other papers show the effect on firm size on return, with small size being better than large size. However, other findings refer to the firm size's positive impact on the value of the firm.

This paper's results imply the importance and significance of diversification and mitigation to the constraints on the investment channel.

Are the findings for the insurance industry valid for other industries? Insurance firms as financial intermediaries differ in financial regularity and the nature of work, so it can be quite challenging to apply the findings of this paper to other financial intermediaries.

This paper utilizes the volatility of returns specifically, standard deviation of assets and the standard deviation of equity instead of measuring systematic risk. This is considered as risk-adjusted on asset and equity.

These conclusions draw attention to finance scholars to enlarge their research in this area to improve this important sector and add value to Egyptian economic growth. Subsequent research could examine the volatility of return on financial performance and regulatory constraints. It could also be applied to the MENA region's insurance industry.

Informed consent

Obtained.

Ethics approval

The Publication Ethics Committee of the Canadian Center of Science and Education.

The journal and publisher adhere to the Core Practices established by the Committee on Publication Ethics (COPE).

Provenance and peer review

Not commissioned; externally double-blind peer reviewed.

Data availability statement

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

Data sharing statement

No additional data are available.

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