Your Financial Future:

A Common Sense Guide for Students of Science and Engineering

Glenn H. Fredrickson
Professor of Chemical Engineering & Materials, UCSB

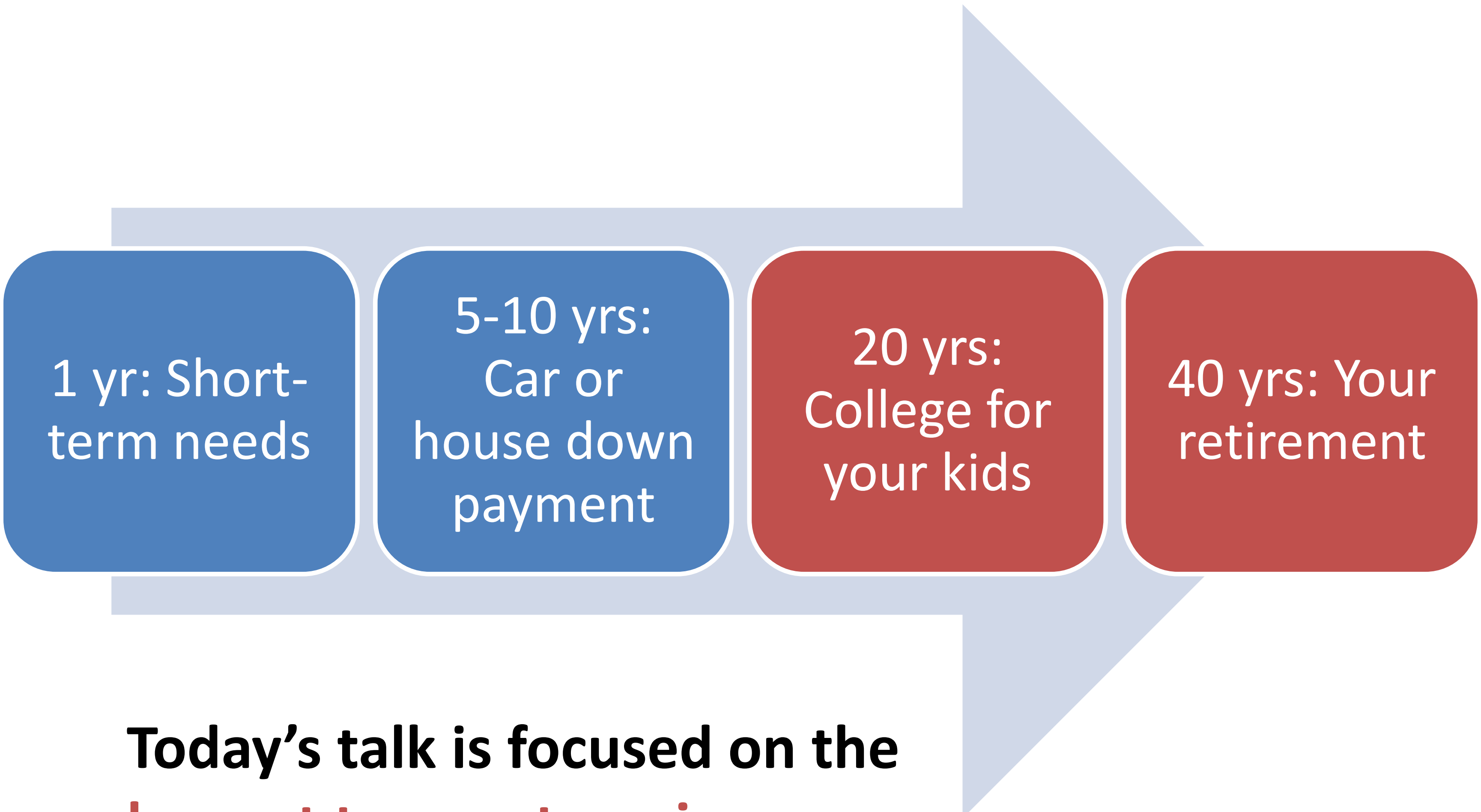
Disclaimer: I am not a registered financial advisor, nor am I an agent of any of the firms mentioned here.

Investing involves taking measured risks!

Why Should You Care?

- When you leave college for employment, you will face some immediate and continuing financial decisions that could determine whether you retire wealthy or poor!
- The key is that time in on your side
- Money and investing are unfortunately not subjects that parents like to discuss….

