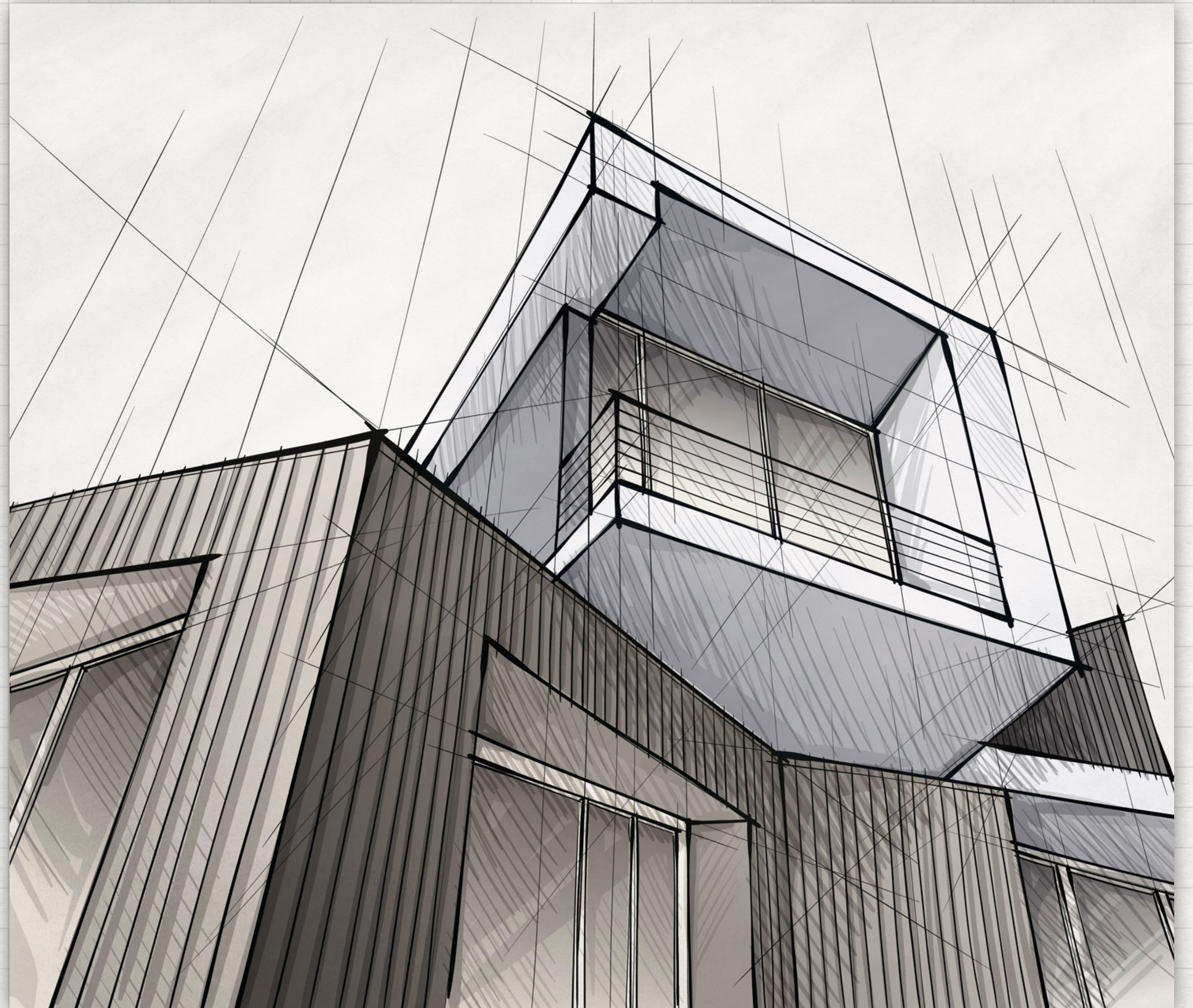


CS 007: SESSION 6
PERSONAL
FINANCE FOR
ENGINEERS



CS 007

ALL ABOUT DEBT

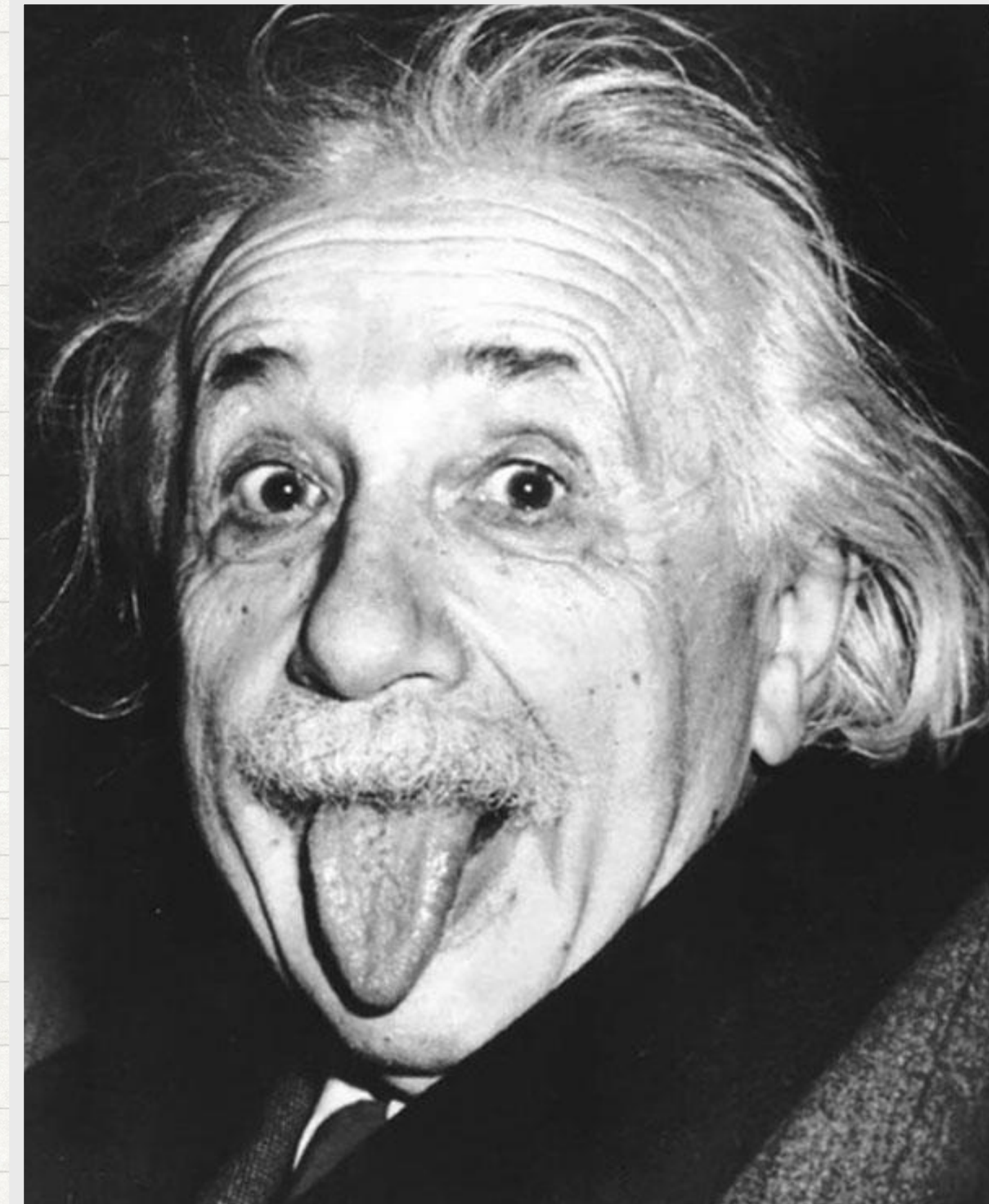


COMPOUNDING

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.



COMPOUNDING MADE EASY

- Rule of 72
- For each year, just use
=POWER(1+rate, year)
- 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!

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

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

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

APR \neq APY

APR = Periodic Rate x Number of Periods in a Year

APY = (1 + Periodic Rate) ^ 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!

