Exploring Market Exposure to Increase Social Security Solvency

Abstract

Social Security, which relies largely on taxes on workers to pay for benefits for retirees, faces sustainability challenges due to demographic shifts and increasing beneficiary demands. This study explores the effects of investing the Social Security fund into the equity market to preserve the fund's real per capita value and reduce long-term tax burdens on workers. Preliminary results of the model's performance indicate that market exposure can lead to fund growth over extended periods and alleviate financial pressures on future generations of taxpayers. However, refining the model's representation of income and expenditures is necessary to ensure proper performance evaluation and feasibility of real world implementation. Additional performance testing against unexpected economic conditions is required to evaluate the resilience of the model.

Introduction

Motivation

Social security, contrary to popular belief, is not "running out". At its core, it takes a small portion of every worker's salary in the form of payroll tax and uses that money to send distributions to eligible retirees. So long as there are people working and paying taxes, there will be money to distribute to retirees. What is being depleted is the Social Security fund. When less money is disputed than is collected as taxes, the excess is used to purchase treasury bonds. Conversely, when required distributions are greater than collected taxes, some of the treasury bonds in the fund are sold to cover the cash flow shortfall. It is this fund that is "running out". Current place 2035 as the year when the fund is completely depleted. At that point, the only options will be to raise taxes or decrease benefits. However, given that the fund still contains nearly three trillion dollars as of 2025, this paper aims to explore the effects of leveraging the asset market as a way to maintain the program's solvency.

Causes of Decreased Financial Health

There are two causes of the decrease in the financial health of social security: the drop in the worker-to-retiree ratio and inflation. Let's explore both of these.

Worker-to-Retiree Ratio

Given the system is fundamentally workers paying taxes to fund distributions to retirees, the more workers per retiree, the less each worker needs to contribute. Below is a graph plotting the number of Americans of working vs retirement age, as well as the ratio of workers to retirees, from 1950 to 2025 and projected out to 2100.

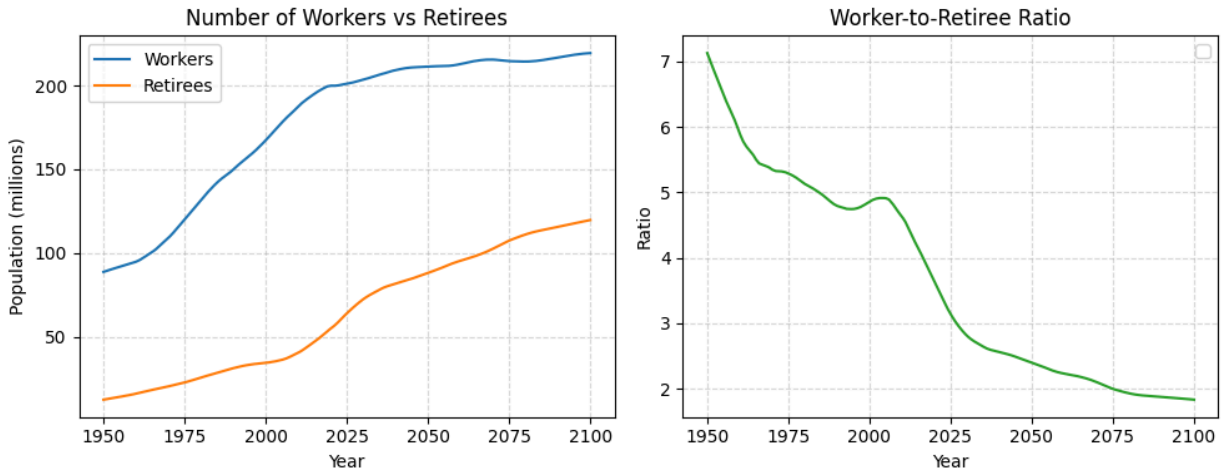


Figure 1

As you can see, both retirees and workers increase over the 150 year time period but the ratio plummets. The ratio today in 2025 hovers around three and will be two by the end of the century, meaning without the social security fund to supplement distributions, we could see the average worker will see their taxes increase 50%, average benefit drop 33%, or some combination of the two.