Investing Horizon



Today's talk is focused on the longest term categories

Discrete Compound Interest

If you start with an initial investment or "principal" of P_0, and it is invested in a non-taxable retirement account with annual interest rate r, compounded annually, what is the value of your investment after n years?

$$P_{n+1} = (1+r)P_n$$

Difference Equation

$$P_1 = (1+r)P_0$$

$$P_2 = (1+r)P_1 = (1+r)^2 P_0$$

...

$$P_n = (1+r)^n P_0$$

or

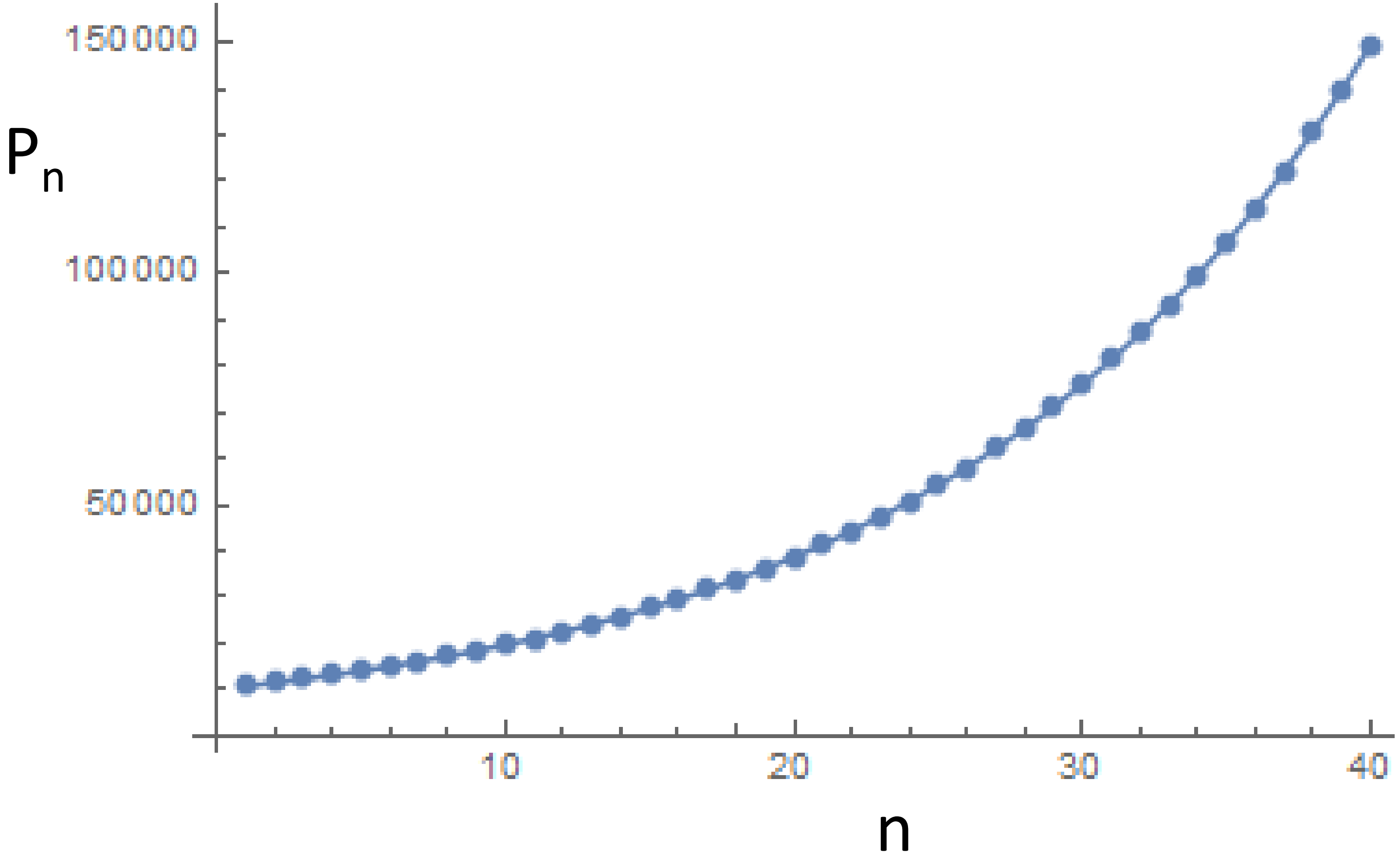
$$P_n = e^{cn} P_0$$

$$c = \ln(1+r) \approx r$$

Geometric growth is exponential growth!

Time is on your side!

$10,000 invested at 7% interest compounded annually (r=0.07) will be worth $150,000 at your retirement in ~40 years!!!



Continuous Compound Interest

If you start with an initial investment or "principal" of P(0), and it is invested in a non-taxable retirement account with annual interest rate r, compounded continuously, what is the value of your investment after t years?