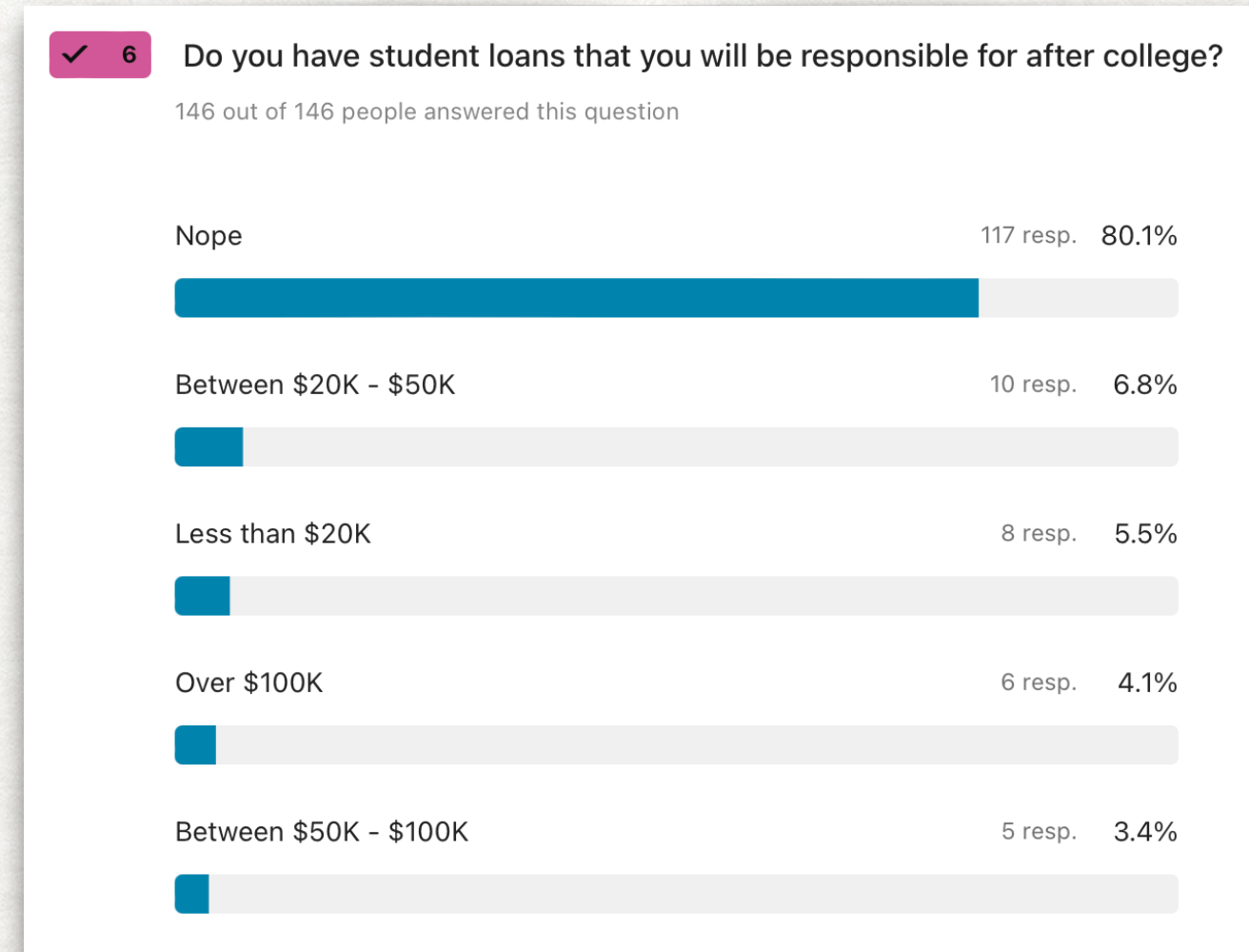
| Years | Return at 8% |
|-------|--------------|
| 10 | 2.16x |
| 20 | 4.66x |
| 30 | 10.06x |
| 40 | 21.72x |
| 50 | 46.9x |

TYPES OF DEBT

student loans, mortgage, auto, credit cards

6: STUDENT LOANS THAT YOU ARE RESPONSIBLE FOR?

- National student loan debt at: \$1.76 Trillion
- 55% of the Class of 2020 graduated with student debt. Average debt of \$28,400
- Average US household w/ student debt has \$58,238 in debt.
- 53% of borrowers owe less than \$20,000 in student loan debt.
- ... but that represents only 13% of the total \$ amount of student debt!



| Debt type | Average debt |
|-----------------------------|--|
| Bachelor's degree debt | \$28,400 |
| Graduate school loan debt | \$71,000 |
| Parent PLUS loan debt | \$28,778 |
| Law school debt | \$130,000 |
| MBA student debt | \$66,300 |
| Medical school debt | \$203,062 |
| Dental school debt | \$301,583 |
| Pharmacy school loan debt | \$179,514 |
| Nursing school student debt | \$19,928: Associate Degree Nursing (ADN) \$23,711: Bachelor of Science in Nursing (BSN) \$47,321: Master of Science in Nursing (MSN) |
| Veterinary school debt | \$147,258 |

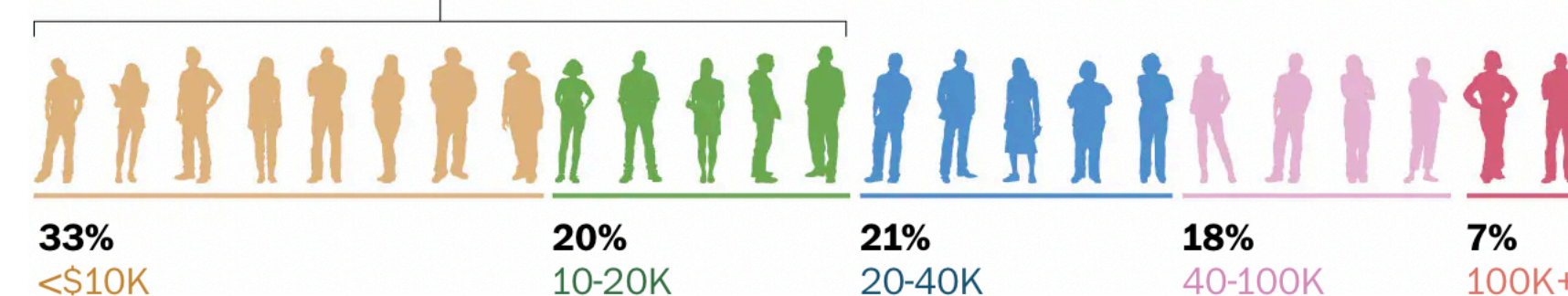
How does the debt break down?

Most student debt is held in large loans, but most borrowers have small loans.

About **13%** of federal student debt is held in loans with \$20K or less still owed...



...but **53%** of borrowers owe less than \$20K



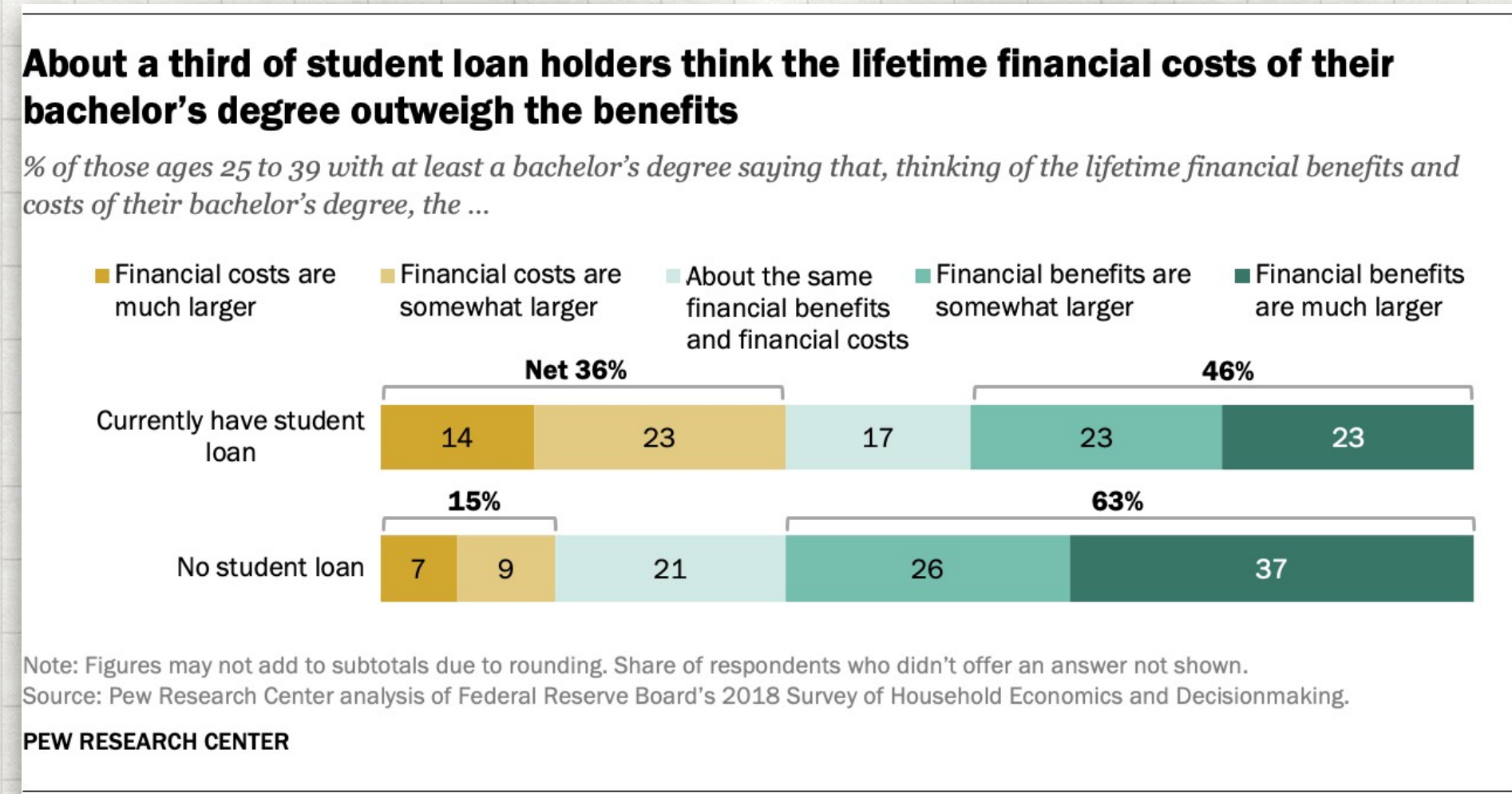
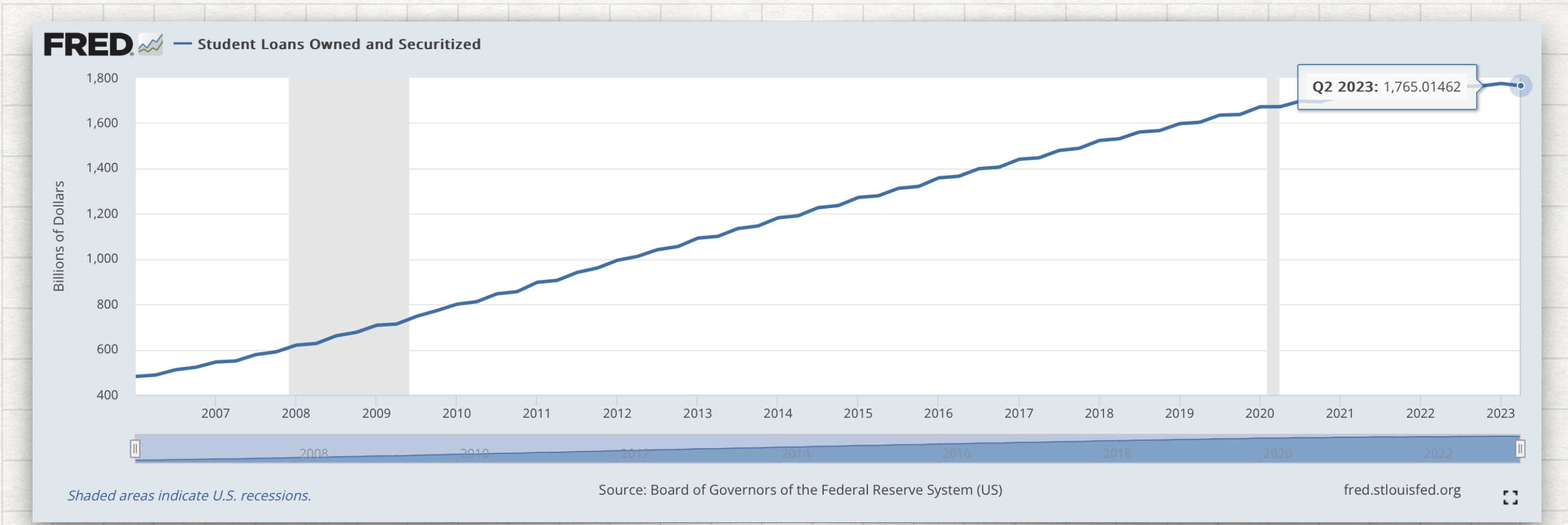
* <https://fred.stlouisfed.org/series/SLOAS>

