

# **State of the Art in Applying Economic Scenario Generators in the Life Insurance Business in the U.S.**

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## **What is the state of practice in applying economic scenario generators in the life insurance business in the U.S.?**

There is a lot of experience with using stochastic ALM systems and different generators

There is some experience with using pricing systems for assets and an interest rate model, but a lot of this is black box. Because of this the properties of the generator and the link to the resulting prices is not well understood. This is also true on Wall Street where the use of models with too many parameters has led to a failure to understand what the models mean, and the link to their meaning to the results. Wall street throws parameters at problems, and throwing parameters at a problem means right away you give up thinking about what is going on.

In contrast in ALM, there is more thought about the properties of the generator, its meaning so to speak, and the results of the ALM runs, e.g. profitability and capital.

**In the Life ALM business, we try to understand what the model means in the context of its application.**

This is not done for pricing assets on Wall Street in most cases.

The critical issue in applying Economic Scenario Generators to business problems is to understand what is the behaviour of the ESG, the behaviour of the business system in response to the ESG and how those two interact.

The properties of the ESG can then be examined in terms of their immediate implications on the results of the business application.

## **An Example of a business problem: Capital Allocation.**

If the issue in the ALM system being examined is capital allocation, and capital is allocated on some rule, like 95 percent of the time the business has sufficient capital to maintain its desired credit rating, then we can look at what properties of the generator are driving that percentile at the point of time it is observed, e.g. 2 years into a simulation, or 5 years, or several time points.

What are the drivers of this number?

Average interest rates

relative rates, e.g. slope of the yield curve.

tails of the distribution of level of rates, or of relative rates,

These tail distributions for events that drive losses are critical to determining which cases result in “ruin” as defined in the business problem and then the probability of those cases.

## **Can't Separate Business Problem from the Economic Scenario Generator.**

We can not separate the business problem from the ESG.

The business problem determines the response to the scenarios and the outputs that are being evaluated.

These then determine what properties of the ESG are critical to generating these cases, and their probability.

## **States of the World for Business Problem**

However, it is not just a question of probabilities narrowly understood. We also need to understand what states of the world the ESG generates that lead to poor results, when we are looking at the capital allocation problem.

These states of the world are not just the final outcomes at 5 years, e.g. ending yield curve, but the path-dependent variables determined by the business problem that are a function of the entire path over the horizon.

This does not mean that the entire path is the object we need to understand.

## **Example of a State of the World Abstracted from the Entire Path**

For example, if a product paid out a credited rate based on the 5 year rate at each point, and account value is compounded with each crediting, then the cumulative account value is one of the statistics of the problem.

If investments are not in 5 year product, then the drivers of investment return matter. Furthermore there is the lapse function, and any interaction between the investment policy, crediting policy and lapse behaviour.

This results in a fairly complex system, and the ending surplus itself may be the only factor that “makes sense” by itself.

## **Difficult to Understand the Link Between Generator Properties and Business Results**

It thus becomes hard to understand the link between the generator properties, i.e. possible paths and their probabilities and the ending surplus.

However, understanding this link is what has to be done to understand how the ESG is driving the business results.

If we also look at expected profitability per unit of capital, which is itself a complex issue to define, since there may be capital flows in and out, we add additional complexity to the problem of understanding how the generator is linked to the business problem.

**So how do we understand the link between the generator properties and the business results?**

It's Hard.

## **How life would be simple if there was one true generator with true parameters.**

It would be simple if there was one true generator with the true parameters.

Then we just apply that generator and we don't have to think about the link between generator including parameters, calibration, possible paths, and probabilities.

We just look at the output of the stochastic ALM system, and apply a business judgement to the output based on the criteria the company has for evaluating these results.

**If we don't have a good starting point, we can't understand the link between the output of the business problem and the generator properties.**

We need the best starting point we can get for the ESG, both in terms of representing the possible paths, the probabilities of important outcomes, e.g. average 3 month rate, average 5 year yield, the tails and the distribution of 5 year – 3month. So we want to start with a generator that is as good as possible.

We know there are still issues we have to understand even with the best generators, but if we don't start with one that is as good as possible, then the resulting work to understand the relation of the generator to the business results is impossibly difficult.

It is still difficult even with a good generator.

So we want a generator that is as good as possible to begin with.

**Usually there is not much time to understand the link between the generator properties and a specific business problem being solved under deadline pressure.**

We also should admit that in reality, when we are making business applications under real world time constraints, and limited resources, most of the time, we just don't have the time to do more than just apply the generator and do a little sensitivity analysis. A lot of the time, we don't really have any time to do sensitivity analysis. Or if we do, we apply it to some other part of the problem, like the lapse function.

**Need to Have the Best Generator with Best Calibration at Hand in case we don't have much time to understand what in generator is driving the business results, or to take action even if we do.**

Because of this, in actual practice, if we don't have the best generator available with the best calibration or pre-canned set of calibrations for different issues (like a high interest calibration or low interest), then we aren't going to do sensitivity analysis, and the answer really will depend on how this generator with its calibration just happened to match up to this business problem.

