Pension simulation

Piia Maria Tomberg

1 Introduction

In a world where inflation constantly eats away at any savings that people can gather during their working life, they become dependent on the national pension system which manages to minimise the effects of inflation by a constant influx of funds from younger working people. However, with the population slowly aging, the proportion of pensioners in the population increases and supporting them with the taxes of the reduced workers' population becomes more difficult. The leading way of reducing this effect on the pension system is to increase the retirement age, to the dismay of many.

For this reason an alternative to the national pension system should be considered, in order to have hopes of retiring at an age where the human body is still capable of living a full life. This alternative is proposed here utilising the global stock market. By investing savings in the stock market, which on average increases in value every year, the negative effects of inflation can be negated if the stock market increase exceeds the inflation rates, which is generally the case. If the yearly allowance removed from the portfolio is smaller than the yearly increase of the portfolio's value due to stock market gains for the majority of retirement, then it is possible to live from this yearly allowance for the duration of the retirement, without the portfolio ever running out of funds. The goal is to find the optimal initial retirement fund size that will fund the allowance until the age of 100 years without running out, but also without the fund size increasing in perpetuity because that would indicate an excessive initial fund size. Of course, depending on the goals of the individual it may be desired for the fund to continue growing throughout retirement, that would just require a larger initial fund size.

Here the creation and results of a retirement simulation is presented, with the possibility of adjusting the desired monthly net income, the start year of retirement, and all possible percentages including the rates of stock increases, inflation and taxes. The simulation is focused on the observation of the total retirement fund size over the course of retirement up to the age of 100, as the monthly income is removed and the applicable rates adjust the fund size as well.

2 Methods

2.1 Inflation

Inflation is historically on average 3% per year (Eurostat) in Europe so this decrease in the value of money is reflected by the yearly 3% increase of the desired net income, the minimum wage and the income tax free minimum. Thus, the desired monthly

net income at its 2025 value is one of the input paramaters of the simulation and its value at a given year of the simulation is calculated as

$$\text{new net monthly} = \text{initial net monthly} \times (1 + \text{inflation}/100)^{\text{year}-2025} \tag{1}$$

2.2 Taxes

Assuming that the retirement begins before the national retirement age, the private retirement fund must provide nationally declared wages in order to provide national health insurance. However if the entire net desired income were paid out of the fund as wages, they would be subject to higher taxes. Thus, it is most reasonable to optimise taxes by only paying out minimum wage as wages and taking the rest out as dividends, which are only subject to income taxes.

The taxes on the wages are nationally set as follows. If X is the net wages received after taxes, Y is the total expense to the employer, Z is the gross wage and A is the income tax free minimum, exempt from income tax, then the relations between them can be described as

$$Y = Z + 0.33Z + 0.008Z \tag{2}$$

$$X = Z - (Z - A - 0.036Z) \times \frac{\text{tax}}{100}, \tag{3}$$

where the 0.33 in 2 represents the social tax and 0.008 represents the unemployment insurance and the 0.036 is the combined mandatory 2% pension contribution and 1.6% unemployment fund contribution. By simplifying we get the following relations for the simulation code:

$$Y = 1.338Z \tag{4}$$

$$X = Z - (0.964Z - A) \times \frac{\text{tax}}{100}. \tag{5}$$

In 2025 the monthly gross minimum wage is Z =886 euros and the income tax free minimum is A =776 euros (Maksu- ja tolliamet). The income tax in 2025 is tax=22 percent but since over the years it is expected to rise, the simulations are all run with this value set to tax=25.

2.3 Dividends

The tax rate for a company paying out dividends is the national income tax, which is 22% in 2025 and assumed at 25% for the duration of the pension simulation in order

to account for possible future tax increases. In order to calculate what the yearly dividend payment needs to be, the following relation is taken into account:

$$\text{net yearly} = \text{min net} + (100 - \text{tax}) \times \text{dividend}, \tag{6}$$

where 'net yearly' is the total yearly payout after taxes, including both the minimum yearly wage, 'min net', and the dividend payout after tax. Thus the dividend is calculated as

$$\text{dividend} = \frac{\text{net yearly} - \text{min net}}{100 - \text{tax}}. \tag{7}$$

2.4 Stocks increase

The average global yearly stock market increase is roughly 9% when averaging over 30-40 years (Carry). However since it is not a given for the future to continue with such large gains, half of the retirement simulations are also run with a more conservative yearly stock increase of 7%.

