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Including Risk in a Case Study of When to Start Social Security Benefits

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Abstract

Risk has long been an important part of engineering economic analysis, and the pandemic's impacts have increased that importance. This is particularly true for economic analyses of when to start Social Security benefits which depend on both economic and health/mortality factors. When assigning this as a case study, the many details and possible situations allow flexibility to match assignments to student maturity and course time constraints. Data for the "when to start" decision is also real world—not just part of a case to be read.

Unlike many benefit recipients, our students understand the time value of money and hopefully probability. Fortunately, as in the real world, a qualitative risk analysis should be the starting point. The results can be used to emphasize that quantitative analysis often requires simplifying assumptions and that qualitative factors may dominate decision-making. This paper summarizes a qualitative view of risks that may drive the choice of when to start benefits.

In advanced or demanding engineering economy courses quantitative risk measures can be explored based on data distributions. One example is supplying data including conditional mortality distributions, links to mortality distributions, or neither. Mortality distributions vary by gender, ethnicity, etc. If students search out sources of mortality data, then credibility of different sources and consistency of results can be explored. Student searches for data may subdivide the population differently offering potential new viewpoints.

Social security payments may be started at age 62 with reduced benefits. Regular benefits begin at a person's full retirement age—66 years and 2 months in 2021. Enhanced benefits may be received by delaying up to age 70. Mortality distribution data together with social security benefits support the paired metric of expected value and standard deviation (the most common measure of risk). Like investments, higher returns and lower risks are preferred. Results for a single individual show that differences in expected NPVs between starting ages are small, but delaying benefits significantly increases risk. This contradicts the conventional wisdom that delaying benefits is better for a single individual.

This case can be extended in masters or doctoral research into other defined benefit programs. It can also be extended to couples where there are two additional benefit types (spousal and survivor's) and many different combinations of ages and earning histories. As better data becomes available, case analysis could address the impact of the pandemic on past results.

Introduction

The U.S. Social Security (SS) program is one of the largest government programs in the world, ranking as the largest expenditure at 23% of the federal budget in Fiscal 2019 [1]. About 81% of expenditures of the Social Security Administration (SSA) went towards retirement benefits in

Fiscal 2019 [2]. The literature on SS is correspondingly vast. However, the literature on the "when to start" decision usually ignores the time value of money and addresses risk only qualitatively. This paper will show how a student engineering economic case study can do better.

Unlike a supplied case, this is a real-world problem. Information is available from many possible sources. Detailed rules must be read and understood. Reasoned judgments are needed about which factors are critical and about which assumptions should be made. Effective presentation approaches must be selected. We suggest that instructors need only to provide their expectations and construct an appropriate motivating description. Case limits can be matched to pedagogical goals, student skill levels, and course time constraints. When time permits, we prefer to have students analyze this in successive rounds of increasing detail and complexity.

While there are many different possible levels of *quantitative* analysis, the problem does permit construction of a *right quantitative* answer at each level—which is very reassuring to students new to case analysis. It can also be very helpful in grading the work of many student groups. Judging a *qualitative* risk analysis is unavoidably more subjective—a *right* answer might not exist.

Most people begin collecting benefits at the earliest opportunity, often age 62. For many the reason is simple—they need the income. Whether through forced retirement, limited savings, or poor financial condition, many people begin benefits early because they have no choice. When starting social security is a necessity, neither a quantitative nor a qualitative return and risk analysis matter.

After the literature review, the material for potential case levels is grouped as:

- Calculating benefits and a NPV for a given starting age and age at death.
- Identifying risks and goals in a qualitative way.
- Adding a mortality distribution to calculate expected values and standard deviations.

Risk is qualitatively addressed first, because we believe that is the correct starting point for risk analyses—and thus what students should be guided to do. In this case the qualitative factors may dominate decision-making.

Quantitative results for a single individual show that differences in expected NPVs between starting ages are small, but delaying benefits significantly increases risk as measured by standard deviation. This contradicts the conventional wisdom based on quantitative results that delaying benefits is better for a single individual.

