ASSET-LIABILITY MANAGEMENT AND ASSET ALLOCATION FOR PROPERTY AND CASUALTY COMPANIES - THE FINAL FRONTIER

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Summary

This paper provides an overview of the asset-liability management and investment process employed by USF&G. We call this five step process the Asset-Liability Management Efficient Frontier (ALMEF). The goal is to provide a framework for superior investment decision making. The five step ALMEF process:

1. Economic evaluation of the balance sheet which considers the ongoing nature of the business,

2. Evaluation of capital markets employing a stochastic economic simulation model,

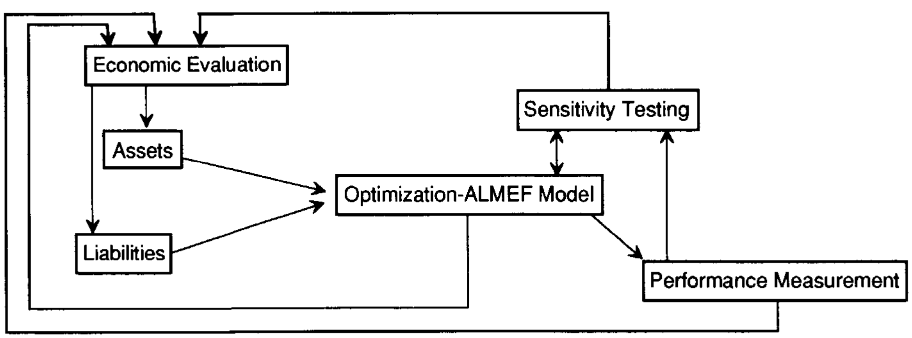
3. Surplus optimization utilizing a multi-time period non-linear optimization model which develops efficient frontier portfolios that explicitly consider the liability cash flows and characteristics, as well as being dynamically linked to changing capital market scenarios,

4. Sensitivity testing of key asset, liability and capital market factors, and

5. A performance measurement system that culminates in a liability benchmark index.

The process loops back to step one at various stages and is reevaluated on an ongoing basis. A diagram of the process is provided below. The result is a prospective investment policy and strategy that considers not only the liability profile for the existing balance, but also how the balance sheet will look going forward.

Exhibit 1. ASSET-LIABILITY MANAGEMENT EFFICIENT FRONTIER



Gestion actif-passif et répartition des avoirs pour les sociétés d'assurance de biens et risques divers - La dernière frontière

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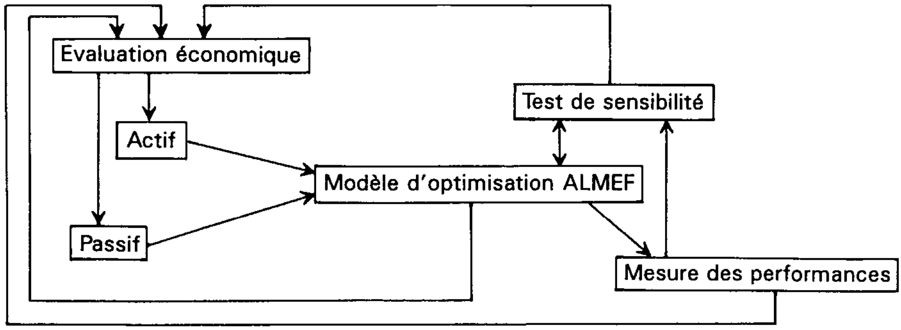
Résumé

La présente étude examine l'ensemble du processus de gestion actif-passif et d'investissement utilisé par l'USF&G. Nous appelons ce processus en cinq étapes le processus de gestion actif-passif à la frontière efficiente (ALMEF). L'objectif visé est de fournir un cadre permettant de prendre des décisions d'investissement optimales. Le processus ALMEF comprend les cinq étapes suivantes :

1. Evaluation économique du bilan reconnaissant la nature continue des activités,
2. Evaluation des marchés des capitaux au moyen d'un modèle de simulation économique stochastique,
3. Optimisation des excédents en utilisant un modèle non-linéaire multipériode qui définit des portefeuilles à frontières efficientes en prenant en compte explicitement les flux financiers et les caractéristiques du passif, tout en étant lié aux scénarios d'évolution des marchés des capitaux,
4. Test de sensibilité des principaux facteurs de l'actif, du passif et des marchés des capitaux, et
5. Système des mesures des performances qui aboutit à la définition d'un indice repère du passif.

