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A RESOURCE ALLOCATION MODEL FOR INSURANCE MANAGEMENT USING GOAL PROGRAMMING

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In this chapter a linear programming model to determine the optimum allocation of assets in order to maximize profits. The model was based on constraints which reflected policy and legal bounds on the insurer's activities. A model company with assets of Rs.100 million served as the insure. This paper is an analysis of the Goal Programming and current asset returns.

KEYWORDS : Resource Allocation, Insurance Management, National Insurance business Goal Programming.

INTRODUCTION

Insurance is an important risk management tool and is frequently used to protect the Federal Home Loan Banks (FHL Banks), Fannie Mae, and Freddie Mac collectively, the regulated entities) and the Office of Finance (OF) from operational losses. Although the regulated entities use some forms of insurance to mitigate credit risk, insurance as discussed in this module is primarily used to mitigate operational risk. The potential for liability arising from the FHL Bank's operations and system of controls must be reflected in the annual risk assessment required to be conducted pursuant to 12 CFR 917.3 of the former Federal Housing Finance Board (Finance Board) regulations. Fannie Mae and Freddie Mac may also conduct regular risk assessments. Risk assessments should clearly support why and how the regulated entity is, or is not, taking advantage of insurance as a risk mitigation tool. The value of insurance lies in the protection it affords from losses arising from risk control failures or from other causes. The specific insurance needs must be assessed on a case-by-case basis; only by reviewing each policy in force can the actual degree of coverage and protection be determined. In addition, insurance management should be reflected in the regulated entities and OF's business continuity plans as the potential for losses and errors may increase due to a disabling event.

The objective of an insurance management program is to minimize losses and costs arising from certain operating risks undertaken by the regulated entity or OF, such as direct costs of loss prevention measures, insurance premiums, and losses sustained, and related administrative expenses. The board of directors and senior management must determine the maximum loss the regulated entity or OF is willing to accept and must, at a minimum, perform

and document an annual review of the insurance management program. The maintenance of adequate insurance should not, by itself, be viewed as a satisfactory substitute for the other elements of a sound risk management program. Furthermore, each regulated entity and the OF should establish standards for when insurance coverage is needed and establish criteria for appropriate insurance coverage.

DATA OF THE PROBLEM

National Insurance Company Limited was incorporated in 1906 with its Registered office in Kolkata. Consequent to passing of the General Insurance Business Nationalisation Act in 1972, 21 Foreign and 11 Indian Companies were amalgamated with it and *National* became a subsidiary of General Insurance Corporation of India (GIC) which is fully owned by the Government of India. After the notification of the General Insurance Business (Nationalisation) Amendment Act, on 7th August 2002, *National* has been de-linked from its holding company GIC and presently operating as a Government of India undertaking.

National Insurance Company Ltd (NIC) is one of the leading public sector insurance companies of India, carrying out non life insurance business. Headquartered in Kolkata, NIC's network of about 1000 offices, manned by more than 16,000 skilled personnel, is spread over the length and breadth of the country covering remote rural areas, townships and metropolitan cities. NIC's foreign operations are carried out from its branch offices in Nepal. Befittingly, the product ranges, of more than 200 policies offered by NIC cater to the diverse insurance requirements of its 14 million policyholders. Innovative and customized policies ensure that even specialized insurance requirements are fully taken care of.

The paid-up share capital of *National* is Rs.100 corers. Starting off with a premium base of 500 million rupees (50 corers rupees) in 1974, NIC's gross direct premium income has steadily grown to 42799 million rupees (4279.9 corers rupees) in the financial year 2008-2009. *National* transacts general insurance business of Fire, Marine and Miscellaneous insurance. The Company offers protection against a wide range of risks to its customers. The Company is privileged to cater its services to almost every sector or industry in the Indian Economy viz.

Banking, Telecom, Aviation, Shipping, Information Technology, Power, Oil & Energy, Agronomy, Plantations, Foreign Trade, Healthcare, Tea, Automobile, Education, Environment, Space Research etc. National Insurance is the second largest non life insurer in India having a large market presence in Northern and Eastern India. The steady growth in premium income has been commensurately matched by profits over the years. As of March 2009, NIC's general reserve stood at 13080.5 million rupees (1308.05 corers rupees) with a net worth of 5015.97 million rupees (501.59 corers rupees) signaling strong financial fundamentals. No wonder than that NIC has been accorded "AAA/STABLE" financial strength rating by CRISIL rating agency, which reflects the highest financial strength to meet policyholders' obligations. The required information is given in the following table 1.

