2018 SOA Annual Meeting Session 003:

Stochastic Modelling for Social Security Actuarial Valuations

Office of the Chief Actuary
U.S. Social Security Administration

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Stochastic Model Basics

- Exploring uncertainty for 75-year projections
  - In addition to deterministic alternatives
  - In addition to sensitivity analysis
- Probabilistic illustration based on past variation
- 5,000 Monte Carlo simulations
- Reflects basic projection methods
  - But with somewhat more limited parameters

Stochastic Model Basics, cont.

- Demographic assumptions:
  - Total fertility rate
  - Mortality rates by sex/age-group
  - Total legal permanent resident (LPR) new immigrants
  - Total LPR and citizen emigrants
  - Rate of transfers of status from other-than-LPR stock
  - Total other-than-LPR immigration

Stochastic Model Basics, cont.

- Economic assumptions:
  - Unemployment rate
  - % change in CPI
  - Real interest rate
  - % change in real wage
- Disability assumptions:
  - Total male and female disability incidence rate
  - Total male and female disability recovery rate

Stochastic Model Basics, cont.

- Based on historical data, we estimate an equation (generally AR or ARMA, depending on the fit) for each assumption.
- Years of data used vary by assumption, depending on which years of data are available and appropriate.

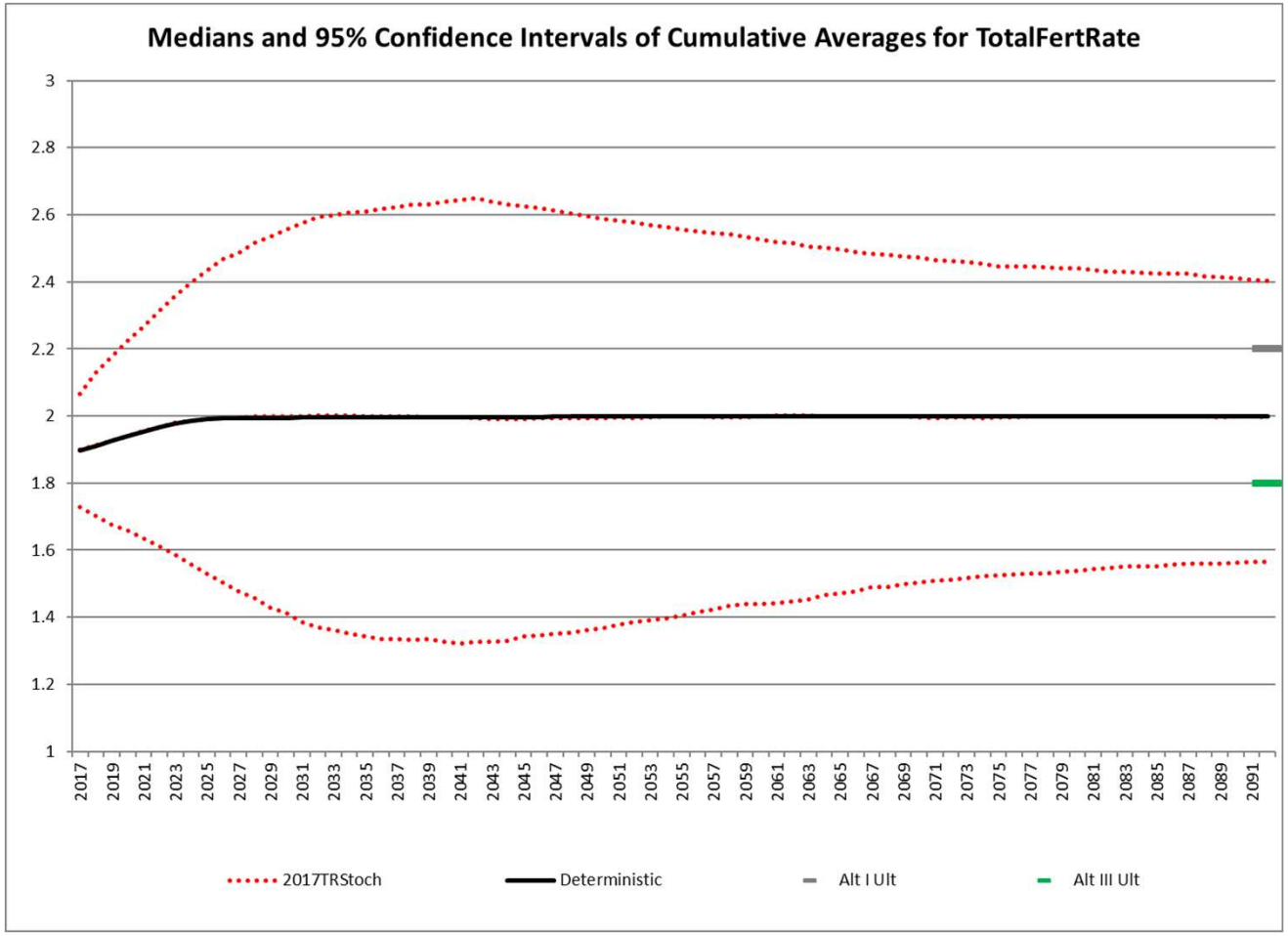
Stochastic Model Equation Example

The total fertility rate (TFR) equation is an ARMA(4,1):

