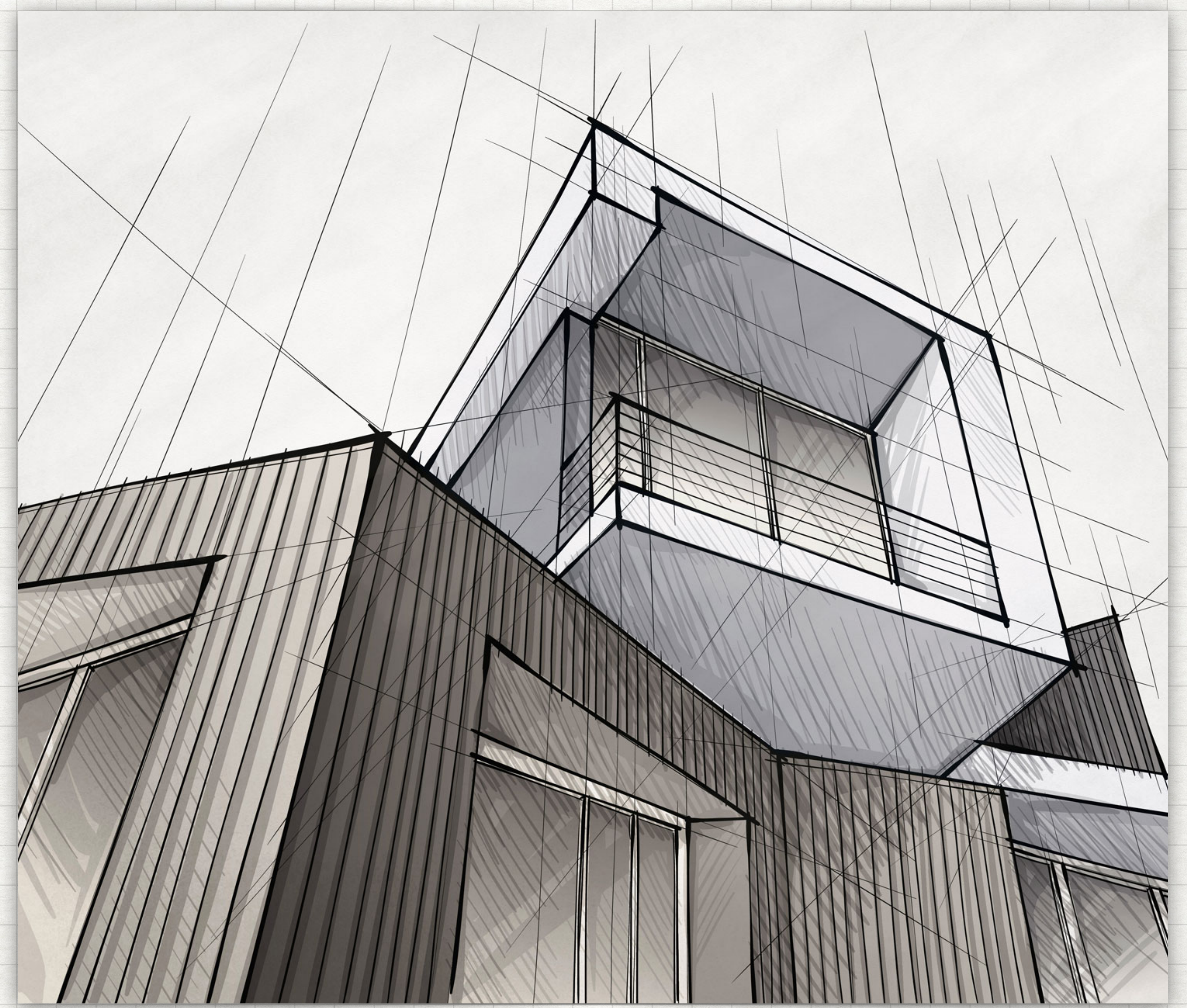
CS 007: SESSION 6

PERSONAL FINANCE FOR ENGINEERS



CS 007

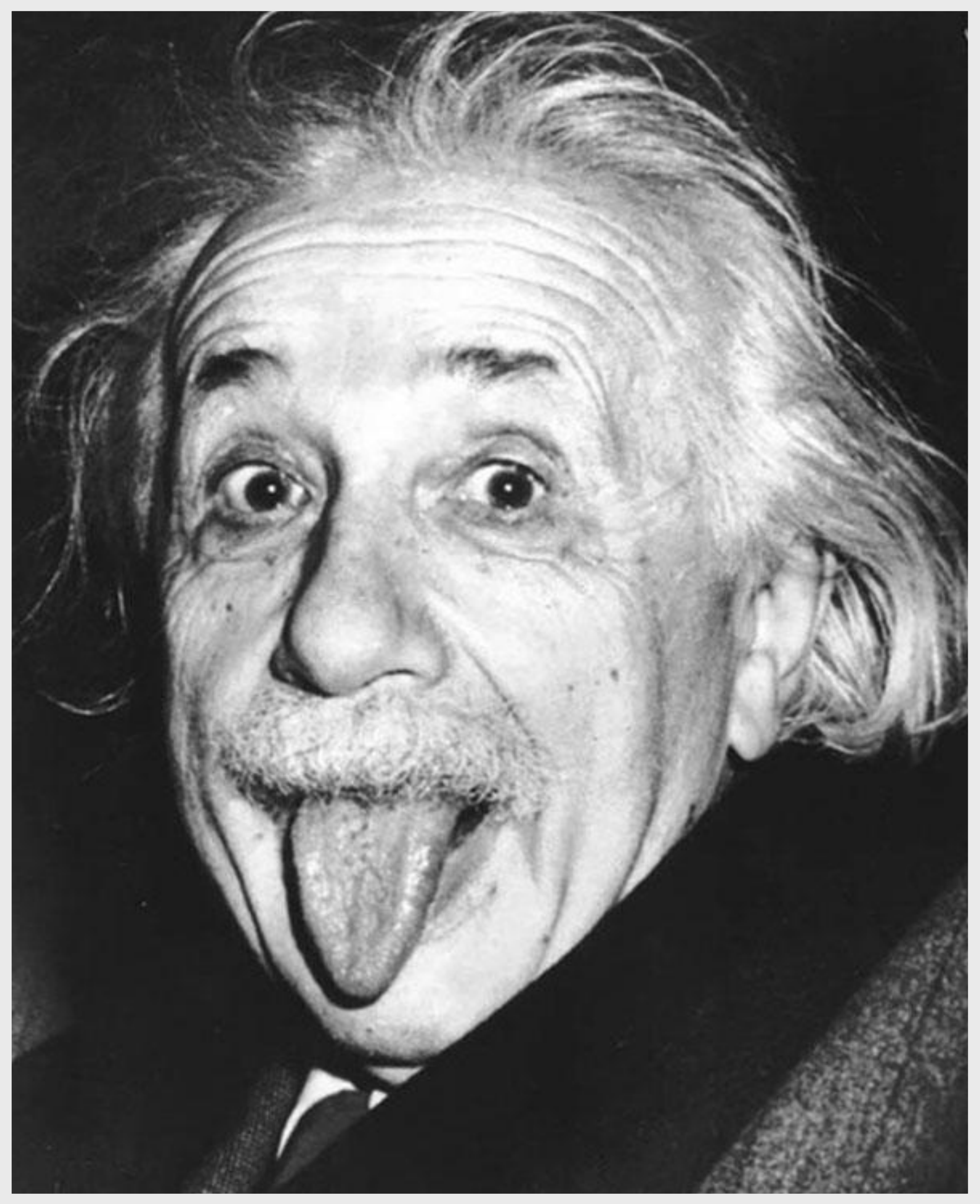
ALL ABOUT DEBT

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 ≠ 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!

