Wishful Thinking About the Risk of Stocks in the Long Run:
Fake Arbitrage and What to Do About It[1]

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Abstract

It is widely believed that while stocks are risky in the short run, in the long run they are sure to outperform risk-free investments like government bonds. This is a dangerous fallacy. It leads to the illusion that one can earn an equity risk premium without bearing risk. This implies that the stock and bond markets provide unlimited arbitrage opportunities. But these are fake arbitrage opportunities—wishful thinking. In this paper I explain the faulty reasoning behind the fallacy and explore some of its consequences for rules governing tax-qualified individual retirement accounts, the measurement and funding of pension promises by businesses and state and local governments, guarantees provided by the Pension Benefit Guaranty Corporation, and proposals for solving the problems of the Social Security system. Finally, I recommend measures to counteract the fallacy's harmful effects.

[1] I thank Robert C. Merton for many valuable comments. His name should be added to mine as coauthor.

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Introduction

It is widely believed that while stocks are risky in the short run, in the long run they are sure to outperform risk-free investments like government bonds. This is a dangerous fallacy, which I originally explored in a 1995 paper entitled "On the Risk of Stocks in the Long Run."[2] It leads to the illusion that one can earn an equity risk premium without bearing risk. It violates the core principle of economics: TANSTAAFL—There Ain't No Such Thing As A Free Lunch. It implies that the stock and bond markets provide unlimited arbitrage opportunities. In this paper I elaborate on the analysis I presented in the 1995 paper and explore some of the consequences of the fallacy for policies regarding the measurement and funding of pension promises, rules governing tax-qualified individual retirement accounts, guarantees provided by the Pension Benefit Guaranty Corporation, and Social Security reform.

I measure the risk of stocks as the market price of insurance against earning less than the risk-free interest rate. Such an insurance policy is equivalent to a European put option with strike price equal to the forward price of the underlying stock index. Both in theory and in practice, the price of such a "shortfall put" *increases* – not *decreases* -- with the time to expiration. Next, I explore the harmful effects that the fallacy has had in the past and continues to have in the present. These harmful effects are:

- In defined contribution plans, the U.S. Department of Labor has set rules for qualified default investment alternatives such as Target Date Funds that discourage stable value investments and encourage investment in stocks. The result is that uninformed plan participants are exposed to more market risk than they are aware of. They think they have insurance when in reality they do not.
- Believing that because they have a very long investment horizon, state and local pension plans invest heavily in stocks. In valuing their liabilities, actuaries use the expected return on the pension fund's asset portfolio as the discount rate. This results in reported liabilities which are too low. The result is underfunding of the true liabilities. Underfunding and the mismatch between the risk of plan assets and liabilities leads to bankruptcy of those plans.[3]
- The Pension Benefit Guaranty Corporation has intermittently invested its assets in stocks instead of hedging its liabilities. This is the exact opposite of the correct investment strategy for an entity that has a large exposure to the risk of the firms whose pensions it guarantees.
- Social Security reform proposals have been based on the fallacious idea that the funding problems of the system can be solved by switching to a privatized system invested in stocks.

The final part of the paper considers policy measures to counteract the harmful effects of the fallacy. The first and most important is to convince pension actuaries to change their standards of practice regarding the valuation of state and local pension liabilities and the investment of pension assets. The second is to adopt a consumer protection law that any institution providing tax-qualified retirement benefits must offer a guaranteed minimum benefit as one option. Such

[2] "On the Risk of Stocks in the Long Run," (1995).
[3] A case in point was the bankruptcy of the city of Detroit in 2014.

consumer protection laws are common in the case of new cars and other consumer durable goods, and they ought to be applied to retirement income contracts. The principles of financial engineering can and should be used to design and produce such guaranteed benefits and manage them efficiently.

How to Lie with Statistics

Of the books I read as a high school student in the 1950s, Darrell Huff's *How to Lie with Statistics*, sticks out in my memory. It made me aware of the many ways people can be misled by graphs and tables. One such graph, produced by the Ontario Securities Commission, is reproduced here as Figure 1. It shows the dispersion of average annual returns on a diversified stock portfolio for different time horizons between 1960 and 2013. As the time horizon becomes longer, the lowest average annual return becomes higher and the highest becomes lower. The conclusion mistakenly drawn from the figure is that stocks become less risky the longer the time horizon. Similar reasoning is reflected in the Morningstar data in Table 1. It shows the best and worst annualized rate of return on stocks for time horizons of different length.

