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Measuring Interest Rates Capital Requirement using Asset Liability Management Applied to Life Insurance Business

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Abstract:
Asset Liability Management (ALM) is relevant to, and critical for, the sound management of the finances of any organization that invests to meet its future cash flow needs and capital requirements. For a life insurance company in particular, it is an important component of the actuarial work in the company, and help to define, measure, monitor, modify and manage liquidity and interest rate risk.
This research describes understandings on the issues managing risks through the ALM process and explains the techniques that can be used to measure interest rate risk. Then, a full description of an ALM model given an empirical study in which it is shown how it is possible to manage the assets backing liabilities and interest rate risk using the basic dynamic ALM techniques applied to participating life insurance contracts in the Egyptian insurance market.
Shock scenarios have been applied for this purpose, aiming to get a suitable match between the assets and liabilities in such a way that changes in interest rates by shifts do not affect the financing of liabilities and calculation of the capital requirement for the interest rate risk.
The findings reveal that the ALM process is the most proper and effective strategy for the construction of portfolios in which the risks are eliminated; and should be incorporated into the framework of any insurance company's Enterprise Risk Management (ERM) plan.

Keywords: Asset Liability Management, Cash flows analysis, Duration strategies, Solvency II, Interest rate risk

1. Introduction

Over the last few years, Enterprise Risk Management (ERM), has been the center of attention in the risk management world, where ERM comprises the management of all the risks facing on an organization (both financial and non-financial).

In the process to reach an effective ERM, a technique known as Asset-Liability Management (ALM) has become a cornerstone of risk management and enjoyed remarkable popularity in recent years.

ALM is the practice of managing a business so that decisions and actions taken with respect to assets and liabilities are coordinated. ALM can be defined as "the continuous management process that formulates, implements, monitors, and back tests financial strategies related to assets and liabilities to achieve an organization's risk tolerances and other constraints"[1].

Ensuring that the portfolio is risk efficient is the first step in ALM. A portfolio is said to be risk efficient if the financial objective is maximized for the level of risk taken. The next step is to assess whether the level of risk is appropriate. The amount of risk taken needs to be consistent with the insurer's risk appetite as taking too little risk may be inconsistent with the risk capacity and risk strategy of the company.

The Asset-Liability Manager's main function is to analyze the balance sheet of the company, and its likely evolution over a period of time. This analysis is based on a number of variables for which he anticipates the future evolution (interest rates, business development, macro-economic indicators and other market variables). The main objective is to estimate and control the balance between resources (assets) and expenses (liabilities) to the risks taken by the insurance company, under the constraint of a level of profitability and a regulatory framework [4].

In order to model liabilities, policyholder behavior should be analyzed to determine all liability flows (for example deaths and lapses). If the financial department invests without taking into account the expected behavior of policyholders, then there will be a mismatch with liabilities.

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[1]Based on the definition from Society of Actuaries (SOA), ALM committee on "principles of underlying Assets/ Liability Management"

Based on that, the scale and scope of the life insurance industry combined with the fact that most of its assets are invested in financial securities allows it to be a major participant in these markets and significant long-term capital to other sectors of the economy. Therefore, ALM will be responsible for producing studies providing recommendations on the financial investment, and marketing strategies and also asset allocation [7].

Now a day, the insurance sector in Egypt is growing with the economic growth of the country. Resulting in increasing the demand for insurance service within insurance companies' sell of different insurance policies and this will enlarge the possibility of increasing the penetration rate[2] of the insurance sector.

Furthermore, Egypt economic reform decisions starting from November 2016 will put the country on the track for growth in many sectors, Insurance sector is not far; where many international insurance companies start to study expanding business in the Egyptian market.

With these companies, inherent and significant risks are a major issue as they will increase challenges in the insurance market due to widen of competition and enlarge of company's risk profile, and this actually will impose Financial Regulatory Authority (FRA) in Egypt to develop a new framework in order to confirm that insurance companies operating in the Egyptian market are cope with the ERM framework within guided risk appetite and risk limit.

Hampering the achievement of the target will back to the high fluctuation in the annual development rates in the insurance activities based on the FRA annual insurance report, this can be summarized in the following figure:
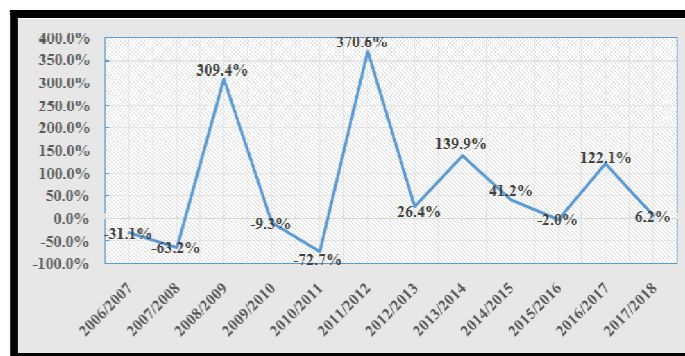

Figure 1: Development Rate for Life Insurance Activities [3]

It is clear from the above figure that;
- There are high fluctuations and instability in the development rates from one period to another.
- In 2009, the development rate was -9.3%; this is due to the decline in the surplus of the insurance activities from 155,292 million to 140,887 million.
- Given that in 2014 shows as decrease in the development rate 41.2% but still positive which means that there is increase in the surplus from 2013 to 2014 but still smaller than that from 2012 to 2013.