$$P(t + \Delta t) = (1 + r\Delta t)P(t)$$

Difference Equation

$$\approx P(t) + P'(t)\Delta t + O(\Delta t^2)$$

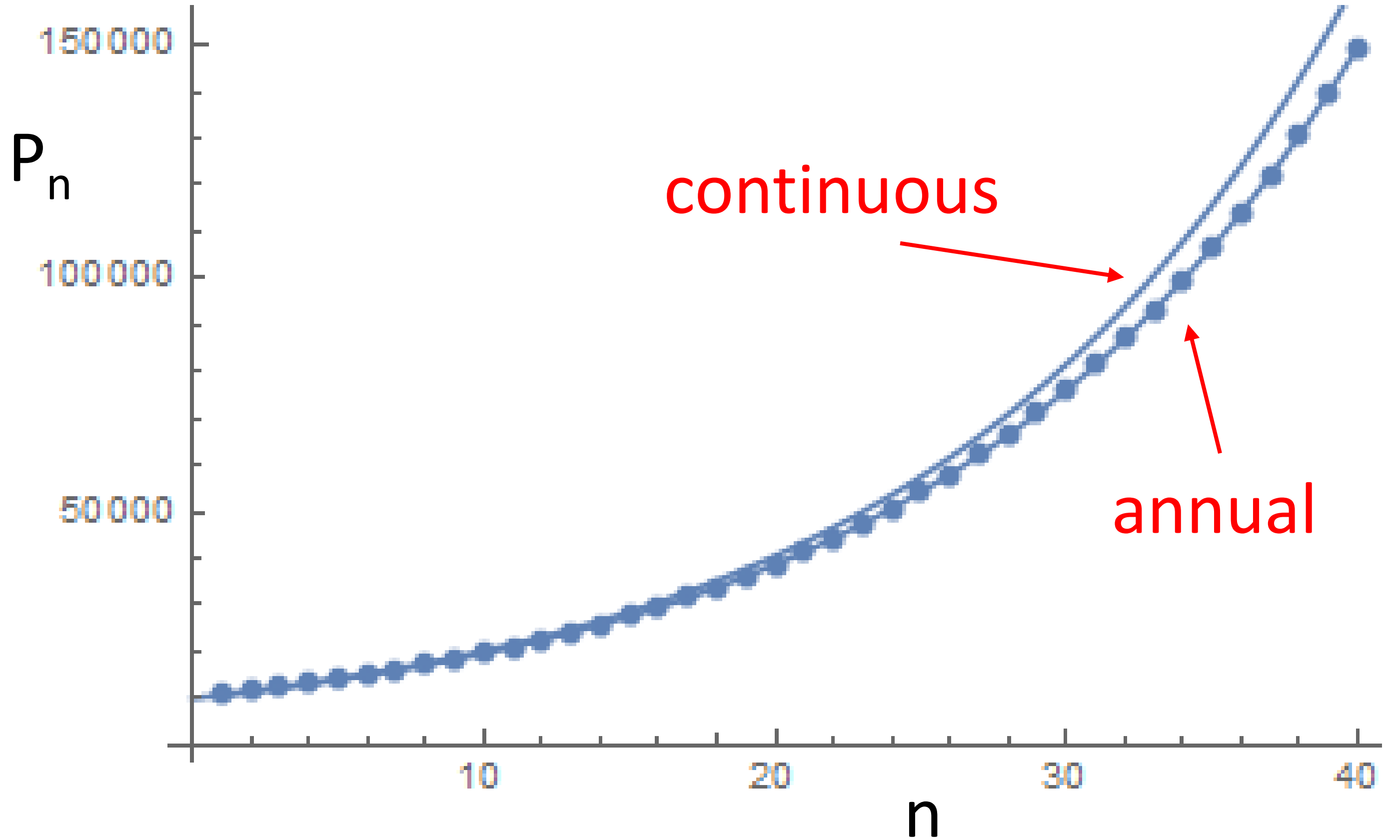
ODE!

$$P'(t) = rP(t)$$

$$P(t) = e^{rt}P(0)$$

Exponential Growth!

Continuous Compounding Slightly Better!



How to Become a Millionaire

If you invest 10% of your salary each year, assuming an initial salary of $100,000, raises of 3.5% per year, and an annual interest rate of 7%, how much money/principal will you have in 40 years?