* <https://www.nerdwallet.com/article/loans/student-loans/student-loan-debt>

* <https://www.washingtonpost.com/education/2022/05/22/student-loan-borrowers/>

STUDENT LOANS

- \$1.76 Trillion in the US, and growing rapidly. *
- Unsecured loan provided to fund education & some related expenses
- Loan programs for students & parents. Financial need based.
- Interest rates can be fixed or variable. Significant difference in undergrad vs. grad
- Rates are much lower than equivalent unsecured long term personal loan to a teenager.
- US government subsidizes in a variety of ways: no interest, rate limits, payment programs, loan waivers
- Typical term is 10 years, but research shows average payoff time is closer to 21 years due to alternative payment plans & refinancing

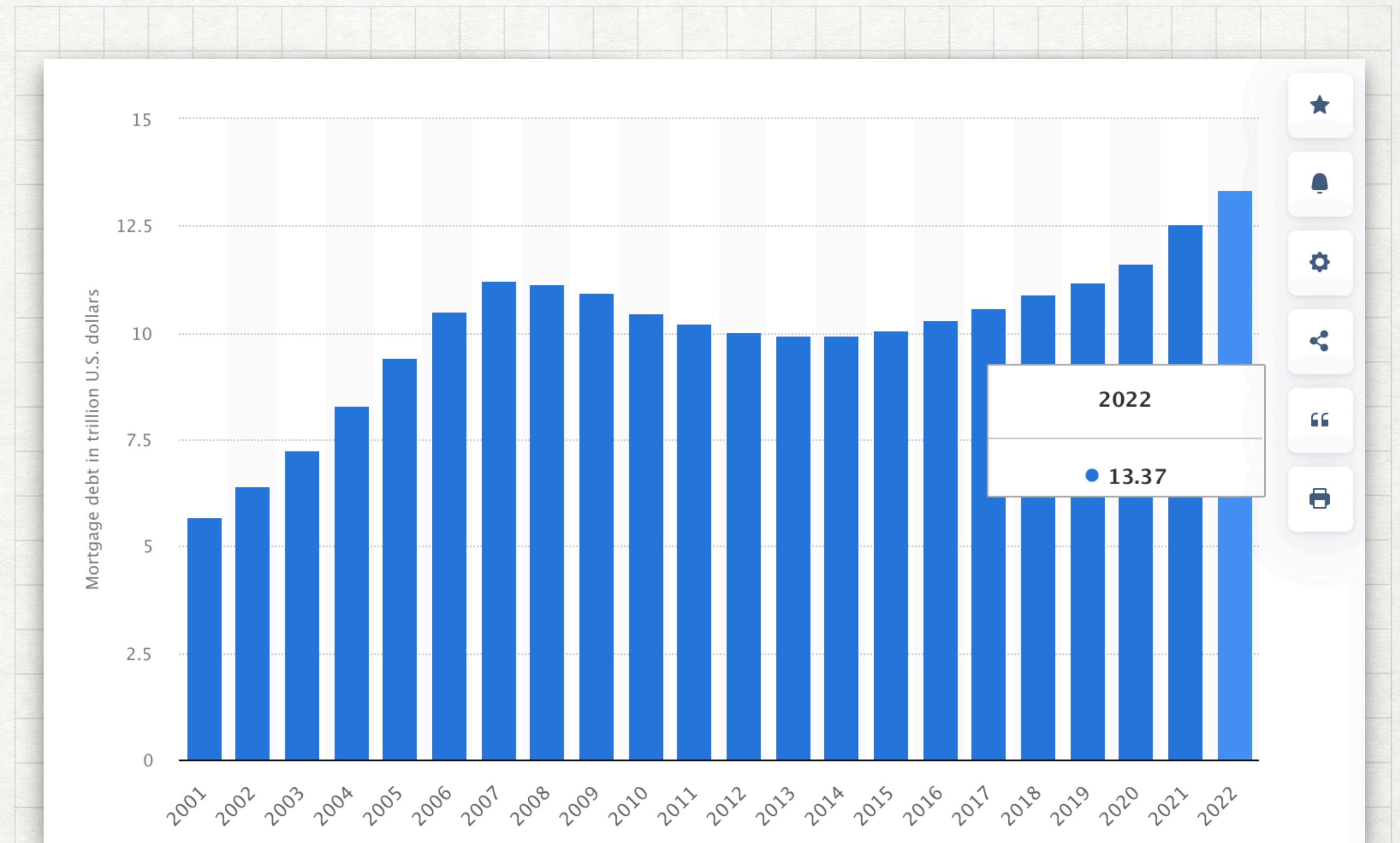


* <https://fred.stlouisfed.org/series/SLOAS>

** <https://www.pewresearch.org/fact-tank/2019/08/13/facts-about-student-loans/>

MORTGAGES

- \$19.3 Trillion in the US. \$13.4 Trillion for just family residences.
- Secured loan against a property. Can be residential or commercial.
- Wide variety of terms. Interest rates can be fixed or variable.
- Common mortgages: 30 year fixed, 5/1 adjustable rate mortgage (ARM)
- Refinancing is common.
- Qualification: debt / income, debt / property value, credit score

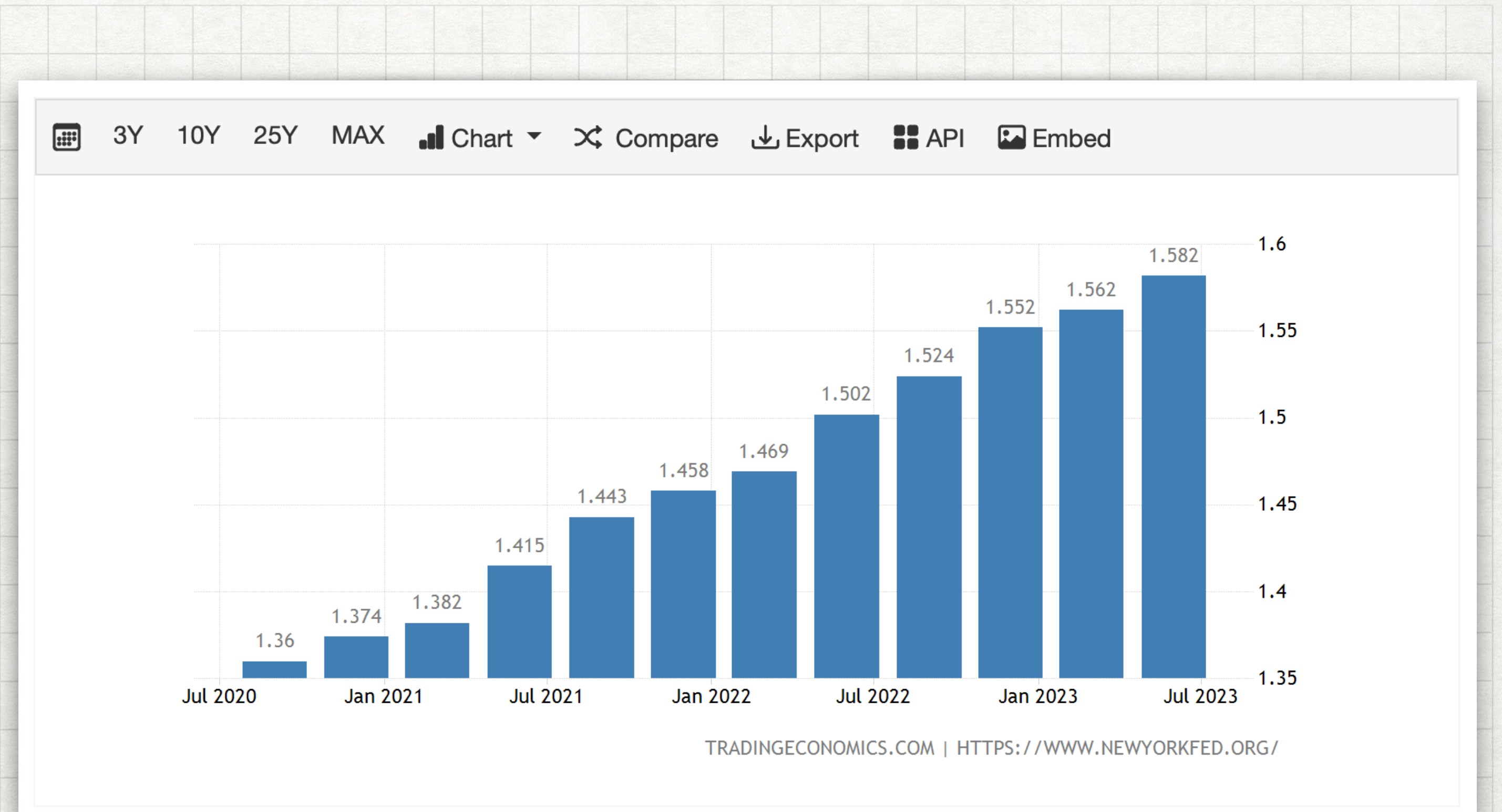


*<https://www.statista.com/topics/1685/mortgage-industry-of-the-united-states/>

*<https://www.statista.com/statistics/274638/mortgage-debt-outstanding-on-us-family-residences/>

