Center for Retirement & Policy Studies

Morningstar Model of US Retirement Outcomes: Technical Appendix

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Authors
Spencer Look, FSA
Associate Director of Retirement Studies
Morningstar Retirement
Spencer.Look@morningstar.com

Jack VanDerhei, PhD
Director of Retirement Studies
Morningstar Retirement
Jack.VanDerhei@morningstar.com

Model Methodology

The Morningstar Model of US Retirement Outcomes, henceforth referred to as the Model, is a quantitative framework to evaluate retirement-income adequacy in the United States. The Model produces a distribution of financial outcomes in retirement for each household (focusing on the main respondent and their spouse, if applicable) in the Survey of Consumer Finances, or SCF. The Model uses SCF data as inputs for each household, such as age, gender, race and ethnicity, balances in financial accounts, salary, and other job-related information.

The Model projects retirement outcomes for each household across 1,000 independent scenarios with the projection going to age 120. To be clear, household members are not assumed to pass away at a specific age. Instead, death ages are modeled stochastically. Before retirement starts, the Model simulates whether death occurs based on Social Security cohort life tables. In retirement, the Model uses a health state transition model. The possible states include 1) good health, 2) poor health, 3) in-home healthcare, 4) in a nursing home, or 5) dead. The Model has specific states for long-term services and supports, or LTSS, because requiring paid LTSS is one of the biggest risks for retirees.

The health state transition model was built based on longitudinal data from the Health and Retirement Study, or HRS. In particular, a series of generalized linear models were fit to the data based on the approach of Fong, et al (2015). The health state transition model considers age, gender, marital status, race and ethnicity, and income level when predicting probabilities. Also, the probability of transitioning from one state to the next is informed by the current state that an individual is in. For example, under this framework, the probability that an individual passes away is much higher if they are currently in a nursing home than if they are in good health. Rates of incidence and continuance from the health state transition model are broadly consistent with the observations of Johnson (2019). Further, life expectancy statistics following from this model are generally consistent with those from applicable Social Security cohort life tables and the Society of Actuaries Pri-2012 Private Retirement Plan Mortality table with generational mortality improvement applied.

The Model leverages Morningstar salary curve methodology to estimate both forward- and backward-looking real wages. Forward-looking salaries are used in the accumulation period in the projection, and the full wage history is used to estimate Social Security benefits.

Before retirement, the Model simulates job change for each household member based on the individual's characteristics, such as age, gender, job tenure, and salary. The likelihood of job change is also informed by whether the individual has access to a defined-contribution, or DC, plan.

Upon a job change, the Model simulates whether the individual has a defined-benefit, or DB, plan with their new employer and the accrual rate if a DB plan exists. Both the likelihood of an individual joining a DB plan and the accrual rate vary based on job information, such as industry, salary, and employer size, and individual characteristics, such as age and gender.

The Model also simulates (at job change) whether the individual has access to a DC retirement plan and whether or not they participate. Furthermore, the Model simulates what plan features are applicable, such as whether the plan has auto-enrollment or voluntary enrollment, whether the plan has auto-escalation, what the default contribution rate is if auto-escalation is present, and what the plan match formula is. The assumptions underlying this process are based on record-kept data.

The Model does not assume a deterministic or static contribution rate in the projection. Instead, the Model estimates employer and employee contribution rates based on the features of the DC plan and relevant information about the individual, such as age, salary, and job tenure. The contribution prediction model is based on record-kept data. The Model also simulates whether contributions are made to an IRA based on SCF data.

The Model reflects investor behaviors that lead to less retirement savings, such as DC-plan cashouts (simulated upon job change), DC-plan hardship withdrawals, DC-plan loans, and IRA preretirement withdrawals. The assumptions underlying these processes are based on record-kept data or SCF data.

The Model forecasts assets within investment accounts to grow based on stochastic portfolio returns from Morningstar Investment Management's Time Varying Model. Refer to the next section of this technical appendix for more information on the Time Varying Model.