Ce processus ramène en boucle à l'étape numéro un et la réévaluation se poursuit en continu. On trouvera ci-dessous une représentation graphique du processus. Le résultat est une stratégie et une politique d'investissement prospectives qui ne considèrent pas uniquement le profil du passif du bilan existant mais également les caractéristiques futures de ce bilan.

Figure 1. Gestion actif-passif à la frontière efficiente



ASSET-LIABILITY MANAGEMENT AND ASSET ALLOCATION FOR PROPERTY AND CASUALTY COMPANIES - THE FINAL FRONTIER

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This paper provides an overview of the investment process employed by USF&G in the form of a case study of the evolution of the investment and asset-liability management (ALM) functions at USF&G's property and casualty company. Our objective is to provide the ideal framework for developing, managing, and implementing the investment process. Our goal is to maximize shareholder wealth through optimal utilization of our assets with respect to the underlying liabilities. We will walk you through the critical elements, some hurdles that must be overcome, and major implementation issues.

A prerequisite for the ALM Process is the understanding and approval of senior management, product line heads, and actuarial and investment personnel. At USF&G, the entire investment department has a basic understanding of all business segments with respect to major differences, business characteristics, organizational structure, and business plans and strategies. Our investment policy statement and guidelines are not only written in a corporate context, but also consider each major business segment.

There are five crucial steps involved in developing the asset allocation - asset-liability process that we call the Asset-Liability Management Efficient Frontier (ALMEF).

1. First, an "economic" evaluation of the balance sheet, an assessment of the market values of assets and liabilities, and a determination of capital requirements.

2. Second, an evaluation of the capital markets and determination of equilibrium economic assumptions utilizing a stochastic economic simulation model.

3. Third, optimization of the assets and liabilities (surplus optimization) utilizing a non-linear optimization model that employs a multi-period stochastic diffusion process to generate the asset-liability efficient frontier.

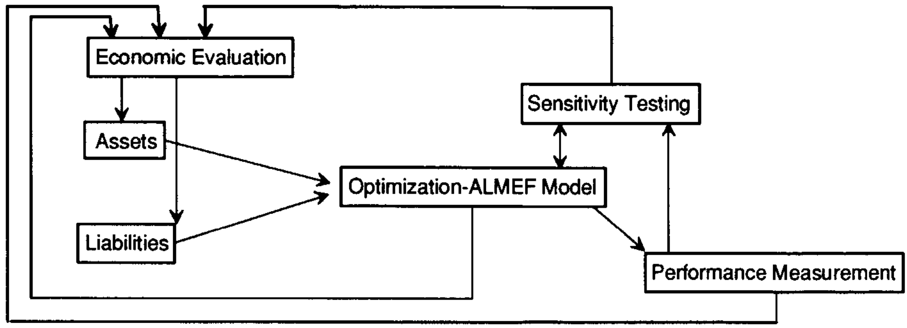
4. Fourth, sensitivity testing for key factors such as inflation, renewal assumptions, loss ratio variability, and capital market equilibrium factors.

5. The final step is the development of a performance measurement system to evaluate actual performance versus the chosen optimal portfolio. The process loops back to step one at various stages and is reevaluated on an ongoing basis.

A senior ALM committee has overall ALM decision making responsibility and approves policy, sets guidelines and constraints, and evaluates performance. Additionally, lower level working committees coordinate efforts, ensure open communication, determine asset allocation and investment strategy, and contribute to product design and pricing on a business segment basis. The lower level committees' primary functions involve analysis, formulation, and recommending policy and strategy.

This paper will address only the ALMEF Process, although both the aforementioned prerequisite and ongoing issues are critical to the success of the ALM process. Exhibit 1 is a flow chart depicting the ALMEF process.

Exhibit 1. ASSET-LIABILITY MANAGEMENT EFFICIENT FRONTIER



I. ECONOMIC EVALUATION OF THE BALANCE SHEET

The first and most critical step of the asset-liability process is the evaluation of the balance sheet.

Asset Evaluation

Most companies view their balance sheet from a Statutory or GAAP perspective (i.e. book value basis), however this evaluation must be conducted on a market value basis. In the long run, a market value basis will provide the best economic benefit. Additionally, with the 12/15/93 implementation of FASB 115, a move toward market value accounting has already begun. Most companies' assets consist of marketable securities. Therefore, a conversion to market value basis is relatively simple with the exception of investments such as private placements and real estate.