AUTO LOANS

- \$1.58 Trillion (as of Q2 2023)
- Secured loan against a vehicle, typically acquired at purchase.
- Wide variety of terms. Interest rates can be fixed or variable.
- Typically 3-5 years, fixed rate.
- Rates vary significantly across providers, auto manufacturers use financing to influence demand.
- Leasing vs. Buying
- Qualification: credit score



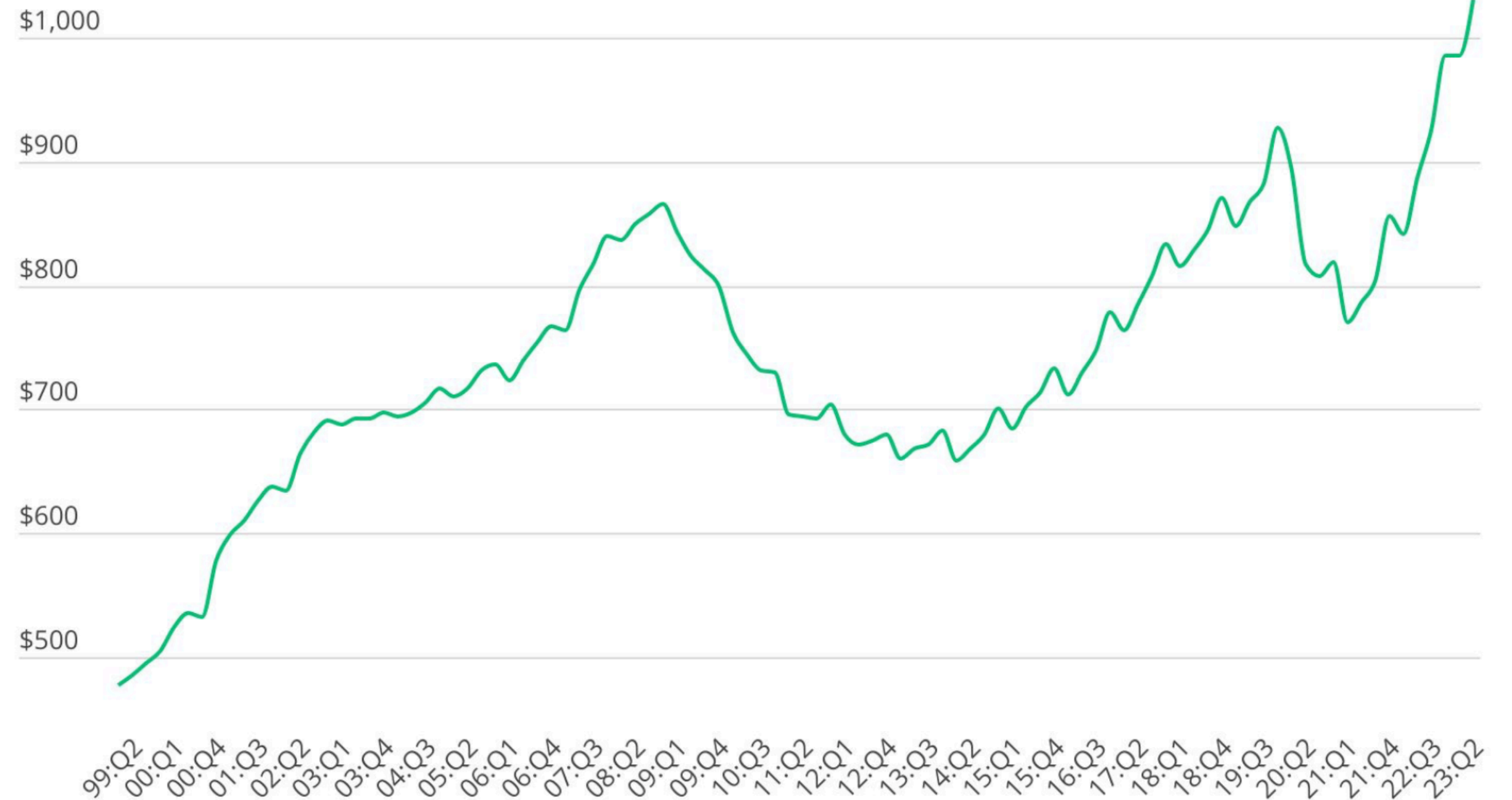
* <https://tradingeconomics.com/united-states/debt-balance-auto-loans>

CREDIT CARDS

- \$1.03 Trillion (Q2 2023)
- Unsecured loan, paid on a revolving 30-day cycle
- Wide variety of terms. Interest rates are typically variable.
- Fees, benefits complicate simple analysis.
- Interest rate is calculated daily, grace period can be counter-intuitive / expensive when exceeded.
- Qualification: income, credit score
- Key component of credit score (!)