In terms of asset allocation, the Model uses a glide path that represents the industry consensus. It is calculated as the average of the target strategic equity allocation weights for the fund families (both CITs and mutual funds) available in Morningstar Direct. Linear interpolation is used to populate the equity weights for points in between the five-year increments. Every year in the projection, the liquid investment portfolio is rebalanced according to the glide path. The fund fee used in the analysis is 0.39%, which is based on the median fee for mega plans according to a Morningstar report on the retirement plan landscape (refer to Mitchell and Szapiro, 2022). This assumption is also consistent with the findings in the Investment Company Institute's 2024 analysis of mutual fund fees.[1]

Once retirement commences, the Model estimates the household's retirement expenses. The expenses consist of two elements: 1) standard expenses assuming no LTSS costs and 2) LTSS expenses. The

1 Refer to https://www.ici.org/system/files/2024-03/per30-02.pdf

standard expenses are based on the 2019 RAND CAMS dataset supplement to the HRS. The standard expenses vary by age, marital status, and income level, with predicted expenses decreasing at higher-attained ages. LTSS expenses are stochastic and only occur in cases wherein a household member is in either home healthcare or a nursing home (per the health state transition model described above). LTSS expenses are based on national median costs from Genworth's Cost of Care Survey.[2]

Social Security benefits are estimated separately for each member of the household. Specifically, the Model uses the estimated historical wages along with the individual's birth year, claim age (which is used to calculate the adjustment to the benefits if the individual is claiming before or after normal retirement age), and other Social Security data to calculate Social Security benefits. The Model does calculate spousal benefits when processing claims. Further, the Model calculates survivor benefits, meaning that the surviving spouse can claim 100% or some portion of their former spouse's benefits.

Every year in retirement, the Model adds up the guaranteed income from Social Security and pensions and deducts it from the simulated expenses. The household's investments (which include any assets in pretax and Roth IRAs, pretax, post-tax, and Roth 401(k)s, and a post-tax account) are used to fund any leftover amount. The Model does calculate both state[3] and federal income taxes, which are added to the next year's required expenses. The Model also calculates required minimum distributions, taxing, and then reinvesting any excess withdrawals that are not needed to fund expenses into the post-tax account (which is assumed to follow the same glide path as described earlier).

If the household is unable to fully fund its projected expenses, any net housing equity (which is estimated at the start of retirement) is assumed to be liquidated and added to the post-tax investment account in the form of a lump-sum payment. Rental costs are added to the projected retirement expenses if this situation occurs in the Model.

The projected income, wealth, and expense cash flows are converted from a nominal basis to an inflation-adjusted, or real, basis. The Model uses this data to calculate two main metrics.

1. Retirement-funded ratio: The Model calculates the funded ratio for each of the 1,000 trials. The numerator is the sum of real (that is, inflation-adjusted) income across all retirement years plus any leftover assets at the time of death,[4] if applicable. The denominator is the sum of real expenses (also across all retirement years). Note this metric shows the magnitude of the shortfalls, with retirement-funded ratios that are well below 1, indicating significant shortfalls.

2. Probability of success: This metric is calculated as the percentage of trials in which the household did not run short of money. While the binary success definition does not capture the magnitude of failure, the Model's estimation of retirement expenses explicitly incorporates the household's ability

2 Cost of Care Report | Genworth. From https://www.genworth.com/aging-and-you/finances/cost-of-care.html

3 The state of Virginia is used for the analysis.

4 For households with two members, the time of the death refers to the second death.

to pay such expenses. In other words, the expenses are already dynamic in the projection, with the household adjusting expenses downward as wealth balances decrease.

The Model has the ability to calculate many other metrics. Additional information is available from the authors upon request.

Capital Market Assumptions and Time Varying Model

Interest rates and portfolio returns are based on forward-looking assumptions and modeled stochastically using Morningstar Investment Management's Time Varying Model. Equity returns are based on a combination of US large cap, US mid-cap, US small cap, and international equity asset classes. Bond fund returns are based on US aggregate bond, international government bond, and US Treasury Inflation-Protected Securities asset classes.

The Time Varying Model forecasts returns for many global asset classes over a long time horizon. The model incorporates current market conditions in its forecast (for example, valuations and interest rates), which influence returns in the first 20 years of the projection. After that, the model's forecasts are based on unconditional, long-run return assumptions.

Inflation is modeled with a stochastic regime-switching Ornstein-Uhlenbeck model, inspired by Ahlgrim and D'Arcy (2012). The "normal inflation" regime corresponds to a period where inflation is relatively stable and stays near the Federal Reserve's target. The "high inflation" regime represents periods of high inflation, well above the Fed's target. We use a 2% inflation target for the "normal" inflation regime in our analysis. Other model parameters are calibrated based on historical data.

Additional information on the projected interest rates, fund returns, and inflation rates are available from the authors upon request.

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