$$S_{n+1} = (1 + 0.035)S_n$$

Salary growth

$$P_{n+1} = (1 + 0.07)(P_n + 0.10S_n)$$

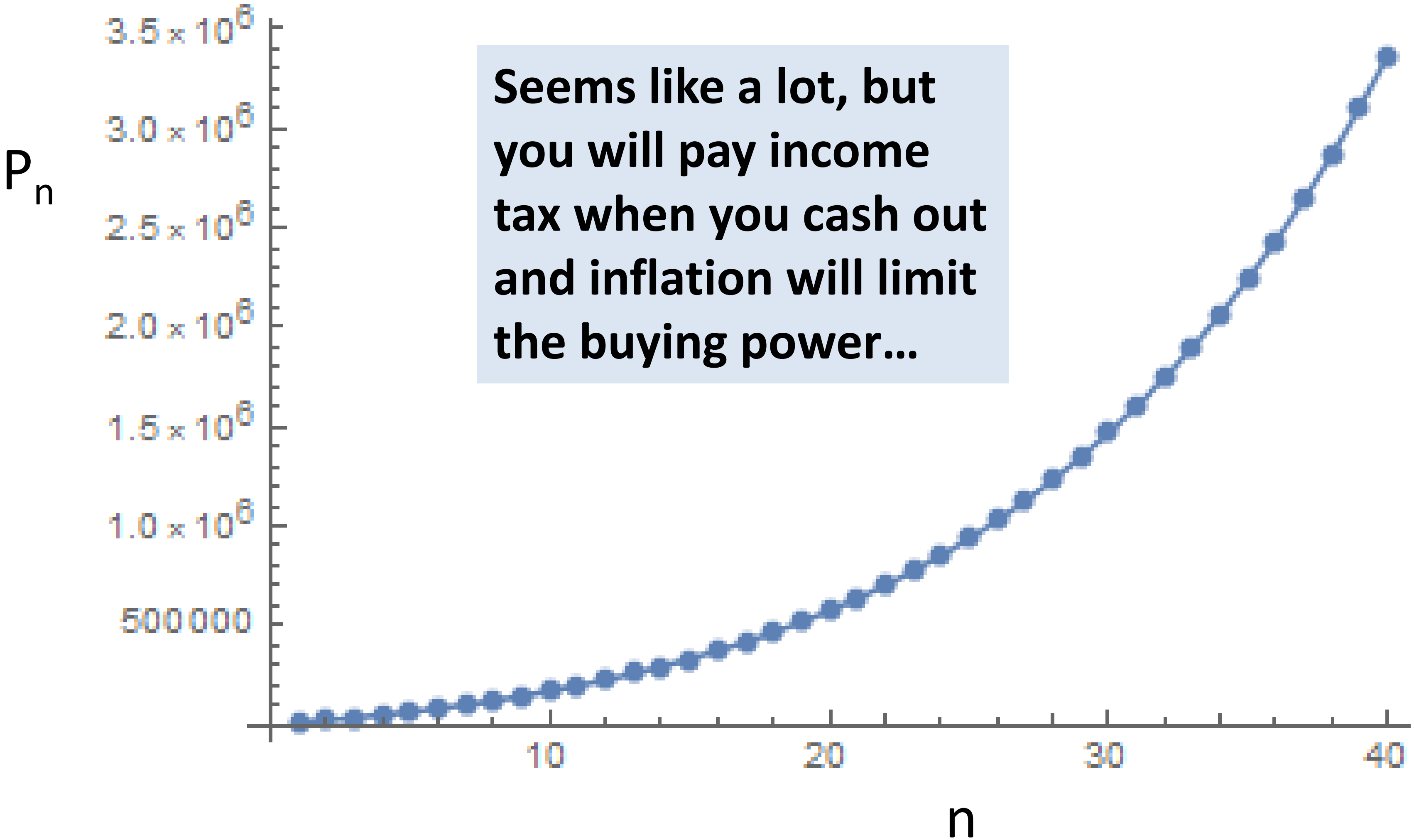
Principal growth

$$P_0 = 0 \qquad S_0 = 100,000$$

Initial conditions

Iterate these numerically, or use continuous time and solve two coupled, linear first order ODEs!

$3.5 Million!