For a directed study course or masters or doctoral research this methodology for "when to start" analysis can be extended. Similar systems with benefits determined by starting age can be found for states, government agencies (military, police & fire, teacher, etc.), other nations, and some firms. If advanced students or instructors confirm data availability and develop good solutions, then class case studies could follow. This approach can also be extended to couples where there are two additional benefit types (spousal and survivor's) and many different combinations of ages and earning histories. As better data becomes available, case analysis could address the impact of the pandemic on past results.

Literature Review

The most authoritative source on the details of regulations and calculations is clearly the website of the SSA (ssa.gov). Books on claiming SS benefits include [3], [4], and [5]. These books and the popular press focus on the monthly payment level or the total of the monthly payments to be received, not on an economically valid measure of the total expected benefit stream. This limitation demonstrates the advantage of engineering economy case analysis, but it is clearly unfortunate from a broader perspective.

The present worth of the benefit stream is common in the refereed literature, and the social security system was designed to be "benefit neutral" for single individuals with average life lengths. For single individuals with an average age at death the NPV of benefits is roughly the same no matter when benefits start [6].

The future age at death for a recipient is *the* key unknown in the decision of when to start collecting. Calculating the NPV of a given annual benefit for a defined number of years is a simple engineering economy problem. Calculating the SS benefits for a single individual's choice of a starting age and the NPVs for different ages at death is a good case study [7].

Mortality distributions underlie the life expectancies for a given gender and birth date available in SS's estimated benefit calculator (ssa.gov/estimator). Mortality distributions have been used to calculate expected NPVs for single individuals and to calculate the cost of the "longevity" insurance of delaying benefits [8]. In the paired metric of (Expected Value, standard deviation) for a single individual, significant differences in risk imply that starting early is a better choice [9].

Most of the qualitative risk factors important in determining the best age to start benefits can be found somewhere in the popular literature—but the SSA provides the best summary [10]. The refereed literature focuses on narrower topics, but it documents the importance of some factors. For example, 75% of elderly single households want to leave a positive net worth estate for their heirs [11].

Case Studies on Social Security without Risk and Mortality Distributions

The SSA must distinguish between retirement and disability benefits. However, retirement may neither be necessary nor sufficient to answer the question of when to start social security. Retirement may be involuntary, SS benefits may be immediately needed, and/or choices may be driven by individual values and situations. Work may be fulfilling or exhausting and boring. Travel, grandchildren, and care-taking requirements for an ailing or aging spouse or parent often drive choices. These are difficult to value for an individual and impossible to generalize for a population.

Case studies on SS focus on the trade-off between starting reduced benefits early, standard benefits at a full retirement age (FRA), or enhanced benefits later. The following steps in the SS calculation may be provided to simplify the case or used to evaluate whether students have found good data and made reasonable assumptions.