$$u_t + 1.84X_{t-1} - 1.29X_{t-2} + 0.83X_{t-3} - 0.41X_{t-4} + 1.00e_t - 0.47e_{t-1}$$

where e_t is the error term at time t, u_t is the alt 2 value at time t, and X_t is the deviation from the mean at time t.

Stochastic Results of Total Fertility Rate



Note: The grey mark is the low-cost ultimate assumption and the green mark is the high-cost ultimate assumption.

Adding Parameter Uncertainty (PU)

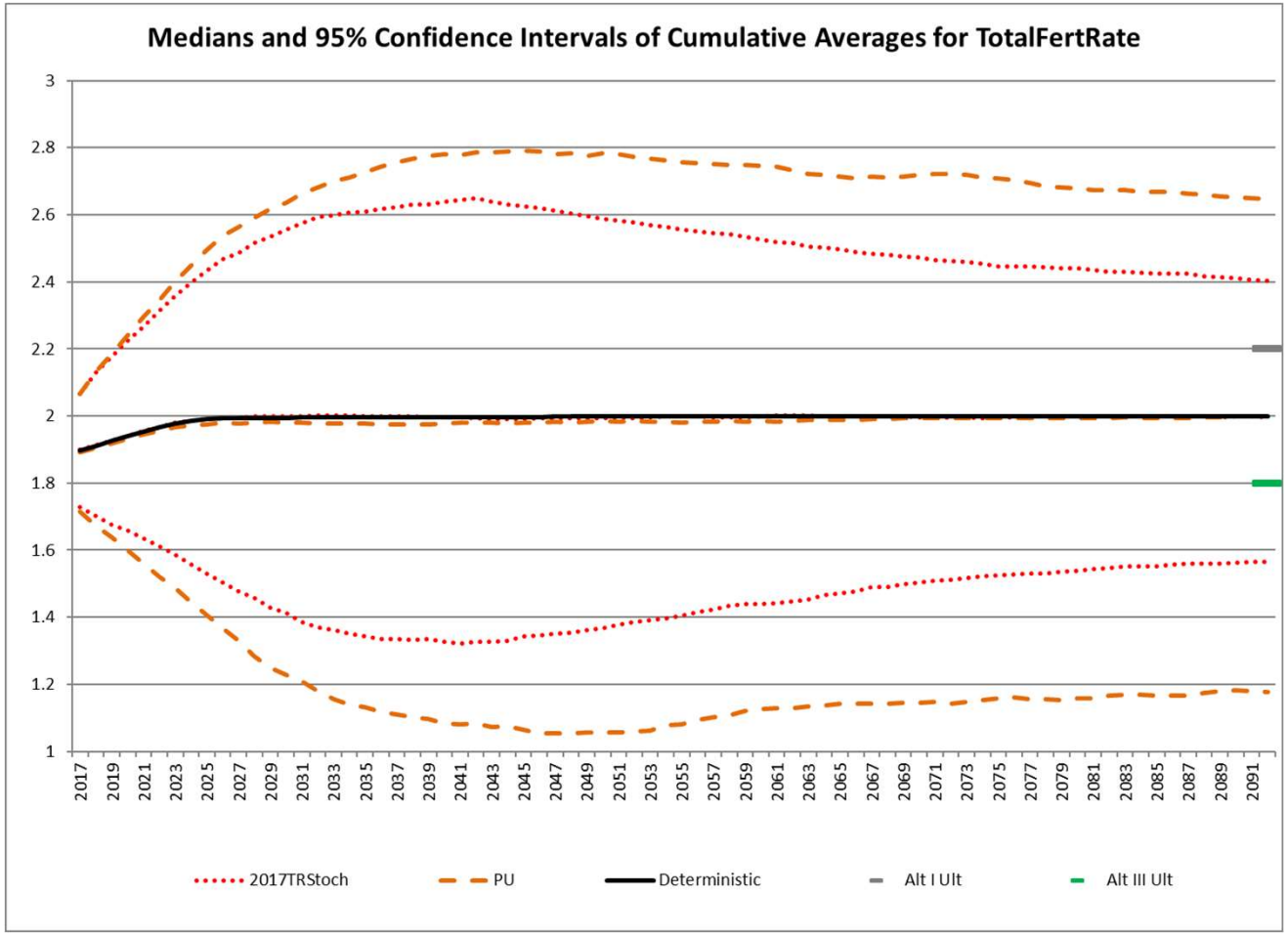
$$u_t + 1.84X_{t-1} - 1.29X_{t-2} + 0.83X_{t-3} - 0.41X_{t-4} + 1.00e_t - 0.47e_{t-1}$$

- Under PU, the parameters 1.84, -1.29, 0.83, -0.41, and 0.47 would change in each simulation.
- u_t would also change for each simulation.