These fluctuations might be due to lack in the underwriting process or deficit in the investment strategies and it show how the life insurance sector suffer from some drawbacks that leads insurer struggling in expanding business and meeting the strategic objectives, and also will frightening external insurer from expanding in Egypt. The most critical drawbacks can be summarized in the following table; based on the financial risks that the insurer is facing nowadays.

2. The Asset-Liability Management (ALM) Model

One of the simplest balance sheets for insurers will be considered which only have two main components: assets and liabilities. The ALM model will be separated into two main sub-models for projections of assets and liabilities. A summary for the model will be shown in the below figure:
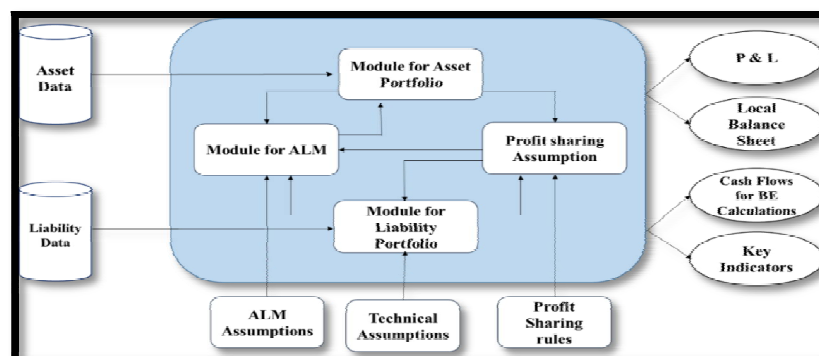

Figure 2: The Overall Structure of the ALM Model

2Penetration rate indicates the level of development of insurance sector in a country. Penetration rate is measured as the ratio of premium underwritten in a particular year to the GDP
3Based on the "Annual Statistical report for Egyptian insurance market", Financial Regulatory Authority (FRA) in for the financial year 2017/2018.

In order to perform the market consistent valuation of assets and liabilities, especially when there are embedded options and guarantees in the insurance liabilities, cash-flow projection model is necessary in order to simulate the development of the balance sheet and the future cash-flow generated from Asset-Liability framework given the best estimate future liabilities.

Best estimate liabilities are calculated on a going concern basis using Embedded Value: the in force portfolio at 31 December 2019 is projected for 30 years in order to obtain the portfolio run-off; the additional premiums that customers may decide to pay in the future are not modeled in compliance with the contract boundaries outlined by the EIOPA[4] specifications, a similar choice was made for the recurring premium policies.

The best estimate is calculated gross of reinsurance, which among other things is not material for the Company's business, and is carried out separately for each policy on the portfolio closed on 31 December 2019 and on the basis of realistic assumptions: Financial assumptions (e.g. Term structure of interest rates) and Demographic or Actuarial assumptions (e.g. Lapse/ Surrender, Mortality/ Longevity, and Expenses).

The risk-free rate curve used to discount future cash flows is estimated using Cox-Ingersoll-Ross (CIR) interest rate model for Egypt Inter Bank Offered Rate (IBOR) 3Months, this is then adjusted to obtain the forward rates useful for considering the minimum investment rate of returns.

2.1. Module for Asset Portfolio

In the asset side, the asset model is used for modeling the development of the asset portfolio. In practice the asset portfolio consists of various financial assets, such as the treasury bonds, corporate bonds, stocks, real estate etc., and since the asset allocation depends on the evolution of financial market, the management rules for determining the proportion of different financial asset classes are usually considered.

For simplicity consider two type of assets: fixed rate bonds and deposits, considering a time horizon $T \epsilon N$, usually greater than thirty years in practice. We will assume that the insurance company only make reallocations at times $t \epsilon N \cap [0,T]$ in order to reach a portfolio with respective weights $w_t^b \epsilon [0,1]$ and w_t^d, the weight invested in deposits, then $w_t^c = 1 - w_t^b - w_t^d$ which is the remaining cash balance, also assume that all assets are hold to maturity.

Assume that different bonds pay coupon at the same frequency: thus at time $t \epsilon N$, the value of a bond with maturity $t + n$, constant coupon c, $P(t, t + n)$ is the nominal value of the bond at maturity with fixed coupon rate c and maximum time to maturity n and a unit nominal value is given by [1];

$$B(t, n, c) = \sum_{i=1}^{n} c\, P(t, t + i) + P(t, t + n) \qquad (1)$$

Also, consider the portfolio containing for any i, $1/n$ bond with maturity $t + i$ and coupon c_t^i, $i \epsilon \{1,2,\cdots,n\}$), then, the average coupon amount for the portfolio of bonds at time $t \bar{B}(t, n, c_t)$ is;

$$\bar{B}(t, n, c_t) = \frac{1}{n} \sum_{i=1}^{n} B(t, i, c_t^i) \qquad (2)$$

In the projection of ALM model, incoming and outgoing cash flows occur in each year. The incoming cash flows include the premium payments at the start of the year, the coupon payments and repayments of nominal for the coupon bonds at maturity at the end of the year.

In contrast, the outgoing cash flows include the benefit payments to the policyholders at the end of the year due to policies maturities or surrenders, with the fulfillment of paying cash flows to shareholders and policyholders the asset portfolio is rebalanced based on market value with constant strategic asset allocation such that majority of the portfolio is invested in fixed income securities ex. Government bonds, corporate bonds, treasury bills, and zero coupon bonds [10].

Starting the year of valuation t, Let FA_t be the value of the fixed rate assets portfolio at the beginning of the year t and C_t is the cash position at the beginning of year t, then the value of the total assets at the beginning of the year;

$$TA_t = FA_t + C_t \qquad (3)$$

At the end of the year, it is expected that the asset portfolio will bring investment's return and this can be separated into coupon on fixed rate assets and interest on cash, given that dealing with the bank deposits using the same bases as the bond valuation techniques.

