CAPITAL, ASSET AND PRODUCT RISK: A SIMULTANEOUS EQUATION MODEL APPROACH FOR THE INDIAN LIFE INSURERS

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ABSTRACT

Introduction and Purpose: *The working of life insurance business involves two wheels, underwriting and Investment. Both these two wheels are necessary for running of life insurance business smoothly and efficiently. The running of wheels entails underwriting risk/product risk and investment risk for the life insurer and these two have significant impact on the life blood of life insurance companies i.e. capital. Accordingly, the aim of the present study is to examine all such risk under one umbrella to have comprehensive view about the relationship of all such risk with each other simultaneously.*

Data Base and Research Methodology: *The study is conducted with Indian life insurance companies and covered a period of 5 years from 2008-09 to 2012-13. The Two-Stage Least Square (2SLS) Regression method of Simultaneous Equation Model (SEM) is used for the analyzing the relationship. The collected data is analyzed with the help of SPSS 16.*

Findings and Suggestions: *The results of 2SLS provided that the significant variation in the CR, AR, ANR, IBR and GBR is explained by the variables taken into consideration. The p-value in all the equations is more than 0.05. Hence, our null hypothesis which states that the positive reciprocal relationship of Capital with Asset Risk and Product Risk (Annuity Risk, Individual Business Risk and Group Business Risk) is accepted. Accordingly, it is suggested that the life insurance companies should restructure or reorganize their underwriting and investment* *business in such a ways that increased risk from one business must mitigate from other resulting no erosion of capital.*

Keywords: Life Insurance, Two-Stage Least Square (2SLS) Regression, Simultaneous Equation Model (SEM), Capital, Assets and Product Risk.

1. Introduction

Human being always sought security. This quest for security was an important motivating force in the earliest formations of families, clans, tribes and other groups. Indeed, the groups have been the primary source of both emotional and physical security, since the beginning of human kind. The group may be our employer, the government or an insurance company, but the concept is same. In some ways, however we today are more vulnerable than our ancestors. The physical and economic security formerly provided by the tribes or extended family is diminishing with industrialization. Accordingly, now more formalized means are required for mitigating the adverse consequences of uncertainties. Although, individuals cannot predict or completely prevent such occurrences, yet they can provide for their financial effects with the help of insurance. The function of insurance is to safeguard against such misfortune by having contribution of many pay for the losses of the unfortunate few *(Black and Skipper, 2003, pp. 1-2).*

From the long back history of insurance, it is classified as life insurance and non-life insurance/general insurance. The life insurance is a contract between insurance company and policyholder whereby the insurance company promises to pay a lump sum at the time of maturity or death of the policyholder for a consideration called premium. Basically, the working of life insurance business involves two wheels, underwriting and Investment. Both these two wheels are necessary for running of life insurance business smoothly and efficiently. Beside this the flow of these wheels should be in same direction to ensure the viable working of life insurance business. Underwriting by life insurance companies means selling of policies and acceptance of risk by the life insurance company for a nominal consideration of premium by policyholder and the same is invested by the insurance company to meet its obligation on the selling of policies and acceptance of risk. The running of wheels entails underwriting risk/product risk and investment risk for the life insurers and these two have significant impact on the life blood of life insurance companies i.e. capital. In other words, although the policyholder will be free from the burden of risk, the onus will be shifted to the insurance companies. This onus of risk will get multiply when the premium amount is invested by the insurance companies in the market. Therefore, the insurance companies are facing underwriting risk/product risk as well as asset risk having significant impact on their capital. Accordingly, there is dire need to study all such risk under one umbrella to have comprehensive view about the relationship of all such risk with each other simultaneously.