3 Results

Since the simulations of this report are run specific to the author, the end year of the simulation, or the year when the age of 100 is reached, is set to 2096. All the input parameters used are brought out in Table 1.

Parameter	Value
End year	2096
Start year	2040 and 2050
Stock increase	7% and 9%
Income tax	25%
Yearly inflation	3%
Income tax free minimum	9312 €/year
Minimum gross wage	10632 €/year

Table 1: Input parameters of the simulations run.

In Figure 1 are the retirement fund sizes are shown over the course of four different retirement simulations, varying both the retirement start year between 2040 and 2050 and also the monthly net income between 2000 and 3000 euros at its 2025 value. The initial fund size has been optimised to end retirement with roughly the initial fund size without the fund size reaching a negative value.

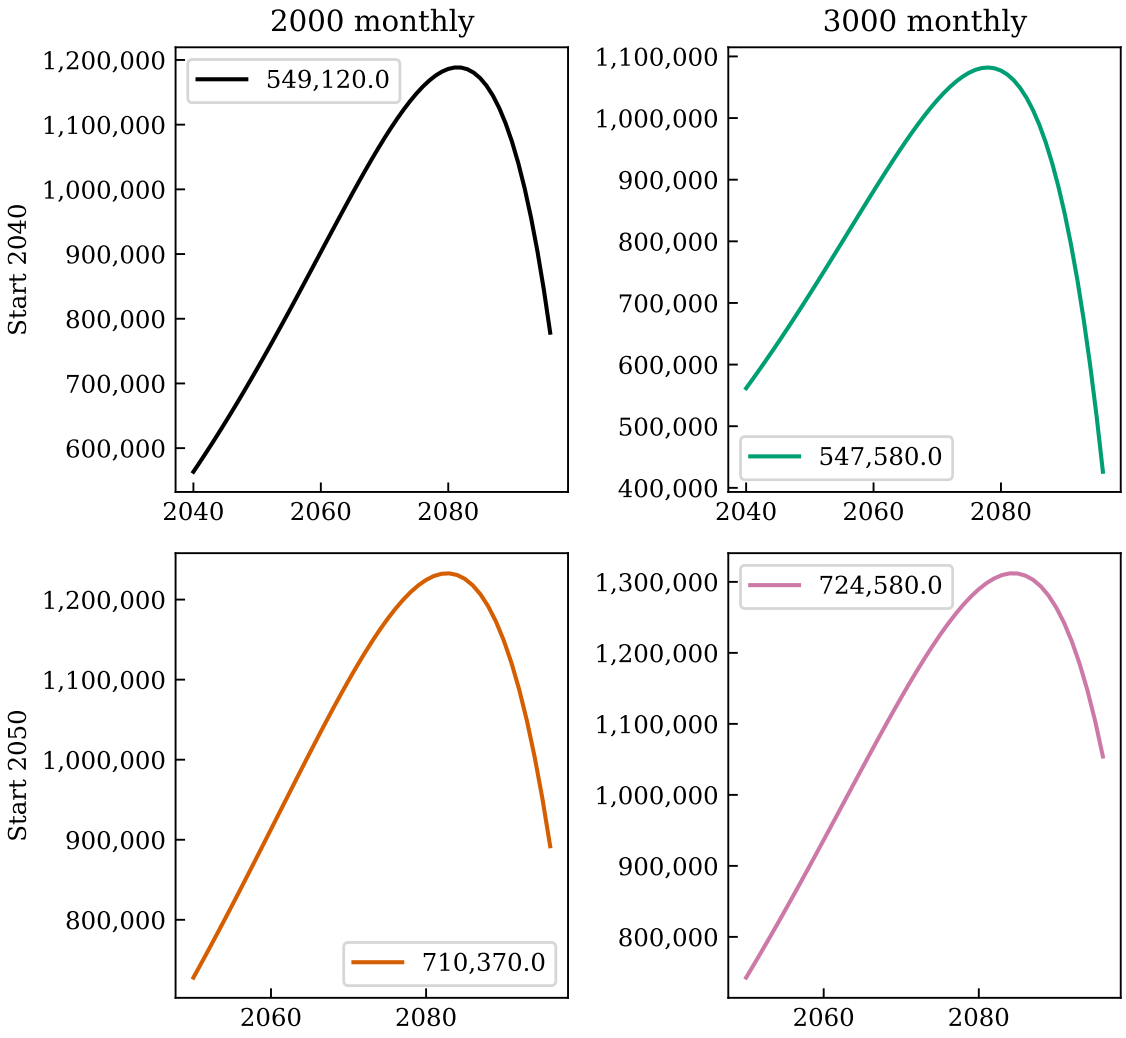

Figure 1: Nest egg fund size of the course of four different retirement simulations with the initial fund size shown in the legends of the individual plots. The simulations in the upper row show retirements starting in 2040 and in the lower row, 2050. In the left column the net monthly income after deducting all taxes is assumed to be 2000 euros and in the right 3000 euros. The yearly stock market increase is assumed to be 7% in these simulations.