This will produce coupons collected from the fixed rate assets given that the maturity year n is less than simulated year t;

$$\bar{B}_t = \sum_{k=1}^{m} \bar{B}_k (t \leq n) \qquad (4)$$

Also, interest on cash should be calculated and to do so, the Critical Investment Level (CIL) or investment return rate is calculated first;

$$CIL_t = \frac{Shorfall_t}{C_t} \quad and \quad Shorfall_t = \bar{B}_t - {}_{ph}AC_t \qquad (5)$$

$$I_t^c = C_t \times CIL_t \qquad (6)$$

This will give the critical value of investment required to meet the gap between the payment from coupons and the amount credited to policyholder's account $_{ph}AC_t$ which is the investment return on reserve, the total amount of this gap will be considered as liquidity gap.

Given all of these, the fixed rate assets and the cash position can be calculated as follow;

$$FA_t = \sum_{k=1}^{m} B_k (t \le n) \qquad (7)$$

$$C_t = C_{t-1} + (FA_{t-1} - FA_t) + \bar{B}_t + I_t^c - CF_t^{opr} \qquad (8)$$

This means that if the premium inflow is not sufficient to cover the contractual payments, the cash amount will be used to cover the remaining balance.

2.2. Module for Liability Portfolio

In the module for the liability portfolio, EV valuation approach will be used where the Best Estimates Liability (BEL) represents the total debt of the insurer corresponds to the discounted sum (present-value) of future surrender cash outflows and terminal liability payment.

[6] and [13] use liability portfolios including participating endowment assurance with and without surrender options by considering mortality rates. [12] and [2] use traditional participating life insurance contracts (endowment assurance) by considering the charges and mortality rates in their liability portfolio.

In order to better reflect the life insurance company's liabilities given the valuation will be as easy as possible, but as complicated as necessary, Liability model in the ALM will assume, a traditional participating life insurance contracts (life assurance) with surrender options by considering mortality rates [8].

Throughout the valuation of the insurance liabilities, traditional whole life insurance policy with premiums payable annually in advance ceasing with the policyholder's death or on reaching age 65 if earlier,

The module for liability portfolio that will be used in the ALM model is concerned about certain output from EV model, this can be summarized in the following figure;
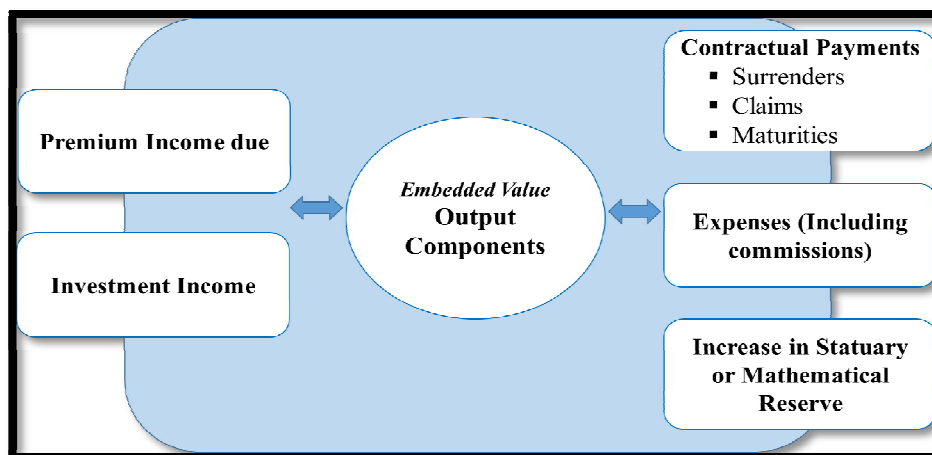

Figure 3: The Output Portion of EV for the Liability Model

During the lifetime of the contract, the insurer should set aside a reserve amount to cover the future obligations, The Mathematical Reserve, denoted by the process $MR_t \, t \epsilon \{0,1,\cdots,T\}$, is the main reserve in life insurance. It corresponds to the insurer's debt towards its policyholders.

It will be assumed that the initial premium MR_0 is paid by policyholders excluding expenses. Thus, the initial value MR_0 of this reserve is given by the initial deposit of the policyholders. At the end of each year, the mathematical reserve is reevaluated by annual benefits (the crediting rate) paid by the insurer to policyholders account [5].

Since all assets are hold to maturities, no Capitalization reserve or Profit-Sharing reserve will be considered in the module for the liability portfolio.

"The future cash flows associated with insurance can be replicated using financial instruments for which a market value is directly observable, the value of Mathematical reserve shall be determined on the basis of the market value of those financial instruments. In this case, separate calculations of the best estimate and the risk margin shall not be required.[5]"

Generally, MR_t could be calculated recursively as;

$$MR_t = MR_{t-1} \times (1 + \max\{r_G, r_{ph}(t)\})$$

$$+ AR_t \times r_{pre}(t) \times (1 + \max\{r_G, r_{ph}(t)\})^{0.5}$$

$$- MR_{t-1} \times r_{surr}(t)(1 + \max\{r_G, r_{ph}(t)\})^{0.5}$$

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[5]Article 76, "Calculation of technical provisions", Solvency II derivative technical specifications.

$$-MR_{t-1} \times r_{ter}(t)\big(1 + \max\{r_G, r_{ph}(t)\}\big)^{0.5} \qquad (9)$$

Where,

$r_{ph}(t)$ → is the crediting rate paid to policy holders' account.