Table 1

Assets		**Return(in percent)**
A(1)	Bonds	4,55%
A(2)	Common stocks	1.82%
A(3)	Preferred stocks	3.92%
A(4)	Mortgages	4.50%

A(5)	Real Estate	9.00%
A(6)	Cash	8.00%
A(7)	Premium Balances	7.00%
A(8)	Total Assets	6.50%
L(1)	Unpaid Claims or Loss Reserves	5.00%
L(2)	Unearned premium Reserves	7.50%
L(3)	Miscellaneous Liabilities	4.40%
L(4)	Policyholders Surplus	3.65%
L(5)	Total Liabilities	5.02%

GOAL PROGRAMMING MODEL

The goal programming model is expressed as follows:

Minimize $z = \sum_{1} P_{1+} (d_{\cdot 1}^{-} + d_{\cdot 1}^{+})$

Subject to $a_{11XX1} + \ldots + {}^{a}\ln^{x} n + d^{-} - d_1^{+} = g_1$

$${}^{a} m1^{x}1 + {}^{a} m2^{x}2 + \ldots + {}^{a} mn^{x} n + d_{m^{-}} - d_{m^{+}} = g_m,$$

$${}^{b}11^{x}1 + {}^{b}12^{x}2 + \ldots + {}^{b}1n^{x} n \le c_1$$

$${}^{b} r1^{x}1 + {}^{b} r2^{x}2 + \ldots + {}^{b} rnx_n \le c_r,$$

with ${}^{x} j \ge o,\ d_1^{-} \ge 0,\ i = 1, 2 \ldots m,\ j = 1, 2, \ldots n.$

The x_1 represent the variables, a_1 the constantans, g_1 the goals with the first m equations expressing the relationships those which the model must satisfy all times.

The variables d_1 – and d_1 + are called deviational variables and represent possible deviations from the respective goals. The former represent under- achievement and the latter over achievement for the respective goals. For any goal equation, at most one of these variables can be non-zero. If both are zero then the goal has been exactly achieved. If over achievement is allowed, then d_1 + need to appear in the objective function; if under-under achievement is permissible, then d_1 – need not appear there.

The objective function minimizes the deviations from the goals, based on a predetermined priority scheme. High priority goals are satisfied before low priority goals, according to a given order. Deviational variable associate with different goals can have the same or different priorities. A modified linear programming computer code was used to solve the model.

For reference the set of variable and constraints of the linear goal programming model are presented in Tables 2 and 3.

Table 2. Variables in the Model

Assets	**Liabilities**

A(1)	Bonds	L(1)	Unpaid Claims or Loss Reserves
A(2)	Common Stocks	L(2)	Unearned premium Reserves
A(3)	Preferred Stocks	L(3)	Miscellaneous Liabilities
A(4)	Mortgages	L(4)	Policyholders Surplus
A(5)	Real Estate	L(5)	Total Liabilities
A(6)	Cash		
A(7)	Premium Balances		
A(8)	Total Assets		

Others Variables

Y Premiums Written. An insurer with total assets of Rs.100 million is assumed.

Table 3. Constraints of the Model

Constraints No.	**Constraint**	**Explanation**
(1)	$L(4) \geq 3.0$	Policyholder's Surplus (net equity) must equal or exceed 83 million
(2)	$A(1) \geq L1$	The bond portfolio must equal or exceed the reserve for unpaid claims.
(3)	$Y \leq 4L(4)$	Premium volume must be equal to or less than 4 times policy holders surplus.(General rule regulation in several state)
(4)	$A(8)/Y \geq 1.23$	Ratio of assets to premium volume must exceed 1.23 (this is the English cover ratio)
(5)	$A(1) + A(4) + A(8) \geq L(4) + .5[L(1) + L(2)]$	Bonds, mortgages and each asset exceed capital plus one half the sum of the unearned premium reserve and the loss reserve.
(6)	$A(1) + A(4) + A(8) \geq L(1) + L(2)$	Bonds, mortgages and cash must equal or exceed the unearned premium and the loss reserve.
(7)	$A(6) \geq .10L(1)$	Cash on hand should be equal to or exceed 10% or unpaid claims (general liquidity rule)
(8)	$A(7) - .20Y$	Premium balances on an average are assumed to be 20% of premium volume.
(9)	$A(4) + A(5) \leq .03A(8)$	Mortgage plus real estate should be less than or equal to 5% of total assets.
(10)	$.07L(5) \leq L(3) \leq .09L(5)$	Miscellaneous liabilities should be 7 and 9 percent of total liabilities
(11)	$1.(1) - 60Y$	Loss reserves are assumed to be 60% of premium volume.
(12)	$L(2) - .70Y$	Unearned premium reserves are assumed to be 70% of premium volume.
(13)	$A(8) - 100 + 1.1Y$	Total assets are equal to \$100 + 110% of premium volume.