Inflation

The Fed's YOY inflation target is 2%. The Fed has done a decent job at achieving this over the years, the notable expectations being the deflation of the 30s, inflation of the 80s and the post covid inflation. Over the course of the last 100 years, inflation has averaged 3%. That would be costs rising three cents on the dollar or, inversely, the same one dollar buying you less and less each year. Below is a graph of the Consumer Price Index from 1913 to 2024 as well as the purchasing power of $1000 over the same time frame to illustrate this concept.

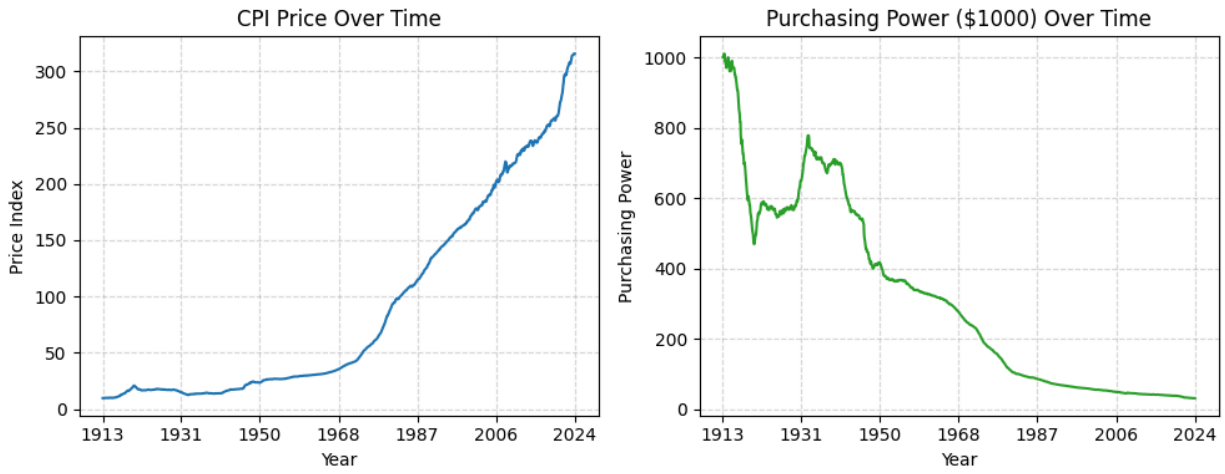


Figure 2

Note how the cost of the same basket of goods (CPI) goes up over time and therefore, the amount $1000 can buy you naturally goes down over time. Applied to the Social Security fund, this means that the fund will lose purchasing power at an average rate of 3% per year. The fund currently has three trillion dollars but accounting for inflation, the three trillion would lose half of its purchasing power by 2050.

Leveraging the Equity Market

Between 1990 and 2025, the S&P 500 has grown 18 fold its 1990 value, equating to an average growth rate of 8.7%. Over the course of its existence, the S&P 500 has averaged an even higher growth rate of 10%. This is in comparison to population and inflation, which in relative terms, have averaged 4.7%. Meaning, the purchasing power per capita of a fund invested in the S&P 500 would grow at 4% per year. Here, the equity market can act as a hedge against both inflation and population growth by growing faster than the effects of these two negative forces combined.