$r_{surr}(t)$ → is the surrender rate used for calculating the surrender amount.

$r_{ter}(t)$ → is the termination rate calculated paid on the mortality experience and used in calculating the maturity amount.

AR_t → is the Allocation after tax deduction, which is the Assigned Capital.

In order to determine the policyholder's earning rate $_h(\ )$ on the period $(t - 1, t)$, a management decision that follows the regulatory constraints and is a reasonable trade-off between policyholders and shareholders' interests is proposed. Most of the existing ALM model use a crediting rate that has been proposed by Grosen and Jørgensen which is the minimal regulatory rate. In this thesis, a more practical approach for the crediting rate will be used. It involves a competitor rate and allocated capital prospective [9].

The terminal bonus declaration is rather simple. The insurer will liquidate part of the allocated amount since it belongs to its policyholders and this will comply with the minimum guaranteed rate of return r_G.

Let the amount to be distributed to policyholders. The credited amount to policyholders is;

$$R_{ph}^t = AR_t \times r_{pre}(t) \times \left[\big(1 + \max\{r_G, r_{ph}(t)\}\big)^{0.5} - 1\right]$$
$$+MR_{t-1}\max\{r_G, r_{ph}(t)\} \qquad (10)$$

2.3. Cash-Flow Matching

Asset-liability matching is a key driver of the profit or loss of an insurance company as the duration of the liabilities is often larger than that of the related assets. The BE of liabilities would change by a larger amount than the BE of assets when interest rate fluctuates, which in turn can create substantial volatility in net income [11].

The first step for the calculation of the cash flows movement analysis, let $^{MV}A_t$ and $^{MV}A_{t+1}$ be the market values of asset portfolio before and after the in/out cash flows, TI_t coupons and interest received on assets and CF_t^{opr} the operational cash flow of liabilities which is the gross premiums inflow after the deduction of the contractual payments, then;

$$^{MV}A_{t+1} = {}^{MV}A_t + TI_t + CF_t^{opr} \qquad (11)$$

Given that,

$$CF_t^{opr} = CF_t^{prm} - CF_t^{con} \qquad (12)$$

Where,

CF_t^{prm} → is the expected future cash flows of gross premiums at time t.

CF_t^{con} → is the expected future cash flows of the future liabilities due to surrenders and maturities plus the expenses including commissions at time t.

The expected present value of cash outflow at time t for the contractual payments can be summarized in the following equation; given $F(t, t + i)$ is the forward discount factor between time t and $t + i$

$$PV(CF_{Out}) = \sum_{i=0}^{i=T} CF_{t+i}^{con} \cdot F(t, t + i) \qquad (13)$$

In order to calculate the expected present value of cash inflows, given that types of inflows can be comprised into principal repayments added to cash value, coupons, and premiums; this can be shown in the following equation; the P_t^{rep} is the expected future cash flows from principal repayments at time t where fixed assets are matured.

$$PV(CF_{In}) = \sum_{i=0}^{i=T} \left[P_{t+i}^{rep} + C_{t+i} + CF_{t+i}^{prm} + \bar{B}_{t+i}\right] \cdot F(t, t + i) \qquad (14)$$

$$P_t^{rep} = FA_t - FA_{t+1} \qquad (15)$$

The difference between cash inflows CF_{In}^t and cash outflows CF_{Out}^t is called the portfolio mismatch $G_{mismatch}^t$. A positive gap $G_{mismatch}^t > 0$; means that assets inflows are sufficient to cover claims. A negative gap $G_{mismatch}^t < 0$; means that additional liquidity is necessary to pay claim-holders. To fill the funding gap, the insurer should sale assets in this situation or invest cash in financial instruments that will fill this gap. In reality, the premium stream from new business might be sufficient to fill in this gap [1].

Therefore, the net cash flow is the difference between the expected market value of assets cash flows and the expected BE liabilities cash flows, this is called Net Asset Value (NAV);

$$NAV = \sum_{i=0}^{i=T} {}^{MV}A_{t+i} \cdot F(t, t + i) - \sum_{i=0}^{i=T} {}^{BE}L_{t+i} \cdot F(t, t + i) \qquad (16)$$

Given the asset portfolio of the participating life insurance contracts, the Macaulay Duration is expected to be calculated for both assets and liabilities as follow;

The Macaulay Duration of the asset's portfolio is;

$$D_{Mac}^A = \frac{\sum_{i=o}^{T} i \cdot [FA_{t+i}] \cdot F(t, t+i) + C_t}{\sum_{i=o}^{T} FA_{t+i} \cdot F(t, t+i)} \tag{17}$$

And the Macaulay Duration of the life insurance liabilities will be;

$$D_{Mac}^L = \frac{\sum_{i=0}^{T} i \cdot CF_{t+i}^{con} \cdot F(t, t+i)}{\sum_{i=0}^{T} CF_{t+i}^{con} \cdot F(t, t+i)} \tag{18}$$

For the ALM duration analysis, the Modified Duration of the asset's portfolio will be;

$$D_{Mod}^A = \frac{D_{Mac}^A}{(1+r)} \tag{19}$$

While the Modified Duration of the liabilities will be;

$$D_{Mod}^L = \frac{D_{Mac}^L}{(1+r)} \tag{20}$$

Where,

$r \to$ is the weighted average interest rate of the simulated yield curve.

