Russell-Yasuda Kasai Model

Multi-stage

Asset / Liability Management

- Cariño, D. R., T. Kent, et al. (1994). "The Russel-Yasuda Kasai model: An asset-liability model for a Japanese insurance company using multistage stochastic programming." *Interfaces* **24**(1): 29-49.
- Cariño, D. R., D. H. Myers, et al. (1998). "Concepts, technical issues, and uses of the Russell-Yasuda Kasai financial planning model." *Operations Research* **46**(4): 450-462.
- Cariño, D. R. and W. T. Ziemba (1998). "Formulation of the Russell-Yasuda Kasai financial planning model." *Operations Research* **46**(4): 433-449.

Developed by Frank Russell Company and The Yasuda Fire & Marine Insurance Company.

Decisions are made on how best to invest in assets to meet a random liability stream over time, with random investment returns.

Goal is to produce a high-income return to pay annual interest on savings-type insurance policies while maximizing the long-term wealth of the firm.

Handles complex regulations imposed by Japanese insurance laws and practices.

Model is multistage stochastic LP with recourse

Random Variables

- rp_{jt} = price return of asset *j* in period *t*
- ri_{jt} = income return of asset *j* in period *t*
- F_t = deposit inflow in period *t*
- P_t = principal payout in period *t*
- I_t = income payout in period *t*
- g_t = rate of interest paid on policies in period *t*
- L_t = liability valuation at end of period *t*

Decision Variables

- w_{jt} = market value held in asset *j* in period *t*
- W_t = total fund market value in period *t*
- u_t = income shortfall in period *t*
- v_t = income surplus in period *t*

Objective:

$$\text{Maximize} \quad E\left[W_H - \sum_{t=1}^{H} c_t(u_t)\right]$$

where $c_t(u_t)$ is a piecewise-linear concave function which specifies the penalties for income shortfalls.

(Converts to LP with introduction of additional variables.)

Constraints include:

$$\sum_{j=1}^{J} w_{jt} = W_t$$

$$W_{t+1} - \sum_{j=1}^{J}\left(1 + rp_{j,t+1} + ri_{j,t+1}\right) w_{jt} = F_{t+1} - P_{t+1} - I_{t+1}$$

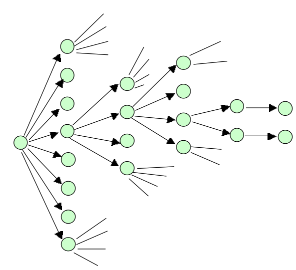
$$\sum_{j=1}^{J} ri_{j,t+1} w_{jt} + u_{t+1} - v_{t+1} = g_{t+1} L_t$$

$$w_{jt} \geq 0, \quad u_t \geq 0, \quad v_t \geq 0$$

Periods are of varying length:

- 8 branches in period 1 (first quarter)
- 4 branches in period 2 (remainder of first year)
- 4 branches in period 3 (year 2)
- 2 branches in period 4 (years 3-5)
- 1 branch in period 6 (terminal conditions)

Total number of scenarios: 8×4×4×2×1=256



Size of Problem (# asset classes=7)

- # rows: 263
- # columns: 431

Size of Deterministic Equivalent Problem

- # rows ~ 31,000
- # columns ~ 44,000

Nested Benders' Decomposition was used.

Three hours of computation was required to solve full model.

Contributed 79 million US$ in first two years of use.