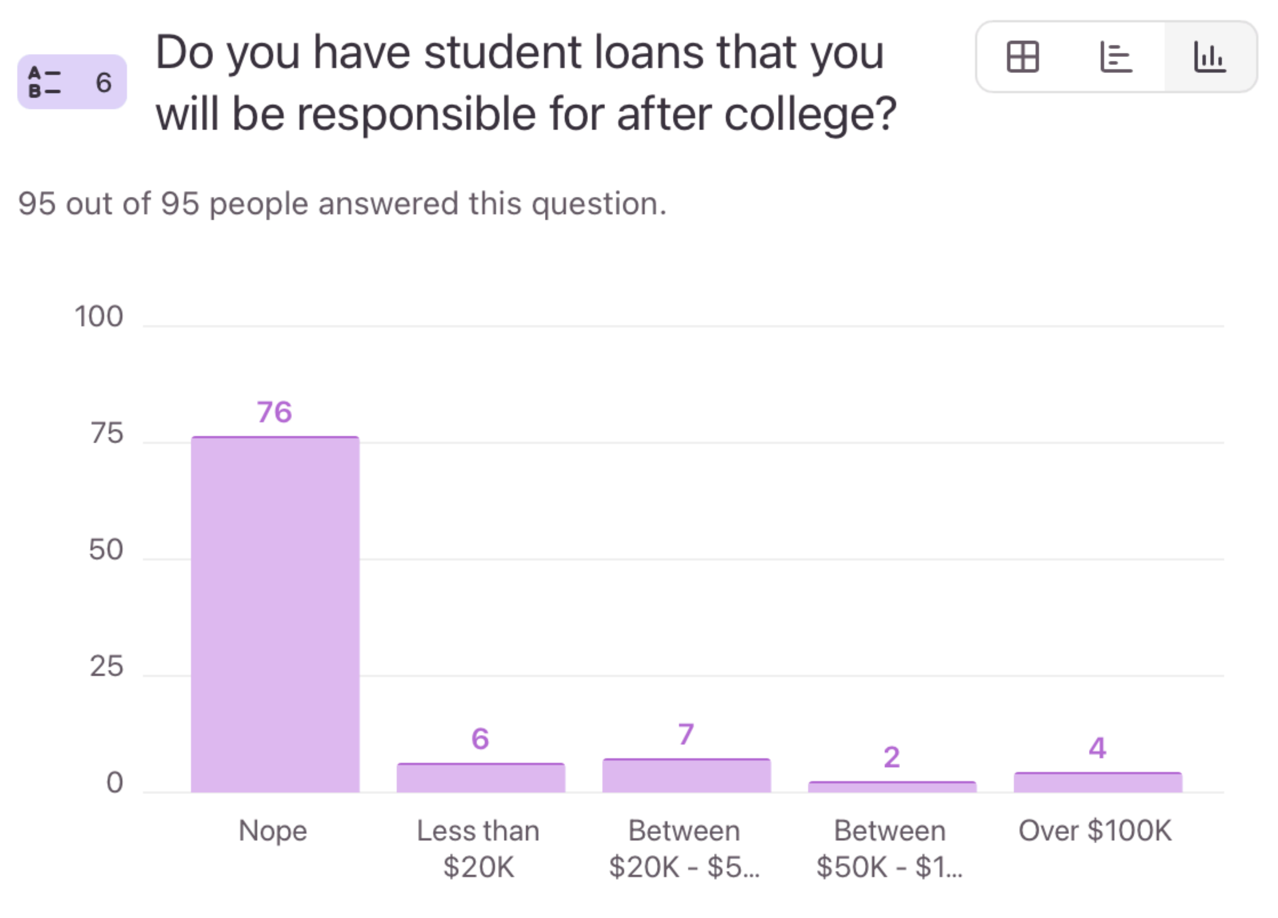
Years	Return at 8%
10	2.16x
20	4.66x
30	10.06x
40	21.72x
50	46.9x