Figure 1. How Time Horizon Affects Risk and Return

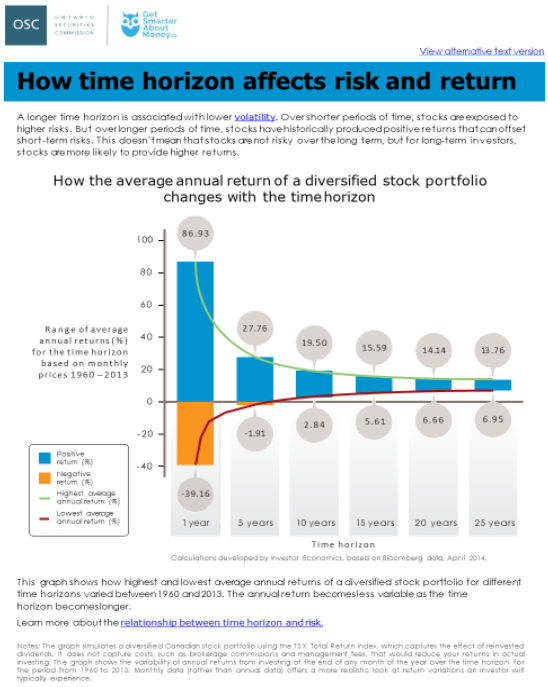


Table 1. Range of Returns on Stocks: 1926 to 1997

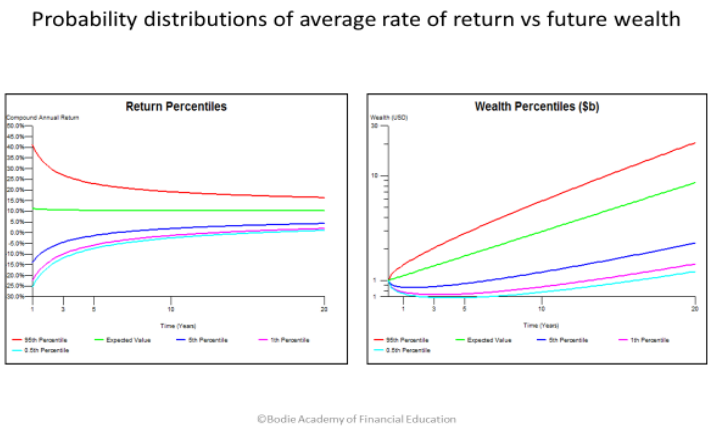
Holding Period	Best Return	Worst Return
1 Year	53.9%	-43.3%
5 Years	23.9%	-12.5%
10 Years	20.1%	-0.9%
15 Years	18.2%	0.6%
20 Years	16.9%	3.1%
25 Years	14.7%	5.9%

> ***Morningstar* Market Risk & Time**
> While the stock and bond markets can be risky in the short run, time has a moderating effect on market risk. The longer you hold a stock or bond investment, the lower your chances of losing money, and the greater the odds of earning a return close to the long-term average. For example, a one-year investment in stocks has historically produced returns ranging from +53.9% to -43.3%. Over ten-year periods, however, returns have varied from -0.9% per year for the worst ten years to +20.1% per year for the best ten years. As you can see, risk can be substantial over short periods. But over longer horizons, the chance of losing money is substantially reduced.

Figure 1 and Table 1 are examples of misleading statistics. By looking at the average rate of return rather than the amount of wealth at the end of the holding period, the impression is created that risk declines with the length of one's time horizon. The standard deviation of the average rate of return declines with the length of the time horizon *because it is an average*. If σ is the standard deviation of the annual rate of return for 1 year, and *T* is the number of years to the time horizon, then the standard deviation of the average annual rate of return for *T* years will be $\boldsymbol{\sigma/\sqrt{T}}$, assuming that returns have no serial correlation. Thus the measured volatility declines steadily as a function of *T* as shown in Figure 1.

But investors are concerned with the amount of wealth they will have at the end of the T years. The standard deviation of final wealth equals the initial wealth times $\boldsymbol{\sigma\sqrt{T}}$. Instead of dividing the annual standard deviation by the square root of *T*, we have to multiply by it. In other words as *T* increases, the probability distribution of terminal wealth becomes more spread out in contrast to the distribution of average annual rates of return depicted in Figure 1. These contrasting distributions are depicted in Figure 2.

Figure 2. Distribution of Average Rate of Return vs Terminal Wealth



Samuelson's Proof

In a two page essay he wrote in 1997, Paul A. Samuelson proposed a simple and convincing way of demonstrating the fallacy that the risk of stocks lessens as the investment horizon lengthens.[4]

> "Here is how to test the theory. Write down those 1,800 percentage changes in monthly stock prices on as many slips of paper. Put them in a big hat. Shake vigorously. Then draw at random a new couple of thousand tickets, each time replacing the last draw and shaking vigorously. That way we can generate new realistically representative possible histories of future equity markets.
> Most of the time the buy-and-hold common stock investors do beat their more cautious neighbors; and, as the time horizon N becomes larger, the odds do grow that the bold holders of stock will win the duel. But it is also true that a longer time horizon brings bigger losses when an inevitable loss does occur.
> Canny risk averters should always keep in mind, in a rational, nonparanoid way, the pains they will feel in those probability-calculated bad-outcome scenarios. (Ask yourself: Will stepping down toward a poverty level, when that rarely but inevitably does happen, outweigh for me the pleasures that occur in those likely outcomes when my equity nest egg does increase?) When we each do that, those of us who truly are more risk averse will rationally hedge our bets by limiting our exposure to volatile equities.
> Yes, in those new histories that the future will bring--even when past probabilities still operate intact--you definitely can sometimes lose, and lose big, no matter whether you have 15 or 40 years to go before retirement. The dogma proves too much. If 60 percent in stocks beats 50 percent of a sure thing, then 100 percent beats 60 percent; and leveraging to put 130 percent in stocks beats 100 percent!"

It is easy to carry out the "bootstrap" simulation that Samuelson is recommending in an Excel spreadsheet. Table 2 shows the statistics of the actual real rates of return on a value-weighted portfolio consisting of all stocks listed on the New York Stock Exchange from 1926 to 1998. The simulated trajectories of 30-year runs in Figure 3 are based on these data.

The scale of the vertical axis in Figure 3 is logarithmic, so the benchmark (in red) of a constant real rate of return plots as a straight line with a slope reflecting the risk-free real interest rate of 1% per year. At the end of the 30-year period, the amount in the risk-free portfolio is 134.78. The other 3 lines represent alternative possible trajectories, given the same historic distribution of actual returns from 1926 to 1998 in Table 3, with mean 9.5% per year and standard deviation of 20%. Note that in the first (blue) simulation run, the ending value is only 75.70, 25% below the starting value of 100 and 44% below the ending value of the risk-free portfolio.

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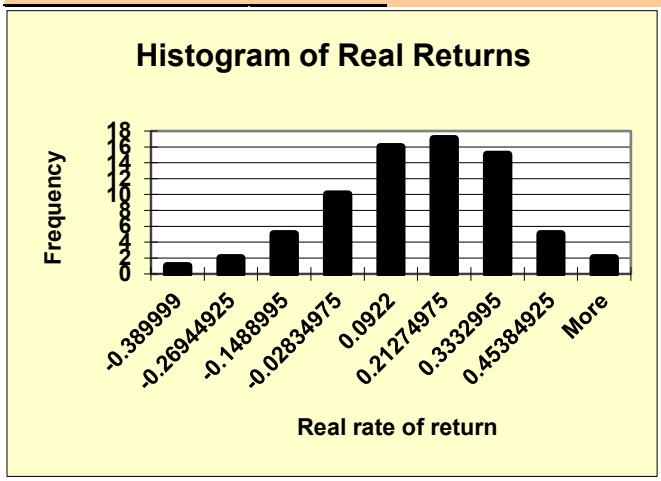
[4] "Dogma of the Day: Invest for the long term, the theory goes, and the risk lessens," Bloomberg *Personal Finance* Magazine, January/February 1997. Samuelson was the first prominent thought leader to disprove the conventional wisdom about stocks in the long run. His 1969 paper, demonstrated that in the standard life cycle model, the fraction of one's assets allocated to stocks would not vary with the length of the time horizon.