The ALMEF model uses asset indices as proxies for asset classes. A thorough analysis and understanding of the key characteristics of major asset classes is necessary to ensure that the proxies serve as reasonable representations of actual portfolios. Our fixed income analytical model, CMS Bondedge[1], allows us to evaluate the effective or option adjusted duration and the four factor duration (parallel, non-parallel, quality spread and pass thru spread). We then compare key characteristics and return profiles under various scenarios to proxy indices thus ensuring that our proxy indices serve as reasonable comparisons to our actual holdings. Our proxy portfolio explicitly incorporates the asset classes' spread to relevant treasury, duration, convexity, and volatility. To approximate the effect of taxes, the tax exempt proxy needs to be adjusted according to an anticipated tax profile. Below is a list of some asset classes we employed, although many other classes can be modeled.

Fixed Income
- U.S. Government - Short
- U.S. Government - Intermediate
- U.S. Government - Long
- U.S. Corporates - 1 - 5 year
- U.S. Corporates - 5 - 10 year
- U.S. Corporates - 10 +
- Mortgage-Backed
- Short Term
- High Yield

Equities
Equity Real Estate

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1 CMS Bondedge is a fixed income analytic software package developed by Capital Management Sciences.

Liability Evaluation

Perhaps the single most difficult aspect of the ALMEF Process is the liability evaluation. The duration measure used for property and casualty liabilities is a modified duration, which is often referred to in terms of sensitivity to interest rate change. No one single liability duration methodology is necessarily correct, therefore each company should resolve the following issues based on its viewpoint and business situation.

1. Is "Liquidation" duration or "Ongoing" duration more appropriate? Stated differently, should one examine only the existing balance sheet or consider the company as a going concern.
2. How is "Ongoing" duration derived?
3. How sensitive are the renewal assumptions?
4. What is/are the appropriate discount rate(s)?

At USF&G, we employ the concept of "Ongoing Duration", which is based on the going concern theory. Much work has been completed in this area for property and casualty companies by respected ALM practitioners. Two interesting articles espousing a market value basis and going concern methodology were written by Alfred Weinberger[2] and William H. Panning.[3] At USF&G, we define Ongoing Duration as the effective liability duration given the payout profile of existing reserves and of new and renewal business. (Liquidation duration considers the payout pattern of existing liabilities only). We execute the analysis at a detailed level, by numerous lines of business, and consolidate the results by primary business segment. USF&G's changing business mix makes it essential to develop investment strategy based on a forward or ongoing evaluation of the liabilities. The calculation of Ongoing Duration requires the support and cooperation of both reserving and pricing actuaries, business segment heads, and senior management.

When using the Ongoing Duration methodology, a decision must be made whether to factor in renewals only, new business, or a blend of both. Exhibit 2 illustrates the range of liability durations depending on the methodology employed.

Exhibit 2. Liability Durations - Personal Lines

	Duration
Liquidation Duration	1.5
Include renewals only	4.4
Include new business for 3 years, then renewals only	5.1
Include new business indefinitely	10.8

Obviously the methodology employed will significantly affect the liability cash flows, the duration, and hence the asset allocation decision.

Additionally, the liability duration is extremely sensitive to the renewal assumption(s). Exhibit 3 illustrates the change in personal lines' duration as a function of the change in the renewal rate. A zero percent renewal rate is equivalent to the liquidation duration.

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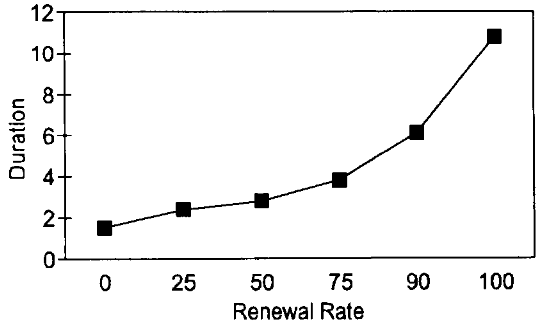
2 Alfred Weinberger, "Allocation Techniques For An Asset/Liability Portfolio", ICFA Continuing Education: Managing Asset/Liability Portfolios, (AIMR, 1991), 21-27.

3 William H. Panning, "Asset-Liability Management For A Going Concern" Working Paper, (The New York University Salomons Center's Conference On: The Dynamics of the Insurance Industry, May 20-21, 1993.)