The goal and their relationship to the original constraints together with assumed reasonable priorities are as follows:

Table 4

Priority	Goal Description	Corresponding Constraints from Table 2
1	Liquidity	7
2	Stability	2, 4, 5, 6
3	Profit	Profit Function

The model in Coal Programming, terms with priorities assigned to the deviational variable is now as follows.

$$\text{Minimize } z = P_1 d_1^- + p_2 (d_2^- + d_3^- + d_4^- + d_5^-) = p_3 d_6^-$$

Subject to the goal constraints:

Liquidity (Priority 1—P_1)

$$A(6) - .10L(1) + d_1^- - d_1 + - 0,$$

Stability (Priority 2—P_2)

$$A(1) - L(1) + d_2^- - d_2^+ - 0,$$

$$A(8) - 1.25.x + d_3 - d_3 + - 0,$$

$$A(1) + A(4) + A96) - L(1) - .5L(1) - .5L(2) + d_4 - d_4^+ = 0,$$

$$A(1) + A(4) + A(6) - L(1) - L(2) + d_5 - d_5^+ = 0,$$

Profit Goal (Priority 3—P_3)

$$\Sigma[R91).A(1)] + R.Y + d_6 - d_6^+ - P_0.$$

where R (i)1 represents the after tax return on investment A (i); R is the return on premiums written Y and Po is a given profit goal.

Result and analysis

The solution will be obtained by using QSB^+ computer software will be interpreted as follows A numbers of runs were made for R = – .05, – .025, .0, + .025 and – .05. In order to determine the maximum profit possible for each run, avail high profile goal of Po = Rs. 50 million was set. This goal of course was never achieved, as it served only as an upper bound to the maximum Profit possible for each run. Table 4 shows the allocations for these runs.

Table 5. Allocations for Ranges *R*

Assets		– .05	– .025^R	0.0	+ .025	+ .05
A(1)	Bonds	$95.0	233.5	*	*	*
A(2)	Common Stocks	0.0	0.0	*	*	*
A(3)	Preferred Stocks	0.0	0.0	*	*	*
A(4)	Mortgages	0.0	0.0	*	*	*
A(5)	Real Estate	5.0	14.7	*	*	*
A(6)	Cash	0.0	10.6	*	*	*

A(7)	Premium Balance	0.0	35.3	*	*	*
A(8)	Total Assets	$100.0	294.1	*	*	*
Liabilities						
*L*1	Unpaid Claims	0.0	105.9	*	*	*
*L*2	Unearned Prem. Res.	0.0	123.5	*	*	*
*L*3	Misc. Liabilities	97.0	20.6	*	*	*
*L*4	Policyholders surplus	3.0	44.1	*	*	*
*L*5	Total Liabilities	$100.0	294.1	*	*	*
Y	Premium Written	0.0	176.5	*	*	*
	Profit	4.8	7.5	11.9	16.4	20.8

From Table 5 it is seen that since $A(6) = .10L$ (1), then $d_1 - = d_1 + = 0$. Therefore the Liquidity goal is satisfied. The deviational variables $d_3^- = d_4^- = d_5^- = 0$ in the Stability constraint equations. Since these appear in the objective function alone associated with Priority 2, the Stability constraint equations have all been overachieved. The Profit goal was not achieved and was not expected to do so. It is seen that the range of the values are the same for $R \geq -.025$, only *Y* and Profit changing in this range. *F*or $R = -.05$, underwriting ceases and the insure operates as an investment house. This analysis holds actually for $R \leq -.05$, with profit = Rs. 4.8 holding constant for this range. Because of the manner in which the model was specified, it is possible to construct a linear function relating Profit to return on premium $R \leq Ro$, we have $Y = O$ and Profit = Rs. 4.8.

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