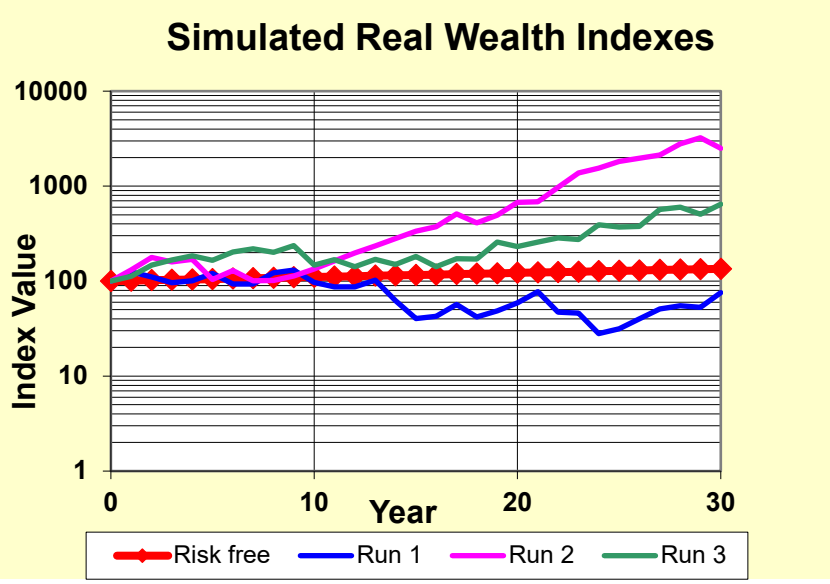
Table 2. Historical Distribution of Annual Rates of Return on NYSE Stocks: 1926-1998

Statistics:	Stock Returns	
	Nominal	Real
Mean	12.65%	9.47%
Median	15.85%	12.13%
Standard Deviation	20.07%	20.57%
Range	102.38%	96.44%
Minimum	-44.43%	-39.00%
Maximum	57.95%	57.44%
Number of obs.	73	



Typical results for 3 simulation runs are displayed in Figure 3.

Figure 3. Samuelson's Simulations



Optimal Saving and Investing Over a Lifetime

Given the stochastic nature of equity returns, what is the optimal amount to save and how should one invest it in the short and long run. Optimal lifetime finance finds its origin in seminal writings by Merton (1969, 1971) and Samuelson (1969). Countless papers have been written on the issues raised therein and their ramifications. Critical extensions of the base models were carried out in Bodie *et al.* (1992) with the addition of flexible labor and a labor/leisure decision. The subsequent literature is vast and has explored various aspects of the life cycle model (see Bodie *et al.* (2009) for a review and an extensive list of references).

Several useful and somewhat surprising properties are identified. It is shown, for instance, that the *fraction of total wealth (human plus financial capital)* optimally invested in equities, can decrease, stay the same, or increase over time as an individual ages. When the fraction in equities remains the same, the *fraction of financial wealth* (the portfolio value) optimally invested in equities can decrease over time as human capital depreciates and financial capital grows.

Options Pricing and the Paradox of Shortfall Risk

Simulations like the one portrayed in Figure 3 ought to cast doubt on wishful thinking about the risk of stocks decreasing in the long run. But not only does it not decrease, the risk of stocks actually *increases* with the length of the time horizon. I call it the paradox of shortfall risk. Because stocks offer a positive risk premium, the *probability* of a shortfall declines with the length of the time horizon, but paradoxically, the *cost of insuring* against the shortfall grows.

This paradox is illustrated in Figure 4. The values for the probability of a shortfall are measured on the left axis, and the values for the cost of shortfall insurance are on the right axis. The conclusion is that probability of a shortfall is a flawed measure of risk because it ignores how severe the potential shortfall might be. But risk depends not only on the probability of a loss, but also on how large the loss might be. People buy insurance against a variety of low-probability events like their house burning down because of the severity of the consequences. The cost of shortfall insurance takes proper account of the severity of possible losses.

Insurance against shortfall risk is effectively a *put* option. The put is of the European type (i.e., it can only be exercised at the expiration date), and it expires in T years. The put's exercise price is the insured value of the portfolio. If at the expiration date T years from now the portfolio's value exceeds its insured value, then the put expires worthless. If, however, there is a shortfall, then the put's payoff is equal to the shortfall.

Let P be the cost of shortfall insurance. Then for each dollar insured against a shortfall, the total amount actually invested at the starting date is $\$1 + P$. The exercise price of the put equals the price of the underlying stock portfolio compounded at the risk-free T-year interest rate.[5] Therefore the *put-call parity theorem* tells us that the price of the put equals the price of the corresponding call.[6]

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[5] Another way to state this is that the exercise price of the put equals the forward price of the underlying stock.

[6] The put-call parity theorem for European options says that:

To show that the value of the put increases with *T,* we could use any option pricing model based on the condition that the financial markets do not allow anyone to earn risk-free arbitrage profits. Because it is so compact and so widely used in practice, we will use the Black-Scholes formula..[7] In our special case, the formula reduces to a relatively simple form. Moreover, with no loss of generality, we can express the price of the put as a fraction of the price of the stock:

$$\frac{P}{S} = N(d_1) - N(d_2)$$

$$d_1 = \frac{\sigma\sqrt{T}}{2}$$

$$d_2 = \frac{-\sigma\sqrt{T}}{2}$$

where:
S = price of the stock
T = time to expiration of the option in years
σ = *standard deviation of the annualized continuously compounded rate of return on the stock*
N(d) = the probability that a random draw from a standard normal distribution is less than d.