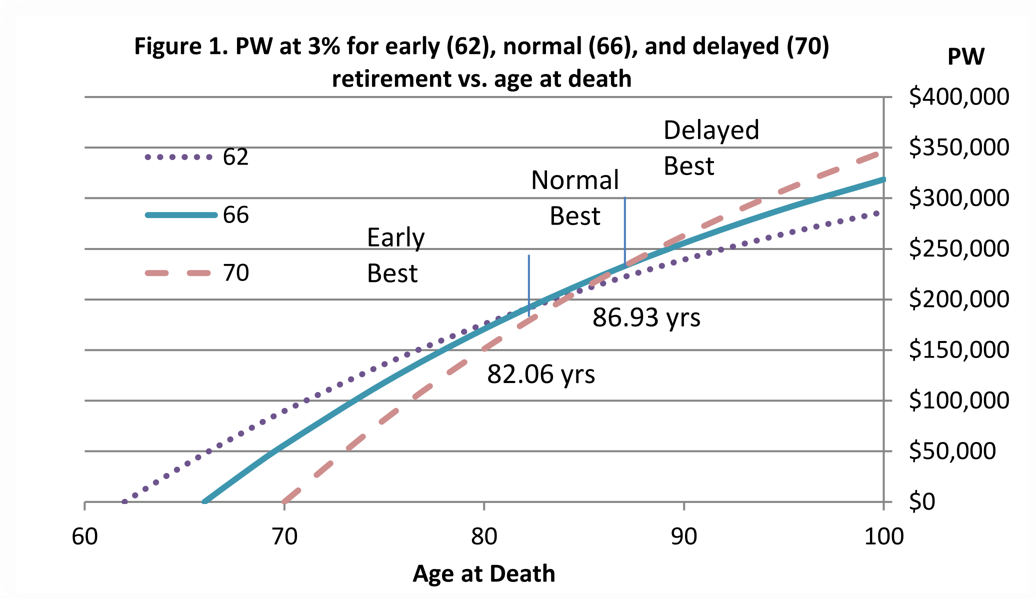
- Average indexed monthly earnings (AIME); the average monthly income subject to Social Security taxes during the previous 35 years having the highest inflation-adjusted income. Choices include:
    - The maximum SSA allowed AIME for the year being studied, an average or median wage, or an engineering salary. Salary trajectories may be limited by the maximum income subject to SS taxes.
    - × Individual earnings records are available online, but the inflation adjustment is complex—a professor nearing retirement can spend much of a day trying to match the SSA calculation.
- Primary insurance amount (PIA); the monthly Social Security payment or benefit at the full retirement age.
    - These example numbers are based on 2018 SSA rules, before the FRA began transitioning from age 66 to age 67.
    - The 2018 maximum AIME was $9936.
    - The PIA formula is progressive. The social security benefit is 90% for low AIMEs, but not for higher-level AIMEs. The example uses the 2018 bend points.
    - The maximum PIA= 0.9(895) + 0.32(5397 – 895) + 0.15(9936 – 5397) = $2927
    - Using the common end-of-year assumption this is $35,124.
        - This is the PIA value for the results shown in the figures and tables.
- What is the full retirement age (FRA)? It was originally 65.
    - For students born after 1960 the FRA is currently 67.
    - For retirees born from 1943 – 1954 it was 66, which was a retirement year bracket of 2009 to 2020.
        - This is the assumed bracket for the results shown in the figures and tables.
    - The FRA increases by 2 months per year for birth years from 1955 to 1959. This can be used to shift detailed calculations in different years.
- For an FRA of 66, starting benefits at 62 resulted in a 25% reduction from the PIA. Starting benefits at 70 increased the monthly benefit to 132% of the PIA. With an FRA of 67, starting early at 62 will result in a 30% reduction and delaying benefits to 70 will increase the benefit to 124% of the PIA.
- Collecting benefits while earning income subject to Social Security tax (FICA). If benefits are started early, they will be reduced when too much income is earned. Once full retirement age is reached there is no reduction in benefits due to earned income.

If students analyze an individual case, such as a grandparent, with the SSA's benefit estimator the years between early and normal retirement can raise their AIME. If a person has less than 35 years with significant income subject to Federal Insurance Contributions Act (FICA) tax, then more years at a high income may raise their AIME significantly. For example, a state university professor may have many years covered by a state pension plan with only limited amounts of social security income or an individual may have long child-care gaps in their employment record.

Calculating an NPV or IRR once a cash flow stream is known is straight-forward, so this paper will show results without supporting formulas. Common student errors in calculating NPVs or evaluating IRRs include:

- Using a *market* interest rate. SSA benefits are adjusted for the cost of living; thus, it is better to assume constant value dollars and use a *real* interest rate. The most common rate in the literature and by the SSA is 3%.
- Computing the PW for each starting age without allowing for years of no benefits. With an FRA of 66 there are 4-year offsets between starting at 62, 66, and 70.

Waiting until normal or delayed retirement age does lead to higher monthly benefits, but how many times that benefit is received can be even more important. Calculations at 0% can be included for comparison with approaches that ignore the time value of money. Figure 1 illustrates how the PW depends on age at death [7, Figure 1].



