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When to Start Taking Social Security – An Engineering Economics Problem

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When to Start Taking Social Security – An Engineering Economics Problem

Abstract

To better motivate our students to learn and apply the material taught in our required engineering economics course, we introduced an open-ended problem based on a real scenario involving social security. Using the data from two of the professors' social security benefit statements, students were asked to determine the optimal age at which to start these benefits.

Students were first asked to individually make an argument for the optimal age to start for each professor, whether they were the same or not, and to account for both the potential life expectancy of the recipients and an assumed interest rate. Then students were put in groups based on these choices (3 groups were formed with the most common responses being early 62-64, middle 65-67, or late 68-70). They were then asked to refine their arguments, and the project culminated with an in-class debate.

The authors found that this problem-based learning exercise was very beneficial in motivating the students to better learn and apply the course material. And, as a bonus, the instructors had a much better idea as to when to start their social security benefits!

Introduction

Most engineering programs require that students take a course in engineering economics as well as ethics. Previous authors [1-3] have introduced the idea of using Social Security as a case study to teach economics in graduate programs. Their work, as they hoped, has sparked us to also pursue a Social Security based case study for teaching purposes. The Social Security administration provides a variety of tools on their website [4] which are at least intended to inform the recipient of the information, but it does not answer the question of when an individual should begin taking social security.

Eschenbach et al. [1] clearly sets up the case study well with background material on social security and then introduces the cases of a 62-year-old male and a 60-year-old female with different wage histories and monthly benefit data for early 62, normal 66, and delayed 70 years of age. The students calculated, using a range of interest rates and a range of ages at death, the value of benefits for the recipient.

In a subsequent paper, Lewis and Eschenbach [2] extended their analysis to consider the decisions facing couples since they have more options than single people do about when to start receiving benefits. For example, a dependent spouse may collect up to half their spouse's benefit and then also may collect survivors benefit if they outlive the providing spouse. Further Lewis and Eschenbach [3] introduced risk assessments into the case study making the calculations well beyond our undergraduate curriculum requirements.

It was apparent to us that we could simplify the previous work [1-3] and at the same time introduce additional twists to the problem that are not as complex, but which would provide our students with an equally interesting case study to address. The differences used in our study were:

a) We also used two data sets but from real people; however, we used the entire data set of estimated monthly benefits from 62 through to 70 versus just 62, 66 and 70. This shows up a rather interesting anomaly that makes it clear that you cannot assume that a uniform increase year by year will result in a greater overall value of benefits, which is a point which will be discussed later.
b) Students performed their own analysis and formed their own opinions. In class, the students were grouped into teams to have a debate about when to take social security. The debate served to emphasize the complexity of the decision and the variety of options available. It also highlighted that not every decision is a purely financial one and the discussion of health and mortality inevitably surfaces. This serves our course well since we teach economics and ethics as a single course, and this results in good crossover between the topics.

The Social Security Options

For those unfamiliar with the choices, social security benefits can start as early as 62 or as late as 70. And the longer one waits, the more one receives. For example, Table 1 below shows the potential benefit received by each professor depending upon the age at which they start. The entries are color coded to designate the first three options (early), middle three options (middle), and last three options (late).

Table 1: Social security monthly benefits of two professors for in class comparison.

Starting Age to receive benefits	**Professor 1 Monthly Benefit**	**Professor 2 Monthly Benefit**
62	$2649	$2280
63	$2875	$2472
64	$3076	$2682
65	$3338	$2956
66	$3599	$3236
67	$3860	$3525
68	$4044	$3606
69	$4356	$3955
70	$4799	$4584

The Course

At the University of Denver, all engineering students are required to take ENGR 2910, Engineering Economics and Ethics. For the mechanical engineering curriculum, this course is listed in the spring of the junior year. For the electrical and computer engineering curriculums, this course is listed in the spring of the senior year. However, many mechanical engineering students will take this course as a sophomore, and even a few will take it as a freshman. In addition to covering engineering economics, this course also covers engineering ethics. For the spring ’24 offering, the enrollment was 78 of which 11 were computer engineering majors, 11 were electrical engineering majors, and 56 were mechanical engineering majors. All the electrical and computer engineering majors were seniors. 35 of the mechanical engineering majors were seniors, 20 were sophomores, and 1 was a freshman.

The co-authors have both taught this course at the University of Denver, but never together. They talk frequently about the course, and the work leading to this paper is one of the many beneficial results.