TYPES OF DEBT

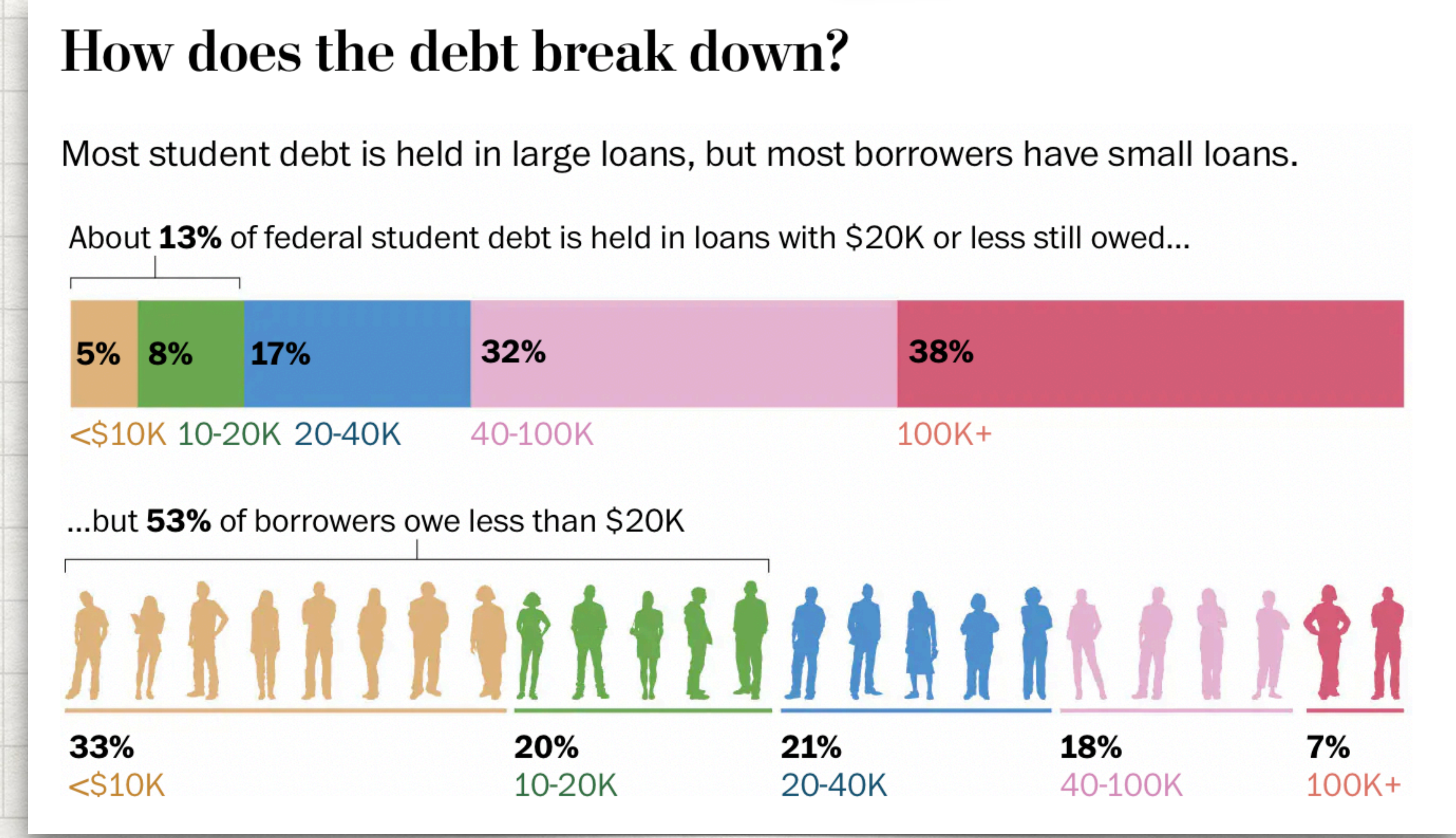
student loans, mortgage, auto, credit cards

6: STUDENT LOANS THAT YOU ARE RESPONSIBLE FOR?