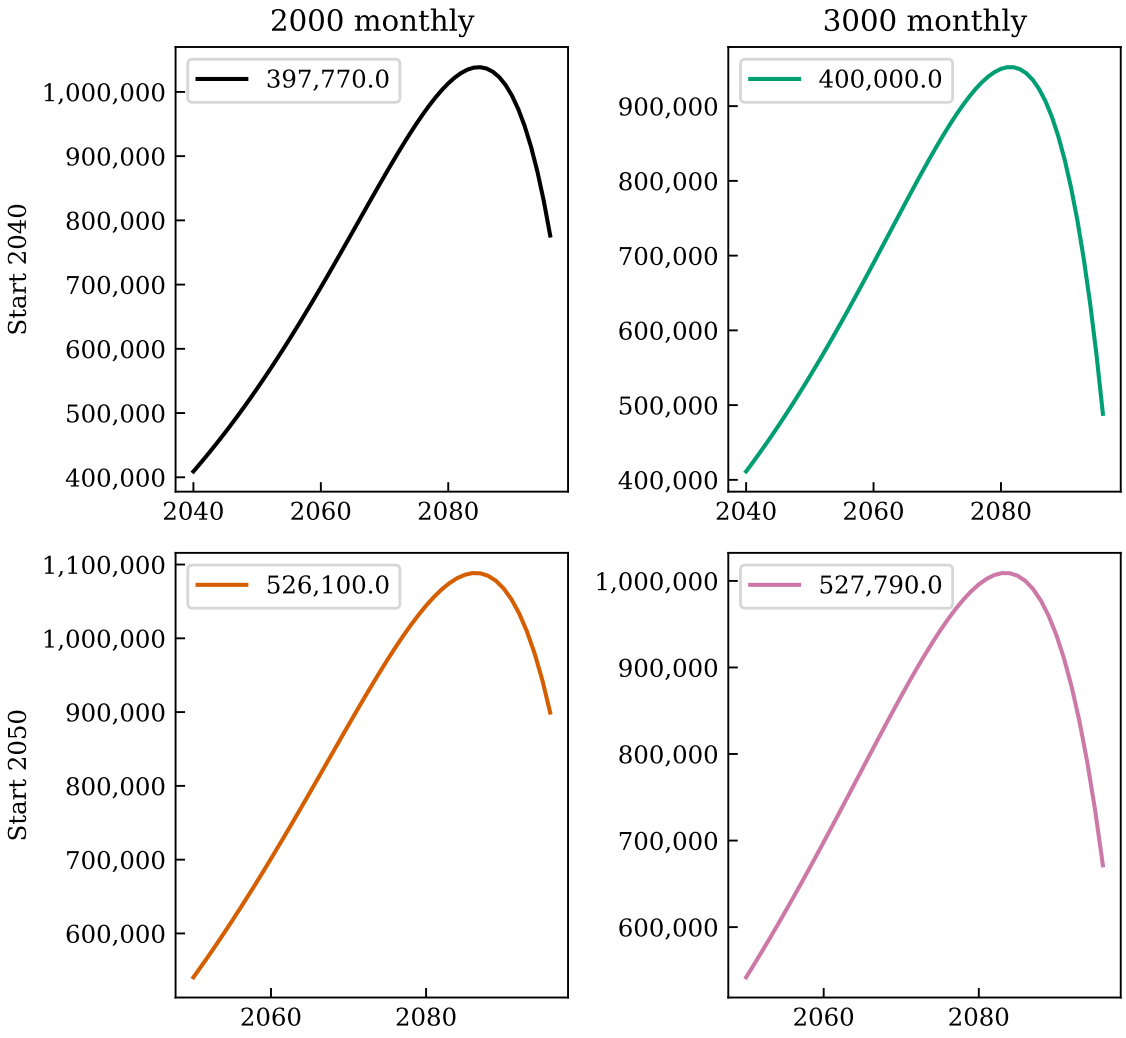

Figure 2: Nest egg fund sizes over the same initial conditions as in Figure 1 but with the yearly stock market increase assumed to be 9%.

As is visible from figures 1 and 2, the necessary initial funds to start retirement are significantly more affected by the start year of retirement, and vary very little by the desired net income size. This is exemplified further in Appendix A where lower values of the desired monthly net income are used but the needed initial fund sizes are not changed by much.

A significant difference in the necessary initial fund size is revealed when varying the yearly stock market increase from 7% to 9%. When starting the retirement in

2040 then increasing the yearly stock market increase decreases the needed initial fund size from roughly 550,000 euros to 400,000 and if retiring in 2050 then reducing from 715,000 to 527,000. That is an initial fund size decrease of 26%, indicating a serious reduction in the work that needs to be done to collect the retirement fund.

4 Conclusions

Early retirement is a dream that can become a reality when utilising the incremental growth of investments in the stock market. Without investing, the value of any savings will be quickly reduced due to inflation but when keeping savings in the stock market, their value will, on average, increase instead. If the yearly payout from the fund does not greatly exceed the yearly income from the stock market increase, this can sustain an early retirement, which is simulated in this work. Here, the optimal initial retirement savings fund or nest egg size is assumed to be the value that will increase over the majority of retirement but will then have a slight downturn at the end instead of increasing infinitely. However, different goals of the retirement simulations can be achieved with slight modifications to the code if the secondary goal of leaving behind a sizeable inheritance is also present.

The necessary initial retirement fund size is not very dependent on the desired net monthly income, but instead the start year of retirement and the yearly fund size increase percentage. The start year of retirement affects the needed nest egg size due to inflation and cannot be changed by the means of the user. The earlier that the necessary nest egg size is reached, the smaller it needs to be, however the time that that can be achieved is highly dependent on the income and savings capabilities during the working life of the individual. It is of course recommended to utilise investments in the stock market for the duration of the working and saving period as well. Naturally it would be most beneficial to start retirement as early as possible to need the smallest nest egg but these sums are likely not immediately available to most, requiring years to save up for.

The other significant variable in the necessary initial nest egg size is the yearly stock market increase over the duration of the retirement. Unfortunately this cannot be easily predicted, thus leading to the historical average assumptions used in this work. The historical average yearly increase of 9% (Carry) can be either exceeded or receded, depending on the specific retirement year, thus it is encouraged to perform yearly comparisons during retirement between the modelled and actual retirement fund size. If the actual stock value increase is consistently greater than the predicted value then it is possible to 'accidentally' leave behind an inheritance at death that

was not predicted to happen with the smaller yearly increase.

The simulation code and report created here is subject to constant improvements and open to suggestions. The current version is last updated on 16.09.2025.