The Debate

As mentioned, the students were first asked to individually decide the optimal age at which to start the social security payments using the data provided. No justification was required at this stage (a mistake, it was concluded after that fact, that will be corrected in subsequent years). Once this assignment was due, there was a mini-debate in class where all could say why they chose what they chose. After that mini-debate, students were asked to pick one of 4 teams for the upcoming official debate. Their choice did not have to match what they said in their individual work. Students would pick either the 62-64 team, the 65-67 team, the 68-70 team, or the team which would serve as judges. Ideally there would be a roughly equal split (which ended up being the result), but that was not required. Once teams were formed, they were given class time (10-15 minutes on two separate occasions) to plot their strategy. They were of course free to use outside of class time to prepare as well. The non-judges would determine their best arguments and who would present (they were told one or more students could present). The judges would determine what questions they would ask each team.

The format for the debate was as follows (set for our 50-minute class period):

1) Randomly choose which team goes first, second, third
2) First team gets 3-4 minutes to present their arguments
3) Second team gets 3-4 minutes to present their arguments
4) Third team gets 3-4 minutes to present their arguments
5) Judges ask questions of all teams (5-8 minutes of questioning - alternating which team is asked every time)
6) First team gets 3 minutes to re-present - can rebut arguments or reinforce their ideas.
7) Second team gets 3 minutes to re-present - can rebut arguments or reinforce their ideas.
8) Third team gets 3 minutes to re-present - can rebut arguments or reinforce their ideas.
9) Judges ask questions of all teams (5-8 minutes of questioning - alternating which team is asked every time)
10) Judges deliberate and choose a winner (5-8 minutes).

Teams had the option to simply orally present their arguments or use visual aids as well.

The instructors chose to provide no other input on the problem or how to approach it before the debate. They were well exposed to the fundamentals of engineering economics when this problem was assigned, but that was it. After the final debate, the instructors presented their take on the problem (described in the next section) to reinforce certain engineering economic principles.

Results and Discussion

As mentioned, this assignment started with the class being shown the data for the two professors and being asked to decide when they thought social security payments should begin (from age 62 through age 70). No formal justification for this initial answer was required, but was encouraged, especially since it would only help with the later stages of the assignment. There were three primary answers at this stage: early years (62-64), middle years (65-67), and later years (68-70). After a brief in-class discussion of their initial thoughts, the class divided into their 4 groups: early years, middle years, later years, and judges. Each group had roughly 20 students. As expected, unfortunately, with groups that large, not everyone was actively involved. The authors would estimate that between 5 and 10 in each group actively participated, but this was more than enough to have a lively debate.

During the debate, there were several key points made by the students and summarized below:

1) Early years is better if you don't expect to live a long time or don't invest at a high interest rate
2) Early years could be problematic if one hasn't retired due to IRS penalties
3) Middle years provides the best of all worlds (the Goldilocks principle, the students presented, garnering the strongest reaction of the debate from the class). Not too soon, not too late, but just right.
4) Later years is better if you expect to live a long time or invest at a more cautious, lower interest rate

The judges did a pretty good job of asking each team questions, particularly trying to get each team to be more quantitative. However, the teams were simply not prepared to be very quantitative, and that was deemed the professor's fault for not requiring more work be done before the debate. Again, no justification for their initial answers were required and they never had to submit anything. This approach was taken on purpose to see what would happen, but for subsequent implementations, a new approach with more individual accountability will be taken. As a result of their lack of quantification, students were unable to distinguish between the two data sets.

As anyone moderately versed in such problems will know, the students' general findings were solid. But questions remain. If you commit to a certain age for your life expectancy, where is the cutoff for the various options? And how much does the assumed investment interest rate impact that answer?

For completeness, the judges decided that the early years team won the debate. That team was probably the best prepared and made the simplest, most easily understood arguments.

During the next class, the professors gave their analysis, hoping to solidify the learning and understanding of the basic engineering economic principles that this problem highlights. This analysis was straight forward. There were three unknowns – when to start payments, life expectancy, and investment interest rate. For every possible starting age (62-70), an integer life expectancy from 75 to 95, and an integer interest rate from 0% to 10%, were analyzed by calculating the present value of each. Figure 1 provides a generic cash flow diagram for this situation. We start all cash flow diagrams at age 62. Then at age X (ranges from 62 to 70), we start the uniform set of monthly social security payments (as is generally done, we use end of payment period for our calculations). Technically, these payments will increase each year based on inflation, but we assume 0% inflation for simplicity here. Then, payments stop at age Y (life expectancy, ranging from 75 to 95).