- National student loan debt at: $1.81 Trillion*
- 61% of the Class of 2025 graduated with student debt. Average debt of $29,100*
- Average US household w/ student debt has $39,375 in debt.*
- 56% of borrowers owe less than $25,000 in student loan debt.
- … but that represents only 13% of the total $ amount of student debt!



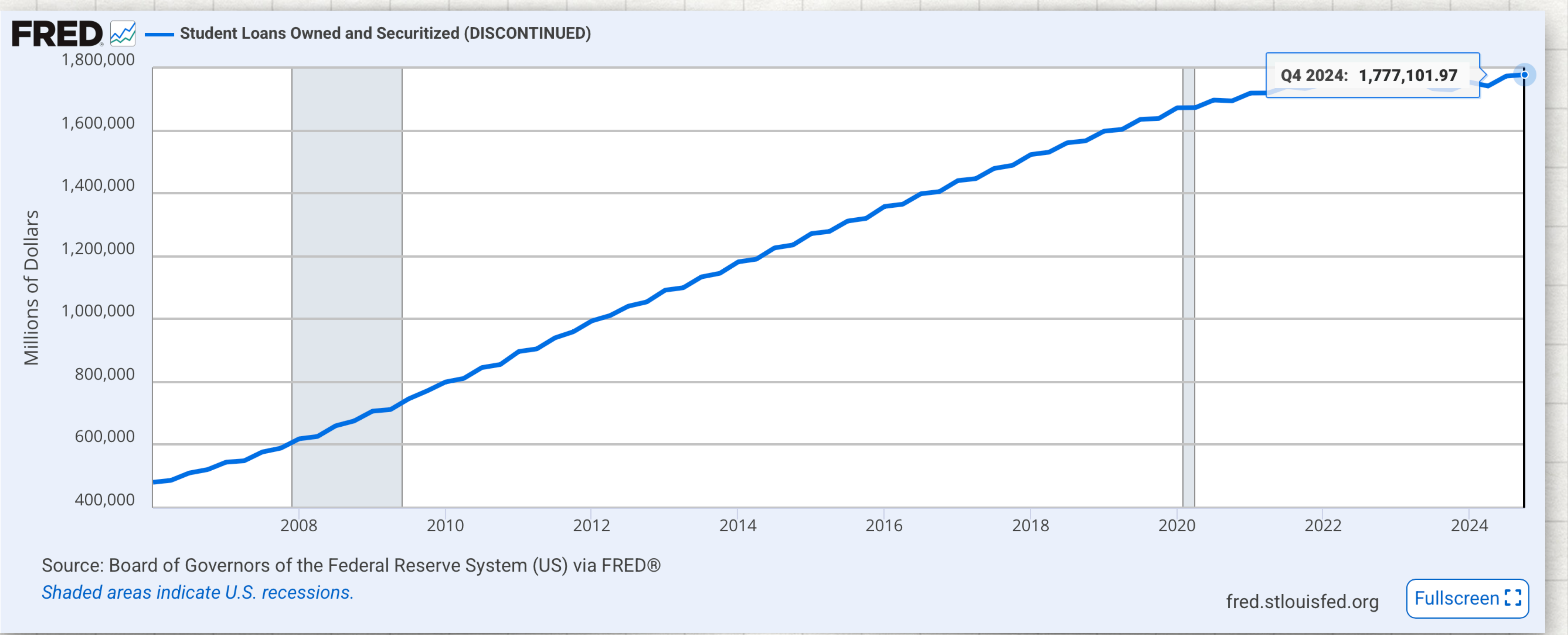
Debt type	Average debt
Bachelor's degree debt	$29,300.
Graduate school loan debt	$77,300.
Parent PLUS loan debt	$30,639.
Law school debt	$132,740.
MBA student debt	$51,850.
Medical school debt	$212,341.
Dental school debt	$296,500.
Pharmacy school loan debt	$170,956.
Nursing school student debt	$40,000-$54,999.
Veterinary school debt	$202,647.