Note that *P/S* is independent of the risk-free interest rate and the risk premium on stocks; it depends only on σ and *T.* Table 3 and Figure 4 show the result of applying the formula to compute *P/S* assuming the annualized standard deviation of stock returns is 20%. The cost of the insurance rises with *T,* the term of the insurance. For a one-year term, the cost is 8% of the investment. For a 10-year term, it is 25%, and for a 50-year term it is 52%. As the term grows without limit, the cost of the insurance approaches 100% of the investment.[8]

$P + S = C + E\,e^{-rT}$

where *P* is the price of the put, S is the price of the underlying stock, *C* is the price of the corresponding call, *E* is the exercise price, and r is the risk-free interest rate. In our case: $E = Se^{rT}$

By substituting into the put-call parity relation we get: *P =C.*

[7] The reference here is to the option-pricing theory originally developed by Black and Scholes (1973), and Merton (1973). There is an extensive literature on using option-pricing models to estimate the value of financial guarantees. For a comprehensive list of references, see Merton and Bodie (1992).

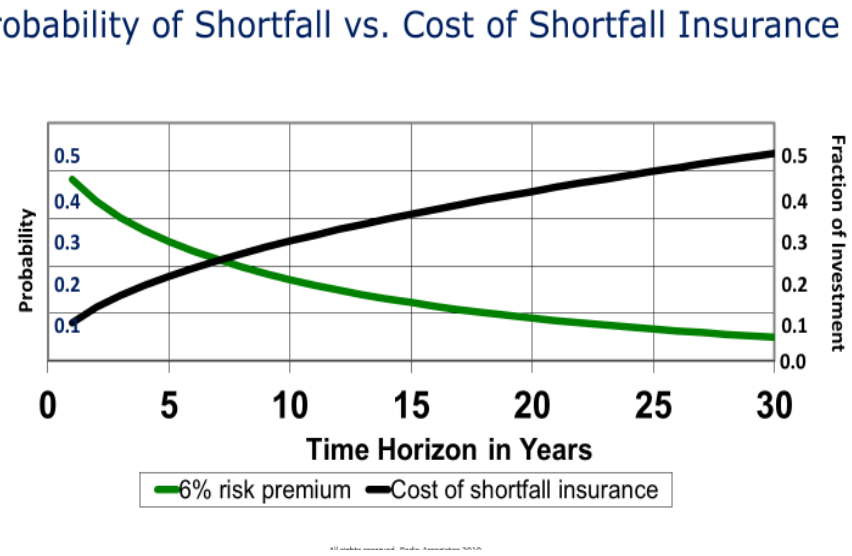
[8] Note that *P* is *not* equal to the expected value of the shortfall. However, if risk-neutral probabilities are substituted for actual probabilities, then one arrives at *P*.

Table 3. Cost of Shortfall Insurance as a Function of Time Horizon

Length of Time Horizon in Years	Cost of Insurance as Percentage of Investment
0	0
1	7.98
5	17.72
10	24.84
20	34.53
30	41.61
40	47.29
50	52.05
100	68.27

NOTES: The table was derived using the Black -Scholes formula with σ = .2 per year. The cost of the insurance is independent of the risk -free rate.

Figure 4. Probability of a Shortfall and Cost of Insurance as a Function of Time



Some economists and other observers of the stock market have claimed that stock returns do not follow a random walk in the long run. Rather, they argue, the behavior of stock returns is best characterized as a mean-reverting process. It is mean reversion in stock returns, some say, that is the

reason stocks are less risky for investors with a long time horizon.[9]

But Figure 4 is valid for mean-reverting processes too. The reason is that arbitrage-based option pricing models, such as the Black-Scholes or binomial models, are valid regardless of the process for the mean. They are based on the law of one price and the condition of no-arbitrage profits.[10] Investors who have different estimates of the mean will agree on the price of the put as long as they agree about volatility. For the relation depicted in Figure 4 to be invalid, mean reversion is not enough. Stock prices would have to behave just like the price of a *T*-period zero-coupon bond that converges towards the bond's face value as the horizon date approaches. In other words, stocks would have to be indistinguishable from the risk-free asset for a *T*-period horizon.

It is not only in theory that the price of the shortfall put increases with *T.* The prices of actual puts traded on the exchanges follow this pattern, and firms that sell puts over-the-counter will verify that their price schedule conforms to this pattern.

Debt, Equity, and the Paradox of Default Risk

Another way to see the paradox of shortfall risk is to consider a hypothetical fund that holds a well-diversified portfolio of stocks valued initially at 100, and issues 2 types of claims: A shares (debt) and B shares (equity). The debt-holder's claim payoff is Min ($100e^{rT}$, S_T), and the equity claim gets the residual value Max (0, $S_T - 100e^{rT}$). The debt claim will be in "default" if $S_T < 100e^{rT}$**.** We assume that the risk-free interest rate is 1%, and the risk premium on the stocks held by the fund is 4%. Holding the current value of the underlying stock portfolio constant at 100, let's ask what happens to the value and riskiness of the debt and equity as *T* is increased. The probability of default becomes smaller and smaller as the time horizon grows, so in that sense one would expect its value to rise. But the market value of the debt decreases. Table 5 displays the results.

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[9] Even if there is mean reversion, two studies show that the volatility of stocks in the long run is greater than in the short run. The first is by Pastor and Stambaugh (2015), and the second is by Fama and French (2018). Pastor and Stambaugh use predictive systems and up to 206 years of data to compute long- horizon variance of real stock returns from the perspective of an investor who recognizes that parameters are uncertain and predictors are imperfect. Mean reversion reduces long-horizon variance considerably, but it is more than offset by other effects. As a result, long-horizon variance substantially exceeds short-horizon variance on a per-year basis. Overall, their results show that long-horizon stock investors face more volatility than short-horizon investors, in contrast to previous research. A clear illustration of such long-horizon effects emerges from their analysis of target-date funds. They demonstrate that a simple specification of the investment objective makes such funds appealing in the absence of parameter uncertainty but less appealing in the presence of that uncertainty.
Fama and French write as follows: "Our general message is universal; because of the high volatility of stock returns, investors cannot draw strong inferences about expected returns from three, five, or even ten years of realized returns. Those who act on such noisy evidence should reconsider their approach. The high volatility of monthly stock returns and premiums means that for the three-year and five-year periods used by many professional investors to evaluate asset allocations, the probabilities that premiums are negative on a purely chance basis are substantial, and they are nontrivial even for ten-year and 20-year periods."