Qualitative Consideration of Risk

What risks are avoided or reduced by starting benefits early? One is mortality risk—the risk of collecting little or nothing before death, which is especially salient if there is a terminal illness or life-shortening health issues. The lower risks of starting benefits early can be expressed positively. Early benefits can make retirement possible and thus allow time to enjoy desired activities while a person is still healthy and vigorous. Early benefits can maintain a lifestyle that a new retiree wants to enjoy while they still can. Early benefits can preserve current savings; if a monthly benefit is received, then that amount of money does not need to be withdrawn from the bank. These savings can address specific and unknown risks. In addition, if these savings are not needed before death, they are available for bequests. As stated earlier, the vast majority of older people have a bequest motive.

What risks are avoided or reduced by delaying benefits? The delayed and higher payments lower longevity risk—the risk of outliving your money. In the academic press, the delayed benefits are described as longevity insurance and presented as *the* reason delay is better. As noted in [9] social security is longevity insurance; delay is only *incremental* longevity insurance. Many popular-press writers say that delaying social security benefits is needed because people keep living longer. That trend was true until about 2010, when U.S. life expectancy leveled off [12].

The Covid-19 pandemic has already reduced U.S. life expectancy at age 65 by nearly one year in the first half of 2020 [13] with more severe impacts on minority communities [12]. As life expectancy declines, future benefits are received for a shorter period, making a delay in benefits of less value. Some universities have incorporated engineering economy as an option for non-engineering students. A qualitative analysis of other pandemic risks and impacts would be a timely case study.

Another qualitative risk topic is the ability to manage risk over time. In this social security case, less future income will be needed if living with relatives is an option. Vacations and eating out can be common and expensive or rare and in-expensive. Many students are familiar with limited budgets and managing the risks of not having enough money; to be effective engineers all students will have to envision possible futures and responses over time.

Possibly the most common or best reason for delaying benefits is that it is a form of required saving for retirement. This link to behavioral economics is another qualitative way to look at longevity insurance.

Qualitative factors are probably the reason that most people begin benefits early. There are valid reasons for people making this choice, and it is not accurate to claim that people are short-sighted or unaware of the facts.

Case Studies Including a Mortality Distribution

The expected value and standard deviation for each possible starting age are determined.

- Calculate the NPV for the benefit stream for each starting age and age at death based on the PIA and any percentage increase or decrease due to the starting age.
- Since benefits cannot start before 62, the relevant mortality distributions should assume that an individual is alive at 62 and find the conditional probability for each age at death.
    - The National Vital Statistics System (NVSS) is a good source of statistical data.
    - The conditional probabilities sum to 1 since death is inevitable.
- For each starting age, use the SUMPRODUCT function to calculate the expected value and standard deviation.

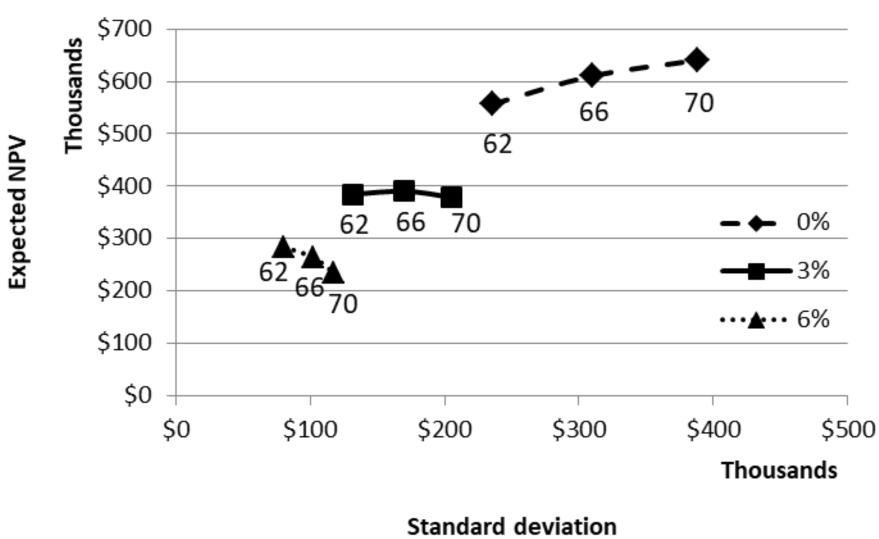
Table 1 [9, Table 1] shows example conditional probabilities calculated from the mortality distribution for the total U.S. population. Data specific to gender and ethnicity is also available from NVSS [14]. On average in the U.S., women live longer than men, which will make starting retirement payments later somewhat more attractive to women.