2. Review of Literature

The review of studies has done to explore the concept, framework and state of capital, assets and product risk of Indian life insurance companies. ***Baranoff and Sager (2002)*** explored the relation between capital and risk in the US life insurance industry and provided with the positive relation between regulatory asset risk and capital ratio, but a negative relation between product risk and capital ratio. ***Baranoff et. al. (2007)*** compared the two candidate measures for the role of proxy for asset related risk and provided that RAR and OAR are not equivalent proxies for asset risks. RAR does not seem to affect the capital structure decision of small firms, although OAR does. ***Sherris (2007)*** explored the risk based capital and capital allocation in insurance and provided that the risk based capital is usually held to provide a level of enterprise wide ability to meet obligations and can be regarded as a target capital level. The risk measure that captures the economic value of this risk based capital is the solvency put option value. The frictional cost and costs of market imperfections related to capital also have impact on insurer pricing. ***Krista et. al. (2009)*** explored the market risk capital Requirement for insurance companies by COPULA approach and estimated the two distinct requirements, the Minimum Capital Requirement (MCR) and Solvency Capital Requirement (SCR) for an internationally diversified equity portfolio for an insurance company. ***MacKay and Belgacem (2013)*** explored the interaction between risk, capital, and reinsurance for Property-Liability insurance firms and provided that the short-run adjustments between risk and capital are positive, providing interesting insights into the effects of regulation on insurer behavior. Reinsurance is negatively associated with capital, for which it acts as a substitute. The capital ratio slowly converges to a long-run target and can thus be viewed as leading decision variables, reflecting insurers' priorities. ***Meyricke and Sherris (2013)*** analyzed the longevity risk, cost of capital and hedging for life insurers under solvency II and provided that as the term of the longevity swap increases, its market price increases in line with the volatility of the underlying survivor index. On the other hand, the capital requirements increase in line with the change in the best estimate liabilities under a stress scenario.

From the literature review it is certain that the research studies conducted so far either is in the area of asset risk and capital risk or product risk and capital risk and no consideration is given towards all the components of product risk. like individual business risk, group business risk and annuity risk. Taking into consideration the non availability of comprehensive risk study in case of Indian life insurer, the present study is focusing on interrelationship of all the components of risk like the capital, asset and product risk (comprises of individual business, group business and annuity).

3. Objective and Hypothesis of the Study

The present study is conducted with a view examine the relationship of capital, asset and product risk of Indian life insurer simultaneously. In order to examine this, the product risk is not considered in aggregate rather the individual components of the product risk like individual product risk, group product risk and annuity risk are considered in isolation.

Further, the following conflicting hypotheses are constructed:

H_0: There is positive relationship between asset risk and capital ratio and also between product risk (individual product risk, group product risk and annuity risk) and capital ratio.

H_1: There is negative relationship between asset risk and capital ratio and also between product risk (individual product risk, group product risk and annuity risk) and capital ratio.

Our null hypothesis states that if the life insurance companies deal in more risky product(s) and/or opt for highly weighted risk asset for investment then the requirement for capital will be more to mitigate the uncertainty posed by risky product(s) and investment. On the other hand if the life insurance companies deal in less risky product(s) and/or opt for risk-free asset for investment then the requirement for capital will be less as there will be no uncertainty posed by risky product(s) and investment. This signifies the positive relation of product and asset risk with capital ratio of the life insurance companies. On the other hand the alternate hypothesis assume that despite of highly risky product(s) or investment in high risk weighted assets the requirement for capital will not increase if the company has already entered into an agreement of reinsurance or has credited huge amount of reserve to take care of increase in risk.

4. Data Base and Research Methodology

In order to achieve the objective, the study is conducted with Indian life insurance companies and covered a period of 5 years from 2008-09 to 2012-13. Presently, more than 20 life insurance companies are operating out of which 5 are selected on the basis of base year 2001 i.e. the companies which are operating since 2001 are forming the part of present study. The basic reason behind the selection of base year as 2001 lies in the fact that, this is the immediate year after the establishment of Insurance Regulatory and Development Authority (IRDA), which was introduced in the year 2000, to infuse a new management system and to regulate the Indian insurance companies. Thereby, the insurance companies started to carry out functioning in a new manner in accordance with the provisions of the IRDA. Hence, the following companies fall under the scope of the study: SBI Life Insurance Company Limited, Reliance Life Insurance Company Limited, Tata AIA Life Insurance Company Limited, ING Vyasya Life Insurance Company Limited, and Bajaj Allianz Life Insurance Company Limited.

The detailed information regarding life insurance business is drawn mainly from the annual reports of the life insurance companies under consideration. For this purpose, the respective web-sites of life insurance companies are used. Beside this, other publications related with the insurance are also used for the collection of facts and figures necessary for studying the relationship of capital, assets and product risk. Two-Stage Least Square (2SLS) Regression method of Simultaneous Equation Model (SEM) is used for the analyzing the relationship. The collected data is analyzed with the help of SPSS 16.

