WW514

Strategic Financial Planning:
Applications in the Public and Private Sectors

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February 2004

This course introduces an important, growing topic for corporate executives and government leaders – to employ strategic planning models based on "optimal" decision-making under uncertainty. We concentrate on *strategic* systems, with an emphasis on long-term financial planning for business and government applications. Due to the difficult nature of the issues, there will be some attention to short cuts (e.g. policy rules) and other practical considerations. Also, general topics in risk management will be discussed.

We start with the traditional corporate financial problem - discovering optimal decisions for funding new projects. These ideas can be traced to the original work on cost/benefit analysis by the US government. Next, we take up the major topic of the course – to address uncertainty in decision making. We focus on the three most popular approaches: 1) decision trees (roll back via dynamic programs), 2) optimization of Monte Carlo simulations, and 3) stochastic programs. We compare these frameworks, suggesting that any single approach will not dominate the others. Software packages simplify the modeling process. These models become large as a function of the number of time-periods and scenarios. Therefore, we take advantage of the problem's special structure.

An important element involves defining the decision maker's goals via a multi-dimensional objective function. Several issues are relevant: the decision maker's attitude towards risk, biases in human judgment (e.g. anchoring and rare event bias), multi-objective methods, and temporal goals. In most cases, the resulting model takes on nonlinear objectives due to risk aversion and other relationships.

Generating stochastic scenarios poses a significant element in a strategic plan. A primary concern is to construct a set of plausible scenarios that depicts a reasonable range of possible outcomes over the planning horizon. We show how to address uncertainty via scenario generators, such Towers Perrin's CAP:Link. The scenario generators are typically systems of stochastic difference equations that are sampled. Due to time limitations, these features can only be highlighted.

Throughout the course, we discuss practical applications, especially planning systems that are part of ongoing decisions processes by businesses and (quasi) government agencies such as Fannie Mae. During the second and third parts of the course (Monte Carlo simulation and nonlinear programs), we stress applications in financial planning – pension plans, insurance companies, and general investment problems. Students will be expected to gain an appreciation of the problem domains at a general level.

Successful (and unsuccessful) implementations help us appreciate excellent professional practice. They provide a context for discussing ethical issues that arise when planning models form the basis for setting policy.

Figure 1 depicts the three major elements of a strategic planning system.

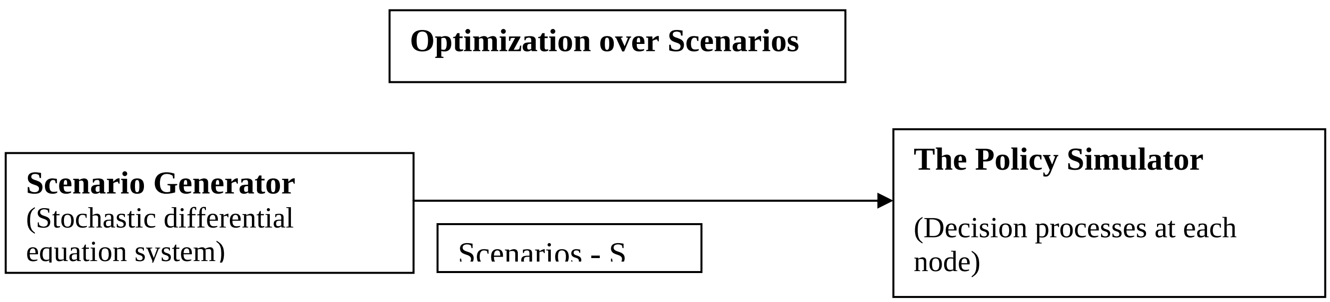

Figure 1
Major Elements of Strategic Planning Models

The course is organized into three parts. First, we present decision trees and the dynamic programming roll back procedure (weeks 1-3). The major components of an optimal decision under uncertainty are defined in this first part. Importantly, the recommendations of optimization models should be stress tested via sensitivity analysis (SA). Software systems and excel add-ins, such as PrecisionTree, @Risk, and solver, are ideally suited to performing sensitivity analysis. We stress the multi-dimensional nature of decision making under uncertainty.

The second part presents policy simulation/optimization as a method for reducing the size of the resulting planning system (weeks 4-8). Managers, company executives, and policy makers readily understand policy rules. They can be easily stress tested by conducting simulations with alternative sets of assumptions. They can be implemented without the need to solve a full scenario optimization problem. Unfortunately, they may lead to sub-optimal solutions, due to non-convexities or due to the inherent limitations embedded in policy rules. Simulation exercises are developed by means of the @Risk package (Excel add-in).

In the third part, we focus on the generic optimization framework, in particular, linear and nonlinear programs (weeks 9-12). We study the problem from the standpoint of building an algebraic model.

Especially, attention is devoted to the multi-objective nature of these problems and approaches for explaining the range of policy options to the decision makers. For example, we will build efficient frontiers across the relevant objectives. We will show that strategic planning models can be posed as multi-stage stochastic programs. However, we will not delve into complex details here.

The pros/cons of decision trees (dynamic programs), policy simulation/optimization, and multi-stage stochastic programs are discussed from both theoretical and practical perspectives.

Grading:

Mid-term Exam	30 %
Homeworks and term project	30 %
Final Exam	40 %

Prerequisites:

1. Experience with basic probability and statistics,
2. Interest in developing systematic methods for optimizing decisions under uncertainty.

Required Books:

- **Investment Sciences**, David Luenberger, Oxford University Press, 1998.
- **Practical Management Science**, W. Winston, S. A. Albright, Duxbury, 2001 (with new software package).

Reference Books:

- **Decision Making Under Uncertainty,** C. A. Holloway, Prentice Hall, 1979.
- **Value at Risk**, P. Jorian, McGraw Hill, 1997.

- **Introduction to Stochastic Programs**, J. Birge, F. Loveaux.
- **Worldwide Asset and Liability Modeling**, W. Ziemba and J. Mulvey (eds), Cambridge University Press, 1998.
- **AMPL: A Modeling Language for Mathematical Programming,** R. Fourer, D. Gay, and B. Kernighan, Scientific Press, 2003

Office Hours:

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Precepts to be scheduled as needed.