Exhibit 3. Personal Lines - Renewal Rate Sensitivity

Renewal Rate	0%	25%	50%	75%	90%	100%
Duration	1.5	2.4	2.8	3.8	6.1	10.8



Renewal rate is critical in determining the appropriate duration of liabilities. Note that the relationship is not linear. Further, since this duration is a combination of expected payments on existing reserves and expected payments on new and renewal business, the duration will not be the same for any two companies.

After agreeing on a duration methodology and obtaining current (calendar year) and future (accident year) payout patterns, the next hurdle in liability evaluation is the determination of a discount rate(s). Is a before or after tax discount rate more appropriate? Does one discount by one treasury rate for all product lines, such as implied treasury rates as a function of each product line's liquidation duration, or a series of discount rates as a function of the spot treasury curve? The discount method chosen can have a significant effect on the durations and market values for longer tailed lines. An example of the duration impact is given below for the longer tailed workers' compensation line compared to the shorter tailed fire line.

Exhibit 4. Duration - Discount Rate Sensitivity

Discount Rate	4%	7%	10%
Workers' Comp Duration	8.7	6.7	5.3
Fire Duration	1.2	1.1	1.0

Because the model we employ explicitly factors in the actual liability cash flows to derive the asset allocation, different discounting methodologies will result only in a different starting surplus (market value of current assets less market value of existing reserves plus capital) and will not materially impact the asset allocation. For simplicity and consistency with our optimization model, we chose the implied normalized treasury rate based on the overall liabilities' average liquidation duration.

Capital

The final phase of developing a market value based balance sheet is determining the appropriate capital to allocate to each business segment. At USF&G, we tied in the ALMEF model with our capital allocation model. The capital allocation model derives required assets and minimum Risk Based Capital, based on NAIC requirements, for each business segment. Our capital allocation and ALMEF processes utilize a consistent framework and the same key inputs (payout pattern, business plan, discount rate, market value basis). One can argue that more or less capital could be allocated to different lines of business. However, using the minimum Risk Based Capital for each line not only provides a consistent framework, but also allows us to evaluate the effect of increasing the growth rate for various lines and the resulting impact on capital.

Resolution of the asset, liability, and capital issues allows one to develop a market value based balance sheet. Market value analysis is utilized not only for balance sheet evaluation, but also to segment the assets by business unit. At USF&G, we've segmented our property and casualty company into five categories. Segmentation allows us to explicitly differentiate between business segments. Actual allocation of existing assets has proven to be a tedious and painful procedure but should ultimately lead to a more rational investment process for each business segment. Business segment heads are involved in the ALM process through our working committee structure. The long term development of investment portfolios will be driven by the distinct liability profiles of each line of business. Two crucial requirements for segmentation are accurate cash flow information by segment and an investment accounting system that supports segmentation.

II. EVALUATION OF THE CAPITAL MARKETS - ECONOMIC SIMULATION

Accurate evaluation of the capital markets requires both historical data and the corporate viewpoint concerning future expectations. Capital markets' analysis involves specifying both the current environment and the long term equilibrium assumptions for key economic and capital market factors (inflation, interest rates, and asset classes). The model employed at USF&G is a stochastic economic simulation model that allows one to customize asset class assumptions.[4] Asset classes are defined relative to core classes (fixed income, equity, and cash) to maintain consistency. Additionally, fixed income categories are defined as a function of their anticipated yield (spread to relevant treasury), duration, convexity, and default or volatility risk. The model also allows one to select the desired time horizon, and to analyze the results in nominal, real or income based returns.

The stochastic economic simulation model has several advantages over traditional lognormal models. Lognormal models provide an extension of the single period mean/variance models pioneered by Dr. Harry Markowitz, thus allowing multi-period simulations.[5] They assume asset returns will follow a lognormal distribution. (A logarithmic curve is similar to the shape of traditional efficient frontier curves. Since a logarithmic curve is the inverse of an exponential curve, it follows that the curve increases at a decreasing rate).[6] To accomplish this multi-period extension of the Markowitz model, several key assumptions are required. First, in order to allow for multi-period simulation, the assumption is made that year to year returns are independent. Second, equilibrium assumptions must remain constant (constant return and variability assumptions). These assumptions oversimplify actual market and asset class relationships. Both stocks and bonds have been shown to have varying amounts of serial correlation and to exhibit mean reversion to capital market factors, thereby implying year to year returns are not independent.[7] Additionally, lognormal models require equilibrium assumptions that reflect a set of constant return expectations and constant variability, precluding the use of initial market conditions.