In order to determine the effective duration of a cash flow, the present value of the cash flow is calculated in many different ways: with the original term structure of interest rates, with a term structure that is generated if the instantaneous interest rate is increased by a specific amount $(r + \Delta r)$, and if the instantaneous interest rates is decreased by a specific amount $(r - \Delta r)$. The effective duration is then calculated as [3];

$$Duration_{Eff} = \frac{PV^- - PV^+}{2PV_0(\Delta r)} \tag{21}$$

Where,

$PV^- \to$ is the present value of the expected cash flows if the market interest rate decline by Δr.

$PV^+ \to$ is the present value of the expected cash flows if the market interest rate increases by Δr.

$PV_0 \to$ is the initial present value of the expected cash flows based on the original term structure.

Based on the ALM model, the effective duration for assets and liabilities will be based on basis point change in the yield curve given the BE liabilities.

Then, convexity for the asset portfolio is;

$$Convexity^A = \frac{\sum_{i=0}^{T} i \cdot (i+1) \cdot [FA_{t+i}] \cdot \left(F(t, t+i)\right)^{i+2} + C_t}{\sum_{i=o}^{T} FA_{t+i} \cdot F(t, t+i)} \tag{22}$$

And Convexity of the liabilities will be;

$$Convexity^L = \frac{\sum_{i=0}^{T} i \cdot (i+1) \cdot CF_{t+i}^{con} \cdot \left(F(t, t+i)\right)^{i+2}}{\sum_{i=0}^{T} CF_{t+i}^{con} \cdot F(t, t+i)} \tag{23}$$

A positive convexity is a good attribute for an asset to have, for example if the interest rate increases by 100 basis points the asset will gain more value than if the interest rates falls by the same amount. Liabilities, on the other hand benefit from negative convexity.

To estimate the solvency capital for the risk on interest rates, the EIOPA provides upward and downward shocks to the initial term-structure.

The shifted yield curves are then given by;

$$r^{up/down}(t.T) = \left(1 + s_t^{up/down}\right) \cdot r^{mkt}(t.T) \tag{24}$$

Where, s_t^{up} (s_t^{down}) is the upward (downward) shock to the yield with maturity T, and $r^{mkt}(t.T)$ is the market interest rate which is the interest rate term structure obtained from CIR stochastic model. Changes to the interest rates by constant shifting in the yield curve upward and downward will be considered. The SCR for up and down shock are determined by the variation of the NAV if the stressed yield curve is used instead of the initial term-structure [1].

Let $SCR_{up} = \left(NAV_{basic} - NAV_{up}\right)$ and $SCR_{down} = (NAV_{basic} - NAV_{down})$. The SCR for the risk on interest rates is defined as the worse one of the two shocks;

$$SCR_{int} = max\left(SCR_{up}, SCR_{down}\right) \tag{25}$$

3. Main Results

The gap between the interest coming from coupons in the asset side and the amount credit to policyholders in the liability side will constitute what is called the expected shortfall, this is important to determine the Critical Investment Level (CIL) which is the minimum investment rate of return on cash to cover the shortfall happen each year if any.
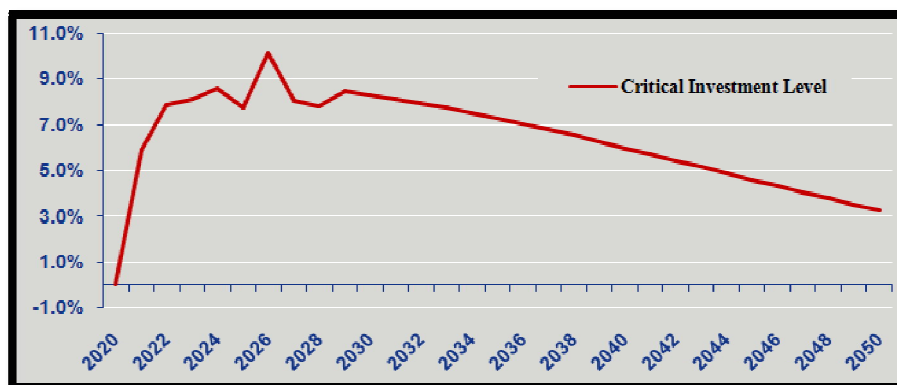
Figure 4: Critical Investment Level

The average CIL is calculated to be 7.27%, when comparing this rate with the investment rate of return in the market from the interest rate term structure; Liquidity gap is equal to 4.5 million.

Analyzing the cash flows is essential step, first of all, it is important to calculate what is called the uncovered position which is calculated based on $FA_t - MR_t$;

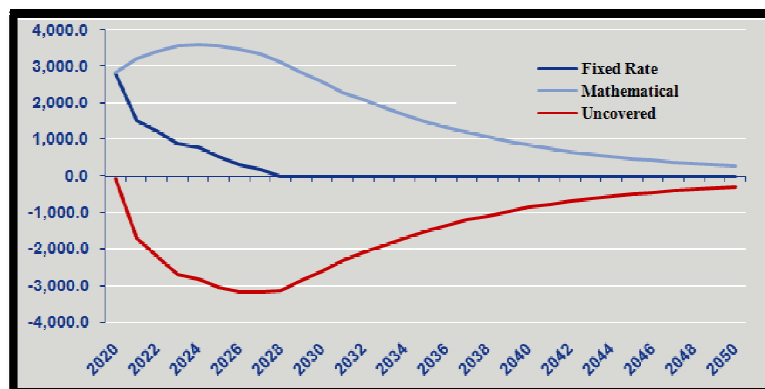The following figure shows how the uncovered position changes over time;