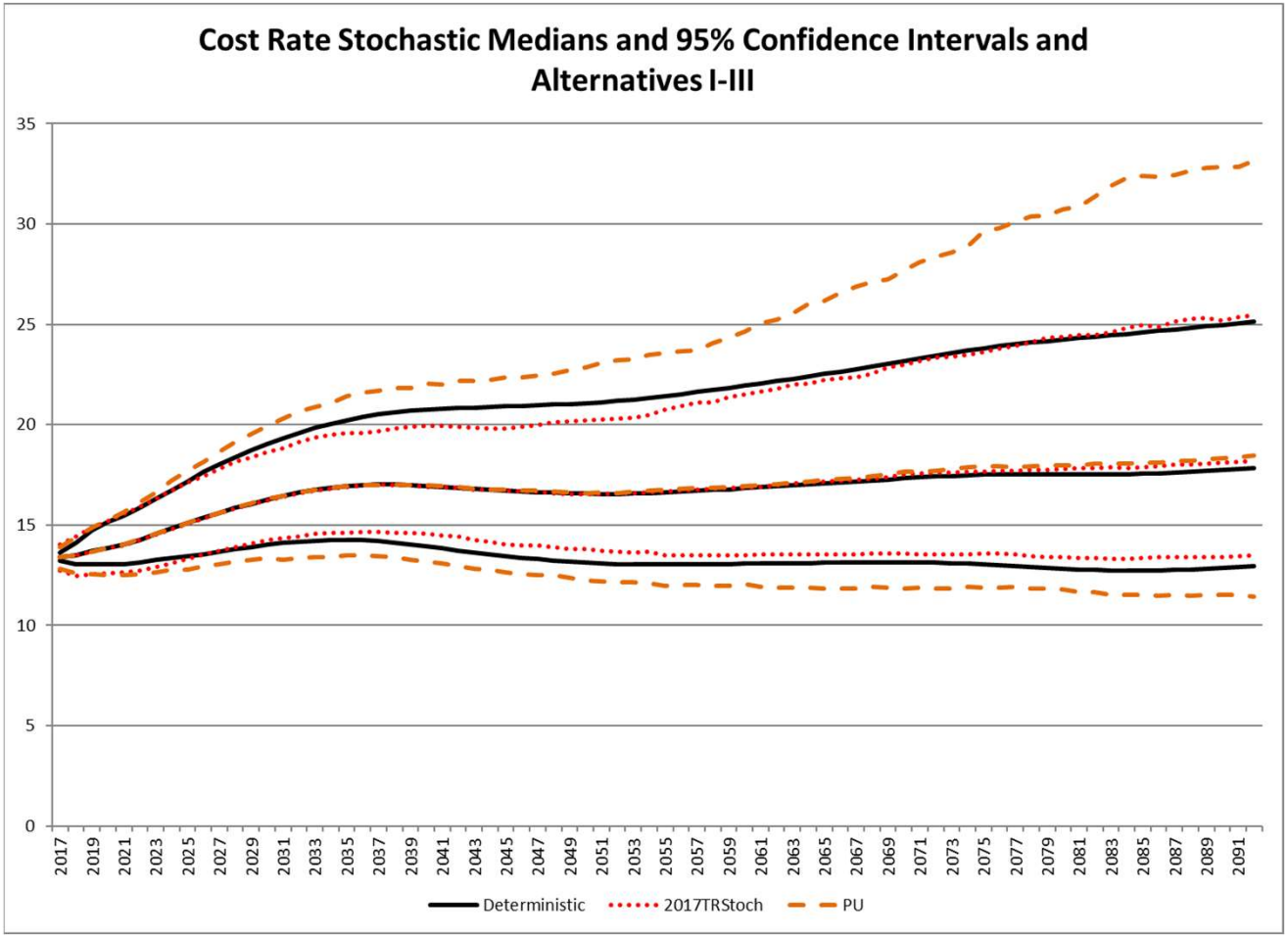
Issues in Implementing Parameter Uncertainty

1. Demographic bounds reached more often.
2. Negative other-than-LPR population can occur.
3. Disability rates can go under 0% and over 100%.
4. Economic values can have extremely high variance.

