OVERVIEW OF DYNAMIC FINANCIAL ANALYSIS

Prepared by
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Abstract

The purpose of this paper is to provide an overview of Dynamic Financial Analysis (DFA) and its usage in a property-casualty insurance context. It highlights the evolution of financial modeling from static financial planning to dynamic financial analysis, presents some potential uses for DFA models and provides a few cautions about the use of such models.

This document is intended to serve two purposes: first, as a non-technical overview for interested parties and second, as an introduction to a comprehensive rewrite of the Dynamic Financial Analysis Handbook currently being done by the Casualty Actuarial Society Dynamic Financial Analysis Committee.

Overview of Dynamic Financial Analysis

The property/casualty ("P/C") insurance industry accepts and mitigates the effect of financial loss due to fortuitous events. By pooling the assets and losses of many individual policyholders, P/C insurers can forecast and reduce the risk of such financial loss to within acceptable limits. It cannot, however, remove this risk completely. This residual risk and its cost are of primary concern to the financial management of the property/casualty industry.

The residual risk of financial loss is complex, and resides both in the liabilities and assets of an insurer. One of the tasks of property/casualty executives is the assessment of the risks and rewards associated with strategic decisions, decisions that can lessen or increase this residual risk. Too often, insurance executives must rely on intuition rather than systematic analysis when making these decisions. Even when financial decisions are based on a careful evaluation of the risk factors, the outcome of those decisions can be highly uncertain. Today, a systematic approach to financial modeling exists which projects financial results under a variety of possible scenarios, showing how outcomes might be affected by changing business, competitive and economic conditions. This approach has been called Dynamic Financial Analysis, or DFA.

DFA has its roots in post World War II military strategizing or "scenario planning" work developed by the Rand Corporation. To date, one of the most prominent users of scenario planning has been Royal Dutch/Shell. Starting in the early 1970's, Shell began experimenting with scenario planning to identify threats to "business as usual" in the oil industry and responses to those threats.[1]

In one scenario developed by Shell in the early 1980's, they envisioned the conditions in which oil prices would drop rapidly as the result of new oil field discoveries outside of the regions controlled by the OPEC oil cartel and the increasing determination by oil consumers to be less dependent upon imported oil for energy. With this scenario as a guide, Shell was able to position itself in such a manner as to rise from fourteenth to second place among the oil multinationals during the mid-1980s as prices fell and other companies, which were heavily overinvested, lost large sums of money.

[1] Van der Werff, Terry J., Washington CEO, October, 1994.

At a later point in time, Shell researched scenarios in which the price of natural gas might fall. The single largest potential market influence was a liberalization of the policy of the Soviet Union with regard to the use of their vast gas reserves. Accordingly, Shell researchers identified a few, at that time, obscure politicians, whose rise to power might lead to just such a change. One of the politicians so identified was Mikhail Gorbachev. When Gorbachev began his ascent, Shell took it as a harbinger of eventual change, saving the company from potentially disastrous investment decisions.[2]

But, how can this type of planning tool help the insurance industry? In the oil industry, much like the insurance industry, companies make enormous investments many years before the true payoff for those investments becomes known. A company that is able to measure risks earlier than its competitors can make decisions with an awareness that its competitors do not yet have. The success of Shell over the past thirty years, while they have been using scenario planning demonstrates the value of their investment in this management tool.

The application of DFA to the insurance industry began with the work of Finnish and British working groups on solvency.[3] Their primary motivation was recognition of the inadequacy of accounting documents for solvency evaluations. These evaluations were viewed as too static, too retrospective to properly measure future solvency. The fundamental insights of the Finnish and British researchers redefined the assessment of solvency from a static accounting basis to a dynamic (going concern operation), cash flow focused approach. Having accepted the real perspective of the organization as an ongoing enterprise, the financial model implementing this perspective required assumptions about possible future operating conditions. In order to develop and sustain the type of model that the British and Finnish researchers envisioned, actuaries have begun reaching out to strategic planners, financial analysts and investment professionals. Experts

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[2] Schwartz, Peter. The Art of the Long View. New York: Doubleday, 1991