4.1 Equation Specification: This section deals with the specification of equation forming the part of the present study. In single equation mode, the partial-adjustment model used by an unobservable target (or desired, or equilibrium) level Y_t^* for an observable response Y_t. Over time, the actual response Y_t adjusts to the target by (partially) closing the gap according to the partial-adjustment hypothesis $Y_t - Y_{t-1} = \delta\ (Y_t^* - Y_{t-1})$, where $(Y_t^* - Y_{t-1})$ is desired change, $Y_t - Y_{t-1}$ is the actual change, and δ is the partial-adjustment coefficient. Although Y_t^* is not directly observable, it is a function Y_t^*=f (X_{1t},…,X_{kt}) of observable predictors. Upon substitution of that function for Y_t^* and rewriting the partial-adjustment relation as Y_t= δ Y_t^*+(1- δ) Y_{t-1}= δ f(X_{1t},…,X_{kt})+ (1- δ) Y_{t-1}, we have Y_t expressed more conventionally for estimation purposes as a function of the predictors and the lag of Y_t.

Earlier studies by some researchers utilized the partial-adjustment model in simultaneous equation mode. But have not considered the individuals components of various faced by the life insurance companies. But we have taken the same into consideration with response variables (Capital to Asset Risk[C], Asset Risk [A], and Product Risk [P]) Comprises of AN_t, IB_t and GB_t.

$$C_t - C_{t-1} = \delta_c (C_t^* - C_{t-1}) + u_t^c$$
$$A_t - A_{t-1} = \delta_A (A_t^* - A_{t-1}) + u_t^A$$
$$AN_t - AN_{t-1} = \delta_{AN} (AN_t^* - AN_{t-1}) + u_t^{AN}$$
$$IB_t - IB_{t-1} = \delta_{IB} (IB_t^* - IB_{t-1}) + u_t^{IB}$$
$$GB_t - GB_{t-1} = \delta_{GB} (GB_t^* - GB_{t-1}) + u_t^{GB}$$

In this we will measure the desired Capital, Asset Risk, Annuity Risk, Individual Business Risk and Group Business Risk adjustment $(C_t^* - C_{t-1}, A_t^* - A_{t-1}, AN_t^* - AN_{t-1}, IB_t^* - IB_{t-1}, GB_t^* - GB_{t-1})$ endogenously, simultaneously and interrelated. But each of the targets $C_t^*, A_t^*, AN_t^*, IB_t^*, GB_t^*$ is a function of exogenous variables X_1, X_2 as well as of concurrent values of the other four observable responses (four of$C_t^*, A_t^*, AN_t^*, IB_t^*, GB_t^*$). The decision of the life insurer for capital and other risks(IBR, GBR, AR, ANR etc.) depends upon their preference regarding matters such size, return on capital earning and retained earnings. Examples of exogenous disturbances for the life insurance industry include changes in legal environment, political environment, Global environment from other financial institutions. Considering all, we will rewrite the equation as:

$$C_t = \delta_C C_t^* + (1 - \delta_C) C_{t-1} + \varepsilon_t^C$$
$$C_t = \delta_C (L(X_{1t}, X_{2t}, A_t, IB_t, GB_t, AN_t) + Y_t) + (1 - \delta_C) C_{t-1} + \varepsilon_t^C$$

Where, L represents the linear form for C_t^* and Y_t is an exogenous disturbance. By rewriting the equations will be as:

$$C_t = \beta_0^C + \beta_C^C C_{t-1} + \beta_A^C A_t + \beta_{IB}^C IB_t + \beta_{GB}^C GB_t + \beta_{AN}^C AN_t + \beta_1^C X_{1t} + \beta_2^C X_{2t} + \varepsilon_t^C \quad \text{(I)}$$

$$A_t = \beta_0^A + \beta_C^A C_t + \beta_A^A A_{t-1} + \beta_{IB}^A IB_t + \beta_{GB}^A GB_t + \beta_{AN}^A AN_t + \beta_1^A X_{1t} + \beta_2^A X_{2t} + \varepsilon_t^A \quad \text{(II)}$$