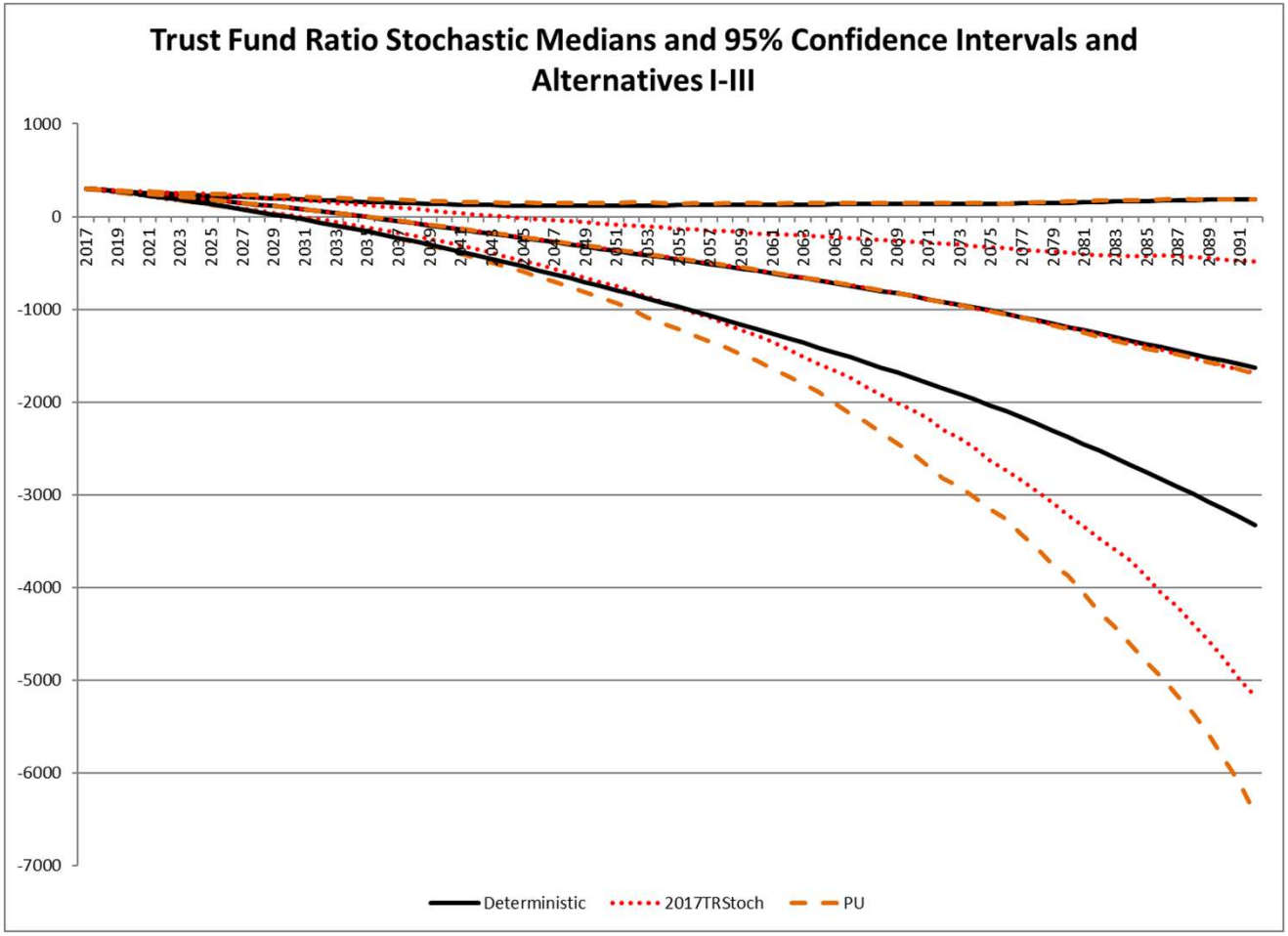
Results of Total Fertility Rate



Summary Results – Cost Rate



Summary Results– Trust Fund Balance



Summary Results – Actuarial Balance

Alt / Percentile	Deterministic	2017TRStoch	PU
Alt 1 / 97.5	0.12	-1.07	0.14
Alt 2 / 50.0	-2.83	-2.81	-2.82
Alt 3 / 2.5	-6.63	-5.01	-6.74

Conclusions and Questions

- Usefulness of stochastic simulations
  - For Social Security
    - Is risk aversion same in both directions?
  - For private insurance
    - Is risk aversion one-sided?
- How is stochastic used in private insurance/ pensions/other areas?
  - Univariate or multiple variables?
  - Parameter uncertainty?