[3] The work of the Finnish working party is summarized in Pentikainen, "On the Solvency of Insurers," *Classical Insurance Solvency Theory*, J.D. Cummins and RA. Derrig, Eds., pp. 1-49, Finland: Kluwer Academic Publishers, 1988. The work of the United Kingdom working party was reported in two papers: Coutts & Devitt, "The Assessment of the Financial Strength of Insurance Companies - Generalized Cash Flow Model," *Financial Models of Insurance Solvency*, J.D. Cummins and R.A. Derrig, Eds., pp. 1-37, United Kingdom: Kluwer Academic Publishers, 1989, and Daykin, et. al., "The Solvency of a General Insurance Company in Terms of Emerging Costs," *Financial Models of Insurance Solvency*, J.D. Cummins and R.A. Derrig, Eds., pp. 87-151, United Kingdom: Kluwer Academic Publishers, 1989. The amalgam of both approaches is presented in detail in a

from these areas have pooled their talents and developed sophisticated computer models that incorporate all major aspects of insurance operations (*e.g.*, assets, liabilities, underwriting, pricing, taxation, *etc.*) into a cohesive model to help insurance company executives better understand how their day-to-day decisions interact to affect overall returns, capital and the all-important bottom line. DFA's goal is to provide management with:

- solid information about the ***interaction*** of decisions from all areas of company operations,
- a quantitative look at the ***risk-and-return trade-offs*** inherent in emerging strategic opportunities, and
- a ***structured process*** for evaluating alternative operating plans,

so it can make more informed – and more rewarding – decisions.

DFA's goal is ***not*** to forecast the future. Rather, DFA's goal is to give company managers insight into how they should manage their company's financial affairs. With DFA tools these managers can (hopefully) better position their companies to absorb the transfer of insureds' risk, to earn an appropriate return and to minimize the company's exposure to insolvency.

A Different World

Dynamic financial analysis and traditional financial forecasting are worlds apart. While DFA models have evolved from more traditional models, each stage in the evolutionary process has involved a quantum leap in the model's capabilities. To keep it simple, we will define four stages or types of financial models.

"**Financial Budgeting**" is essentially a static model which uses only one set of assumptions about the future operating results from a company's various divisions or business units. For example, it could include a projection of expected investment returns from the investment division, a projection of premiums and expenses from the operating divisions and a projection of expenses from other support departments. Generally, the company would simply combine this

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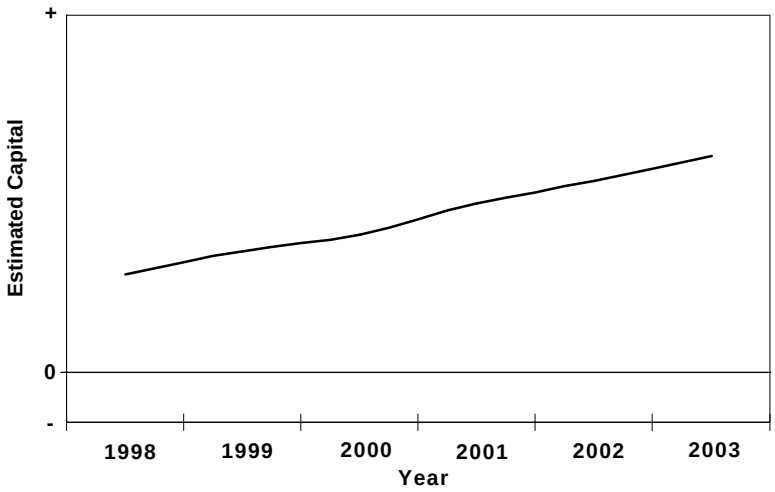
subsequent book by Daykin, Pentikainen, and Pesonen, *Practical Risk Theory for Actuaries*, pp. 546, Chapman & Hall, 1994.

information and use it to make critical business decisions about its future operating and financial plans.