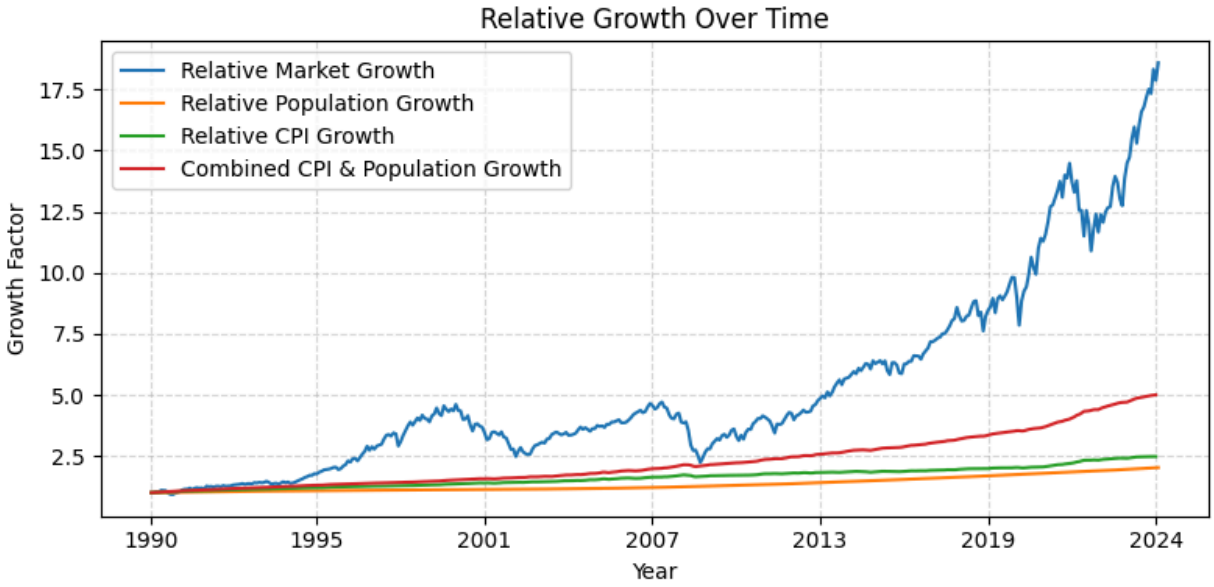


Figure 3

Overall Objectives

In order to improve Social Security's financial health, we need to outline a few overall goals to address some of the concerns above. It's these goals we will use to assess the performance of our model. The goals are as follows:

1. Guarantee distributions to retirees that maintain their purchasing power.
2. Preserve and grow the real value of the Social Security fund.
3. Produce stable predictable tax burdens for taxpayers that decrease overtime.

Methodology

Model Objectives

In order to improve Social Security's financial health, we need to outline a few overall goals for the model. It's these goals we will use to assess the models performance. The goals are as follows:

1. Guarantee distributions to retirees that maintain their purchasing power.
2. Preserve and grow the real value of the Social Security fund.
3. Produce stable predictable tax burdens for taxpayers that decrease overtime.

Assumptions

Numerous constants are used within the model. Below are the values that we used when performing our calculations.

Measurement	Value (Average Annually)
S&P 500 Return	9.5%
S&P 500 Volatility	18%
Average Inflation	3%
Average Retiree Population Growth	1.5%
Margin of Safety	0%

Model Design

Distributions

Every beneficiary is guaranteed a monthly payment based on the following formula:

$$B_r(t) = C \cdot P_{\text{CPI}}(t), \quad \text{where } C = 6$$

Here the distribution each retiree receives is directly tied to the Consumer Price Index (CPI) for a given month by a constant multiplicative factor. For this model, the multiplicative factor was set at six to closely mimic the average benefit in 2025. This formula produces a benefit of $1893.63 in January of 2025 while the average Social Security distribution at the same time is $1,976.

Fund Composition

The fund itself is fully invested in the S&P 500. Using the above assumed values, investing the fund exclusively in the S&P 500 should result in growth far greater than inflation and population growth. See Figure 3 for a visual representation.

Principal Payments

The majority of model complexity lies in determining the burden that falls on each taxpayer. The core of this calculation falls on the relation between the realized and target fund sizes.

1. Calculate Target Withdraw Rate

   We first make the following assumptions for the below values. These are largely driven by historical records:

Symbol	Description	Value (Average Annually)

r	S&P 500 Return	9.5%
σ	S&P 500 Volatility	18%
i	Average Inflation	3%
g	Average Retiree Population Growth	1.5%
m	Margin of Safety	0%

By plugging these values into the formula below, we can derive that over the long term, a withdrawal rate of 0.28% per month will still enable us to preserve the real per capita value of the fund.

$$w_{target} = \frac{r - i - g - \frac{\sigma^2}{2} - m}{12}$$

2. Calculate Distribution Obligations

   We can utilize the following equation to determine our required distributions for a given month. Simply put, it is the benefits per retiree times the number of retirees.

$$D(t) = B_r(t) \cdot R(t)$$

3. Calculate the Target Fund Size

   Using these two values, we can determine the target size of the fund. This is the size at which the obligatory distributions can be withdrawn from the fund while still maintaining its real per capita value.

