PERSONAL FINANCE FOR ENGINEERS
GOOD INVESTING IS BORING
COMPOUNDING

good for savings. bad for debt.
THE MAGIC OF COMPOUNDING

- Not convinced that Albert Einstein said it was the greatest force in the universe.
- It's the key to almost all long term financial planning.
- Exponentials are bad in algorithmic cost, good for savings returns.
- The problem is that financial rates of return seem small, particularly in the early years.
- The key is to stick with it.
• Rule of 72

• For each year, just use

\[ A = P \left(1 + \frac{r}{n}\right)^{nt} \]

Where,

- \( P \) = principal amount (initial investment)
- \( r \) = annual nominal interest rate (as a decimal)
- \( n \) = number of times the interest is compounded per year
- \( t \) = number of years

• 4% over 20 years is 2.19x

• 8% over 20 years is 4.66x

• Careful: it works on debt just as well as savings... in reverse!
ANNUAL PERCENTAGE RATE (APR)

- Standardized measure of how expensive a loan is, or the expected return of an investment
- Needed because of the wide variety of fees and interest-rate structures possible.
- Does not include compounding
- Tends to be higher than nominal interest rate due to fees or related payment requirements.
- APR = simple interest
  APY = compound interest

1% monthly = 12% APR = 12.68% APY

$\text{APR} \neq \text{APY}$

$\text{APR} = \text{Periodic Rate} \times \text{Number of Periods in a Year}$

$\text{APY} = (1 + \text{Periodic Rate})^\text{Number of Periods} - 1$
**THE BENEFITS OF AN EARLY START**

- Compounding really takes off over long time periods.
- Exponential functions are non-linear. Every time period builds on the previous one.
- In most retirement planning models, money saved between ages 25 - 35 produces more assets in retirement than all savings between 35 – 65!

<table>
<thead>
<tr>
<th>Years</th>
<th>Return at 8%</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>2.16x</td>
</tr>
<tr>
<td>20</td>
<td>4.66x</td>
</tr>
<tr>
<td>30</td>
<td>10.06x</td>
</tr>
<tr>
<td>40</td>
<td>21.72x</td>
</tr>
<tr>
<td>50</td>
<td>46.9x</td>
</tr>
</tbody>
</table>
CLASS SURVEY

how do we feel about investing?
In which type of market would you prefer to invest?

66 out of 66 people answered this question

<table>
<thead>
<tr>
<th></th>
<th>A Rising Market</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td>36</td>
<td>55%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Either is Fine</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td></td>
<td>16</td>
<td>24%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>A Declining Market</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td></td>
<td>14</td>
<td>21%</td>
</tr>
</tbody>
</table>
## In which type of market would you prefer to sell your investments?

66 out of 66 people answered this question

<table>
<thead>
<tr>
<th>Option</th>
<th>Count</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>A Rising Market</td>
<td>31 / 47%</td>
<td></td>
</tr>
<tr>
<td>A Declining Market</td>
<td>19 / 29%</td>
<td></td>
</tr>
<tr>
<td>Either is Fine</td>
<td>16 / 24%</td>
<td></td>
</tr>
</tbody>
</table>
### Which investment would you prefer?

66 out of 66 people answered this question

<table>
<thead>
<tr>
<th>Rank</th>
<th>Preference</th>
<th>Votes</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>The one that previously performed the best</td>
<td>37</td>
<td>56%</td>
</tr>
<tr>
<td>2</td>
<td>It doesn't matter</td>
<td>24</td>
<td>36%</td>
</tr>
<tr>
<td>3</td>
<td>The one that previously performed the worst</td>
<td>5</td>
<td>8%</td>
</tr>
</tbody>
</table>
**How do you maintain your ideal risk / reward balance?**