Graph 1 – Financial Budgeting

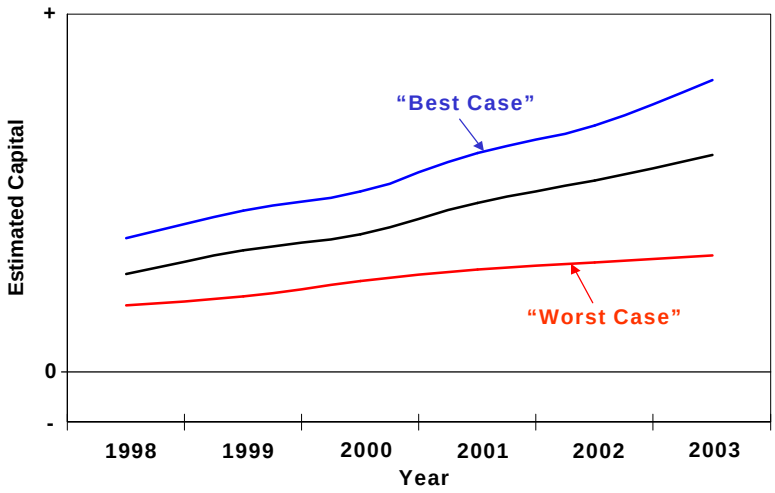


As illustrated in Graph 1, a financial budget is essentially only one "path" into the future. While many different iterations of this plan could have been reviewed and amended prior to a final plan being "approved", the model still ends up being static.

Early model builders realized that improved decisions could result from an expanded view of the future. Thus, the next generation of models allowed the user to answer "What if…" questions about the future, by identifying key assumptions in the model and testing their relative impact by changing them over a fixed range. These "**Sensitivity or Stress Testing**" models can best be described as models that incorporate "best case" and "worst case" scenarios along with the expected outcome.

As illustrated in Graph 2, sensitivity or stress testing adds more financial "paths" into the future. The executive could now use these additional "What if… " views of the future to more effectively plan their strategies.

Graph 2 – Sensitivity or Stress Testing



Unfortunately, there was still something missing from this picture. Essentially, there was no sense of how likely it is that the company would achieve the best case or avoid the worst one. In a static forecasting environment, there is no way to quantify the variability of possible outcomes or to easily see the full depth and breadth of possible outcomes. This is, however, a critical factor in strategic decision making.

When a company is faced with a series of strategic options, it is difficult to decide which ones to pursue without understanding the differences in the range of possible outcomes, the likelihood of each outcome, and the results each option would produce. Thus, " **Stochastic Modeling"**[4] makes it possible to describe critical assumptions—and their combined financial implications—in terms of ranges of possible outcomes, rather than in terms of fixed values and results.

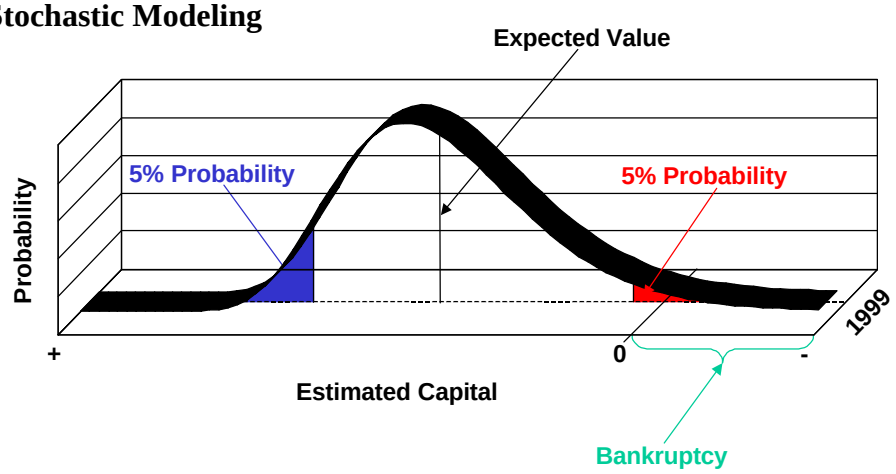
For example, a traditional business plan might assume the company will write $100 million premium in a particular line of business next year with a loss ratio of 70%. A probabilistic financial model, in contrast, assumes that the premiums written by the company will fall in a range from $90 million to $120 million and the loss ratios will range from 60% to 85%. Values within

[4] See Feller, William *An Introduction to Probability Theory and Its Uses*, New York, John Wiley & Sons, volume 1, third edition. Footnote 26 on page 419 states, "The term 'stochastic process' and 'random process' are synonyms and cover practically all theory of probability from coin tossing to harmonic analysis. In practice, the term 'stochastic process' is used mostly when a time parameter is introduced."

these ranges will depend on the economic and competitive environment and are defined with a probability associated with each value.