$$F_{target}(t) = \frac{D(t)}{w_{target}}$$

4. Calculate Shortfall

   If the fund is below its target value, this will need to be captured in order to calculate catch up contributions in the following steps. Here we prevent the shortfall for a given month from being negative i.e. ignoring situations of surplus.

$$S_m(t) = \max(F_{target}(t) - F_{real}(t), 0)$$

5. Determine Catch Up Contributions

Assuming the fund is below its target value, catchup contributions are calculated and factored into principal payments. Here we utilize a formula that does us the magnitude of monthly payment required to close the shortfall over a given time period. For our calculations, we assume the same average market return as above and a time period of 30 years.

$$P_{PMT}(t) = S_m(t) \cdot \frac{r/12}{(1 + r/12)^{12N} - 1}, \quad \text{where } N = 30$$

6. Determine Tax Burden per Worker

   The fund will be responsible for paying a portion of the distributions, relative to its size to the target fund value. The withdrawals missing due to the shortfall will have to be made up by the taxpayers. In addition, the taxpayers will also be responsible for the catchup payments.

$$T_{proposed}(t) = P_{pmt}(t) + \frac{w_{target} \cdot S_m(t)}{12}$$

   In order to achieve objective number three, payments will be limited to a ceiling equal to the required distributions:

$$T(t) = \min\left(T_{proposed}(t), D(t)\right)$$

   Finally, the per worker tax burden can be calculated:

$$T_w(t) = \frac{T(t)}{W(t)}$$

Data Sources

Population

Population data was sourced from PopulationPyramid.net, which sources its data from the UN, and consisted of data from 1950 to 2024 as well as projections from 2025 to 2100. Each year consisted of data of the raw number of people in each age from, broken up in five year chunks, and gender.

Age	**M**	**F**

0-4	8751915	8432442
5-9	6886231	6669379
10-14	5761053	5585557

Combining male and female numbers and pulling data from each year, we generate the following form:

year	**0-4**	**10-14**	**15-19**
1950	17184357	11346610	10849518
1951	17668446	11611572	10825966
1952	17825549	12010170	10866993

Finally, extrapolating the data out to each age in the columns and each month in the rows, we get the following:

date	**0**	**1**	**2**
1950-12	3727171	3582021	3436871
1951-01	3734622	3589781	3444939
1951-02	3742074	3597540	3453007
1951-03	3749525	3605300	3461075

Consumer Price Index

Sourced from U.S. Bureau of Labor Statistics and recorded monthly:

date	**cpi**
2024-11	315.493
2024-12	315.605
2025-01	317.671

S&P 500

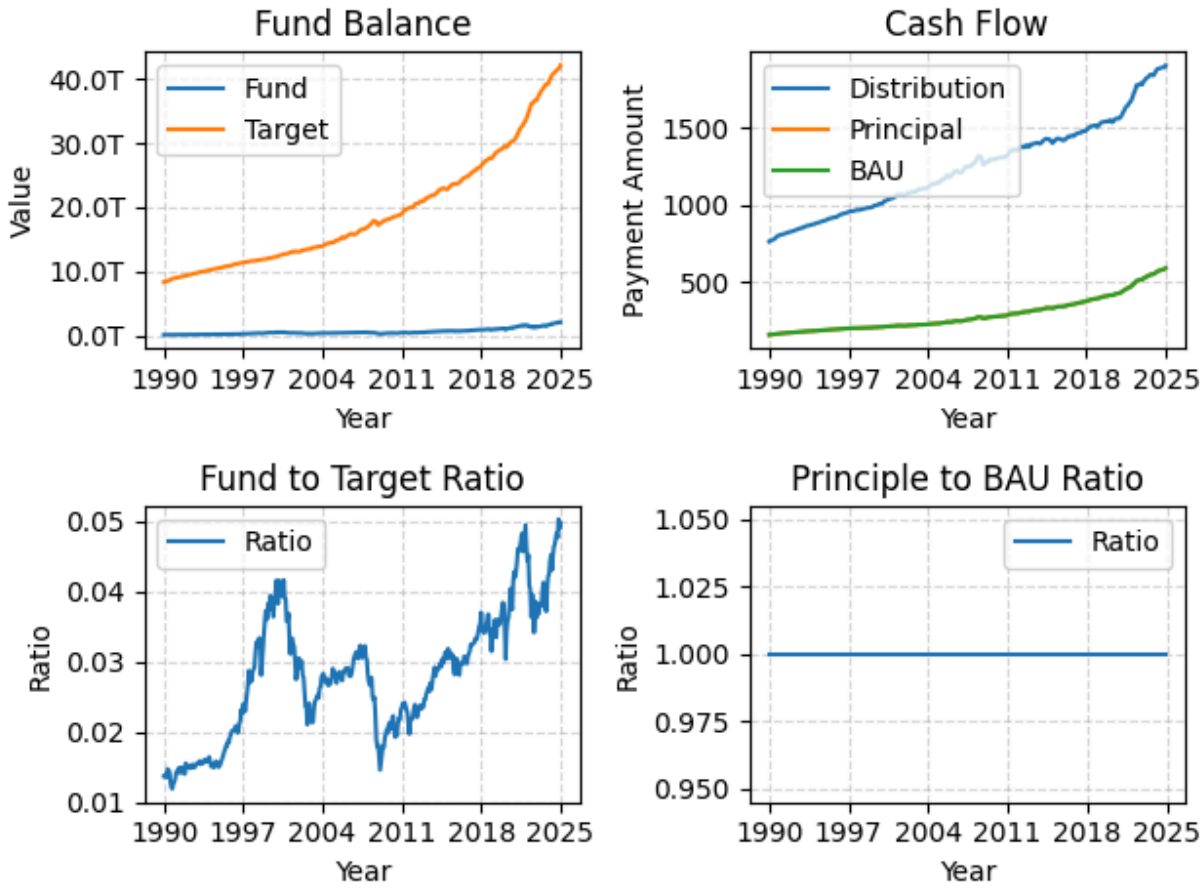
Sourced from MarketWatch and recorded monthly:

date	price
2024-02	5096.27
2024-03	5254.35
2024-04	5035.69

Results

1990 Baseline

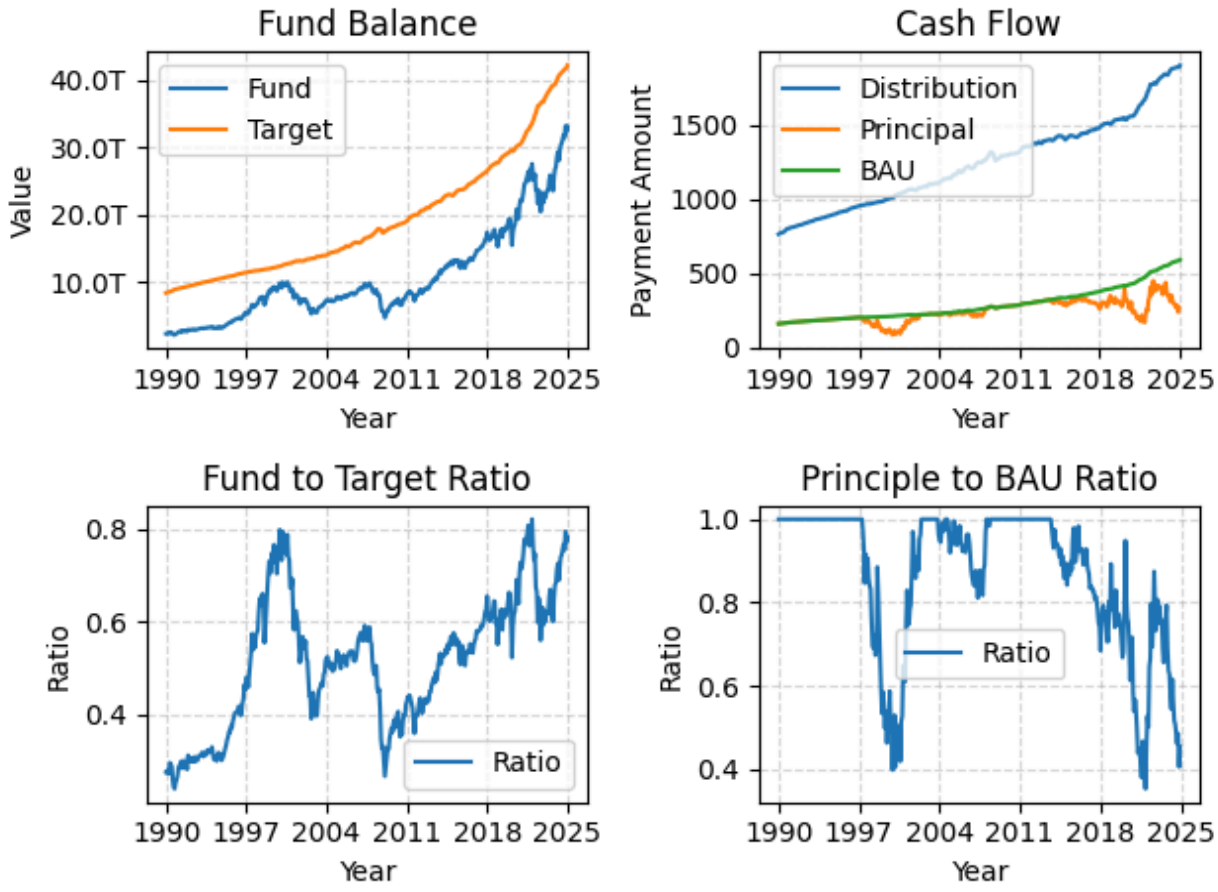
Assuming we apply this model starting in 1990, we get the following results:



A few important things to note here. Given that the balance of the trust fund was so low, approximately 1.5%, of the target in 1990, the fund never grew to a size that would impact principal payments. The fund does, however, grow substantially in comparison to the target, ending at 5% of the target value. Over the 35 years, the fund grew 18x while the target, based on inflation and the population of retirees, only grew 5x.

1990 Additional Seed Funding

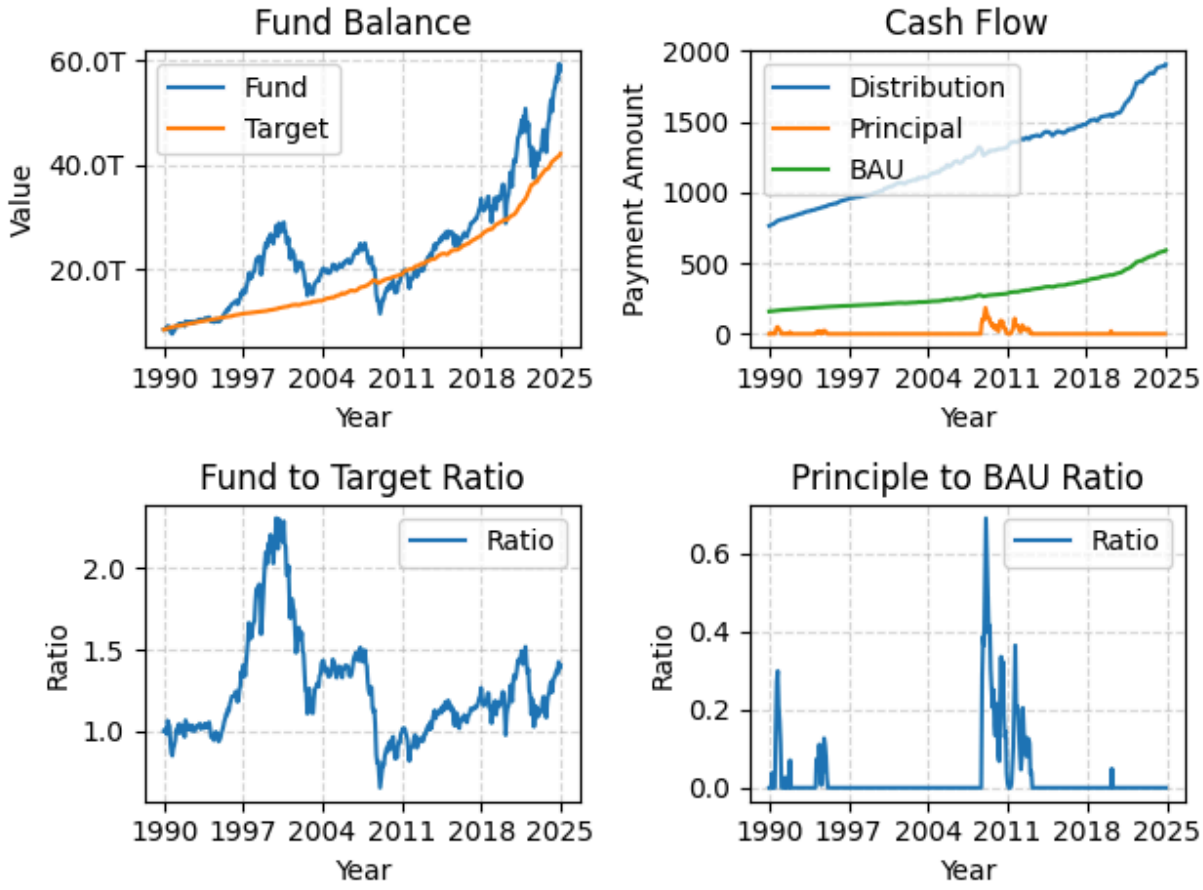
Starting this time with an initial fund value of 20x what was present in the fund in 1990, we get the following outcome:



A few things to note here, during the two relative highs experienced by the market, those being the Dot Com and Post COVID bull markets, the fund rose to around 80% of the target. In these environments, the principles also began to drop as the fund began to cover a larger share of distributions.

1990 Full Funding

Assuming that the fund starts with the target value, we will see the following performance:



In this scenario, note how the fund follows the target over the long run. This is evidence for the assumptions that underlie our withdrawal formula, that returns, inflation, and population will all deviate from their long term averages in the short term, but will converge in the long term, producing a steady growth to cover both current distributions and prepare for future growth in distributions.

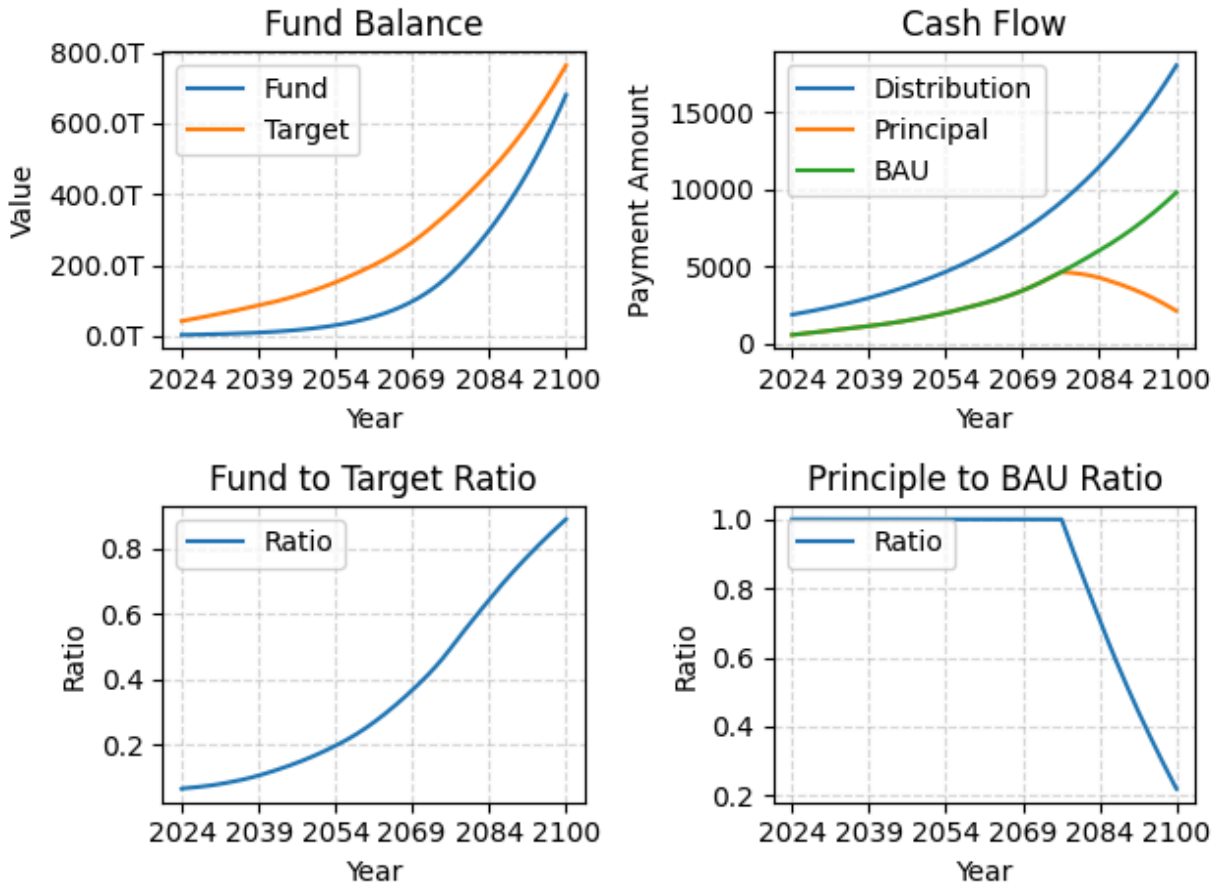
While the market and economy are not the same, this strategy would tie the two closer together. When the market crashed during the 2008 recession, principles spiked. While only about 70% of what they would be given by BAU, it would still result in hundreds of dollars per month coming out of taxpayers' paychecks at a time of economic uncertainty, potentially increasing the severity of the economic downturn. Alternatively, given a period of a bull run in the equity markets, a decreased principle would result in more money in the hands of taxpayers, potentially fueling a stronger bull market. This feedback loop is lessened through the 30 year shortfall repayment timeline but additional considerations need to be taken.