[10] For a demonstration that mean reversion does not alter the result see Feinstein, Steven P., "Measuring risk with the Bodie put when stocks exhibit mean reversion." Journal of Risk 1465-1211 September 1998.

Table 4. Value of Debt and Equity as a Function of Time Horizon

(1) Length of Time Horizon in Years	(2) Face value of debt shares	(3) Probability of Default	(4) Value of Debt shares	(5) Value of Equity shares
0	100		100	0
1	101.01	.4654	92.02	7.98
5	105.13	.4230	82.28	17.72
10	110.52	.3918	75.16	24.84
20	122.14	.3488	65.47	34.53
30	134.99	.3171	58.39	41.61
40	149.18	.2914	52.71	47.29
50	164.87	.2695	47.95	52.05
100	271.83	.1925	31.73	68.27

NOTES: The table was derived using the Black Scholes Merton Model with σ = .2 per year. The riskless rate of interest is 1% per year, and the equity risk premium is 4%.

The probability of default (a shortfall) in column 3 declines from .4654 to .1925 as the time horizon lengthens from 1 year to 100 years. Our intuition is that as the probability of default decreases, the market value of the debt should increase. But paradoxically the opposite is the case: as the length of the time horizon increases, the probability of default decreases and the value of the debt shares (in column 4) decreases from 92.02 to 31.73.

Could A Long-Run Shortfall Actually Happen?

Advocates of the stocks-for-the-long-run hypothesis generally argue that in a well-developed capitalist system like that of the U.S., it is unimaginable that the real return over a long period would not be significantly positive. They say that only in cases of war or other doomsday scenarios can one envision a negative outcome. But there is a prominent counterexample – Japan. Since the end of WWII, the Japanese economy has flourished, yet its stock market has performed erratically. In the 1980s, Japan was the second largest economy in the world and many experts were predicting it would overtake the U.S. by the end of the century. Figure 5 and Table 5 show the value of the Nikkei 225 index from 1984 to 2020. It peaked in 1989 at 38,951; hit a low point 20 years later in 2009 at 7.909, and in 2020 it is at 23,828. Thus after 31 years it is down 39% from its peak. This could happen in the U.S. or any other country.

Figure 5. The Japanese Stock Price Index 1984 to 2020

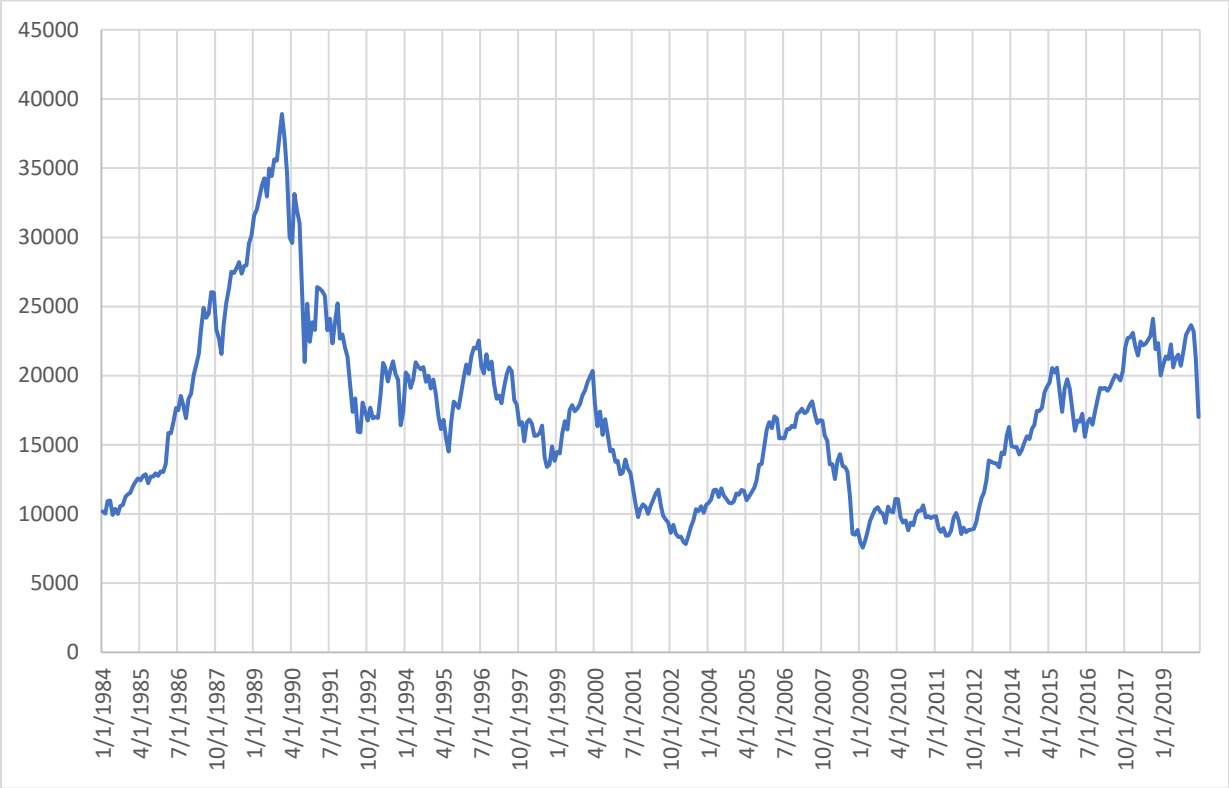

Table 5. The Japanese Stock Price Index 1984 to 2020

Japan: Second/Third Largest GDP in the World	Nikkei 225 Index 1984-2020
1984	10,071
1989	31,577
1990	**37,242** [high 38,951]
1991	23,271
1992	22,076
1993	17,038
1994	20,256
1995	18,647
1996	20,806
1997	18,308
1999	14,544
2000	19,537
2001	13,741
2002	10,027
2003	8,286
2004	10,785
2005	11,422
2006	16,929
2007	17,377
2008	13,518
2009	**7,909**
2010	10,212
2011	10,282
2012	8,789
2013	11,153
2014	14,414
2015	17,913
2016	16,060
2017	19,469
2018	21,182
2019	21,449
2020	**23,828**

In the next section we consider the harmful effects of the fallacy.