Total outstanding credit card balances, 1999 to present

In billions; seasonally adjusted



Source: New York Fed Consumer Credit Panel/Equifax

* <https://www.newyorkfed.org/newsevents/news/research/2023/20230808>

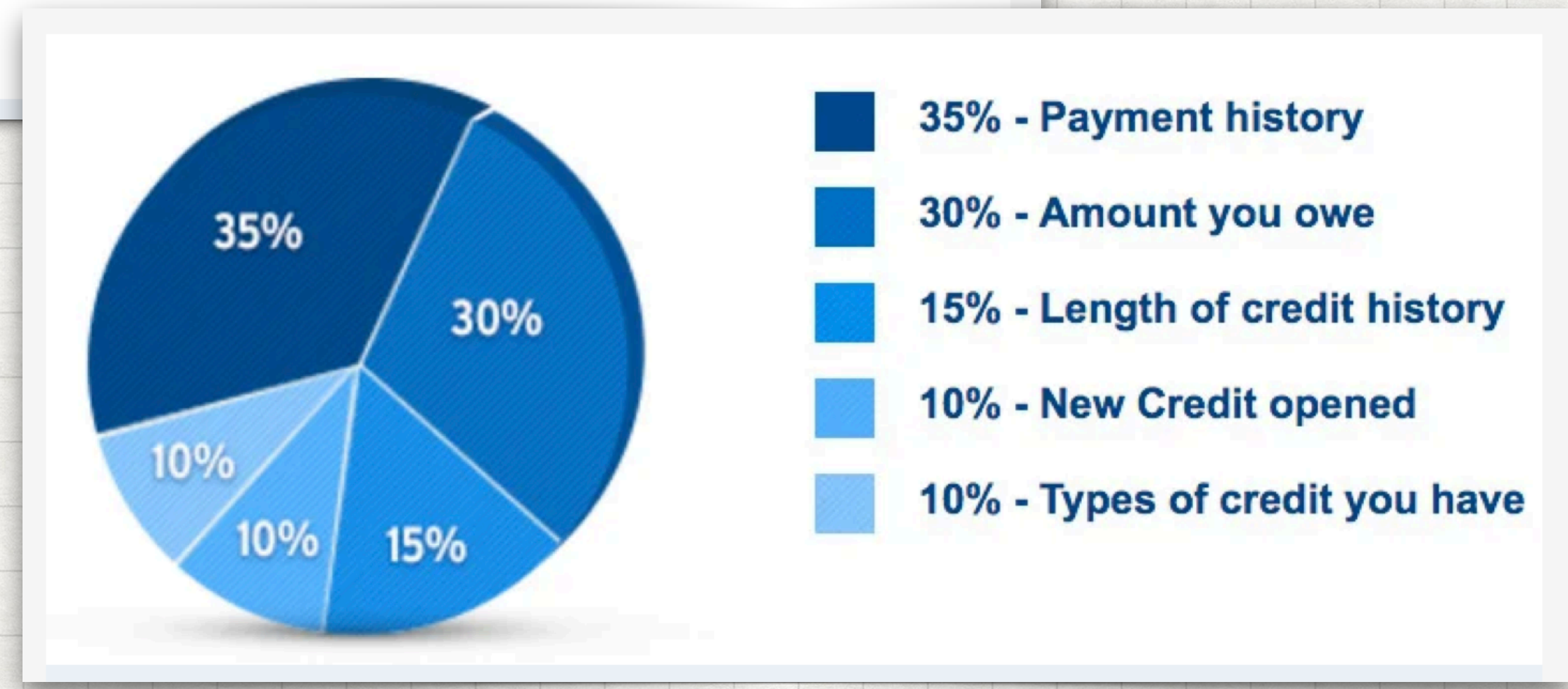
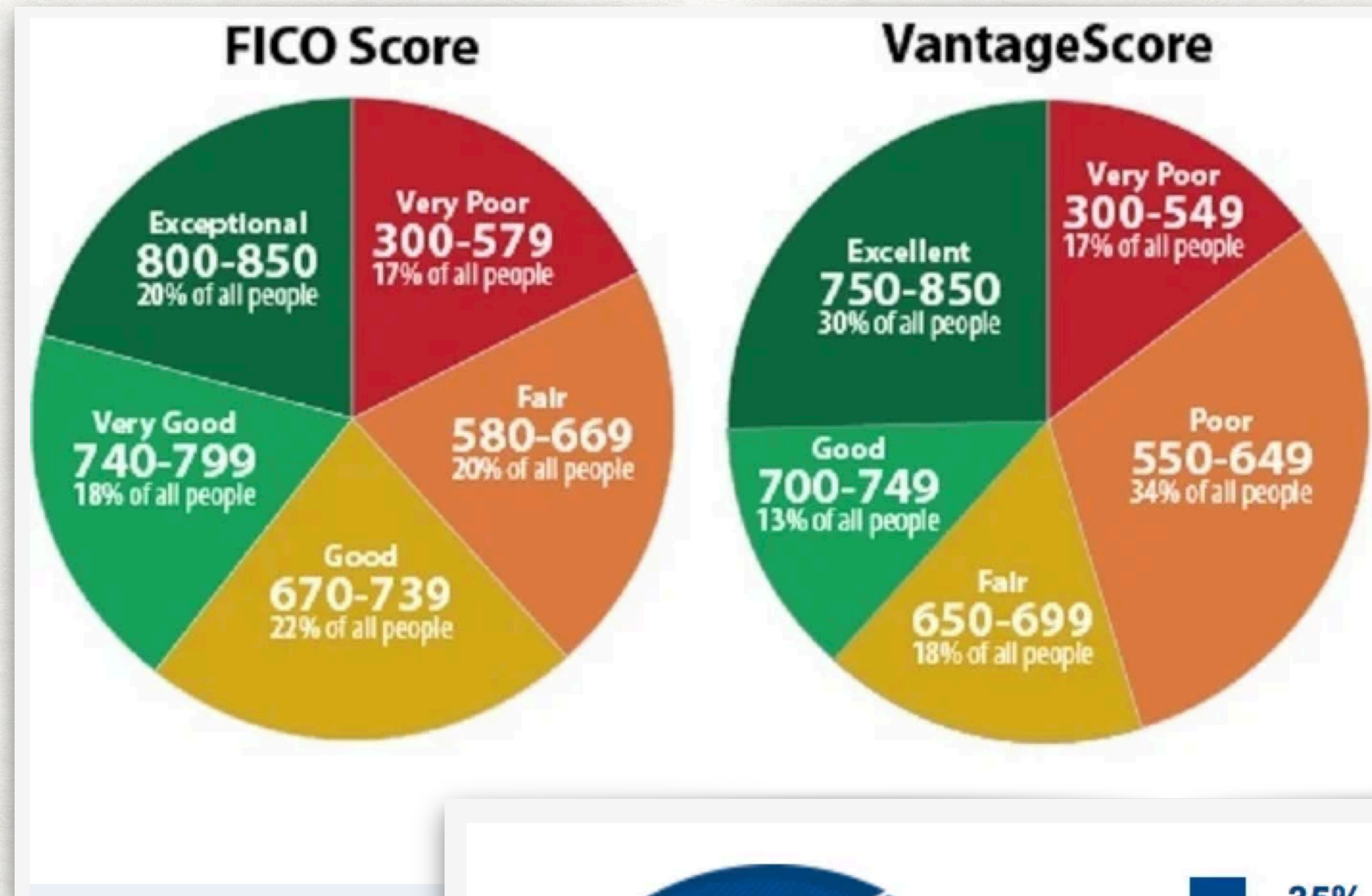
* <https://www.lendingtree.com/credit-cards/credit-card-debt-statistics/>

CREDIT SCORES

your borrowing record & why it matters

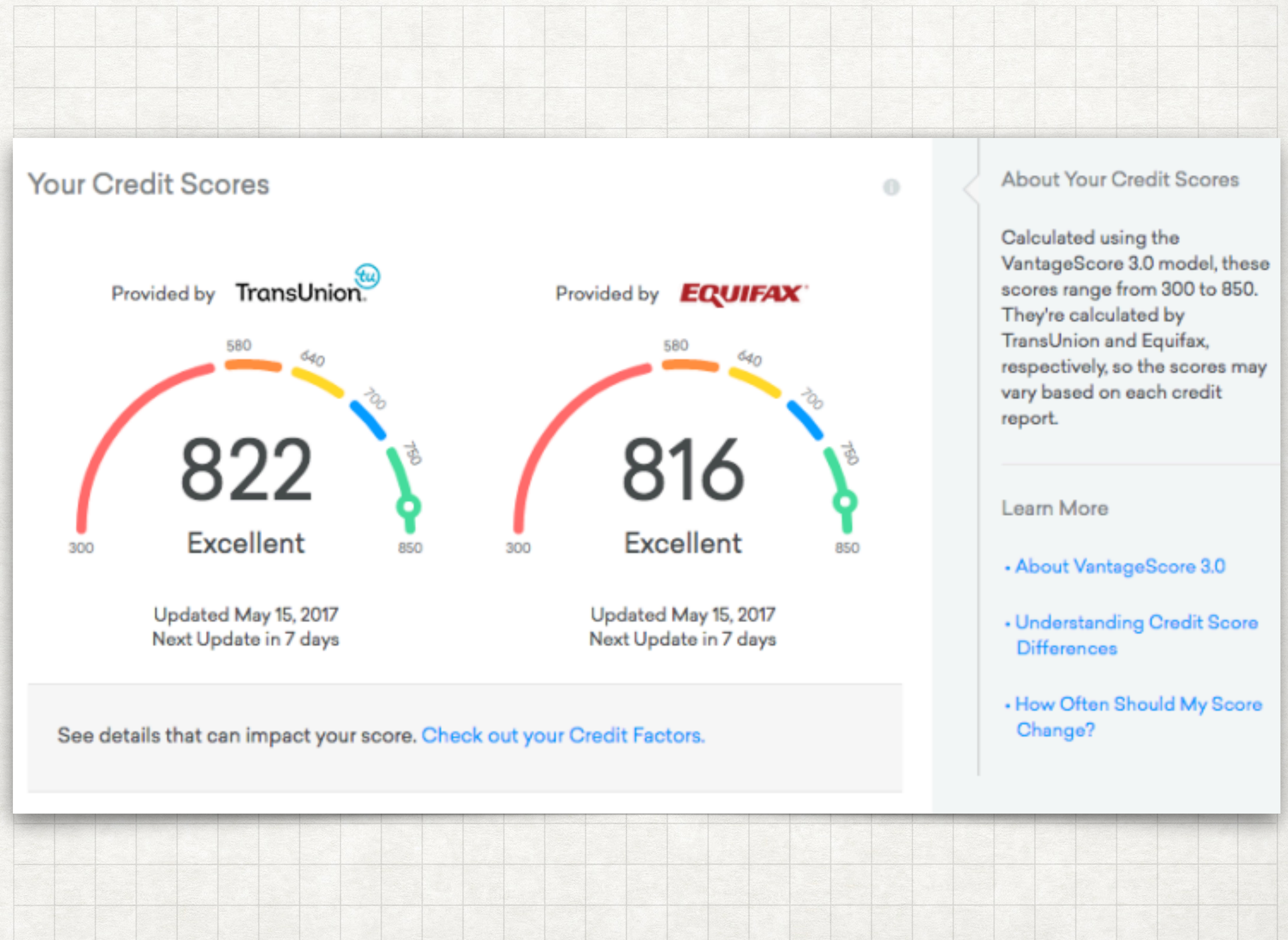
WHAT'S A CREDIT SCORE

- Lenders report to 3 major centralized credit agencies when you apply for debt, receive debt, and when you pay off debt.
- Building a good credit score is essential for qualifying for most loans. It can affect other services too, as it is used for identity verification.
- Issues that affect credit score: length of history, on time payment, percent of capacity utilized, new applications for debt, bankruptcy.
- Credit Karma ¹⁰⁰
<http://www.creditkarma.com>