Once a range of possible outcomes and associated probabilities is defined for each critical assumption, a computer simulation process takes over, recalculating the model again and again, returning different values each time. This process generates a range of results that reflect the parameters and interrelationships defined for key variables such as interest rates, inflation rates, premium growth, new business profitability, and asset investment strategies.

Graph 3 – Stochastic Modeling

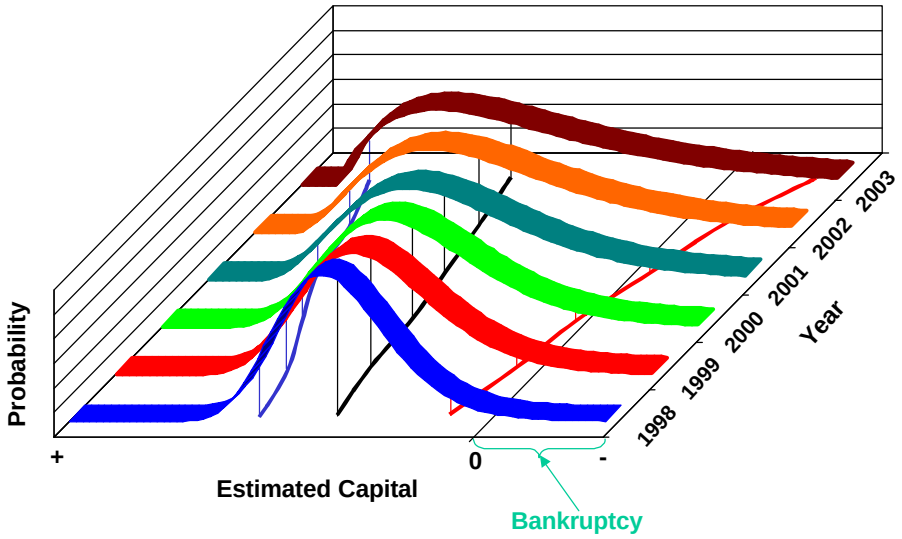


As illustrated in Graph 3, a probabilistic model adds a new dimension to our view of the future so that we can evaluate the likelihood of many possible outcomes.

As the most recent evolutionary step, "**Dynamic Modeling**" incorporates feedback loops and "management intervention decisions" into the models. For example, if a given scenario shows that the loss ratio is unacceptably high for a line of business, then the model will assume that rate level and other underwriting decisions will be made by management. While the fundamental business model is little different from a financial budget, a simple form of artificial intelligence is added to the modeling process.

Differences in financial results arising from alternative strategic decisions can be evaluated by replacing one set of strategic decisions with another, re-running the modeling exercise, and comparing the ranges of possible outcomes under each decision path.

Graph 4 – Dynamic Modeling



As illustrated in Graph 4, DFA assists the insurance executive in fully accounting for the interrelationships between the various factors in the analysis. For example, the expected outcome could call for capital to increase steadily over the next 5 years; however, the probability of bankruptcy (capital less than zero) is also increasing. The insurance executive may be able to quantify this probability with DFA.

Seeing the Whole Picture

Traditional financial models also lack the ability to assess the interrelated effects of investment and underwriting decisions. This shortcoming can be addressed by performing dynamic financial modeling using an "integrated" financial model. An integrated model combines the underwriting and investment activities of the company to promote a better understanding of how business decisions affect the entire organization.

Why does an integrated financial model have so much potential value to a company? An insurer's day-to-day operations include buying and selling assets, underwriting business, collecting premiums, administering claims, and incurring costs related to running the company. Decisions made on the underwriting side of the business have an impact on the investment decisions. Likewise, investment decisions affect the underwriting decisions that can be made within a given

risk tolerance framework. Decisions that may be appropriate when viewed in the context of one division or business unit may not be the best course of action for the company as a whole.