Additionally, the model here produces an overshoot. While the ratio of the fund to the target hovers around 1 for much of the simulation, it does rise to 2 during the Dot Com bubble. While this is eventually undone by the 2008 recession, this would not have been known at the time.

Additional mechanisms need to be introduced here to decrease volatility/risk, pay back to taxpayers, increase benefits, etc.

2025 Projection

Finally, when this model is applied today and projected out to 2100, we see the following results. The fund continually grows towards the target, resulting in a decreasing principle.



Analysis and Discussion

Objective Review

Taking a look back at our initial objectives, we can begin to analyze the success and failures of the model.

1. Guarantee distributions to retirees that maintain their purchasing power.

   This was successfully achieved through pegging distributions to CPI. This however, does

over simplify distributions. Further investigation needs to be done to ensure our distribution calculations accurately models real life distributions by factoring in things such as a varying retirement age, the distribution of benefit payments based on salaries from working years, and taxes on benefits.

2. Preserve and grow the real value of the Social Security fund.

   The model was shown to have achieved this through numerous simulations. Given variable principals that are guaranteed to equal distributions in the worst case scenario, the fund is never depleted with respect to distributions. Additionally, the equity market has shown to outpace inflation and population growth, given enough time. This has allowed the fund to, overtime, increase its real value per capita. The fund does have the potential to overshoot without any mechanism to correct down towards the target.

3. Produce stable predictable tax burdens for taxpayers that decrease overtime.

   The model has shown, given enough time and/or adequate initial funding, principals will drop in absolute terms, additional work needs to be done towards investigating the real value of the principals from taxpayers. Additionally, distribution calculations do not take into consideration workforce participation, distributions of taxpayer incomes, or tax rates. The model should output a tax rate rather than a dollar amount and performance of the model evaluated by the decreasing of the tax rate overtime in comparison to what it would need to be without the fund.

Additional Considerations

The model, the way it is designed, is not possible to implement. Principals and distributions are adjusted monthly, which is impractical from a bureaucratic perspective. Additionally, the CPI data used is lagging, meaning data for a specific month is not known for an additional month or two. A more likely implementation is quarterly or annually adjustments of distributions and principals using the most recent data available.

Only real data was used to test the model's performance. Future simulations designed around edge cases and high strain should be designed to better determine model performance. Simulations may include scenarios of hyperinflation, economic depression, mass immigration, etc.

Conclusion

Summary

Investing the social security fund into the equity market is an effective way to preserve the real value per capita of the fund over a sufficiently long enough term and has the potential to decrease the tax burden on workers as the fund reaches a sufficient size. Further refining of the model around expenditures and income is required to fully assess the impact of the investment.

Future Work

The model should be updated to better represent income and expenditures as well as to increase real world implementability. Additionally stress testing should be run to observe model performance in unforeseen events.