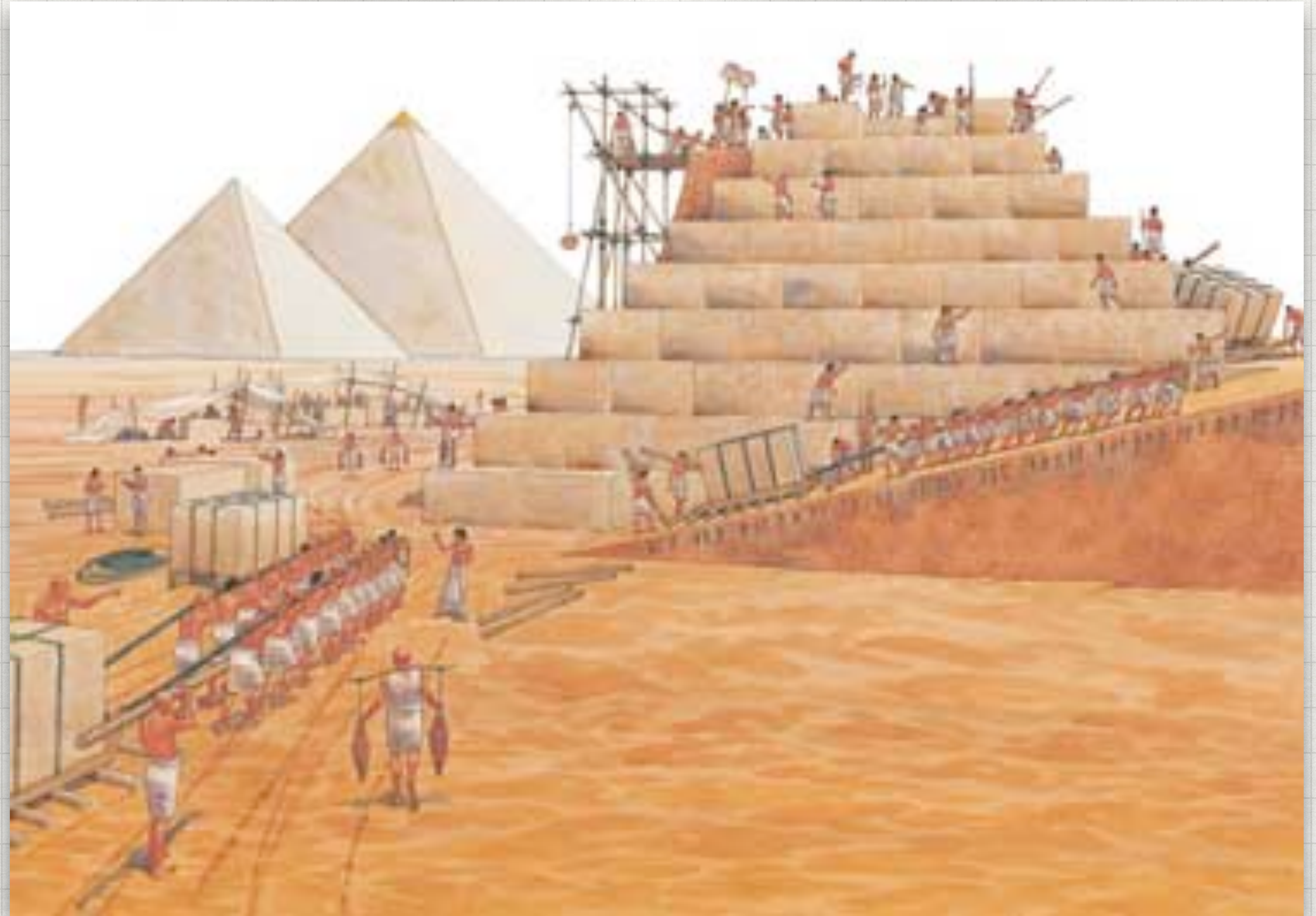
WHY DO CREDIT SCORES MATTER?

- Critical component in qualifying for new loans and the rate they are set at.
- Many products & services (like wireless & cable plans) utilize them as well to assess credit risk.
- Often utilized for identity verification purposes.
- Particularly difficult for new immigrants to build.
- Seems like a Catch-22, but there are entry products that make it easier.



HOW DO I GET A CREDIT SCORE?

- **Most common methods**
 - Secured credit cards
 - Student credit cards
 - Store credit cards
- Authorized user on a parent's card
- Student loans, auto loans
- Don't pay interest. Don't miss a payment. Don't spend too much.
- There are services now that report rent payments

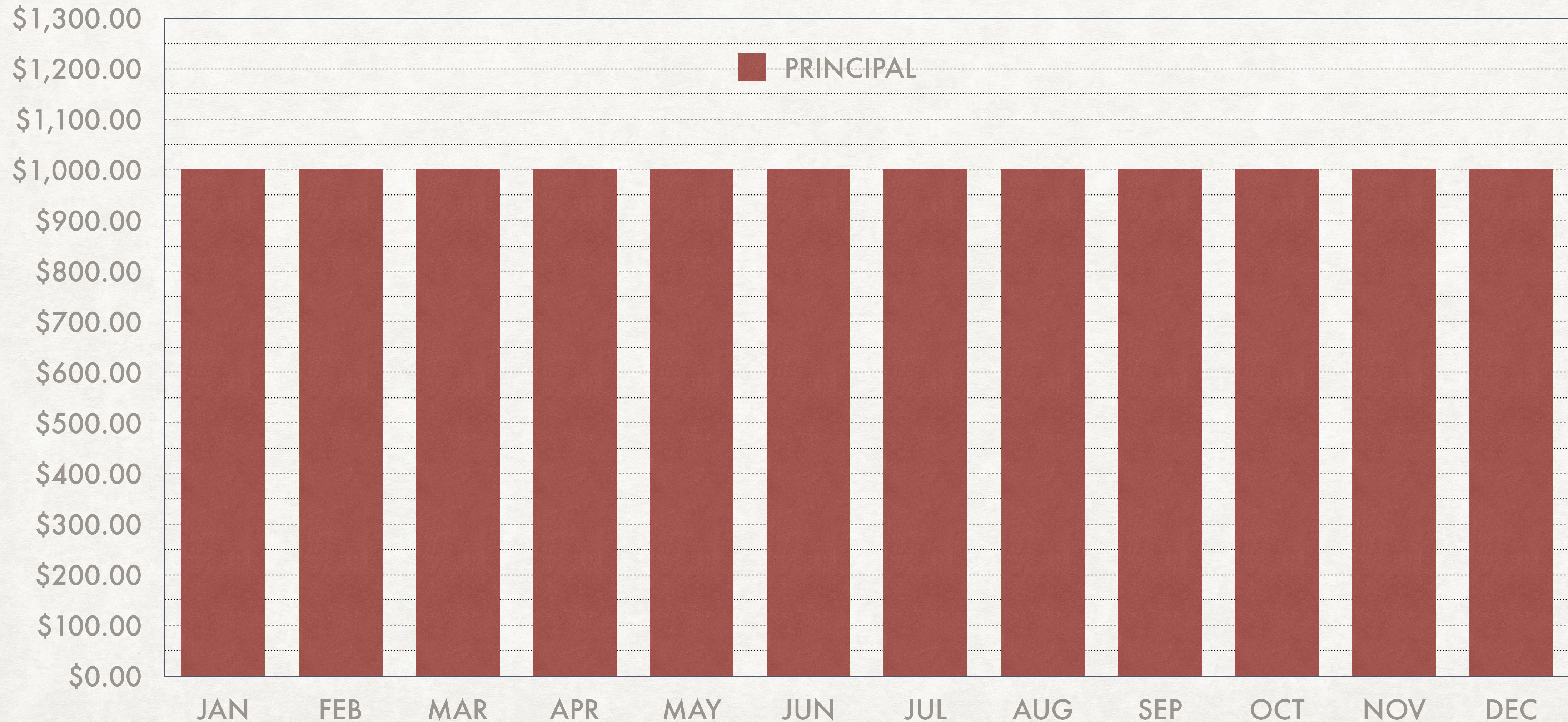


LOANS & RATES

how much will you owe?

SIMPLE LOAN

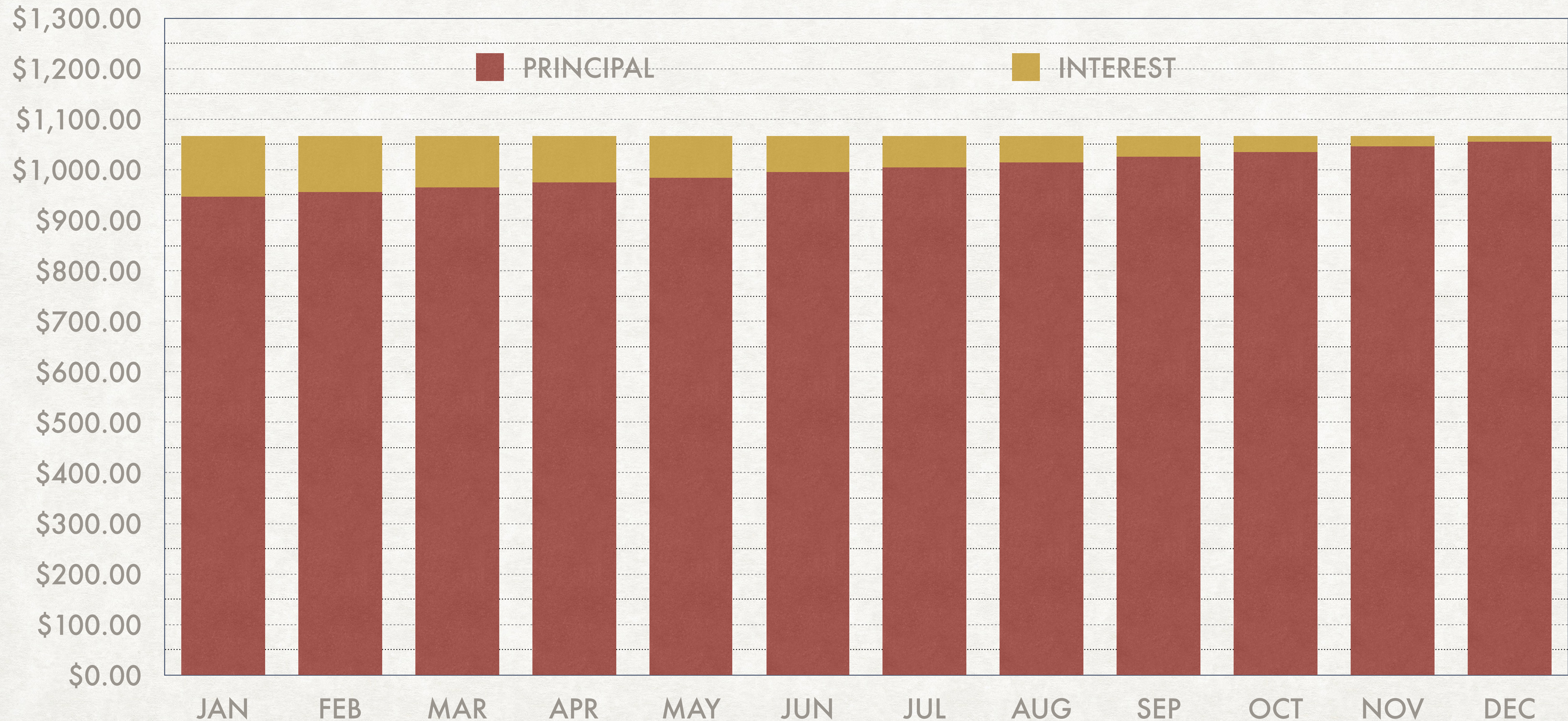
\$12,000 AT 0% INTEREST FOR 1 YEAR



PAYMENT = \$1,000 PER MONTH

SIMPLE LOAN

\$12,000 AT 12% INTEREST FOR 1 YEAR



PAYMENT = \$1,066.19 PER MONTH. FIRST MONTH = \$120.00 INTEREST.