Figure 5: Fixed Rate Asset vs. Net Liabilities Maturity

The figure above shows based on the investment performance, the uncovered position is decreasing over time which is logic because of the accumulation of the mathematical reserves which start at the beginning to be high and once more premiums are collected and sum at risk starts to decline the mathematical reserves decline which in returns push the uncovered position up.
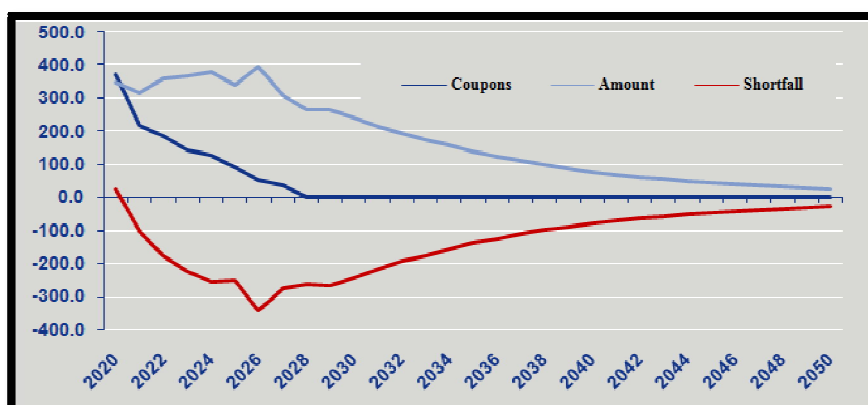

Figure 6: Income from Fixed Rate Assets vs. Credits to Policyholders

Continuing the analysis for the cash flows in the current ALM model, figure 5.3.2 shows that coupons payments from bonds without reinvestment of assets again after maturities and the decline of the amounts credited to policyholders without new business stream which are considered sufficient to build a good view of the future cash flows stream for the shortfall and how to cover it as described before.
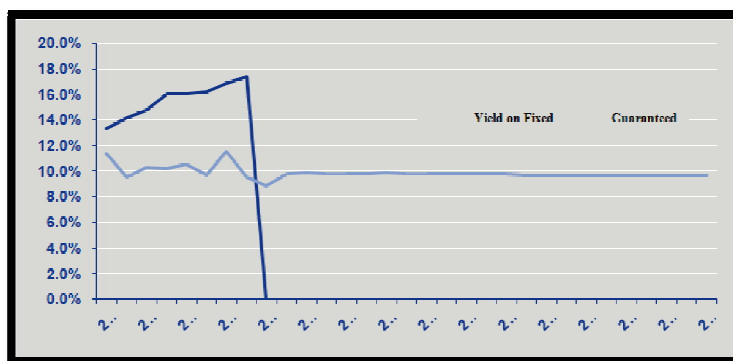
Figure 7: Yield on Fixed Rate Assets vs. Amount Credited on Liabilities

Figure 7 gives a good illustration for the investment mix allocated for the participating contracts portfolio given that the portfolio of assets designed without reinvestment assumptions and mostly it is going to deteriorate between 2027 and 2028, the figure shows the during this period the expected yield from fixed rate assets is higher that of the guaranteed yield, given that the guaranteed yield (GY) is calculated as;

$$GY_t = \frac{R_{ph}^t}{(MR_t + MR_{t+1})/2}$$

Finally, an analysis for cash flow projection and matching over the time period is conducted. The following figure shows the analysis for the liability cash flows;
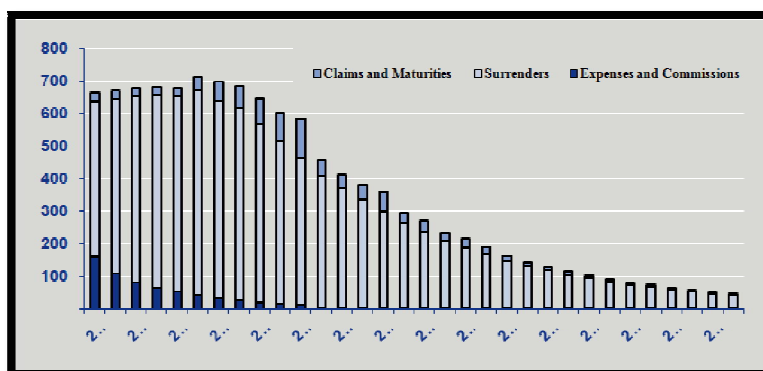

Figure 8: Liabilities Cash Flows

It is clear that payments due to surrenders constitute majority of the contractual payments, and this might be back to lack of awareness for the importance of insurance coverage and also the high competition in the market given that certificate of deposits in banks during this period is giving high investment rate of return compared to any investment benefits offered by the insurance companies.

As a result of that, revising the market plan for the participating contracts is a must on a periodical basis. The following figure shows the cash flows analysis for the liability side in the ALM model;
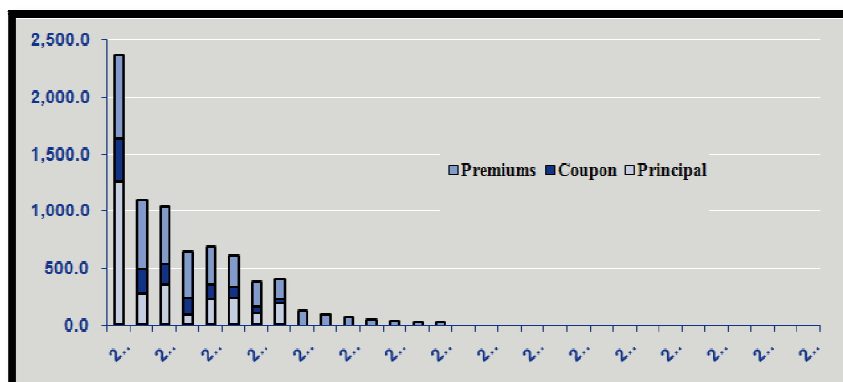

Figure 9: Asset Cash Flows (Including Premiums)

The figure above shows that mostly premiums is considered as the main source for the cash inflows in the business given that in cash flow projections, it is considered that no stream for new business is included when designing the EV model.