Our model's principal advantage over a mean/variance or lognormal model is the ability to reflect the dynamic processes inherent in the economy through the utilization of stochastic differential equations which allow for changes in inflation and interest rates in order to project the future behavior of assets for more than one period. The model starts with the user-specified generation of current and equilibrium economic variables (interest rates and inflation). Capital market factors are generated consistent with the economic variables. The model then develops a range of up to 500 scenarios or possible outcomes. The stochastic economic simulation has the following benefits and considerations relative to a lognormal model:

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4 Towers Perrin's Cap:Link System is the economic simulation model employed at USF&G. (See Appendix A: General Structure of Cap:Link

5 Stephen M. Sonlin and John C. Sweeney, "Stochastic Forecasting: An Alternative to the Log Normal Model" (International Association of Business Forecasting, Sixth Annual Conference, 1991.)

6 Alpha C. Chiang, Fundamental Methods of Mathematical Economics, 3rd ed. (New York: McGraw-Hill, Inc., 1984), 288.

7 Stephen M. Sonlin and John C. Sweeney, "Economic Simulation Models: A General Description" (Society of Actuaries: Pension Forecast Bootcamp - Fall Education Series, 1992.)

Benefits

1. Provides a more realistic return generation as opposed to the assumed independence of year to year returns generated from a lognormal model.
2. Ensures stable interest rate distributions while explicitly dealing with the concept of mean reversion.
3. Allows both initial and equilibrium economic assumptions.
4. Develops capital market and economic returns on a consistent basis.
5. Provides the means for a link between assets and liabilities.

Considerations

1. Complexity - more assumptions to consider and explain.
2. There is no standard approach to generating interest and inflation models.

We believe the benefits far outweigh the complexities, and the model provides a much better assessment of assets' behavior with respect to liabilities under changing economic environments.

III. STOCHASTIC OPTIMIZATION

There are many methodologies for performing optimization. Traditional mean/variance optimization models as pioneered by Dr. Harry Markowitz require the input of means, variances and correlations. Quadratic programs can then be used to solve for the efficient frontier.

The model employed at USF&G is a multi-period non-linear optimization model which utilizes the simulation results obtained from the above-referenced economic simulation model. These models, developed by Towers Perrin,[8] consider both assets and liabilities, resulting in a surplus optimization that maximizes final surplus with respect to the standard deviation of surplus. The principal advantage over the mean/variance or lognormal model is the ability to handle multi-period optimization problems dealing with dynamically changing distributions that cannot be solved by the use of quadratic algorithms. Additionally, liability cash flows are modeled with respect to simulated interest rates and inflation to ensure consistency of assets and liabilities. The model allows for multiple asset class constraints that can consider acceptable ranges for duration, risky assets, and income requirements. The optimization model then analyzes up to 500 scenarios or possible outcomes to determine the asset allocation that maximizes the specified reward objective with respect to a particular level of risk. This process is then repeated for all possible risk levels resulting in the formation of an efficient frontier. The model allows for optimization based on return on assets or surplus. At USF&G, we optimize based on maximizing surplus subject to a minimum income requirement.

IV. SENSITIVITY TESTING

The fourth step in our ALMEF process is to test the key input factors such as renewal rates, inflation and interest rate sensitivity of future premiums and liability payouts, changes in capital market equilibrium assumptions, and variability of loss ratios. Sensitivity testing will highlight the major factors affecting each business segment and the degree to which those factors affect each segment. Each factor needs to be tested independently, and relevant factors should be tested in tandem. Sensitivity testing allows one to assess the individual as well as collective impact of modifying key factors by business segment.

The result is an investment strategy which considers not only the existing balance sheet, but also future business, renewals and sensitivity to key asset-liability factors, as well as capital market factors leading to a range of optimal asset allocations. For example, the illustration below shows the impact on duration and portfolio mix from changing the renewal rate for personal lines from 75% to 90%. Suppose that the ALM Efficient Frontier produced the following asset allocations for the same risk level (i.e. standard deviation of surplus):

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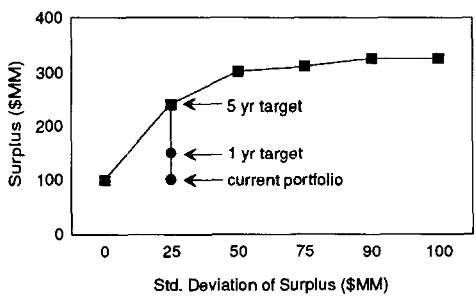
[8] Towers Perrin's ALF:Link System includes the CAP:Link Economic Simulation Model and Opt:Link Optimization model.