Financial MisEducation

In the early days of 401(k) plans, most people, when asked to choose among investment options, stuck with the default option. Unfortunately, the default option was usually a money market fund, and the choice turned out to be a bad one. The default option *should* have been an inflation-indexed DB plan. When it became apparent that so many people, through inertia, were "choosing" the default option, there was general agreement that, if people were more educated, they would learn to diversify out of money market funds. That thinking is what gave birth to the kind of slogans (in italics) that are causing problems today:

"*You can't afford not to take risk.*" This simply flies in the face of common sense. The fact is that the less you can afford to lose, the less you can afford to take risk.

"*Investing in safe assets is not safe for the long run, because you need the growth of equities to keep up with inflation.*" What people didn't realize about this particular slogan was that it took for granted that people who already had defined-benefit plans—and *also* had 401(k)s—would invest their 401(k) money in mutual funds. That made perfect sense when the defined benefit was the base and the mutual fund investments only an add-on; with the safe allocation in their defined-benefit plan, people could afford to take on some risk in an incremental allocation. What we're looking at now, however, is a completely different situation, because now in most cases the 401(k) plan is *replacing* the defined-benefit plan—and if some politi- cians have their way, the 401(k) will replace even Social Security.

"*Our economy has been growing for the last two hundred years—a diversified portfolio of stocks gives the investor a way to participate in that growth*." Perhaps, for 90 percent of the people who are targeted by this kind of investment advice, the correct solution is to hold whatever it is that the mutual fund companies are trying to sell. I'm not arguing that there's no risk premium on equities. I am simply saying that equities are not safe, no matter how long your time horizon is.

What's Worse Than Not Having Insurance?

One of the problems with the way such investing slogans are accepted is the result of the way they are presented. There is a difference between marketing and education. Providers have a responsibility to indicate which is which.

Some people hear that they get a premium for taking a risk, and, without understanding the whole picture, they want to go for the premium. Some of them can afford to risk a certain portion of their assets, but there is another 10 percent who cannot afford to take any risk at all, who should not under any circumstances be investing in equities. Some people with low incomes are in jobs that have a very high correlation with the stock market; these people are *already* overexposed to equities. Should they be putting their retirement money into equities as well? What's more, many in this same group of people, who cannot afford any risk whatsoever, are using their 401(k) plans for severance, or unemployment, insurance, instead of using them for retirement.

In the category, not of slogans, but of misinformation is an unsafe investment approach that was outlined in a book put out by a leading discount broker on the subject of retirement planning. The heuristic for the average investor—and maybe it was a good one—was that the percentage of a portfolio that should be in equities was 100 minus your age. That would mean that, if you were fifty, you would have exactly half your portfolio in equities. The book, however, was proposing that the equities proportion stay at 50 percent even at ages sixty, seventy, and beyond.

The problem is that, although the principle of diversification works across securities and asset classes, it does *not* work over time. Even a highly diversified portfolio of stocks does not become safe in the long run. Yet here is the kind of thing customers are told on a typical website: Invest in stocks, either individually or in mutual funds, for long-term growth. While in any given year stocks can be more volatile than other investments, over time, they have typically outperformed all other types of investments while staying ahead of inflation. Stocks should be the core of a long-term investing strategy.

If stocks are so great for the long run, then why don't the same firms offering this advice offer a performance guarantee to pay at least what a customer contributes to a diversified equity portfolio adjusted for inflation? After all, the firm managing the fund is in a much better position to evaluate and manage the risk than the customer is. If the firm believes what it is saying, it ought to offer a free guarantee for its product. That's what other industries do. Of course, option-pricing theory shows that such a guarantee is far from free.

Qualified Default Investment Alternatives

A 401(k) or 403(b) QDIA (Qualified Default Investment Alternative) is a default investment used when money is contributed to an employee's 401(k) or 403(b) account, but the employee has not made an investment choice. That money is automatically invested into the QDIA. The plan fiduciary—typically the business owner or 401(k) plan manager—is responsible for selecting the QDIA. If the plan has a default investment that meets the DOL's QDIA (Qualified Default Investment Alternative) rules, the plan fiduciaries are not liable for the QDIA's investment performance. It is considered a "safe harbor" for the employer.

All 401(k) plans should have a QDIA, because all plans could at some point have business owners or employees saving without an investment election. Plans with automatic enrollment always need a QDIA, but other situations may occur over the life of a 401(k) that result in the need for a QDIA. These instances include:

- Employer contributions on behalf of an employee who isn't contributing
- Incomplete enrollment forms
- Beneficiary or alternative payee balances
- Qualified domestic relations order
- Removal of investment options
- 401(k) rollovers
- Missing persons

There are four types of QDIAs.

1. A product with a mix of investments that takes into account the individual's age or retirement date—like target date funds.
2. An investment service that provides an asset mix (based on an employee's current contributions and existing plan options) that takes into account the individual's age or retirement date—like a managed account.
3. A product with a mix of investments that accounts for the demographic characteristics of all employees, rather than each individual—like a balanced fund.
4. A short-term, low-risk, low-return product (a "capital preservation" product) for only the first 120 days of participation—like a money market fund.

The fourth of these effectively ended the tendency of participants to avoid stocks in favor of stable value funds. It was motivated by the false belief that for investors with a long time horizon stocks offer a risk premium without risk.