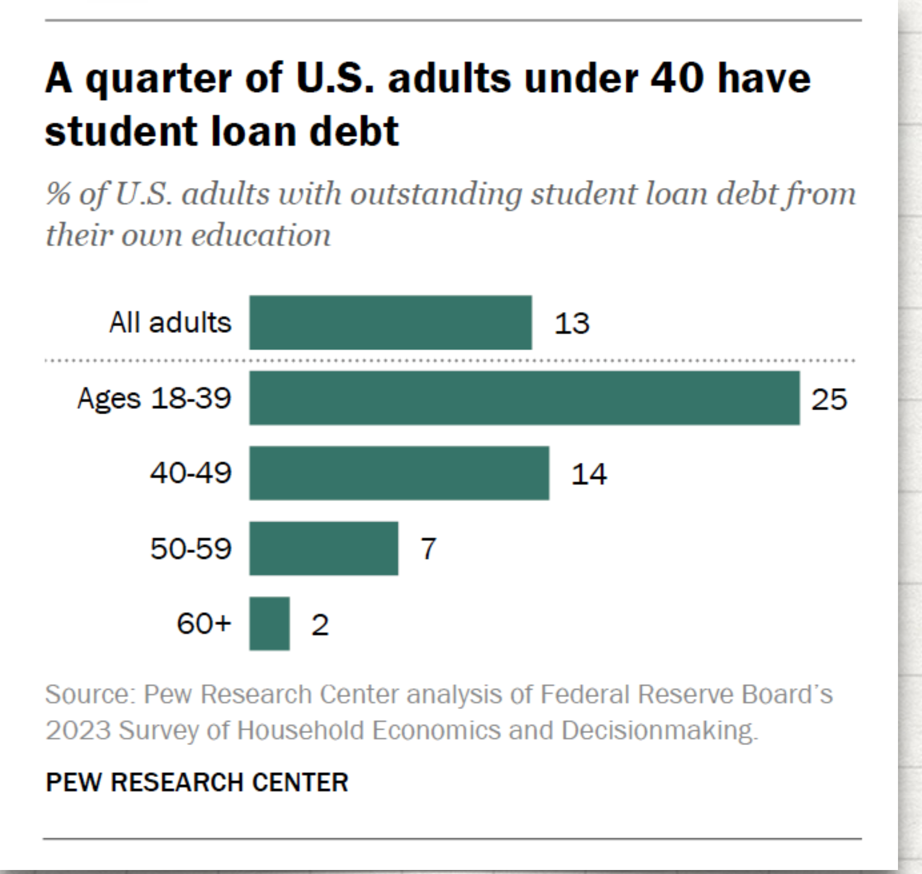


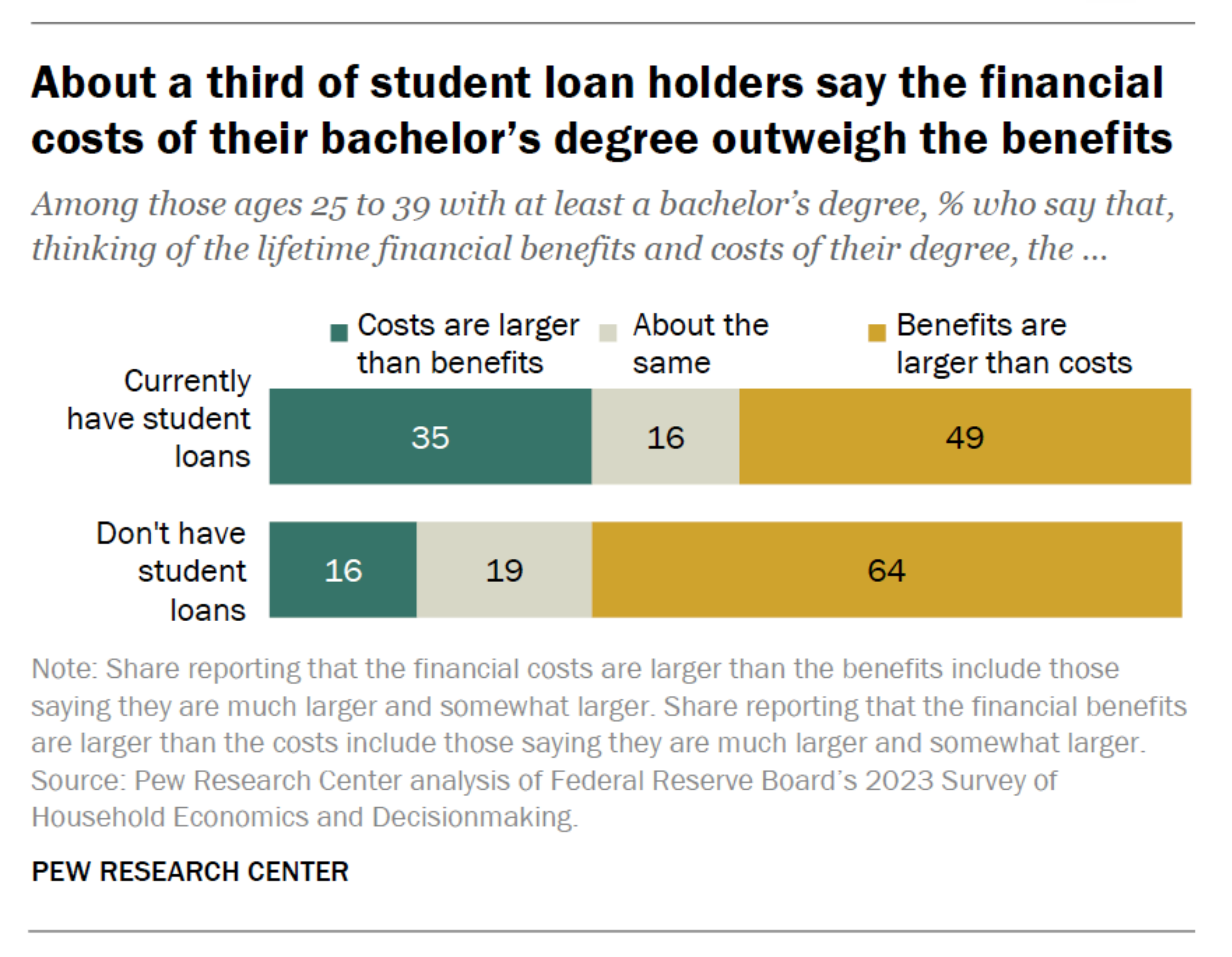
* https://fred.stlouisfed.org/series/SLOAS
* https://www.nerdwallet.com/article/loans/student-loans/student-loan-debt
* https://www.washingtonpost.com/education/2022/05/22/student-loan-borrowers/
* https://www.usnews.com/education/best-colleges/paying-for-college/articles/see-how-student-loan-borrowing-has-changed