Renewal Rate	75%	90%
Duration	3.8	6.1
Asset Allocation:		
1-5 year corporates	25%	20%
5-10 year corporates	45%	30%
10 + year corporates	30%	50%
	100%	100%

By selecting a constant risk level, one effectively creates the target asset allocation ranges for each business segment. This method provides a rationale for an investment policy statement. The testing also provides a range of durations and a means to assess risk for each business segment. Sensitivity testing is a critical process in terms of ascertaining both the behavior of a liability and its effect on asset mix, and also of developing a profile by business segment for the investment policy statement.

V. PERFORMANCE MEASUREMENT

No process is complete unless there is a mechanism to assess results. The final step in our ALMEF process is performance measurement. As mentioned above, sensitivity testing allows us to derive optimal asset allocation ranges. Based on these ranges and the current portfolio mix, we select a short term and long term target allocation. In theory, one would wish to move to the optimal portfolio immediately. However, income requirements and regulatory constraints make that impracticable. An illustration is provided below:



Asset Mix	Current	1 Yr Target	5 Yr Target
1-5 Yr. Corp.	25%	20%	20%
5-10 Yr. Corp.	45%	40%	30%
10+ Yr. Corp.	30%	40%	50%
	100%	100%	100%

Since the asset allocations are driven by the liability cash flows and sensitivities under 100 (the model allows up to 500 simulations) stochastic economic scenarios, the optimal target mixes derived in the ALMEF model serve as liability proxies. In the above illustration, the one year target optimal allocation for personal lines is comprised of 20% 1-5 year corporates, 40% 5-10 year corporates, and 40% 10+ year corporates; the weighted average return of the three respective indices is used as the one year target proxy for personal lines. One would then assess the actual portfolio performance compared to these synthetic liability indices, which are measured by utilizing readily available market return data. The model produces not only total return, but also income estimates; therefore we measure investment performance on an income basis as well.

SUMMARY AND CONCLUSIONS

In summary, the ALMEF process at USF&G serves as a guideline or framework for better investment decision making. The five step ALMEF process:

1. economic evaluation of the balance sheet,
2. evaluation of capital markets employing a stochastic economic simulation model,
3. ALM optimization utilizing a multi-time period non-linear optimization model,
4. sensitivity testing, and
5. performance measurement

requires a coordinated effort among numerous departments, extensive and ongoing communication, senior management's support, and appropriate systems capabilities. The result is a prospective investment policy and strategy which considers not only the liability profile for the existing balance sheet, but also how the balance sheet will look going forward. At USF&G, we've taken what many companies may approach intuitively and quantified and implemented the process to not only assess asset-liability characteristics and sensitivities, but more importantly to determine optimal investment strategies which maximize surplus and ultimately improve shareholder wealth.

APPENDIX A: GENERAL STRUCTURE OF CAP:LINK

CAP:Link utilizes diffusion models to generate stochastic projections of economic and capital market variables. A diffusion model is simply a process which attributes the change in a particular variable to two separate components. These components include an expected change and a random shock term, both of which are functionally related to the time interval involved. More specifically, the diffusion models used within CAP:Link are variations of general stochastic models where only the present state of the process is relevant for projecting the future. This type of stochastic process is referred to as a Markov process.

The random shock term used within CAP:Link's diffusion models follow a Wiener process. A Wiener process (also referred to as Brownian motion) is a particular type of Markov process such that if z follows a Wiener process, then:

$$\Delta z = \epsilon \sqrt{\Delta t}$$

$$dz = \epsilon \sqrt{dt} \qquad \text{as } \Delta t \rightarrow 0$$

Where,

ϵ is a random sample from a standardized normal distribution and values of Δz are independent for any two intervals of time, Δt

The full form of the diffusion models used within CAP:Link are derived in full or in part by variations to one of the following processes:

Generalized Wiener Process (Brownian Motion With Drift);

$$dx = \mu\, dt + \sigma\, dz$$

Geometric Brownian Motion:

$$\frac{dx}{x} = \mu\, dt + \sigma\, dz$$

Ito Process:

$$dx = \mu\,(x, t)\, dt + \sigma\,(x, t)\, dz$$

Orstein Uhlenbeck Process:

$$dx = k\,(\mu - x)\, dt + \sigma\, dz$$

where,

μ = mean drift rate
σ = instantaneous volatility
k = mean reversion rate
dz = a Wiener process

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