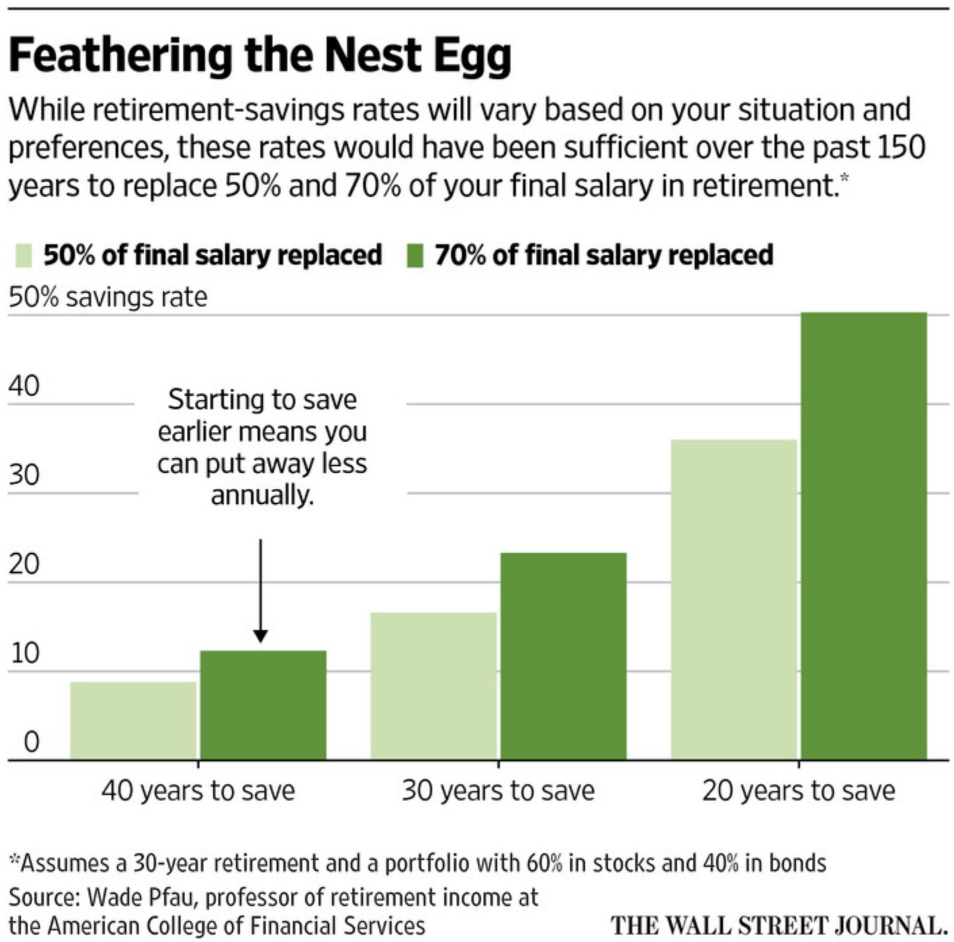


Seems like a lot, but you will pay income tax when you cash out and inflation will limit the buying power…

Save for Your Future Early and Steadily

- Time is on your side—start early
- Have the 10% (ideally 15% or more) automatically deducted from your paycheck into a retirement account – you will never miss it!
- If you don't set aside money for retirement, you may be missing a matching 3-6% contribution from your employer in addition to your salary – so opt in!
- Set aside additional money for shorter term goals, e.g. car, house down payment, kids educations, etc., but these should be lower priority than retirement

Reinforcing the Need to Start Early



January 21, 2017

Types of Retirement Plans

- Defined Benefit
  - Old fashioned "pension" plan
  - At retirement age you are paid a guaranteed (taxable) retirement pension based on highest salary, years of service, and age
  - The benefit is maximum if you don't change your job and work 30+ years
  - You have no responsibility to manage the investments

- Defined Contribution
  - You and your employer both contribute a % of your salary into an investment account
  - It is your money when you retire and can be withdrawn after age 59.5 without penalty (but with ordinary income tax due)
  - You have full responsibility for managing your retirement accounts!

Unless you work for a government or state agency, you will probably only have access to a Defined Contribution plan

IRAs

- After fully funding your retirement plan at work, you should consider opening an Individual Retirement Account (IRA) with any extra money
- Conventional IRA
  - You **invest pre-tax money** (possibly lowering your taxable income), and **pay taxes only when you cash out** after age 59.5
  - Everyone with earned income can contribute, but you can take a tax deduction only if your income is less than $72K - $119K
- Roth IRA
  - You **invest after-tax money**, and can withdraw invested funds plus earnings **tax-free** after age 59.5
  - Roths have other significant tax benefits in passing money to your heirs
  - Eligibility phases out once your income > $200K

Invest in Roth IRAs as long as you are eligible!

Some Important Decisions

- Do it yourself or get help?
- How do I allocate my investments among different categories and manage risk?
- Should I be a passive or active investor?
- How do I adjust my allocations over time?

Should I get help?

- There are many people working for brokerage houses, banks, and financial institutions that would love to assume responsibility for investing your money!
- In return, they will take an annual fee that could be as much as 2% of your portfolio
- If you agree, make sure the person is a “fee only” advisor with “fiduciary responsibility” to put your interests first and belongs to a reputable firm
- Remember, many of these “financial advisors” could not cut it as a graduate student in science or engineering –do you want to leave your future to them?

Asset Classes

- Fixed Income (Bonds)
  - Cash equivalents, checking & savings accts
  - High or low quality US government, state, or corporate bonds
  - Short, Mid, and Long-term US government, state, or corporate bonds
  - Foreign bonds

Buy a bond: loan money to somebody

- Equities (Stocks)
  - US small, medium, or large ("cap") stocks
  - US value or growth stocks (or funds)
  - International stocks
  - Emerging market stocks
  - Real estate stocks

Buy a stock: you are a part owner in a company

Mutual Funds and ETFs

Individual stocks/bonds

- Tedious work to select and purchase many individual securities
- Need to assemble a diverse portfolio so you are protected against failure of one or more investments failing

Mutual funds or ETFs

- Mutual funds or Exchange Traded Funds (ETFs) pool your money with that of other investors and invest broadly in a particular asset category, e.g. large cap US stocks
- You can build a diverse portfolio with 2 to 5 funds

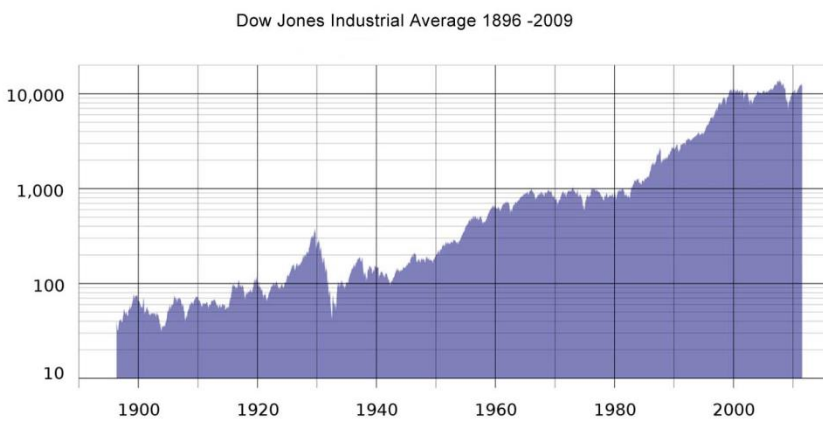
Target Date funds

- Even simpler, many companies offer Target Date Funds, where you simply indicate the year you plan to retire, and they will put your money in a fund that invests in a wide range of bonds and stocks and adjusts the mixture to be more conservative over time