$$AN_t = \beta_0^{AN} + \beta_C^{AN} C_t + \beta_A^{AN} A_t + \beta_{IB}^{AN} IB_t + \beta_{GB}^{AN} GB_t + \beta_{AN}^{AN} AN_{t-1} + \beta_1^{AN} X_{1t} + \beta_2^{AN} X_{2t} + \varepsilon_t^{AN} \quad \text{(III)}$$

$$IB_t = \beta_0^{IB} + \beta_c^{IB} C_t + \beta_A^{IB} A_t + \beta_{IB}^{IB} IB_{t-1} + \beta_{GB}^{IB} GB_t + \beta_{AN}^{IB} AN_t + \beta_1^{IB} X_{1t} + \beta_2^{IB} X_{2t} + \varepsilon_t^{IB} \quad \text{(IV)}$$

$$GB_t = \beta_0^{GB} + \beta_c^{GB} C_t + \beta_A^{GB} A_t + \beta_{IB}^{GB} IB_t + \beta_{GB}^{GB} GB_{t-1} + \beta_{AN}^{GB} AN_t + \beta_1^{GB} X_{1t} + \beta_2^{GB} X_{2t} + \varepsilon_t^{GB} \quad \text{(V)}$$

Where, $\beta_C^C = 1 - \delta_C$, $\beta_A^A = 1 - \delta_A$, $\beta_{AN}^{AN} = 1 - \delta_{AN}$, $\beta_{IB}^{IB} = 1 - \delta_{IB}$, $\beta_{GB}^{GB} = 1 - \delta_{GB}$

C_t=Capital Risk during the time period t, C_{t-1}=Capital Risk during the previous time, A_t=Asset Risk during the time period t, A_{t-1}=Asset Risk during the previous time, AN_t=Annuity Risk during the time period t, AN_{t-1}=Annuity Risk during the previous time, IB_t=Individual Business Risk during the time period t, IB_{t-1}=Individual Business Risk during the previous time, GB_t=Group Business Risk during the time period t, GB_{t-1}=Group Business Risk during the previous time, X_{1t}= SIZE during the time period t, X_{2t}=ROC during the time period t

4.2 Variables Description

A. Endogenous Variables

1. Capital-to-asset ratio: Capital is wealth owned by a person or organization invested, lent or borrowed excess of company's assets over its liabilities. For capital risk, we have taken the logarithm of the capital to total assets ratio, where capital comprises of shareholder funds and total assets comprises of both current and fixed assets.

2. Asset Risk: Although the life insurance industry is in the business of selling insurance coverage yet it is also in the business of investing the funds entrusted in the form of premium. The investment in the market is subject to various types of risks like market risk, interest rate risk, asset risk, default risk etc. For the purpose of present study we are considering the asset risk which is calculated as:

Step I. The Investment in particular type of asset is multiplied by respective risk weight. (The BASEL II risk weights are considered. The idea behind the usage of these weights is that it helps *to estimate the asset risk involved in investment by the banking industry and the same can be used as proxy to estimate risk involved in investment by the Insurance industry.)*

Step II. Summation of calculation in step I for every investment will give risk based investment.

Step III. Since this penalty-driven portfolio measure depends on the size of the insurer, it is normalized by dividing by firm invested assets.

Step IV. Asset Risk = log of value calculated in step III.

3. Product Risk: The life insurance industry provides an array of products – annuity, life, health, and reinsurance products. Each product sold by the life insurance industry is basically a contract which involves the exchange of risk between insured and insurer. The risk taken by the insurer in the process of selling of policy is called as product risk. For the purpose of present study, all the components of the product risk like individual business risk, group business risk and annuity risk are considered.

a. Individual Product Risk: Individual life insurance is typically offered as a benefit for individual such as himself or herself, children, protection, savings, spouse, parent etc. It is calculated as: *premium collection from individual business divided by total premium collection in a particular year.*

b.Group Product Risk: Group life insurance is offered as a benefit through employer or membership in an association. It is calculate as: *premium collection from group business divided by total premium collection in a particular year.*

c. Annuity Product Risk*:* An annuity is a contract that promises to make a series of payments for a fixed period or over a person's lifetime. The life is uncertain and at the time of selling the annuities, actuaries make estimates. Sometime, an annuity holder survives more than that of estimated life. In this case, the company suffers losses, this is called annuity risk. This is calculated as: *premium collection from annuity business divided by total premium collection in a particular year.*

B. Exogenous Variables

1. Size: In our study size is an independent variable and this is one of the variables assumed to have significant impact on the entire endogenous variable. For the measurement of size, we have taken the *natural log of invested assets* of the life insurance company for particular year.