An integrated financial model enables a company to model each of these operations both separately and in conjunction with each other to produce realistic financial projections. Such a model:

- Applies the same macroeconomic environmental conditions (*e.g.*, interest rates, inflation rates, and catastrophic events) across all divisions and departments of the company.
- Allows executives to consider both their operating needs and conditions in the financial markets as they make investment decisions.
- Examines the risk-and-return trade-offs of various investment and operating decisions in terms of how they affect the entire organization, not in isolation.
- Allows executives to tailor and integrate their reinsurance programs for divisions and the entire company, all at once.

In addition, an integrated financial model also enables management to combine both internal and external relationships. For example, how will the pricing cycle in the reinsurance sector effect our internal net results? How will an increase in inflation affect our claim costs? How will competition impact our ability to increase rates and retain good business? Like the models used by Shell, one of the most important features of an integrated financial model is that it can identify unfavorable scenarios so that corrective measures or avoidance actions can be implemented.

Support for Decision Makers

The financial information that can be modeled is virtually unlimited—any data that can be put in a spreadsheet can be modeled dynamically. To date, however, dynamic financial analysis has concentrated on providing management with more powerful information to support decisions in the following areas:

Realism of a Business Plan. Many companies find themselves in the unenviable position of explaining why they didn't achieve last year's business plan. If this has been a consistent problem, the Board of Directors and/or stockholders may question the realism of the company's future business plans. In this case, DFA could be used to determine if the difference between actual and planned results in prior years was the result of a string of bad luck or unrealistic planning.

Looking forward, it can then be used to determine how likely it is that next year's plan will be achieved and, if unlikely, what factors will most likely be the cause.

Product and Market Development. As companies or segments of companies grow into marketing segments beyond their own experience, dynamic financial analysis can provide insight into pricing policies. It can also explore the possible financial effects new markets and products will have on the financial results of existing products and markets.

Claims Management. Claims are settled in a dynamic environment. The level of claim settlement costs can be affected by policies on the use of claim stipulations and commutations, structured settlements, the term structure of interest rates, the impact of taxes, changes in legal theories and other factors. Dynamic financial analysis can provide insight into the costs, benefits, and risk associated with changes in claim management philosophies. DFA can also aid in estimating loss reserve ranges under these changing conditions.

*Capital Adequacy***.** Dynamic financial analysis can better quantify the appropriate level of capital a company needs to support the business risks it is taking, given the uncertainties of future economic conditions, interest rate levels, and underwriting results. Assume, for example, that a company's strong rating by the rating agencies is contingent upon its ability to maintain capital levels above $1 billion. In such a case, senior management wants to know how much capital in excess of $1 billion must be held today to achieve an acceptably low probability that capital could drop below $1 billion at any point in the next five or ten years.

Alternatively, a company with excess capital (as is the case for many insurance companies today, largely owing to statutory accounting requirements and the current rating agency criteria) has many options. It can look for an acquisition, expand one or more product lines, buy back stock, or pay additional dividends. Each course of action has its own set of rewards and risks. DFA can help the company understand which alternative provides the greatest marginal benefit for the risk that it adds to the company.

Capital Allocation. Deciding how best to deploy available capital is another crucial management issue. Many companies are now using a DFA approach to evaluate the risks and risk-adjusted returns of their operating divisions and allocating existing capital accordingly.

Liquidity. As investment portfolios are expanded to include less liquid assets, as more capital is tied up in subsidiaries and affiliates, as exposure to potential catastrophic events rises,

companies must concern themselves with the volatility of future cash flows. DFA can aid a company in understanding this volatility and help it determine what level of short-term financial protection might be needed to address liquidity concerns.

Reinsurance Structure / Securitization Structure. Deciding upon an optimal reinsurance or securitization structure for a company can be a daunting task. By modeling claim distributions individually and collectively, DFA can help answer questions about retention levels, limits, treaty coverages, etc. Using different combinations of treaties in the model will allow the company to determine the structure that will maximize net profit over time for a given risk tolerance level.