66 out of 66 people answered this question

<table>
<thead>
<tr>
<th>Option</th>
<th>Count</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Buy more of the winners</td>
<td>37</td>
<td>56%</td>
</tr>
<tr>
<td>Do nothing</td>
<td>23</td>
<td>35%</td>
</tr>
<tr>
<td>Buy more of the losers</td>
<td>6</td>
<td>9%</td>
</tr>
<tr>
<td>Option</td>
<td>Votes</td>
<td>Percentage</td>
</tr>
<tr>
<td>-------------------------------------------------------------</td>
<td>-------</td>
<td>------------</td>
</tr>
<tr>
<td>Index fund with a 0.04% fee</td>
<td>43</td>
<td>65%</td>
</tr>
<tr>
<td>Great mutual fund with a 1% management fee</td>
<td>23</td>
<td>35%</td>
</tr>
</tbody>
</table>
TYPES OF INVESTMENTS

stocks, bonds, commodities, real estate
COMMON WAYS TO INVEST

• We have aggregated over 200 years of data on the primary ways that people invest their money.

• Real return is return net of inflation, which measures how money devalues over time. (in this chart, dollars)

• Stocks have the highest annualized return over long time periods, but also higher volatility.

STOCKS / EQUITIES

- Stock is a security that represents ownership in a corporation.
- There are over 3,000 publicly traded stocks in the US alone.
- Returns based on capital appreciation & dividends.
- Businesses over time grow with the economy & adjust for inflation.
- Many ways to sub-divide stocks:
  - Large cap vs. Small cap
  - US vs. Developed Markets vs. Emerging Markets
  - Growth vs. Value
BONDS

• A bond is a debt investment representing a portion of a loan.

• Maturity date, coupon rate & market price all matter. Typically issued at $1000 per bond, but then trade at any price.

• Higher credit quality, the lower the rate.

• Returns based on capital appreciation & interest income.

• U.S. Treasuries = key benchmark

• Many ways to sub-divide bonds:
  • Government vs. Corporate
  • Domestic vs. International

• Municipal bonds have special tax treatment
A commodity is a basic good used in commerce.

- Renewable (e.g. agriculture, lumber)
- Non-renewable (e.g. iron, oil, gold)
- Returns based on appreciation only.

Simon-Ehrlich wager from 1980, scarcity vs. tech. Pick commodities non-government controlled, will they rise or fall in price?

(Simon won in 1990, but there is quite a bit of debate about alternate time periods)

REAL ESTATE

- Real estate is a combination of land & facilities that occupy that land.
- Investment real estate excludes your primary residence.
- Returns based both on rental income & capital appreciation.
- Real Estate Investment Trusts (REITs) trade on the public markets w/ special tax treatment.
DIVERSIFICATION

don’t turn down a free lunch
ASSET CLASSES: VOLATILITY & CORRELATION

- Asset classes vary in terms of historical return, but also vary in volatility

- Movements of different asset classes vary in correlation

- Asset class correlation has been increasing over time, but still varies.

* https://research.wealthfront.com/whitepapers/investment-methodology/*
RISK-ADJUSTED RETURN

• Absolute return of an asset class isn’t the only thing that matters. Volatility also matters.

• Bill Sharpe developed the Sharpe Ratio in 1966, revised in 1994.

\[
\text{The Sharpe Ratio} = \frac{\bar{r}_p - r_f}{\sigma_p}
\]

Where:

\( \bar{r}_p \) = Expected portfolio return
\( r_f \) = Risk free rate
\( \sigma_p \) = Portfolio standard deviation
MODERN PORTFOLIO THEORY

- You can reduce portfolio risk for a given expected return by combining different asset profiles.
- The Markowitz Bullet

* https://en.wikipedia.org/wiki/Modern_portfolio_theory
TAXES MATTER

• Tax rates vary for interest, dividends & capital gains.

• Asset classes vary in terms of the source of their historical return.

• After-tax risk-adjusted return is critical for taxable accounts.

• Before-tax risk-adjusted return is critical for tax-deferred accounts (401k, IRA)

* https://research.wealthfront.com/whitepapers/investment-methodology/
HOW TO INVEST
what to do & why you do it
• In most countries, large banks provide brokerage services.

• In the United States, brokerages are financial firms that offer security accounts, regulated by the SEC & FINRA.

• Most large banks have acquired or built brokerages.

