Asset Allocation and Risk Analysis: The Art and Science

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Objectives of Stock Company

Primary Objective:

Earn a high, but stable, return on equity from the insurance business.

Secondary Objective:

Earn an excess return after risk from investments

How to constrain investment risk to achieve primary objective

Require that the return on equity meet its target in economic scenarios that have a reasonable probability of occurring.

Require that the surplus not fall below an acceptable level in less probable but still meaningful scenarios.

Require that performance is still good enough even if we make mistakes or our assumptions contain errors.

How is this done?

Science:

What we can justify using economics, finance, and statistics.

Art:

Understanding the limitations of the science, and dealing with those limitations.

The limitation of the science does not mean we don't do the science, it means *we have to understand how far the science takes us*, and what to do with it.

Limits in the science produce limited models.

“The model is wrong, we start with that.”

Some model scenarios can’t happen.

Some model scenario can happen.

Some scenarios that can happen are left out.

The probabilities are not exact.

We can’t abandon all science because it contains errors.

We can’t do everything by hand without models or computers.

We would still be using some model, even if we didn’t admit it.

A model can only be beaten by another model.

We may have to use several models to capture different aspects of reality.

The Art is to deal with the errors in the Science

What errors in the science could hurt us?

Are those errors there?

What are we depending on in the science?

Is that reasonable?

How do we alter our actions so that we succeed even if these errors are there?

Knight and Keynes: Risk and Uncertainty

Risk:

When we can define the possible outcomes and their probability.

Uncertainty:

When we are unsure about the possible outcomes or their probability.

What is the role of an interest rate model?

The role of an *interest rate model* is to:

- produce the possible scenarios
- calculate the probability of those scenarios

Shareholder Objective

Shareholders expect an insurance company to earn a reasonable profit in different economic environments.

Shareholders expect this profit to be sufficient to maintain not only solvency but to be able to pursue its business objectives vigorously.

Conclusion:

This means that the business policies should not be tuned to work only if one specific economic forecast occurs or set of model assumptions is exactly right.

What are Best Practices in Asset Allocation?

Optimize Return on Risk not just Return on Investment.

Control risk through analysis.

Invest where risk premia are high for the risk taken.

Look at how economic conditions can change over time.

Best Practices (continued)

Look beyond just mean variance optimization.

Look to scenarios over time not one time period.

Look at multiple measures of performance.

Some Problems in Previous Generations of Best Practice:

Jackknifing:

Modest changes in expected return or variance lead to very different portfolios in mean variance optimization.

Instability in Expected Returns:

One of the main problems in previous best practices in asset allocation (i.e mean variance optimization) was the tendency to over invest in one asset class based on a momentary higher expected return or lower variance.

These are consequences of over constraining the analysis to the latest experience, and not looking at what happens if there are changes in the economic assumptions during a scenario.

What happens if things go wrong?

Look at the dynamic strategy that will be taken if the actual scenario turns out different than the expected.

At what stage does one recognize that the current strategy is based on economic conditions that are changing?

What is done next?

If that in turn depends on an assumption of what will happen that turn out to be wrong, what is the resulting cumulative loss?

Understanding risks dynamically

Best Practice is to subject the investment strategy to multiple scenarios to determine what will happen if at each stage of investment, the actual yield curve scenario is different than the expected scenario.

This can only be done with a model of the assets and liabilities and an *interest rate model* that can generate realistic scenarios of yield curve movements over time.

Interest Rate Models Best Practice

Able to reproduce range of historic yield curves.

Reproduces tendency of rates to persist in a trading range for an extended period and then switch to a new trading range.

Models yield curve inversions and other stylized facts.

Can reproduce historical frequency of yield curves, even if that frequency is later modified based on judgement or other factors.

Model lends itself to sensitivity analysis to test other sets of assumptions.

Change in Best Practices in Asset Allocation

Old Best Practice: Mean variance optimization over one period.

New Best Practice: Multiple time periods.

Old Best Practice: One economic environment assumed to exist. For example, a fixed forecast of expected return and variance.