Asset/Investment Strategy Analysis. This analysis examines the interrelationship of the investment strategy and the insurance company's operations. Changes in asset strategy can affect a company's long-term financial performance. For example, investing less in bonds and more in equities will consume more risk capital and lower a company's current investment return because less current investment income will be produced. However, a company that chooses this strategy may generate the potential for much more rapid growth of underlying capital through unrealized capital appreciation of the equity portfolio.

Changes in asset strategy also affect the ways in which a company's financial performance should be measured (short-term return on equity versus long-term return on equity). An asset strategy analysis performed with a dynamic financial model can help companies determine an asset strategy whose level of volatility of earnings and capital is consistent with the company's appetite for risk. It can also help them develop more appropriate tools for measuring future company performance.

Rating Agency Support. DFA can aid in company discussions with rating agencies by providing the company with the tools to demonstrate its understanding and quantification of the company's risk exposure. Rating agencies recognize the importance of risk management techniques. Therefore, if a company is in a position to show the rating agencies that business decisions were made after a rigorous analysis of the risks and rewards associated with each decision, it may be viewed more favorably by the rating agencies.

Merger and Acquisition Opportunities. The fundamental questions raised by any M&A deal is whether the resulting synergies and economies of scale and scope will justify the purchase price

offered by the acquiring company and whether the purchase price provides fair value to the owners of the company being acquired. Dynamic modeling can provide a more rigorous analysis of the possible effects of a transaction, including a more thorough examination of the conditions leading to success or failure of the deal to achieve the objectives intended.

Benefiting from Technology

At one time, a company that sought to develop a corporate financial model usually ended up with a model that was either fast and simple or slow and complex. Typically, the results would be static, particularly if the model were complex. This led to the Catch-22 of financial modeling: Any model sophisticated enough to provide valuable information required such extensive "care and feeding" that the information it generated was not timely enough to be of value.

Current computer capabilities and analysis techniques have eliminated, or at least mitigated, this problem. Financial modeling software using the latest technological innovations not only can address the complexities facing a company, but can do so at a level of sophistication never before imagined. And it can produce valuable insights into the possible results of decisions before the decisions are made.

However, the benefits of technology do not come without costs. Dynamic financial analysis models can be large-scale models involving thousands, if not millions, of lines of computer code or cells of formulas and data. These models must be designed, validated and operated by people that can benefit from the insight they bring. They must be maintained and used in conjunction with valid operational data. These requirements are costly and involve both direct cost of the experts, models and data and the indirect cost of using a possibly flawed process.

Final Considerations

Even though computer technology is expanding at a dramatic pace, management must still be mindful that "the devil is in the details." Like any other business decision, the cost of creating the model must be weighed against the expected benefits to be gained. A DFA model is not off-the-shelf software; it is a process of gaining knowledge through the combination of analysis, data and technology. Additionally, a model is only as valuable as the information that comes out of it. That information is dependent upon how well the model reflects reality. Therefore, model

builders should expect to spend considerable time testing and validating the variables used in a model.

By clearly defining the business problem(s) to be addressed, the model builder can:

- select an appropriate model structure (*i.e*., what business areas to include),
- decide which variables (*e.g*., claim costs, premium growth, *etc*.) and their interrelationships should be in the model,
- determine what types of scenarios should be developed and modeled (*e.g*., interest rate environment, competitive environment, *etc*.),
- estimate the parameters that should be used for each variable (*i.e*., the mathematics that specifies the behavior of each variable), and
- test and validate the reasonableness of the assumptions and their interactions (*e.g.*, the projection of future claim payments versus historical levels of claim payments).

In other words, the model design is specific to the problem(s) being addressed. While technology has enabled us to keep track of more details, management's confidence in the results of a DFA analysis will also depend on their confidence in the analyst, the data and the model being used. This is not a one-shot process; a DFA model must be continuously updated to remain relevant in the ever-changing environment in which companies operate.

Conclusion

The world has changed dramatically in the last decade. The companies that recognize those changes and have the tools to evaluate their implications are the ones that will be able to shape the most effective response. Advanced financial modeling capability will be a critical ingredient in the strategy of the companies that grow and prosper in the future.