AMORTIZATION

- The process of reducing the value of a loan by a periodic amount.
- PMT(), PPMT(), IPMT() built into spreadsheets
- E60 teaches the basics of how to convert cash flows to rates of return (or vice versa)
- Once you have payment, you can figure out interest & principal portions trivially on an iterative basis. (e.g. calc 1st period, reduce principal, repeat for 2nd period, etc)

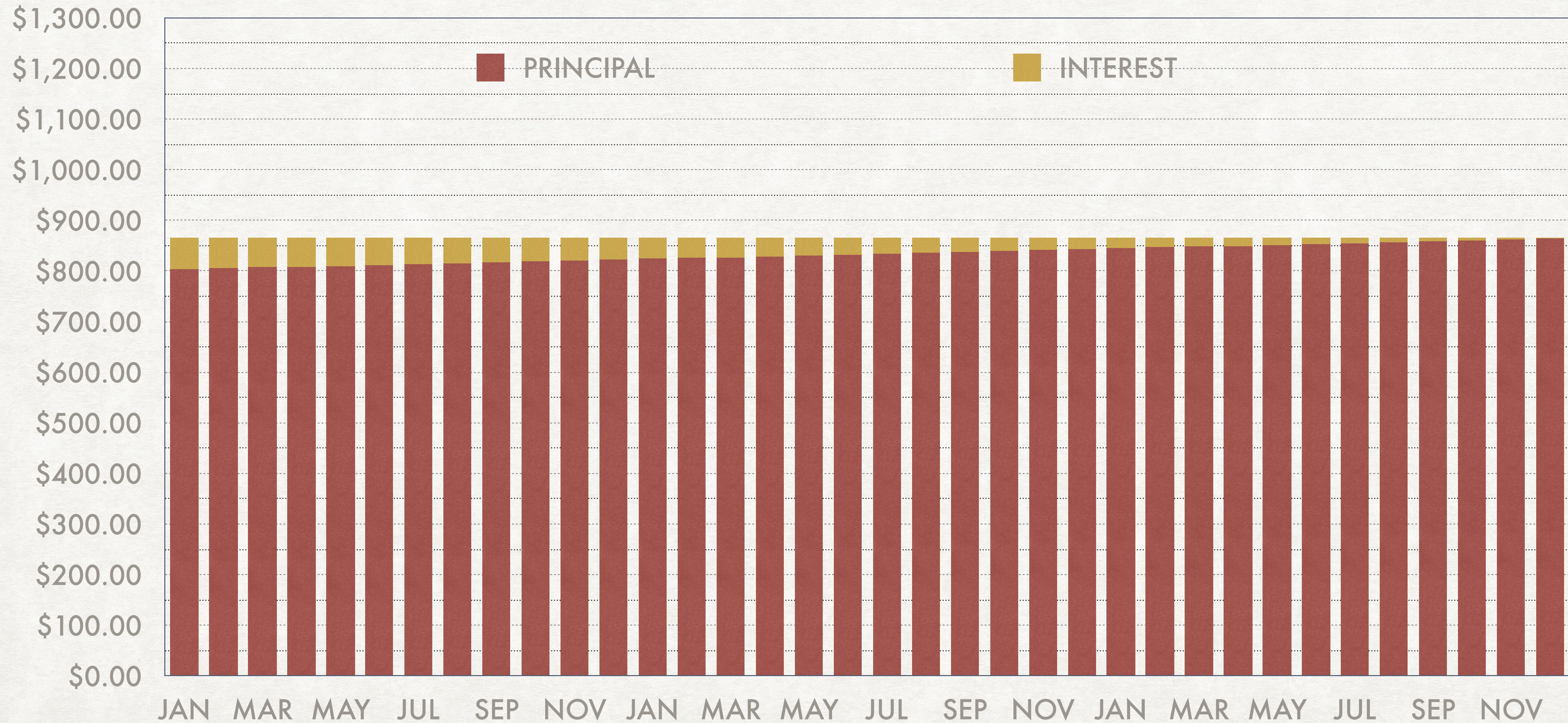
$$A = P \frac{r(1+r)^n}{(1+r)^n - 1}$$

where

- A = payment Amount per period
- P = initial Principal (loan amount)
- r = interest rate per period
- n = total number of payments or periods

SAMPLE AUTO LOAN

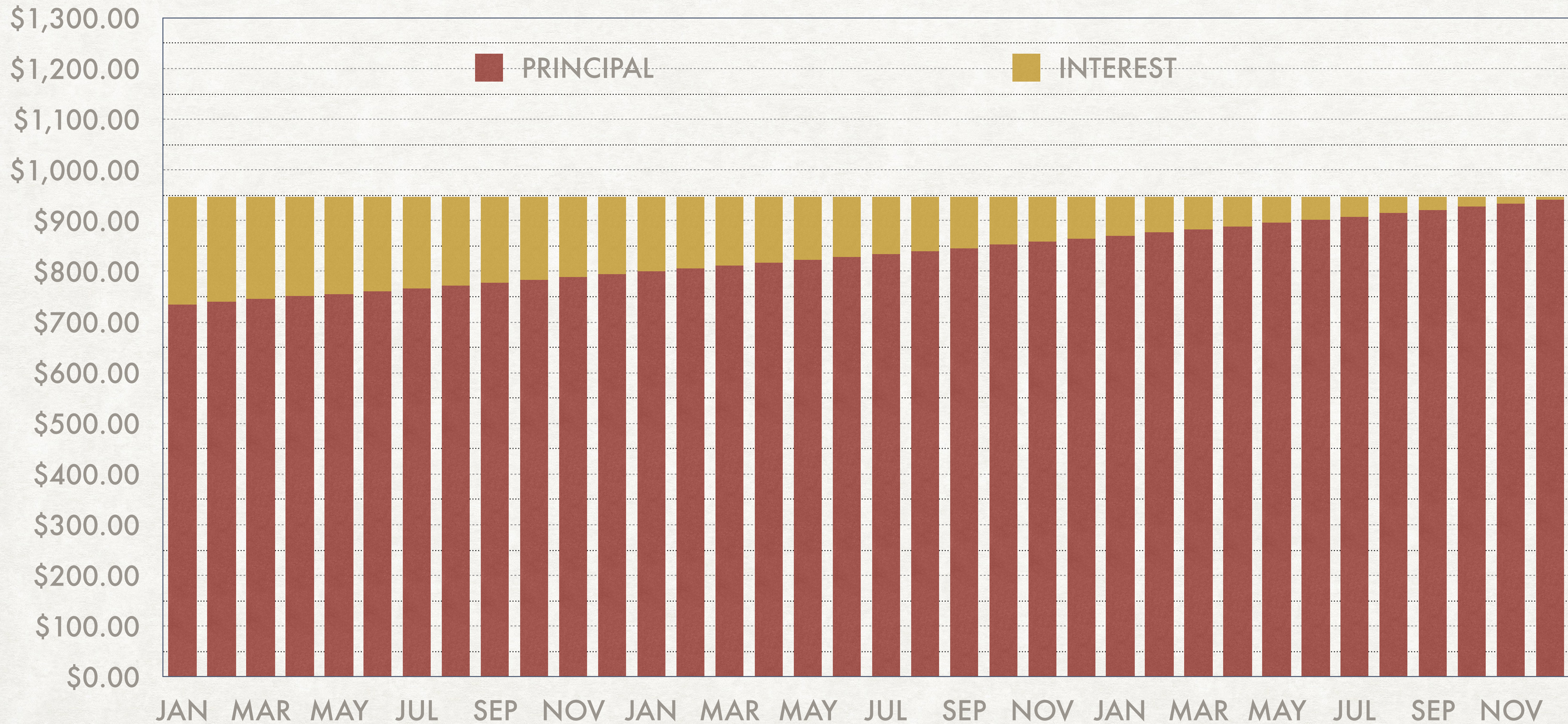
\$30,000 AT 2.5% INTEREST FOR 3 YEARS



PAYMENT = \$865.84.19 PER MONTH. FIRST MONTH = \$62.50 INTEREST.