2. Return on Capital: This is the important variable assumed to have significant impact on the all the risk of life insurance companies as it affect the risk taking capacity of the life insurers. It is calculated as: *profits after taxes divided by shareholder funds.*

5. Analysis and Interpretation

This section deals with the analysis and interpretation and is divided into four parts. Part 5.1 deals with the summary statistics. Part 5.2 deals with Pearson Correlation and Hausman's Specification Test for Exogeneity. Part 5.3 deals with the identification and test for Instrument Variables. Part 5.4 deals with Estimation of Equations with 2SLS Regression.

Part 5.1 Summary Statistics of Variables: Under this the summary statistics of all the variables under consideration is calculated.

Table 5.1

Descriptive Statistics

Variables	Minimum	Maximum	Mean	Std. Deviation
LCR	-0.20585	0.830575	0.458983	0.274933
LAR	1.229668	2.664889	1.604438	0.255542
LANR	-1.47731	1.245259	0.10761	0.910535
LIBR	1.670808	1.987081	1.910069	***0.079413***
LGBR	-1.32489	1.415157	0.56381	0.719782
LSIZE	4.580026	6.371058	***5.586003***	0.461438
LROC	-1.80308	-0.32798	***-0.79701***	0.428319
LAG_CR	-2.55233	3.640065	0.018799	1.329625
LAG_AR	-432.078	407.2993	-0.56294	***124.1962***
LAG_ANR	-17.4086	17.52756	0.020524	8.274526
LAG_IBR	-10.7235	29.10367	1.092961	9.324812
LAG_GBR	-8.88449	10.96664	0.701786	4.810284

The table 5.1 shows the descriptive statistics, comprises of mean, standard deviation, minimum and maximum value of the all the variables under consideration. The mean value is least in case of LROC i.e. -0.079701 whereas highest mean value is in case of LSIZE (5.586003). On the other hand, the standards deviation is least in case of LIBR i.e. 0.079413, whereas highest standard deviation is in case of LAG_AR i.e. 124.1962.

Part 5.2 Pearson Correlation and Hausman's Specification Test for Exogeneity: In order to examine, whether an endogeneity problem exists or not, we have used both Pearson correlation and Hausman's Specification Test of Exogeneity.

5.2.1 Pearson Correlation: The rationale for using the Pearson Correlation is to test an endogeneity problem present in the following equations:

$$C_t = \beta_0^C + \beta_C^C C_{t-1} + \beta_A^C A_t + \beta_{IB}^C IB_t + \beta_{GB}^C GB_t + \beta_{AN}^C AN_t + \beta_1^C X_{1t} + \beta_2^C X_{2t} + \varepsilon_t^C \quad \text{(I)}$$

In other words, we assumed that some of the variables like (AR, ANR, IBR, GBR) has reciprocal relationship with CR and there is an endogeneity problem in the model where one/more/all the explanatory variables are stochastic (i.e., not fixed) in repeated sampling because they are correlated with the error terms of other equations. The other equations are:

$$A_t = \beta_0^A + \beta_C^A C_t + \beta_A^A A_{t-1} + \beta_{IB}^A IB_t + \beta_{GB}^A GB_t + \beta_{AN}^A AN_t + \beta_1^A X_{1t} + \beta_2^A X_{2t} + \varepsilon_t^A$$

(II)

$$AN_t = \beta_0^{AN} + \beta_C^{AN} C_t + \beta_A^{AN} A_t + \beta_{IB}^{AN} IB_t + \beta_{GB}^{AN} GB_t + \beta_{AN}^{AN} AN_{t-1} + \beta_1^{AN} X_{1t} + \beta_2^{AN} X_{2t} + \varepsilon_t^{AN}$$

(III)

$$IB_t = \beta_0^{IB} + \beta_c^{IB} C_t + \beta_A^{IB} A_t + \beta_{IB}^{IB} IB_{t-1} + \beta_{GB}^{IB} GB_t + \beta_{AN}^{IB} AN_t + \beta_1^{IB} X_{1t} + \beta_2^{IB} X_{2t} + \varepsilon_t^{IB} \quad \text{(IV)}$$

$$GB_t = \beta_0^{GB} + \beta_c^{GB} C_t + \beta_A^{GB} A_t + \beta_{IB}^{GB} IB_t + \beta_{GB}^{GB} GB_{t-1} + \beta_{AN}^{GB} AN_t + \beta_1^{GB} X_{1t} + \beta_2^{GB} X_{2t} + \varepsilon_t^{GB} \quad \text{(V)}$$