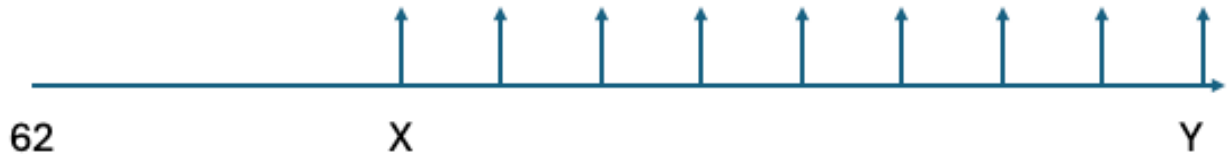

Figure 1: Generic Cash Flow Diagram

For example, if the monthly payments start at age 62 (X) with a life expectancy of 75 (Y), at 0% (i) the present value (PV) is calculated using the following formula:

$$PV = PMT * ((1+i)^n - 1)/(i(1+i)^n) \text{ Equation 1}$$

Since i is 0%, we need to take the limit of this expression as rate of return approaches zero, which is simply n, the total number of payments. So, using professor 1, we take $2,649 times 156 (the total number of monthly payments over 13 years) to obtain $413,244.00.

Similarly, if the monthly payments start at age 70 (X) with a life expectancy of 95 (Y), at 10% (i, annual) the present value is $238,086.04. For this calculation, there are two steps. First, one would use the Equation 1 to calculate the PV(X=70), but this PV(X=70) is at year 70. To move that PV(X=70) from 70 to 62, we would use a PV given FV formula:

$$PV = FV * (1+i)^{-n} \text{ Equation 2}$$

Where FV in Equation 2 is the PV(X=70) from Equation1. PV in Equation 2 is the desired PV at age 62. In both equations, we are given an annual rate of return so we divide by 12 to obtain a monthly value. So, again, for professor 1, if payments start at age 70, the monthly payment would be $4,799 (PMT in Equation 1). Using a monthly rate of return of 0.1/12 (i) and for 300 total payments (total monthly payments over the 25 years), we obtain $582,116.66 for the present value at year X (PV'). Using this value as FV in Equation 2, the same rate of return as before, but now noting that there are 96 periods (n) between 62 and X (70), we obtain the previously stated $238,086.04 value.

It is pretty straight forward to complete all of these calculations in a spreadsheet. It is less straight forward to determine what to do from there – that is, how best to present the results. The authors decided to present the data in Ttables 2 and 3 below. For each possible pairing of unknowns (life expectancy, shown on the left, and interest rate, shown on top), there would be 10 present values to compare, one for each of the possible starting ages. For our purposes, the goal was to maximize this present value, and so for every combination, we noted at which starting age the highest value would result. So, for example, in Table 2 for professor 1, with a life expectancy of 75, the optimal age to start payments is 62 for any interest rate other than 0%. At 0%, one should wait until 63. Alternatively, with a life expectancy of 95, one should wait until the age of 70 for any interest rate less than 6%. However, if higher rate of returns are assumed, one should start earlier. Again, these are the same trends that the students inferred (clearly they learned some key concepts during the class), but more quantified here. Note that the table is color coded so that all matching optimal years to start payments have the same color.

Table 2: Table data shows the Optimal Starting Age for Professor 1 given an interest rate and a life expectancy

	0%	1%	2%	3%	4%	5%	6%	7%	8%	9%	10%
75	63	62	62	62	62	62	62	62	62	62	62
76	63	63	62	62	62	62	62	62	62	62	62
77	63	63	63	62	62	62	62	62	62	62	62
78	65	63	63	63	62	62	62	62	62	62	62
79	66	65	63	63	62	62	62	62	62	62	62
80	66	66	65	63	63	62	62	62	62	62	62
81	67	66	66	63	63	62	62	62	62	62	62
82	67	67	66	65	63	63	62	62	62	62	62
83	70	67	66	66	63	63	62	62	62	62	62
84	70	70	67	66	65	63	62	62	62	62	62
85	70	70	70	66	66	63	63	62	62	62	62
86	70	70	70	67	66	63	63	62	62	62	62
87	70	70	70	70	66	65	63	62	62	62	62
88	70	70	70	70	67	66	63	62	62	62	62
89	70	70	70	70	70	66	63	62	62	62	62
90	70	70	70	70	70	66	63	63	62	62	62
91	70	70	70	70	70	66	63	63	62	62	62
92	70	70	70	70	70	70	66	63	62	62	62
93	70	70	70	70	70	70	66	63	62	62	62
94	70	70	70	70	70	70	66	63	62	62	62
95	70	70	70	70	70	70	66	63	62	62	62

Table 3 shows the same results for professor 2. We expected the result to more similar than they are. And while the trends are clearly the same, the breakpoints are different. Perhaps this is to be expected as few of us earn the same amount each year and for the same number of years. It really pays to do this analysis for each person's specific data. To better explain the differences, in Figure 2 we plot the normalized payment values (both series are normalized to unity at age 62 - that is, each series has each value divided by its initial, age 62, value). For whatever reason, professor 2 has higher relative payments at the later years. Thus, there is more incentive for professor 2 to wait than there is for professor 1, consistent with the table data.