Table 1. Example conditional dying probabilities given alive at 62 derived from NVSS data for all individuals.

Year ending at Age	*P*(die|62)	Year ending at Age	*P*(die|62)
63	0.0103	94	0.0318
64	0.0109	95	0.0284
65	0.0115	96	0.0246
66	0.0121	97	0.0208
67	0.0128	98	0.0171
68	0.0136	99	0.0136
69	0.0145	100	0.0105
70	0.0155	≥101	0.0242

Applying the data for Table 1 with the 2018 SS values results in Figure 2 and Table 2 [9, Figure 2 and Table 2] for a single individual. Students should conclude from results like these that the expected values are about the same for each interest rate and risks are lower if benefits are started early.

Figure 2. NPV's risk and expected return for total population



In Table 2 note that the probability of collecting nothing due to dying before starting benefits puts numbers to one of the qualitative risk factors.

Table 2. Descriptive statistics for the NPV of benefits at 3% real interest.

	Start 62	Start 66	Start 70
Expected NPV	$384,710	$390,531	$379,019
Std. dev.	$131,227	$170,186	$205,574
P(die before start)	0	4.48%	10.12%

Subtracting one expected value or *P*(die) in Table 2 from another does equal the incremental NPV or *P*(die), however that is not true for the standard deviations. The standard deviations shown in Table 2 are descriptively useful, but the incremental standard deviations are about $40,000 for 66 vs. 62 and 70 vs. 66. The mortality distributions for different starting ages are *not* independent. Rather there is one mortality distribution with a paired difference between the starting ages that are being compared.

When looking at a single starting age it is not possible to calculate an IRR. The benefit stream is a "return" on the years of FICA contributions. However, if incremental analysis is done such as starting at 63 versus 62 or 70 versus 66, then both an incremental NPV and an incremental IRR can be calculated. When calculating IRRs we recommend that dying before starting benefits be assigned an IRR of −100% (the complete loss of potential benefits).

The ΔIRR_{66-62} column of Table 3 [9, Table 5] shows IRR values corresponding to the probabilities shown in Table 1. The conditional probabilities for 70 vs. 66 are conditioned on being alive at 66.

Table 3. Incremental IRRs.

Die at	ΔIRR_{66-62}	ΔIRR_{70-66}	Die at	ΔIRR_{66-62}	ΔIRR_{70-66}
63	−100%	-	94	6.2%	5.2%
64	−100%	-	95	6.3%	5.4%
65	−100%	-	96	6.4%	5.6%
66	−100%	-	97	6.5%	5.7%
67	−74.9%	−100%	98	6.6%	5.8%
68	−48.6%	−100%	99	6.6%	6.0%
69	−33.6%	−100%	100	6.7%	6.1%
70	−24.0%	−100%	≥101	6.8%	6.2%

As shown in Table 4 [9, Total columns of Table 6], the expected value of incremental IRRs will be negative. Dying early has highly negative IRRs and positive IRRs are less than 7% even with centenarian status. The standard deviations are large, unlike stock market investments where annual standard deviations are reduced for longer periods. For each social security recipient *n* equals 1 life.

Table 4. Summary statistics for incremental IRR.

	66 – 62	70 − 66
E(ΔIRR)	−6.65%	−11.00%
Std. dev.	26.5%	29.1%

Summary and Conclusions

We believe that this case can be presented appropriately to undergraduate students who are personally a long way from retirement. It has the enormous advantage of not depending on the instructor or a case writer to assemble the information—thus students must do much of the searching and problem refinement that is one of the principal differences between textbook problems and the real world.

The future focus of engineering economic analysis means that risk is an inescapable part of real problems. When to collect social security has qualitative risk factors that students can readily search for, brainstorm about, and understand. Adding a mortality distribution supports understanding the need to balance return and risk; it also supports a comparison of quantitative measures of risk with qualitative factors.

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