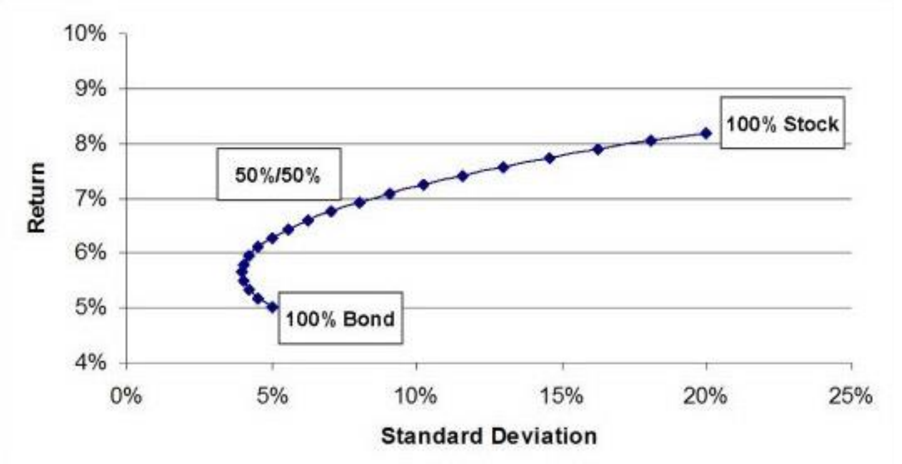
High quality companies offering mutual funds and ETFs include Vanguard, Fidelity, T. Rowe Price, and BlackRock, among many others

Risk and Reward

- Stocks are more volatile than bonds, but with that unpredictability comes higher long-term reward
- Unlike a casino, where the house has an advantage, the stock market grows in value over time because the worlds best companies grow, increase productivity, and increase in value!



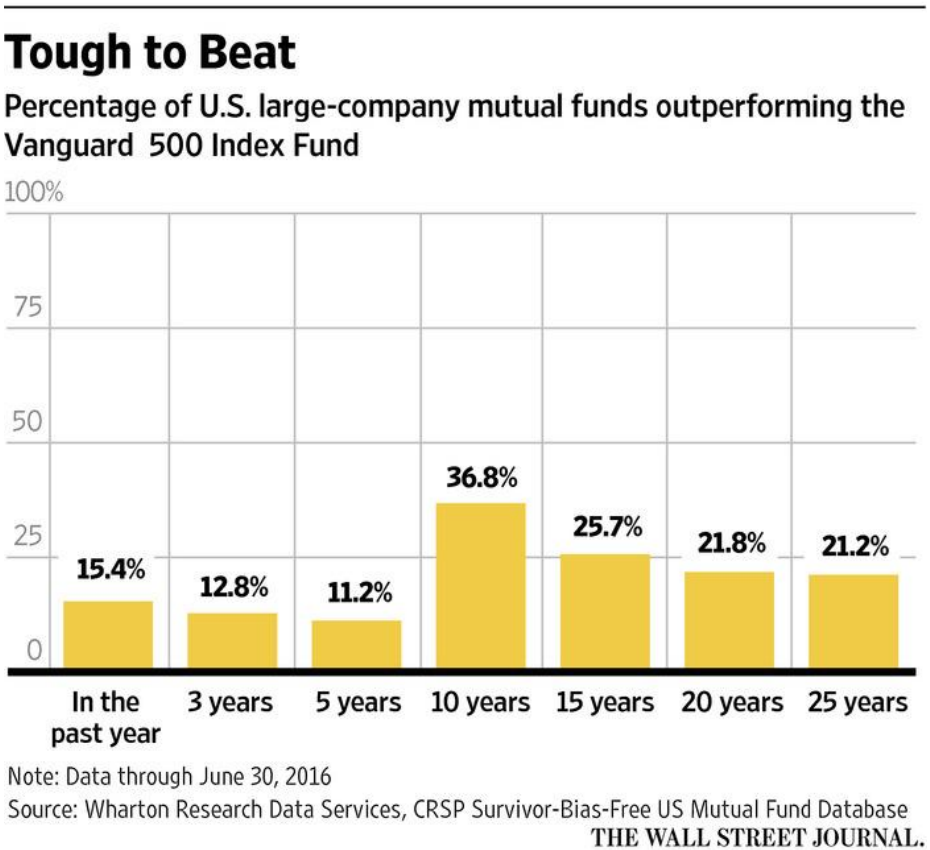
Note semi-log exponential growth!