The present value of expected shortfall can be financed on annual plan using the CIL average rate, finally the percentage of the liabilities that can be covered by fixed assets is 105.1%, this ratio is sufficient to ensure that all the company's obligations are covered 100%.The average maturities of liabilities (9.4) are greater than the average maturities of assets (2.5), and that's why a duration analysis is important in this situation.

4. Model Evaluation

Based on the ALM model given the BE liabilities and the dynamic duration analysis; the economic balance sheet can be formed as shown in the following table;

	Assets	Liabilities	Assets	Liabilities	Assets	Liabilities
	Present Values		Modified Duration		Convexity	
Fixed Rate Assets w/o Cash	3,120.8		1.83		8.28	
Fixed Rate Assets Incl. Cash	3,125.4		1.83		8.27	
Net Premiums	2,143.0		3.12		16.97	
Contractual Payments		4,816.9		1.82		9.34
S/H equities		451.5		8.1		27.0
Total	5,268.3	5,268.3	2.4	2.4	11.8	10.9

Table 1: Economic Balance Sheet (BE Case, in Mn of Local Currency)

Solvency II own funds are reconciled to IFRS shareholder's equity in order to reconcile between NAV and Shareholder's Equity. At this point testing for the sensitivity of interest rates is essential, so upward/downward shock to the yield curve with 50bps, 100bps, and 150bps, the result can be shown in the following figure;
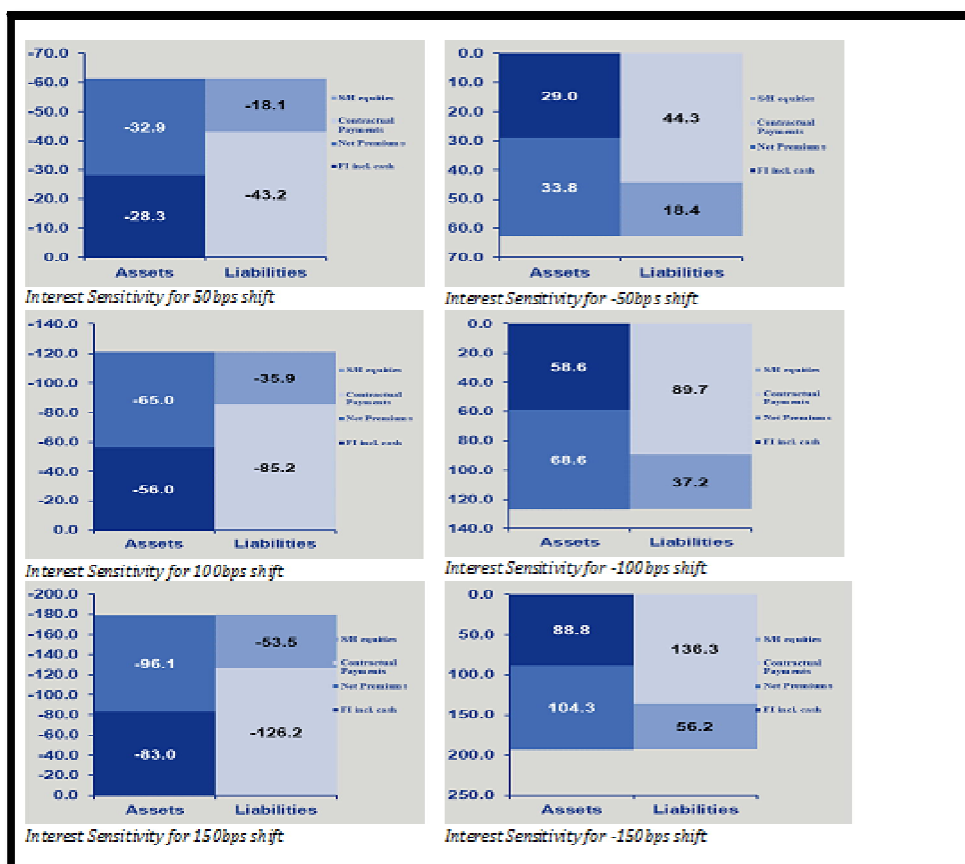

Figure 10: Economic Balance Sheet Sensitivities (In Mn of Local Currency)