Eventually we run across a business problem for which they don't match up well, and the answers are tragically wrong. These may lead to wrong decisions on capital, volume, pricing, investment strategy.

Even if these decisions are made by other professionals, not using the ESG, the dangers of what is done, are not analysed properly in the stochastic ALM, so there can be errors of omission that are just as costly as errors of commission.

So most of the time we depend on the generator being as good as possible.

## **So what is the process by which we as a company, or we as an industry have the best generator or generators at hand?**

First using the best generator we can find.

Second, at various points in time, people do study some of these issues with respect to the generator used, or some set of generators. This generates some level of general knowledge which is diffused acrossed companies or within a company.

This can lead to understanding some of these links for some standard business problems.

Because this work is so hard, and so time consuming, it is the effort of many people that is required.

Furthermore, because the total problem of ESG and business problem is so complex that it can't be analyzed into discrete logical bits, the work of different people is necessaary to develop "approximate concepts" that are partial answers to what aspects of a generator are important to business problems.

## **Some Heuristic Concepts that help in Understand the Relationship of Generator Properties to Business Results.**

These are things like what Craighead calls razors.

Examples of these are the qualitative stylized facts developed by MFC several years ago, which were incorporated into some Chalke Newsletter articles by Groover and Tenney in 1992 and 1993.

The independent work by Becker on yield curve inversions and distributions of rates.

Becker's list of stylized facts that incorporated the Groover-Tenney ones.

The Craighead Tenney stylized facts.

The Harper Razor at Nationwide

and so on.

## **Some Contributions that have helped me.**

A lot of work has been done at many companies at looking at some of the interactions between calibrations, generators and business results.

Craighead and Nationwide have done a lot of work with my generator and a generator they developed in house and looked at a lot of business problems..

Dave Becker, Mike Smith, Don Groover, Howerd Lodge, Vish Tirupatur, Dick Roberstson and others at Lincoln have looked at my generator and offered critical evaluations as well as results of their own research.

Phil Elam, Kent Qam, Mark Gilbert, and others at Jefferson Pilot and Alan Brender and others at William Mercer.

In work on a Swiss model, Barbara Artmann and Roger Zeller helped a lot in looking at the implications of some investment problems in Switzerland.<sup>2</sup>

I have also benefited from comments from Mike Davlin, Don Groover, Peter Fitton, Yuri Galperin, Jim McNatt and Eugene Vishnevetsky.

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<sup>2</sup> In fact, everyone who has gotten the generator and spent a lot of time with it, has brought up some issues that we either didn't think about at all and others that we hadn't given as much importance to as we should have. If I have left anyone out please, let me know

**What goes into the best generators at the current time?**  
**First, the generator is arbitrage free.**

Why is this so important?

If the generator is not arbitrage free, then there are relationships within the generator that are inconsistent. For example, the short term interest rate process is inconsistent with the 5 year interest rate process.

We have seen how understanding the total generator business application problem is so difficult that it can't be resolved into atomic facts, but must be dealt with heuristically.

If the generator already contains logical inconsistencies, then trying to build heuristic rules on the business generator problem is perilous. It is already too difficult to achieve, so adding logical inconsistency makes it almost a waste of time.

## **Generator Must Have a Logical Structure That is Meaningful with Respect to Understanding the History of Interest Rates.**

The second thing is that the generator has a logical structure that is meaningful with respect to the macro-economies behaviour over long time periods. This means that we can understand the activity of different macro-economic agents in the context of the model.

One such agent is the Federal Reserve. Others are investors. Others are financial intermediaries like Life Insurance Companies. The model should allow us to think about the economy in a way that we can apply our ideas about these economic agents in thinking about the scenarios generated.

If the model is a mishmash of model components that don't correspond very well in this way, then we can't think with it. This means that in calibrating the model with respect to important business decisions, we can't get very far. The ability to develop heuristic rules for the links between generator structure and calibration and business results is severely hampered. Because the problem is so hard to begin with that it can't be done exactly, this means that not much progress can be made.

## **What about applying to problems with more economic variables?**

Inflation

Stock index

etc.

Inflation can enter into a lot of ALM problems, because of expenses and policy holder behaviour.

Stock index and interest rates enters into Equity Index Product pricing, investments and capital allocation.

We have to add additional relationships, heuristical rules and qualitative and quantitative stylized facts.

Some of this work was done by Craighead and Tenney looking at the relationship of yield curve shape and future expected returns and volatility of stock returns.

Craighead and Tenney also looked at inflation and the yield curve.

## **Conclusion**

Get the best generator or generators available.

Get a good understanding of the research that exists, published, working papers, or conference talks.

Do some work with a generator when you get it.

As you use it, tinker with it, and look at the results. Ask questions and be demanding.