Exploring Market Exposure to Increase Social Security Solvency

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.

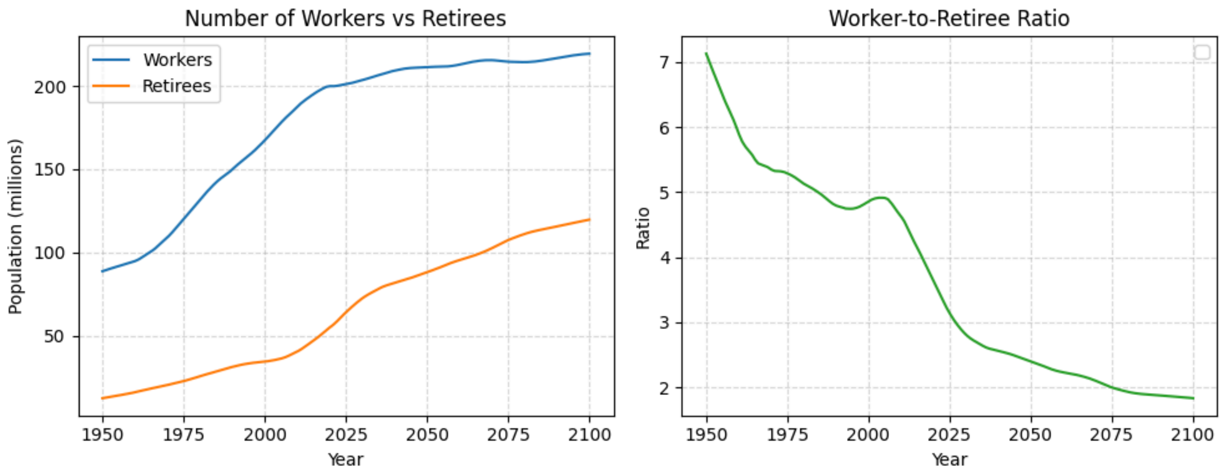

Figure 1

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.

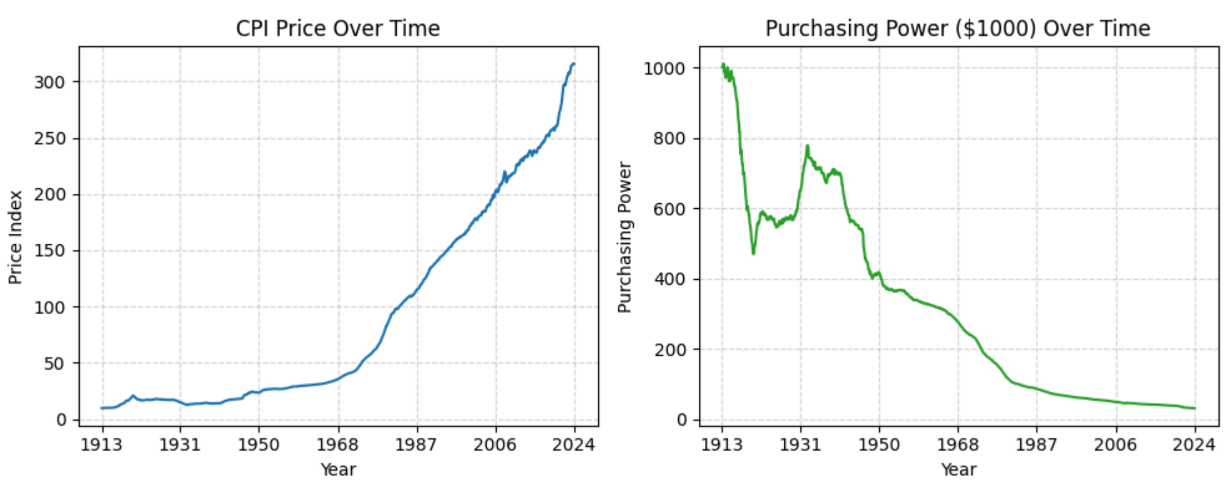

Figure 2

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.

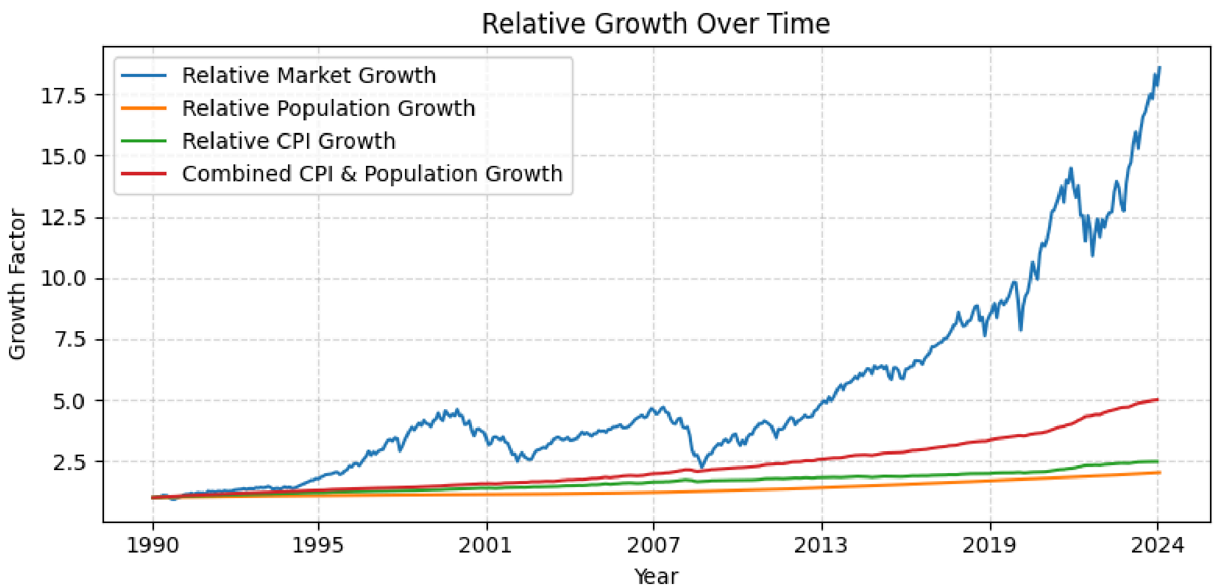

Figure 3

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.

Model Design

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%

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 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.