SAMPLE AUTO LOAN

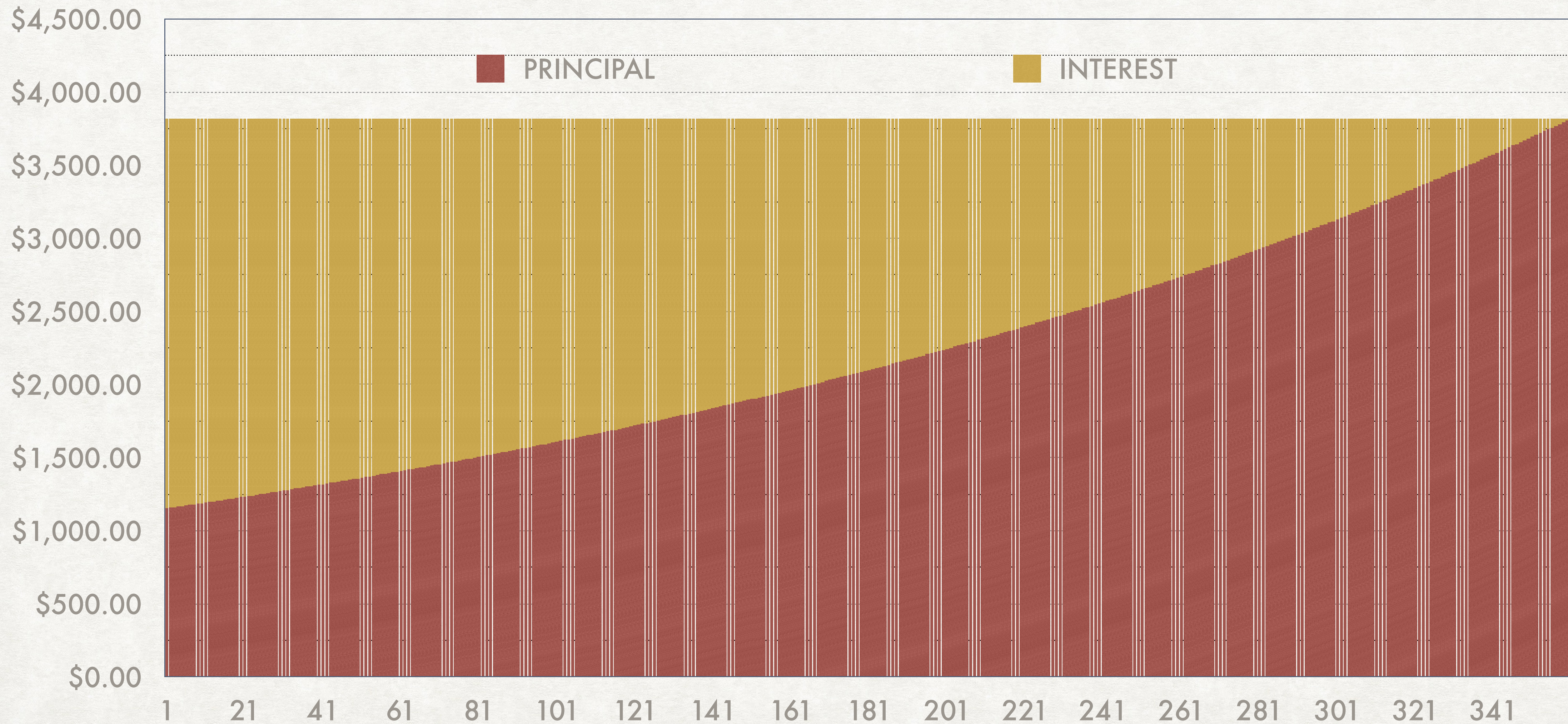
\$30,000 AT 8.5% INTEREST FOR 3 YEARS



PAYMENT = \$947.03 PER MONTH. FIRST MONTH = \$212.50 INTEREST.

SAMPLE MORTGAGE

\$800,000 AT 4% INTEREST FOR 30 YEARS



PAYMENT = \$3,819.32 PER MONTH. FIRST MONTH = \$2,666.67 INTEREST.

PAYING OFF DEBT

different strategies to dig out

THE DANGERS OF DEBT

- Bankruptcy is literally when you can't pay your debts. You can't go bankrupt if you don't have debt.
- You will never find a legitimate investment that pays 8% guaranteed, let alone 20%+
- You will find an endless supply of credit offers out there that will charge you 20%+
- "Bad" debt is toxic, your best return is to pay it off. But emergency fund can take precedence



HOW DO I PAY OFF DEBT EFFICIENTLY?

- This process assumes you can allocate more \$ per month to paying off debt than the minimum payments. Otherwise, that's your priority.
- Organize your loans that you want to pay off. Exclude mortgage from this calculation.
- Use consolidation to simplify loans and minimize interest rate. In some cases, extending the term can make sense to free up cash.
- **Debt Snowball** is a popularized term. Refers to paying off the smallest loan first. Based on emotional benefit of paying off debt.
- Mathematically, ideal to **line up loans in terms of interest rate**. Minimumize payments on all loans, use surplus to pay off most expensive loan first.
- Problem is that you don't get cash flow relief until you completely payoff a loan.

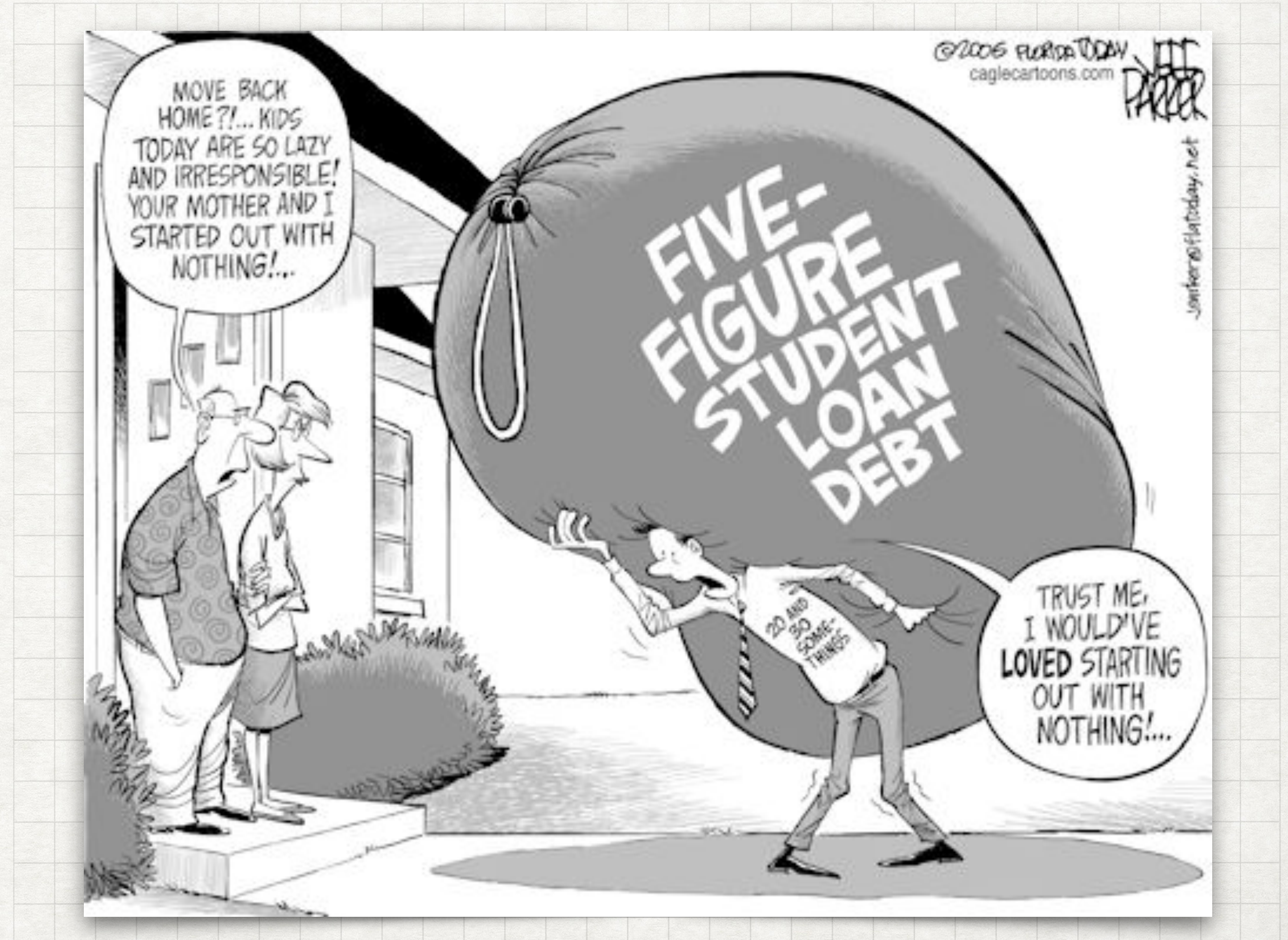
| | Student Loan 1 | Student Loan 2 | Credit Card | Auto Loan |
|----------------------|-----------------------|-----------------------|--------------------|------------------|
| Amount | \$6,000 | \$8,000 | \$10,000 | \$20,000 |
| Rate | 2.5% | 4.5% | 22.9% | 1.9% |
| Min Pmt | \$200 | \$250 | \$120 | \$450 |
| Term | 10yrs | 10yrs | ~ | 3yrs |
| Peanut Butter | \$500 | \$500 | \$500 | \$500 |
| Snowball | \$1180 | \$250 | \$120 | \$450 |
| Optimal | \$200 | \$250 | \$1100 | \$450 |

ASSUME \$2,000 IN DEBT PAYMENT PER MONTH

** These numbers are illustrative only. They are not accurate representations of payment amounts for the rate & period given.*

SHOULD I PAY OFF ALL OF MY DEBT?

- More debt = more risk
- Not all debt is the same
- Compounding is not your friend with debt, especially high interest debt.
- Some debt is subsidized (e.g. Mortgage, Student Loans)
- Paying off debt can be emotionally satisfying, but financially irrational.
- Paying off debt can improve savings rates over time.



CS 007

QUESTIONS



WEEK 7: GOOD INVESTING IS BORING

- The Magic of Compounding
- How to Calculate Returns
- Different Types of Investments: Stocks, Bonds, Commodities, Real Estate
- Diversification
- Modern Portfolio Construction
- Taxes Matter



*If investing is entertaining,
if you're having fun,
you're probably not making
any money.*

Good investing is boring.

- George Soros

"Success in investing
doesn't correlate with I.Q.
Once you are above the
level of 25, once you
have ordinary
intelligence, **what you
need is the temperament
to control the urges that
get other people into
trouble in investing.**"

- Warren Buffett