Accordingly, in this case the Pearson Correlation is determined for the error terms of all the equations in order to find out some useful information regarding the presence of any endogeneity problem in the model. This requires the error term for all the equations, which is determined by executing OLS methods on all the equations. The error terms calculated for all the equations denoted by: ε_t^c, ε_t^A, ε_t^{AN}, ε_t^{IBR}, ε_t^{GBR}

Table 5.2

Pearson Correlation Matrix of All Equations' Residuals

	Equation I	**Equation II**	**Equation III**	**Equation IV**	**Equation V**
Equation I	1				
Equation II	0.278 (0.381)	1			
Equation III	-0.055 (0.864)	-0.384 (0.218)	1		

Equation IV	0.281 (0.377)	0.123 (0.704)	-0.24 (0.453)	1	
Equation V	-0.21 (0.513)	0.414 (0.181)	-0.266 (0.403)	-0.008 (0.979)	1

The table 5.2 shows the results of the correlation coefficients (*r)* among the error terms of the CR, AR, ANR, IBR, GBR equations. The error term of AR and IBR equations are positively associated with CR equation, where as ANR and GBR are negatively associated. The IBR and GBR equations are positively associated with the AR equation; whereas ANR is negatively associated with the ARIn short, the value of r is not 0, which signifies that the error terms of the equations are correlated and there is problem of endogeneity in the model.

5.2.2 Further Evidence on the Endogeneity Problem: The Hausman Test: Although, the correlation coefficients provide useful information on the extent of how endogenous variables and explanatory variables are correlated, yet it does not provide the information regarding how the error terms actually cause the simultaneity problem. Thus, the hypothesis testing for the endogeneity problem is needed. So as an additional check on the findings mentioned above, the "Hausman's Specification Test" is used to diagnose the exogeneity problem. By following the steps as given in *Chmelarova (2007)* the F Statistics are computed as shown in table 5.3.

Table 5.3

ANOVA

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	60.512	4	15.128	63.773	.000
Within Groups	19.689	83	0.237		
Total	80.201	87			

Here the p-value is .000 which is less than .05 which shows that the null hypothesis (***no correlation between x and e)*** is rejected. In other words, correlation exists between the e and various *x* which include CR, AR, ANR, IBR, GBR. This signifies that there is problem of endogenity and reciprocal cause and effect exist in the model.

Part 5.3 Identification and Test for Instrument Variables

5.3.1 Identification of Instrument Variables: For Two Stage Least Square (2SLS) Regression, we require the creation of other variable namely ***Instrumental Variable (IV)*** which will have relation with exogenous variable but not with the error term of the endogenous variable. More formally, variable "Z" is called as an instrument or instrumental variable and for the purpose of present study, the lag of expected endogenous variable is taken as instrument variable and the exogenous variable which are not expected as endogenous are also taken as instrument variable.

5.3.2 Test for Instrument Variables

While testing the Instrument variable(s) (Z), the following two conditions are considered:

Instrument Relevance: Z is correlated with the regressor X or corr (Z_i X_i) ≠ 0

Instrument Exogeneity: Z is uncorrelated with the error u or corr (Z_i u_i) = 0

Instrument Relevance: Z is correlated with the regressor X or corr (Z_i X_i) ≠ 0: In order to check this assumption, the pearson correlation coefficient is calculated for identified Z (LAG_CR, LAG_AR, LAG_ANR, LAG_IBR, LAG_GBR, SIZE and ROC) with X (AR, ANR, IBR,GBR) and the results are shown in table 5.4.