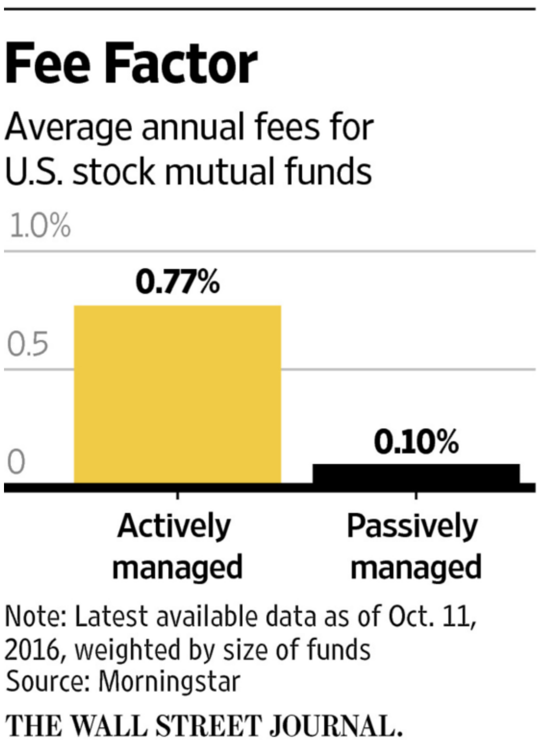


Risk

Active vs Passive Investing

The conclusions of many studies is that the information surrounding the pricing of securities is so “efficient” that it is very difficult to pick individual stocks and do better than the stock market as a whole. As a result, so called **“index funds,” which invest to simply replicate the composition of a major stock index,** have become extremely popular and are attracting most investment money today.





Interesting Case: Warren Buffett

One of the world's richest persons and most successful active investor recommends passive investing to his heirs!

His instructions to his heirs (2014):

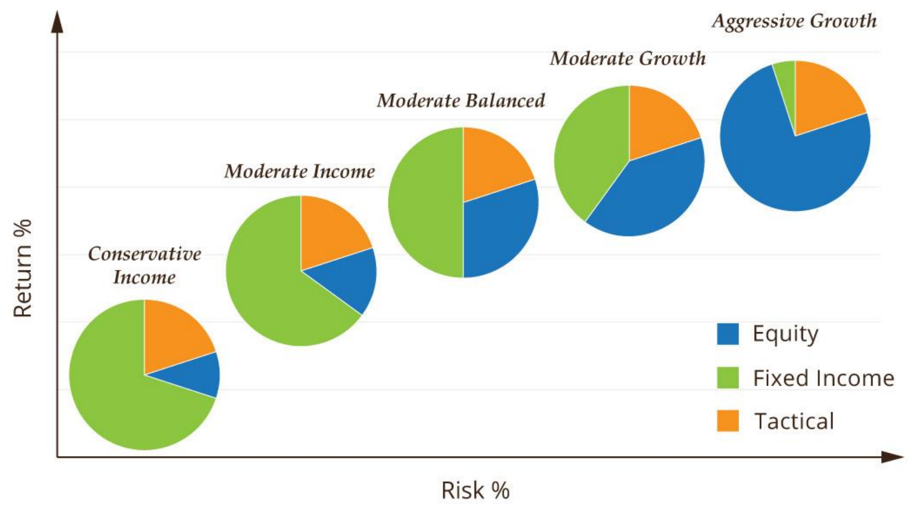
My advice to the trustee couldn't be more simple: Put 10% of the cash in short-term government bonds and 90% in a very low-cost S&P 500 index fund. (I suggest Vanguard's.) I believe the trust's long-term results from this policy will be superior to those attained by most investors — whether pension funds, institutions or individuals — who employ high-fee managers.

Model Portfolios and Target Allocation

- With just 2-5 mutual funds, you can build a very suitable investment portfolio for any point in your life
- Generally you want your portfolio to become more conservative with time since in your old age you do not have time to recover from a big drop in the markets

Target Allocation rule of thumb:

% invested in stocks = 100 - age

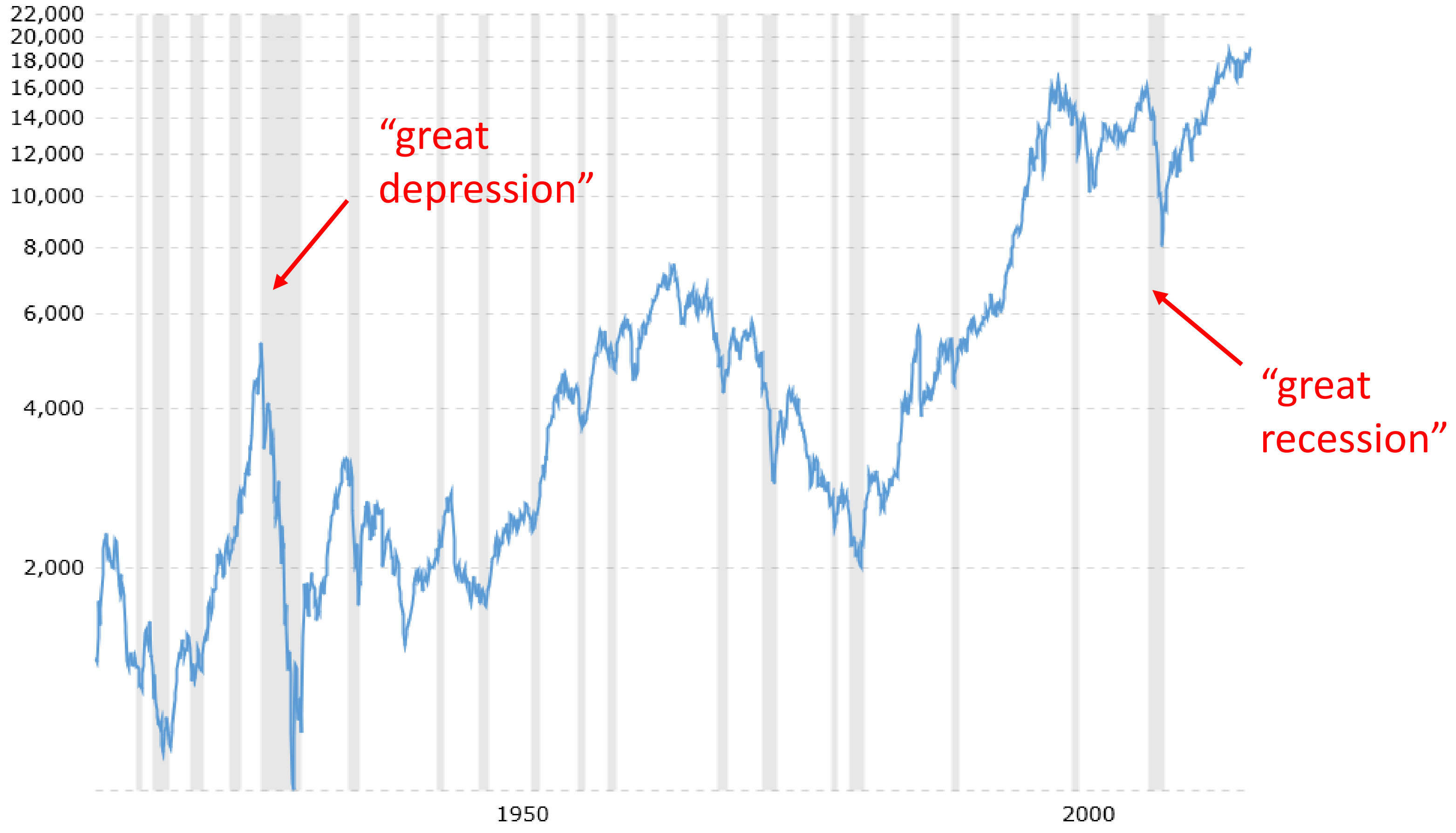


Keeping this or a similar target in mind over time is the most important thing you can do to preserve and grow your wealth!!

Investing Psychology

- When the market is up, investors are happy and mistakenly buy more stocks
- When the market is down, investors are scared and mistakenly sell their stocks
- **Don't behave this way!**

DJIA



Rebalancing

- Ignore the hourly, daily, weekly, and monthly chatter about the market and the economy
- Keep abreast about major developments in the world that have long-term implications for world economies and your investments
- Once or twice per year, or after a major stock market move up or down of more than 5%, rebalance your portfolio to keep it aligned with your target allocation:
  - Equity percentage is too high: sell some stocks
  - Equity percentage is too low: buy some stocks

By following this procedure you will mostly be “selling high” and “buying low,” which is the ideal path to creating long-term wealth!

Dollar Cost Averaging

- Beyond periodic rebalancing, you should invest consistently your entire working career with automatic deductions from your monthly paycheck
- This allows you to benefit from what is known as “dollar cost averaging” (DCA)
- DCA means you are spreading your purchases over time, so you are less likely to buy at a peak in the market
- However, if you have a lump sum to invest for the long term (a bonus or inheritance), you are better off investing it immediately according to your target allocation, rather than a staged DCA approach

Some Dumb Things to Avoid

- Cashing out your retirement accounts when you change jobs (ordinary income tax + 10% penalty + you lose the growth!) Instead, do a "direct rollover" to an IRA or your new employer's retirement plan.
- Raising your standard of living faster than your salary rises
- Borrowing money other than for a primary residence
- Carrying credit card debt
- Day trading (a loser's game: you don't have more information than the traders on Wall Street!)

References

- Lots of very good financial advice can be found free online at websites maintained by companies such as Vanguard, Fidelity, and T. Rowe Price

- Two books that I like:
  - *The Investment Answer*, D. C. Goldie and G. S. Murray (Hachette Book Group, New York, 2011)
  - *The Intelligent Investor*, B. Graham (original 1949; Revised edition with commentary by J. Zweig, Harper Collins, 2003)