A Varied net income

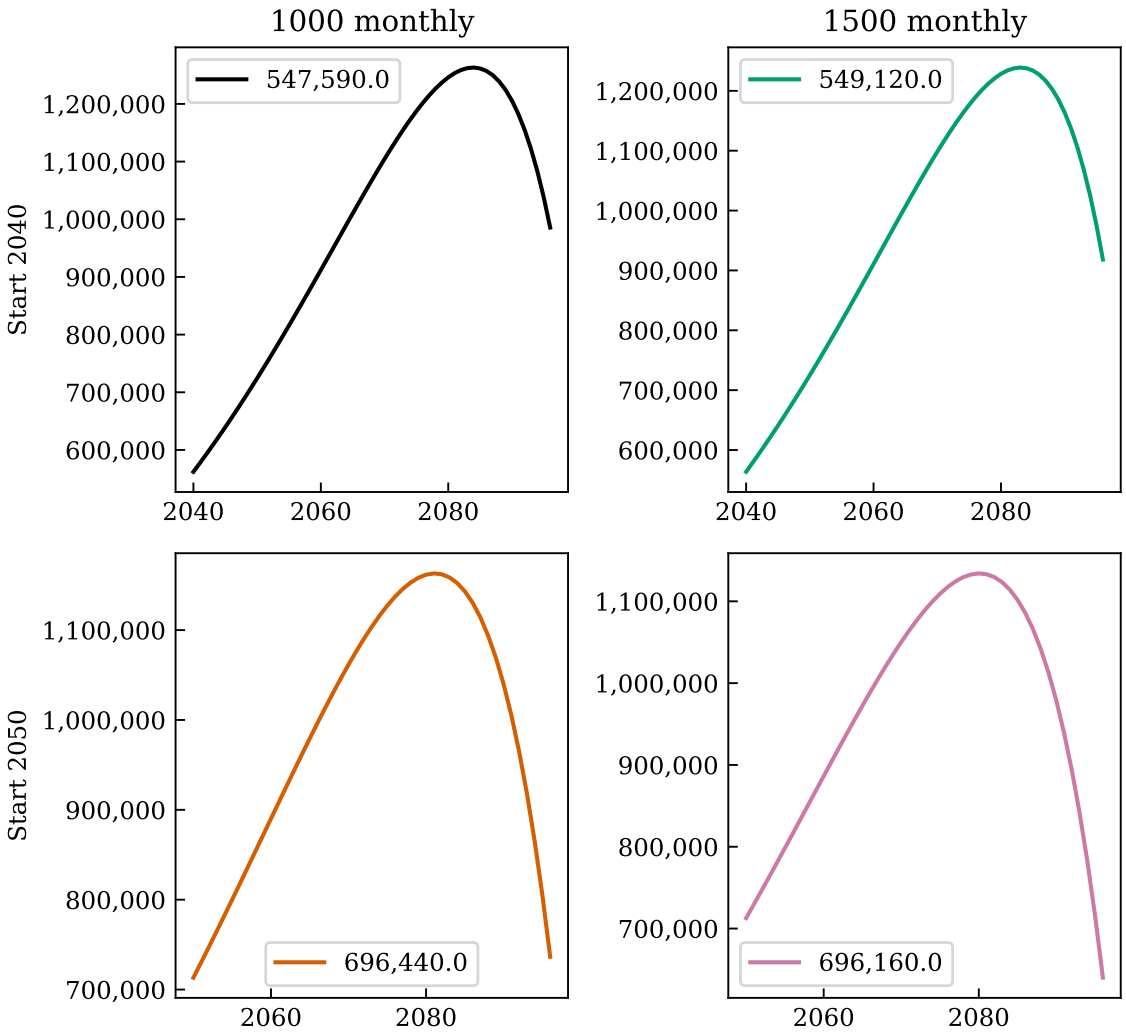

Figure 3: Nest egg fund size of the course of four different retirement simulations with the initial fund size shown in the legends of the individual plots. The simulations in the upper row show retirements starting in 2040 and in the lower row, 2050. In the left column the net monthly income after deducting all taxes is assumed to be 1000 euros and in the right 1500 euros. The yearly stock market increase is assumed to be 7% in these simulations.