Table 5.4

Correlation Matrix of Z and X

	LAG_CR	LAG_AR	LAG_ANR	LAG_IBR	LAG_GBR	LSIZE	LROC	LAR	LANR	LIBR	LGBR
LAG_CR	1										
LAG_AR	-0.191 (0.36)	1									
LAG_ANR	0.288 (0.17)	0.035 (0.86)	1								
LAG_IBR	0.205 (0.33)	-0.349 (0.09)	-0.589 (0.00)	1							
LAG_GBR	-0.230 (0.27)	-0.094 (0.66)	-0.637 (0.00)	0.077 (0.17)	1						
LSIZE	-0.181 (0.39)	-0.275 (0.19)	0.065 (0.76)	-0.099 (0.64)	0.215 (0.31)	1					
LROC	0.496 (0.07)	-0.66 (0.00)	0.443 (0.11)	-0.242 (0.40)	0.076 (0.79)	0.738 (0.00)	1				
LAR	-0.452 (0.02)	0.674 (0.00)	-0.076 (0.72)	-0.166 (0.43)	-0.202 (0.34)	-0.252 (0.22)	-0.62 (0.01)	1			
LANR	0.403 (0.08)	0.438 (0.06)	0.565 (0.01)	-0.486 (0.03)	-0.582 (0.00)	-0.289 (0.21)	-0.437 (0.15)	0.390 (0.08)	1		
LIBR	0.181 (0.39)	-0.21 (0.39)	-0.230 (0.27)	0.111 (0.60)	0.154 (0.47)	-0.54 (0.00)	-0.202 (0.48)	-0.29 (0.15)	-0.110 (0.64)	1	
LGBR	0.161 (0.49)	-0.379 (0.09)	-0.217 (0.35)	0.048 (0.83)	0.537 (0.01)	0.446 (0.04)	0.599 (0.02)	-0.62 (0.00)	-0.723 (0.00)	-0.074 (0.74)	1

The table 5.4 shows that the Pearson correlation coefficient is calculated for identified Z (LAG_CR, LAG_AR, LAG_ANR, LAG_IBR, LAG_GBR, SIZE and ROC) with X (AR, ANR, IBR,GBR) is not 0. Hence, the correlation exists between various identified Z and X and our identified instruments are relevant.

Instrument Exogeneity: Z is uncorrelated with the error u or corr (Z_i u_i) = 0

It can be checked with the Hansen Test or J-test for Overidentifying restrictions

Null Hypothesis: Instruments are valid or Z is uncorrelated with the error u or corr (Z_i u_i) = 0

Alternate Hypothesis: Instruments are invalid or Z is correlated with the error u or corr (Z_i u_i)$\neq$ *0*

Steps to Conduct Hensen test or J-test for Overidentifying Restrictions and its Result: - Compute the 2SLS results for equation I with included Z (LAG_CR, LAG_AR, LAG_ANR, LAG_IBR, LAG_GBR, SIZE and ROC) and save the prediction and error for the same which will be used to conduct diagnose test. Here the error term saved are called as IV residuals (err_1).

-We perform a regression of the IV residuals (err_1) against all the instruments Z (LAG_CR, LAG_AR, LAG_ANR, LAG_IBR, LAG_GBR, SIZE and ROC).

-Note the R-square from this regression and multiply it by the sample size (N) to get the test statistic. In this case, the degrees of freedom is (m − k) (where m is the number of instruments and k is the number of endogenous variables).

-If the calculated value will be more than the tabulated or critical value then the null hypothesis will be rejected otherwise accepted.

The outcome of the application of above mentioned steps is provided that our null hypothesis which states that all the instruments (Z) are exogeneous, or Instruments (Z) are valid is accepted.

Part 5.4 Estimation of Equations with the 2SLS Regression : After the Pearson Correlation and Hausman's Specification Test for Exogeneity; and identification and testing of instrument variables, we will move ahead for the calculation of coefficient of all equations with 2SLS Regression. The results of 2SLS are shown in table 5.5.

Table 5.5

Equation Estimation with 2SLS

Variables	**Equation I**	**Equation II**	**Equation III**	**Equation IV**	**Equation V**
Intercept	13.568	-18.408	-104.2	13.1	-29.939
CR	-	0.425	11.498	-0.169	1.869
AR	-1.312	-	12.002	-0.863	2.796
ANR	0.201	-0.709	-	0.901	-0.687
IBR	-2.229	2.511	11.387	-	4.178
GBR	0.217	-0.83	-2.879	0.641	-
SIZE	-1.219	2.579	10.987	-1.627	3.005
ROC	-0.196	-0.386	4.642	0.727	0.352
LAG_CR	0.044	-	-	-	-
LAG_AR	-	0.008	-	-	-
LAG_ANR	-	-	-0.134	-	-
LAG_IBR	-	-	-	0.033	-
LAG_GBR	-	-	-	-	0.04
	R Square 0.834 P= 0.163	R Square 0.869 P=0.108	R Square 0.911 P=0.988	R Square 0.536 P=.705	R Square 0.910 P=.054