• These are not bank accounts, but they are institutions where you can deposit money and purchase (and sell) securities.

• Unlike bank accounts, you can lose money. Investments can and do go down, sometimes over long periods of time.

• SIPC insurance created in 1970, is currently $500,000. Covers when brokerages inappropriately endanger customer assets.
HOW DO YOU MEASURE INVESTMENT RETURN?

• Alpha $\alpha$ is defined as excess return over the market rate of return.

• Beta $\beta$ is defined as the measure of volatility compared to its market benchmark over time.

• Beta of 1 implies expected market performance & volatility.

• Both are derived from the Capital Asset Pricing Model (CAPM)

• The key is to achieve the best risk-adjusted return, net of fees & taxes.
TYPES OF INVESTMENT APPROACH

• Fundamental analysis attempts to choose securities based on the business performance & valuation.

• Technical analysis attempts to choose securities based on price patterns.

• Neither have demonstrated credible & repeatable above-market risk-adjusted performance net of fees in practice for the average professional.

• Fundamental analysis is very useful as a business owner & operator. Warren Buffett annual letters are famous for good reason.
THE SECULAR RISE OF INDEX FUNDS

- A Random Walk Down Wall Street was published in 1973.
- Vanguard launched the first consumer-focused index mutual fund on Dec 31, 1975.
- Index funds now hold more than $4 trillion in assets, and represent the majority of new equity fund inflows.
- Large difference between broad, market based index funds (like VTI) and niche index funds based on alternate approaches or subsets of the market.
- Factor-based investing has credible academic evidence, but the primary issue in practice has been high fees.

Figure 1. The Growth of the Index Fund

Sources: Morningstar, Strategic Insight Simfund.
GOOD INVESTING IS BORING
otherwise, you are doing it wrong.
GOOD INVESTING IS BORING

• No one wants to be average, but with investing, “average” is actually well above average.

• You will beat most mutual funds, hedge funds & your peers with simple, low cost index funds.

• Asset allocation explains ~90% of the variance in manager performance
• Over 40 years old, by famous Princeton economist Burt Malkiel

• Most professionals fail to beat a simple market-weighted index, net of fees.

• The fee is the killer. It means professionals have to reliably beat the index by more than their fee.

• The ones who do, don’t repeat for the next time period.

• Keep your fees low by using index funds for each asset.
RETAIL INVESTORS DO WORSE THAN THE PROS

• Dalbar publishes research annually covering 20 years of retail investor returns.

• The average equity investor underperformed the S&P 500 by 4.32% over the 20 year period from 1992-2011. **

• The overall S&P 500 return over the same time period was 7.75% with dividends reinvested. *

• Biggest causes are high fees and market timing errors.

MARKET TIMING IS TERRIBLE

• History of money flowing into equities shows how badly people do.

• Dalbar research consistently shows market timing as one of the main reason retail investors underperform the market.

• You have to be right twice.

• Just. Keep. Saving.
ASSET CLASSES: WINNERS RARELY REPEAT

- Asset classes vary in terms of historical return, but also vary in volatility.
- Movements of different asset classes vary in correlation.
- Asset class correlation has been increasing over time, but still varies.
- Stay diversified.

* https://research.wealthfront.com/whitepapers/investment-methodology/*
• Over long time periods, asset allocation will drift due to varied performance.

• Tax efficient methods: intelligent dividend reinvestment, deposits, withdrawals.

• Trigger-based rebalancing occurs only after a certain % drift from the ideal allocation.

• Reduces risk over time, does not necessarily improve returns.
FOUR KEYS TO GOOD INVESTING

1. Keep Saving
2. Low Fees
3. Stay Diversified
4. Minimize Taxes

IT’S A MARATHON, NOT A SPRINT.
Investing is simple, but not easy.
- Warren Buffett
WEEK 8: FINANCIAL GOALS

• How to Plan for Financial Goals

• Different Types of Goals: Travel, Marriage, House, Children, College, Starting a Business, Retirement

• Life Insurance

• Couples & Financial Decisions