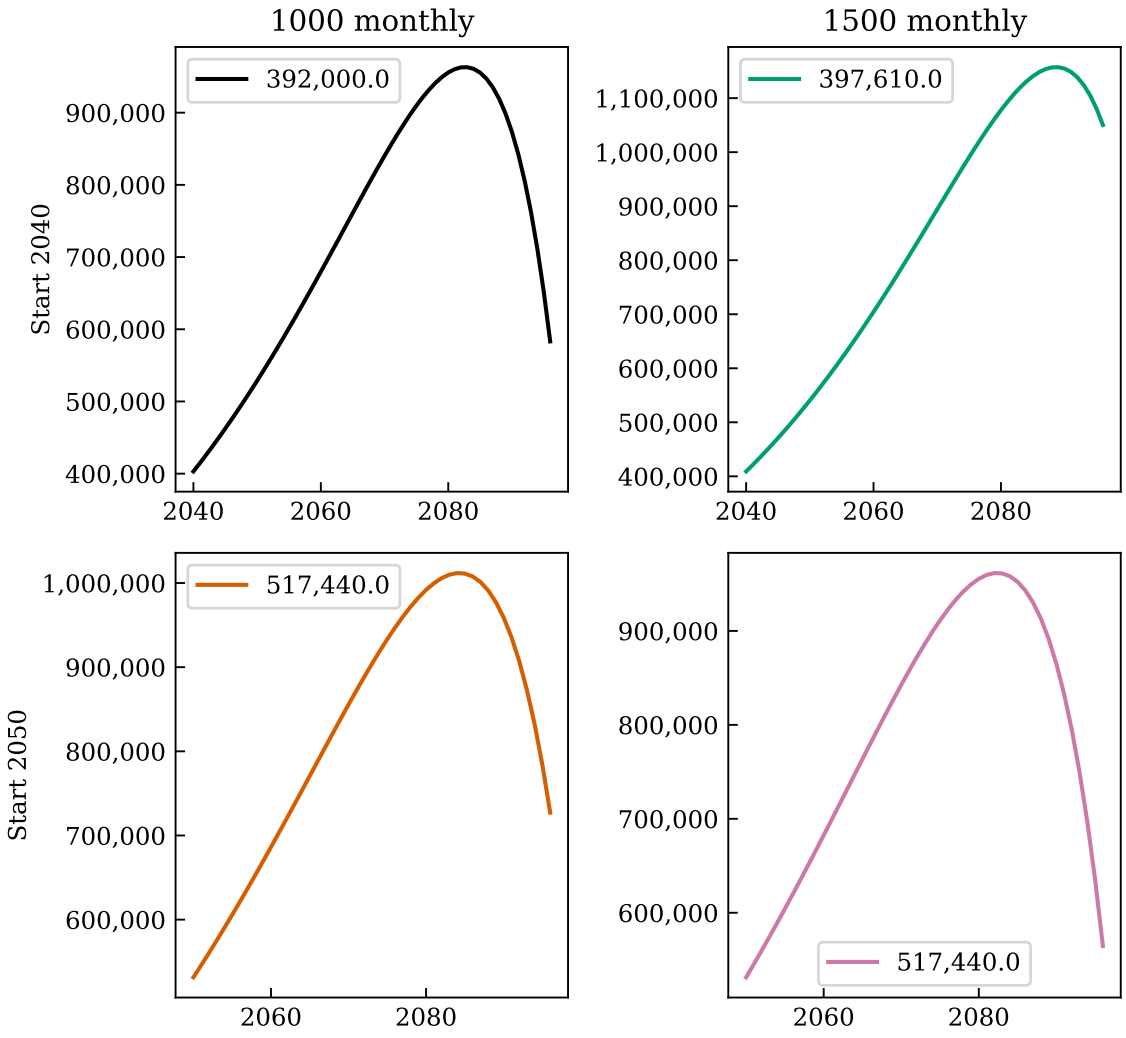

Figure 4: Nest egg fund sizes over the same initial conditions as in Figure 3 but with the yearly stock market increase assumed to be 9%.

References

[Carry] Carry. The average stock market returns over the past 10, 20, 30, and 40 years. https://carry.com/learn/average-stock-market-returns. Accessed: 12.09.2025.

[Eurostat] Eurostat. Consumer prices - inflation. https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Consumer$_p rices_ i nflation.Ac$ 12.09.2025.

[Maksu- ja tolliamet] Maksu- ja tolliamet. 2025. aasta maksumuudatused. https://www.emta.ee/uudised/2025-aasta-maksumuudatused. Accessed: 12.09.2025.