The figure shows that the total cash inflows from premiums, coupons, and principal repayments are sufficient to cover the total cash outflows for claims payments, surrenders, and maturity benefits up to 2024, then a deficit situation is found. But the discounted cash flows will give a more realistic picture for the matching process.
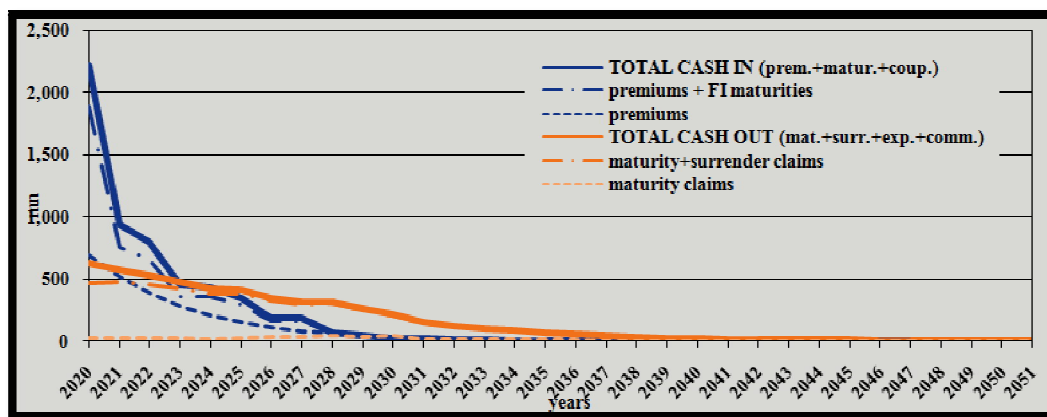
Figure 11: Discounted Cash Flow Matching for Assets and Liabilities

When taking interest rate term structure into account, it is now clear that the present value of cash in flow $PV(CF_{In}) = 5,740$ million $>PV(CF_{Out}) = 5,289$ million.

In order to calculate the NAV, the same shocks should be conducted to the company's cash outflows, the results of this shocks are summarized in the following table;

	Shock	Cash IN	Cash OUT	NAV	Δ Cash IN	Δ Cash OUT	Relative Δ NAV
IR down 200bps	-2.00%	5,920.9	5,962.1	-41.3	180.8	673.5	-109%
IR down 150bps	-1.50%	5,881.7	5,783.3	98.4	141.6	494.6	-78%
IR down 100bps	-1.00%	5,843.6	5,614.1	229.5	103.5	325.5	-49%
IR down 50bps	-0.50%	5,776.7	5,440.2	336.5	36.6	151.6	-25%
Base case	0%	5,740.1	5,288.6	451.5			
IR up 50bps	0.50%	5,704.5	5,144.8	559.7	-35.5	-143.8	24%
IR up 100bps	1.00%	5,670.0	5,008.2	661.9	-70.0	-280.5	47%
IR up 150bps	1.50%	5,636.5	4,878.2	758.3	-103.6	-410.4	68%
IR up 200bps	2.00%	5,604.0	4,754.5	849.5	-136.1	-534.1	88%

Table 2: Sensitivity Analysis for Change in the NAV (Number in Mn of Local Currency)

Given that all shocks upward will create a SCR higher that its downward shocks, then, using the standard formula found, the interest rate risk can be found to be 255 million which is the average of all the upward shocks;

The Actuary needs to be mindful of uncertainties in the incidence of cash flows & parallel shifts in the yield curve, thus a continuous follow up on the assets and liabilities is required.

5 Conclusions

- ALM is simple as a concept: matching a (positive) asset cash flow against a (negative) liability cash flow. If this can be achieved at every duration, then essentially a perfect ALM position has been produced and the reinvestment risk is nil.
- To achieve such a position is almost impossible in the first place, due to market constraints, Government regulations with respect to investments, self-imposed investment policy guidelines, etc.
- Shifts in the term structure of interest rates are the major sources of risk to fixed-income portfolios. Two important portfolio investment strategies in ALM are cash flow matching and immunization. The cash flow matching strategy can be enhanced by allowing cash carry-forward and borrowing from future surpluses.
- The techniques described in this thesis can add significant value to the ALM of a company by understand better the extent to which various aspects of the economic balance sheet (e.g. required economic capital, market value of liabilities etc.) are influenced by the investment strategy.
- Also, it helps in informing investment manager's decisions to identify the best investment strategies for the company within the acceptable level of risk limits; this will improve the Enterprise Risk Management (ERM) framework.
- The NAV may decrease under Solvency II because the market value of "embedded" options in insurance contracts (like profit sharing mechanisms or minimum return guarantees) needs to be considered explicitly.
- Based on the results derived, it appears that there can be significant differences between the traditional measures of duration (i.e., Macaulay and modified duration, and effective duration. Of these measures, only effective duration is capable of properly accounting for the impact of interest rate pressures on assets and liabilities cash flows. This means that effective duration is the appropriate tool for measuring the sensitivity for assets and liabilities of life insurance companies to interest rates when performing ALM.

6. Recommendations

Based on the conclusions above;

- In line with many other results presented in the previous chapter, it is concluded that static regulations, like the prescription of investment constrains or the minimal participation rates for policyholders, are insufficient to control the company's default risk. Instead, regulation as well as internal risk management guidelines should lay more emphasis on prescribing stress tests and stochastic simulations as these methods are much better suited to take into account the complex interaction of the assets and liabilities of a life insurance company.
- The life insurance industry must not delay efforts to integrate an ALM process into its investment management strategy, given the unstable financial market, and the competitive nature of the industry, an ALM process is critical to the profitability and solvency of life insurers.
- The important aspect of the recommendation is not which mode to select - this is a matter of management discretion and resources. Instead the pressing issue is that all insurers embark upon a plan which provides for an integrated ALM process.
- Also, potential further studies surrounding the discount rates applied is highly recommended, given their huge impact on the value of assets and liabilities, where using other interest rate models (e.g. Hull-White, Nilsen Sigel, Svensson models) might improve the results for the board approved risk limits.
- With the ongoing extensive work on valuation modeling in academia and outside academia, the day will soon come when valuation models based on more realistic stochastic processes will be available in the Egyptian insurance market. When that happens, ALM can be fully, efficiently and correctly undertaken.

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