Actuarial Science and Pension Finance[11]

In the early 1990s I was approached by Jeremy Gold, a pension actuary of my age, who was doing a PhD in insurance at the Wharton School. Jeremy wanted me to be one of his thesis advisers. He had worked with many financial experts at Morgan Stanley during the 1980s, and was influenced by their view of the world. It was very different from his actuarial perspective in one fundamental respect—financial economists used models based on the principles of market values or fair values (an estimate of market value)—rather than historical cost for all assets and liabilities. His focus was defined-benefit pension plans.

In a defined-benefit pension plan, the employer who sponsors the plan promises to pay retirement benefits based on a formula. The accruing benefits are backed by contributions made to a fund that is invested and eventually produce the cash to make the promised payments as they come due. The safest investment strategy for both the plan sponsor and the plan beneficiaries is to invest in a portfolio of fixed income instruments that will produce the cash exactly when it is needed to pay the benefits. This procedure of cash flow matching is called *immunization* of the pension liability. When this procedure is followed, the cost of accruing benefits and the present value of the liability are computed using as the discount rate the interest rate on the fixed income portfolio that immunizes the liability.

But most pension plans of corporations and state and local governments in the U.S. have

[11] Bader and Gold (2003) provide a comprehensive critique of the actuarial model and advocate accepting the approach of financial economists. As a longtime critic of the same actuarial principles and practices that they criticize, I welcomed the initiative taken by Bader and Gold. I would add to their list of references some earlier articles from the financial economics literature that might help to further elucidate and support their arguments. The seminal paper was Jeremy Bulow's "What are Corporate Pension Liabilities?" *Quarterly Journal of Economics*, (August 1982): 435-52. It is reproduced in the collection of papers which I co-edited with Phil Davis, *The Foundations of Pension Finance*, published by Edward Elgar in January 2001. My own article on this subject is "The ABO, the PBO, and Pension Investment Policy," *Financial Analysts Journal*, September/October 1990. It too is reproduced in *The Foundations of Pension Finance.*

not followed this procedure in recent decades. Bond interest rates have been much lower than the historical average returns earned on stocks. With the support of actuarial consultants, they argue that they have a long time horizon, and in the long run a diversified portfolio of stocks will earn an assumed 7% rate of return with *very high probability*, and it is virtually certain that they will earn a rate of return at least as great as the rate of interest on bonds.

So they invest their contributions to the pension fund in a portfolio that is mostly in stocks. They then calculate the cost of accruing pension benefits to employees by assuming that the funds invested to pay those benefits will earn a rate of return equal to the roughly 7% per year earned in the past. That same rate is used by actuaries and accountants to compute the present value of the pension liabilities on the government's balance sheet instead of the current interest rate on bonds, which is now roughly 2%.[12]

Jeremy Gold describes it very clearly:[13]

> Although pension finance theory says most defined benefit pension plans sponsored by publicly traded corporations should invest entirely in fixed income, 60% of assets are invested in equities. The existing theory makes a strong – but often unstated – assumption of transparency, implying that investors view the pension plan as a financial subsidiary of the operating parent and value it as a market portfolio. I explain the equity choice made by managers as a reaction to how investors perceive the opaque standard pension accounting model. Investors view the plan in operating terms and value it based on reported earnings. Defined benefit pension plans' earnings (expenses) are computed using actuarial methods and economic assumptions that anticipate expected equity returns and strongly dampen the volatility of actual equity returns. Thus, corporations whose plans invest in equities overstate the financial value of their earnings and understate the volatility of such earnings.

Thus, the pension accounting procedure for public plans amounts to acting as if there is an arbitrage opportunity allowing these plans to "earn" roughly 4% on each dollar of pension liabilities they have. Despite the fact that it is just wishful thinking, many state and local governments have treated it as a genuine arbitrage opportunity. They have issued "pension obligation bonds" to fund their unfunded pension liabilities. These are bonds issued by the local government at a fixed rate of interest, and the cash raised is invested in a portfolio of stocks.[14] In reality this set of transactions amounts to a highly levered investment in the stock market—a fake arbitrage position.

Implications for the Pension Benefit Guaranty Corporation

The PBGC insures the pension benefits of employees covered by private defined benefit pension plans. When a PBGC-insured pension plan is terminated with insufficient assets to pay

[12] The practice of using the expected rate of return on pension assets to discount the liabilities is recommended under the Government Accounting Standards Board (GASB) Statement 67.
https://www.gasb.org/jsp/GASB/Pronouncement_C/GASBSummaryPage&cid=1176160219444

[13] Gold, Jeremy, "Accounting/Actuarial Bias Enables Equity Investment by Defined Benefit Pension Plans" 2003.

[14] In 1986, the federal government ruled that in such transactions state and local governments lose the tax exemption on their bonds.

the benefits promised to employees — typically, after an employer bankruptcy — the PBGC takes it over and makes up part of the shortfall. The expressed purpose of establishing the PBGC was to insure a minimum level of promised defined-benefit pensions against default risk of the plan sponsor. However, if firms can transfer their pension obligations to the PBGC, then the government effectively pays a portion of the workers' total compensation because these obligations are linked to workers' pay. The size of this government subsidy can be large. PBGC insurance has served as a less visible way to guarantee the debt of financially troubled firms than guaranteeing the bonds issued by these firms.

By law, the PBGC is supposed to finance all of its operations from three sources: (i) the premiums it collects from companies that still sponsor defined-benefit plans, (ii) the assets it recovers from terminated underfunded plans, and (iii) the interest, dividends, and capital gains it earns on its accumulated reserves. Significantly, the funding requirements and premiums charged by the PBGC are completely unrelated to the way pension assets are invested. *A plan sponsor with 100 percent invested in equities has the same funding requirement and pays the same premium as a sponsor with 100 percent in fixed-income securities.*

In the early 1990s, I was hired by the Department of Labor to analyze the financial health of defined-benefit pension plans. I concluded that there was a fundamental mismatch between the liabilities of these plans — future pension payouts — and the assets in which they were investing their reserves. This mismatch meant that even plans that were fully funded at the time could quickly become underfunded as a result of changes in interest rates or stock prices.