Table 3: Table data shows the Optimal Starting Age for Professor 2 given an interest rate and a life expectancy

	0%	1%	2%	3%	4%	5%	6%	7%	8%	9%	10%
75	63	62	62	62	62	62	62	62	62	62	62
76	65	65	62	62	62	62	62	62	62	62	62
77	66	65	65	62	62	62	62	62	62	62	62
78	66	66	66	65	62	62	62	62	62	62	62
79	67	67	66	66	62	62	62	62	62	62	62
80	70	67	67	66	65	62	62	62	62	62	62
81	70	70	67	67	66	65	62	62	62	62	62
82	70	70	70	67	66	66	62	62	62	62	62
83	70	70	70	70	67	66	62	62	62	62	62
84	70	70	70	70	70	66	66	62	62	62	62
85	70	70	70	70	70	67	66	62	62	62	62
86	70	70	70	70	70	70	66	62	62	62	62
87	70	70	70	70	70	70	67	66	62	62	62
88	70	70	70	70	70	70	70	66	62	62	62
89	70	70	70	70	70	70	70	66	62	62	62
90	70	70	70	70	70	70	70	66	62	62	62
91	70	70	70	70	70	70	70	67	62	62	62
92	70	70	70	70	70	70	70	70	62	62	62
93	70	70	70	70	70	70	70	70	62	62	62
94	70	70	70	70	70	70	70	70	62	62	62
95	70	70	70	70	70	70	70	70	66	62	62

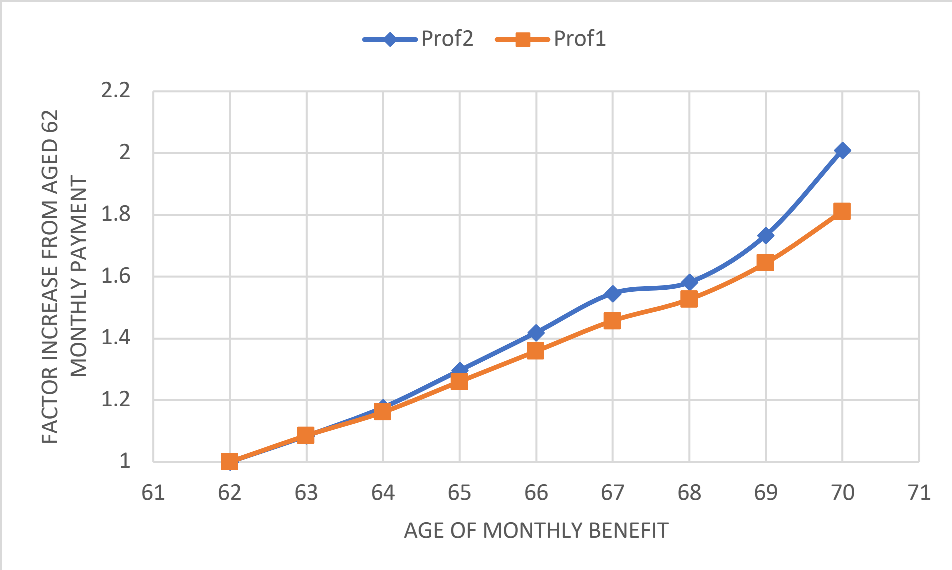

Figure 2: Normalized Monthly SS Payments against aged 62 payment for Professors 1 and 2

Another interesting note is that conventional wisdom says to start your social security payments late (age 70). Almost every financial advisor will tell you this, in large part because they do not want you to outlive your money, which implicitly assumes you will live a long time. Thus, that advice is reasonable. However, more realistically, most of us will unfortunately not live until age 95. If one lives only until 85, for an assumed interest rate of at least 3%, professor 1 would want to start payments earlier than age 70. For reference, according to the CDC, males in the United States are expected to live 74.8 years and females in the United States are expected to live 80.2 years [5].

Lastly, it should be noted that this analysis did not consider penalties, taxes, or spouse payments. Most are perhaps aware that depending on when one retires, the status of one's spouse (whether they are working or receiving social security payments) can and will impact the calculations shown here. Students were encouraged to consider (and look up) such implications, but it wasn't clear that any did.

Conclusions

This exercise was considered a success and will be implemented again during the spring 2025 offering of this course with the few changes noted. More individual work, and thus more individual accountability, will be assigned and expected. More guidance will be given on how students should explicitly and quantitatively consider life expectancy and rate of return.

Referenes

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