$C_t=13.568+0.044C_{t-1}-1.312AR_t+0.201ANR_t-2.229IBR_t+0.217GBR_t-1.219SIZE_t-0.196ROC_t$

$A_t=-18.408+0.008AR_{t-1}+0.425CR_t-0.709ANR_t+2.579IBR_t-0.83GBR_t+2.579SIZE_t-0.386ROC_t$

$ANR_t=-104.2-0.134ANR_{t-1}+11.498CR_t+12.002AR_t+11.387IBR_t-2.879GBR_t+10.987SIZE_t+4.642ROC_t$

$IBR_t=13.1+0.033IBR_{t-1}-0.169CR_t-0.863AR_t+0.901ANR_t+0.641GBR_t-1.627SIZE_t+0.727ROC_t$

$GR_t=-29.939+0.04GBR_{t-1}+1.869CR_t+2.796AR_t-0.687ANR_t+4.178IBR_t+3.005SIZE_t+0.352ROC_t$

The table 5.5 shows the results of 2SLS regression for Equation I, II, III, IV and V. The value of R-square is 0.834, 0.869, 0.911, 0.536 and 0.910, which signifies that 83%, 86%, 91%, 53% and 91% of the variation in the CR, AR, ANR, IBR and GBR is explained by the variables taken into consideration. The p value is 0.163, 0.108, 0.988, 0.705 and 0.054 which is more than 0.05 hence our null hypothesis which states that there is positive relationship of capital risk with various risks (asset risk, individual business risk, group business and annuity risk) is accepted. Overall, the results of 2SLS regression on five equations provided that the size of the life insurance companies is positively affecting the AR, ANR, GBR, whereas negatively affecting the CR and IBR. On the other hand, the ROC is positively affecting the ANR, IBR and GBR whereas negatively affecting the CR and AR. It means that if company is earning more return on capital then capital and asset risk will be reduced as the companies can utilized enhanced ROC to manage the its CR and AR efficiently and effectively. On the other hand, more ROC will enhance the company capacity to take more ANR, IBR and GBR thereby signifying positive relationship. Lag of CR, AR, IBR and GBR have positive effect on respective current year figure except in case of ANR. By considering all the factors together have provided that our null hypothesis which states the positive reciprocal relationship of Capital with Asset Risk and Product Risk (Annuity Risk, Individual Business Risk and Group Business Risk) is accepted in all the five equations.

6. Conclusion

The present study is conducted with the objective to examine capital, asset and product risk (including individual business risk, group business risk, annuity risk) of the Indian life insurance companies under one umbrella to have comprehensive view about the relationship The Two-Stage Least Square (2SLS) Regression method of Simultaneous Equation Model (SEM) is used for the analyzing such relationship. The results of the study provided that the value of R-square is 83%, 86%, 91%, 53% and 91%, which explain the significant variation in the CR, AR, ANR, IBR and GBR by the variables taken into consideration. The p-value in all the equations is more than 0.05. Hence, our null hypothesis positive reciprocal relationship of capital with asset risk and product risk (annuity risk, individual business risk and group business risk) is accepted. Hence, on the basis of results it is suggested that the life insurance companies should restructure or reorganize their underwriting and investment business in such a way that increased risk from one business must mitigate from other resulting no erosion of capital. Beside this, the fast increasing competition provided with the survival of the fittest only and in order to ensure their survival, the insurance companies should construct diversified portfolio of investment.

7. Implications and Scope of Further Research

The life insurance companies at the given level of risk, can measure the other type of risk with the help of coefficients indentified through 2SLS regression. The results can also be helpful to the IRDA for the specification of provisions focusing on internal adjustment of risks, so that the life insurance company can manage risks in an efficient and effective way.

Further, the research can be carried out to have a comparative study of general insurance companies and life insurance companies with respect to risk relationship and its management. Beside this, the study can be extended to cover the risk relationship and its management with respect to the segregation between public sector and private sector insurance companies.

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