New Best Practice: Multiple economic environments can occur. Different trading ranges can occur and persist. We can transition from one trading range to another. Expected returns and variance are not fixed.

Implications of New Best Practices

Implication for investment policy and risk

The investment policy of the firm should not constrain the profitability of the firm to a special set of economic conditions, but should be robust to a variety of economic environments.

Implications for Asset Allocation and Risk Taking on Investments

The investment policy of the firm, and the specific asset allocation should not tie the firm to one set of economic conditions having to occur.

Those sets of economic conditions that can occur with some reasonable probability should not cause undue stress to net income, let alone surplus.

Implications of New Best Practices (continued)

Implications for fine tuning to current conditions

Current conditions should not lead to the over calibration of the model so that the range of historical occurrences are unlikely or removed from consideration.

Robustness

Investment strategy, itself, should be robust to moderate change in model parameters.

Investment strategy performance should be robust.

Potential model errors should not lead to serious problems for the firm.

Risk analysis should include historical occurrences.

Risk analysis needs to consider what has occurred.

What has occurred is one guide to what can occur, and should not be ignored.

Past periods of calm have been followed by turbulence.

The 1960's were considered a golden age of government competence on all levels and in all areas.

The business cycle was declared to be dead.

Economics and other social sciences were considered to have resolved the problems of the past.

Adaptation to current economic conditions

In determining the most likely outcomes, and in evaluating the expected return on assets, adaptation to the recent past can be reasonable.

<u>A period of low interest rate volatility</u>

Volatility of the short term interest rate has been lower for the past 10 years than for the past 25 years.

We are in a low volatility time period.

The DMRP model is wrong, we start with that.

What could be wrong with it?

Volatility or other parameters could be wrong.

The future could drift from past values.

Extreme and sudden changes might happen outside the model.

The sequences, as opposed to the yield curves themselves, might be different.

The model was not directly calibrated to expected returns of assets.

How do we deal with the DMRP's potential problems?

We can check each of these issues individually.

This may require parameter sensitivity.

We can ask how the world might function out of the range of the model.

If we have a particular view of the world, we can ask how consistent is that with the model?

Always, we ask, for a given strategy, what will the consequences of errors in the model be for the company?

How can we avoid this harm?

Calibration of the DMRP model for volatility

The model volatility of the change in the logarithm of the short term rate can be reduced from approximately 30 percent to approximately 20 percent per year.

This will result in a tighter distribution of interest rates.

Because the rate of mean reversion of the target to the ultimate is slow, this will result in a tighter distribution around the current level of rates.

Examining the expected return characteristics of the model.

The model has been calibrated to reproduce the long run tendencies of the economy, both the possible yield curves, and their frequencies.

In particular the rates of mean reversion and target rates and target slope of the yield curve are set based on these.

Every scientific paper ends with a call for more research.

Inverse Calibration: Assessing the Reasonableness of a forecast of structural change in the economy.

One way to address the issue of a structural change is to see the implications of such a change for a robust model of historical episodes.

If we have a model of history, and we believe that conditions have changed to a new regime (i.e. trading range) that will persist for a given period of time, say 5 years, with a given probability say 75 percent, how much must we alter the parameters of the historical model in order to produce the desired forecast.

If this re-calibration is excessive, it calls into question the persistence of the regime or the probability that it will persist.

Strengths of the DMRP Interest Rate Model

Able to reproduce range of historic yield curves.

Reproduces tendency of rates to persist in a trading range for an extended period and then switch to a new trading range.

Models yield curve inversions and other stylized facts.

Can reproduce historical frequency of yield curves, even if that frequency is later modified based on judgement or other factors.

Model lends itself to sensitivity analysis to test other sets of assumptions.

Implications for asset allocation

There is flexibility in coming up with an asset allocation based on judgment.

This can be accomplished either:

- by modifying the parameters of the model to conform with that judgement, but still come reasonably close to reproducing history,

- or by direct application of judgement.

However, the final asset allocation should still lead to acceptable returns over the range of historical outcomes, so that the insurance business is not tied to one special set of economic conditions for its profitability.