I submitted my report to the Department of Labor's Pension and Welfare Benefits Administration and briefed the executive director of the PBGC on my findings. I also made my conclusions known in the professional community. In an article published in the *Journal of Financial Services Research* in 1996 — a time when the PBGC and most of the plans it insures had comfortable surpluses — I issued this warning:

> The possible "doomsday" scenario for the defined-benefit pension system would be an event such as a sharp and prolonged drop in stock prices that causes a sharp decline in the market value of pension asset portfolios. Underfunding becomes much more prevalent. Several major defaults of underfunded pension plans lead the PBGC to significantly raise premiums on the remaining plans in the system. Expectations of even higher premiums in the future lead sponsors of the well-funded plans to terminate their defined-benefit plans to avoid the PBGC "tax." They buy annuities to settle all benefits accrued under the terminated plans and replace them with generous defined contribution plans, thus avoiding criticism from their employees or from the public. Ultimately, the United States could be left only with bankrupt defined-benefit plans with the benefits financed directly by taxpayers.

There are important similarities between the PBGC's current situation and the situation faced by the Federal Saving and Loan Insurance Corporation in the 1980s. The FSLIC's problems began in the 1970s when interest rates became high and volatile. S&Ls that held portfolios of fixed-rate mortgages became insolvent in the environment of rising interest rates of the 1970s

because the mortgages were long term, while their deposit liabilities were short term and rolled over at increasingly higher market rates. Still more S&Ls became insolvent in the late 1980s because the real estate market collapsed. Thus *both* of the market risks to which S&Ls were exposed — interest rate risk and real estate risk — took their toll. The biggest losses to FSLIC were incurred as a result of failure on the part of regulators to act quickly to stem the losses resulting from the asset-liability mismatch.

In the case of the PBGC, the nature of the liabilities of private defined-benefit pension plans is very different from the short-term deposit liabilities that were insured by the FSLIC. Therefore, the type of assets that match those liabilities is different. The similarity is that in both cases there is a mismatch between the market-risk of the assets and liabilities that exposes the government guarantor to substantial shortfall risk.

Governments are subject to constant pressures from various interest groups to subsidize their activities. The provision of "cheap" government guarantees is a less "visible" form of subsidy than outright cash payments, price supports, or other forms that require either immediate cash outlays or budget allocations. If faced with a political constraint limiting the size of the premiums that it can charge, the government can still adopt procedures to maintain the solvency of its guarantee activity, prevent excessive risk-taking, and avoid unintended subsidies. If it can, for instance, establish an effective system of monitoring, then premiums can be kept low with the system solvent. But, if it can neither charge adequate risk-based premiums nor monitor effectively, then the only route left open is to require asset liability matching.

Social Security Reform

The last 8 Trustees Reports have indicated that Social Security's **Old-Age, Survivors, and Disability Insurance** (OASDI) Trust Fund reserves would become depleted between 2033 and 2035 under the intermediate set of assumptions provided in each report. If no legislative change is enacted, scheduled tax revenues will be sufficient to pay only about three-fourths of the scheduled benefits after trust fund depletion.

Policymakers have developed proposals and options that have financial effects on the OASDI Trust Funds. Many of these proposals and options have the intent of addressing the long-range solvency problem. There have been many reform proposals. A complete list in chronological order can be found here: https://www.ssa.gov/OACT/solvency/list.html. Many of these proposals rely on fake arbitrage to make them work.

Conclusion

It is widely believed that while stocks are risky in the short run, in the long run they are sure to outperform risk-free investments like government bonds. This is a dangerous fallacy. It implies that the stock and bond markets provide unlimited arbitrage opportunities. In this paper I explored some of the consequences of the fallacy for policies regarding the measurement and funding of pension promises, rules governing tax-qualified individual retirement accounts, guarantees provided by the Pension Benefit Guaranty Corporation, and Social Security reform:

I measure the risk of stocks as the market price of insurance against earning less than the risk-free interest rate. Such an insurance policy is equivalent to a European put option with strike price equal to the forward price of the underlying stock index. The price of such a shortfall put *increases* – not *decreases* -- with the time to expiration. Next, I explore the harmful effects that the fallacy has had in the past and continues to have in the present. These harmful effects are:

- In defined contribution plans, the U.S. Department of Labor has set rules for qualified default investment alternatives that discourage stable value funds and encourage investment in stocks. The result is that uninformed plan participants are exposed to more market risk than they are aware of.
- In valuing pension liabilities in defined-benefit plans pension actuaries use discount rates which are too high. The result is underfunding of those liabilities, which often leads to bankruptcy of those plans.[15]
- The Pension Benefit Guaranty Corporation has been led to invest its assets in stocks instead of hedging its liabilities. This is the exact opposite of the correct investment strategy for an entity that has a large exposure to the risk of the firms whose pensions it guarantees.
- Social Security reform proposals have been based on the fallacious idea that the funding problems of the system can be solved by switching to a privatized system invested in stocks.

Finally, the paper recommends policy measures to counteract the harmful effects of the fallacy. The first and most important is to convince pension actuaries to change their standards of practice regarding the valuation of pension liabilities and the investment of pension assets. The second is for regulators to require that as a condition for a retirement product to be considered a qualified default investment alternative, the institutions offering them must offer a guarantee of a specified minimum benefit. Such consumer protection laws are common in the case of new cars and other consumer durable goods, and they ought to be applied to retirement income contracts. The principles of financial engineering can and should be used to design and produce such guarantees and manage them efficiently. The destabilizing feedback loop caused by government guarantees of too-big-to-fail financial institutions, moral hazard, forbearance, and ever bigger government bailouts is familiar to analysts of the U.S. banking system. It is less familiar, but no less pernicious, in the case of the pension system. In the case of pensions, however, the vicious cycle is less transparent because of the fallacious belief that the risk of equities goes away in the long run. Until there is a recognition that equities are not a match for the fixed liabilities of defined-benefit pension liabilities, it will remain a serious source of financial instability for the U.S. economy.

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