STUDENT LOANS

- $1.81 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





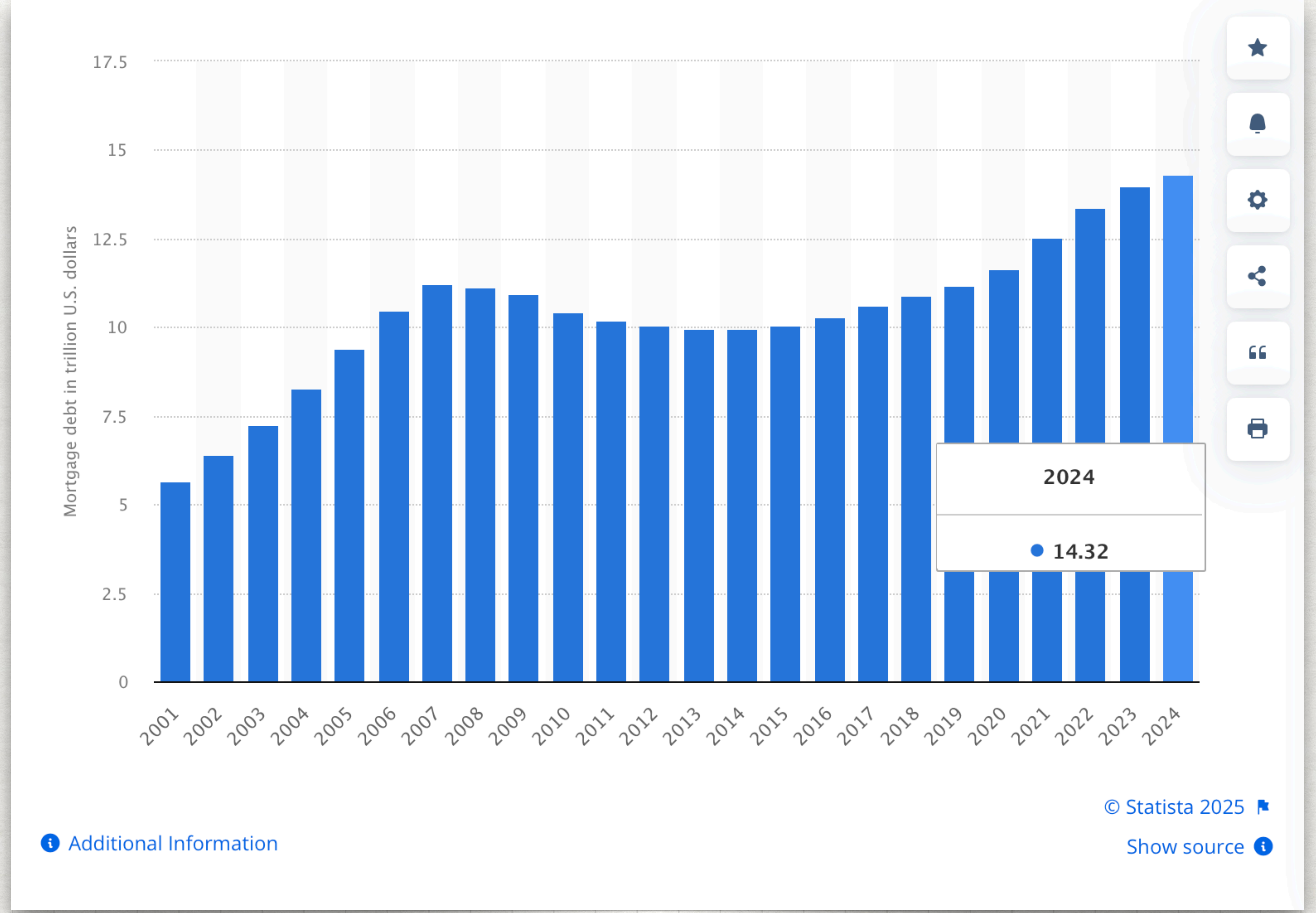


* *https://fred.stlouisfed.org/series/SLOAS*

** *https://www.pewresearch.org/short-reads/2024/09/18/facts-about-student-loans/*

MORTGAGES

- $20.8 Trillion in the US. $14.3 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

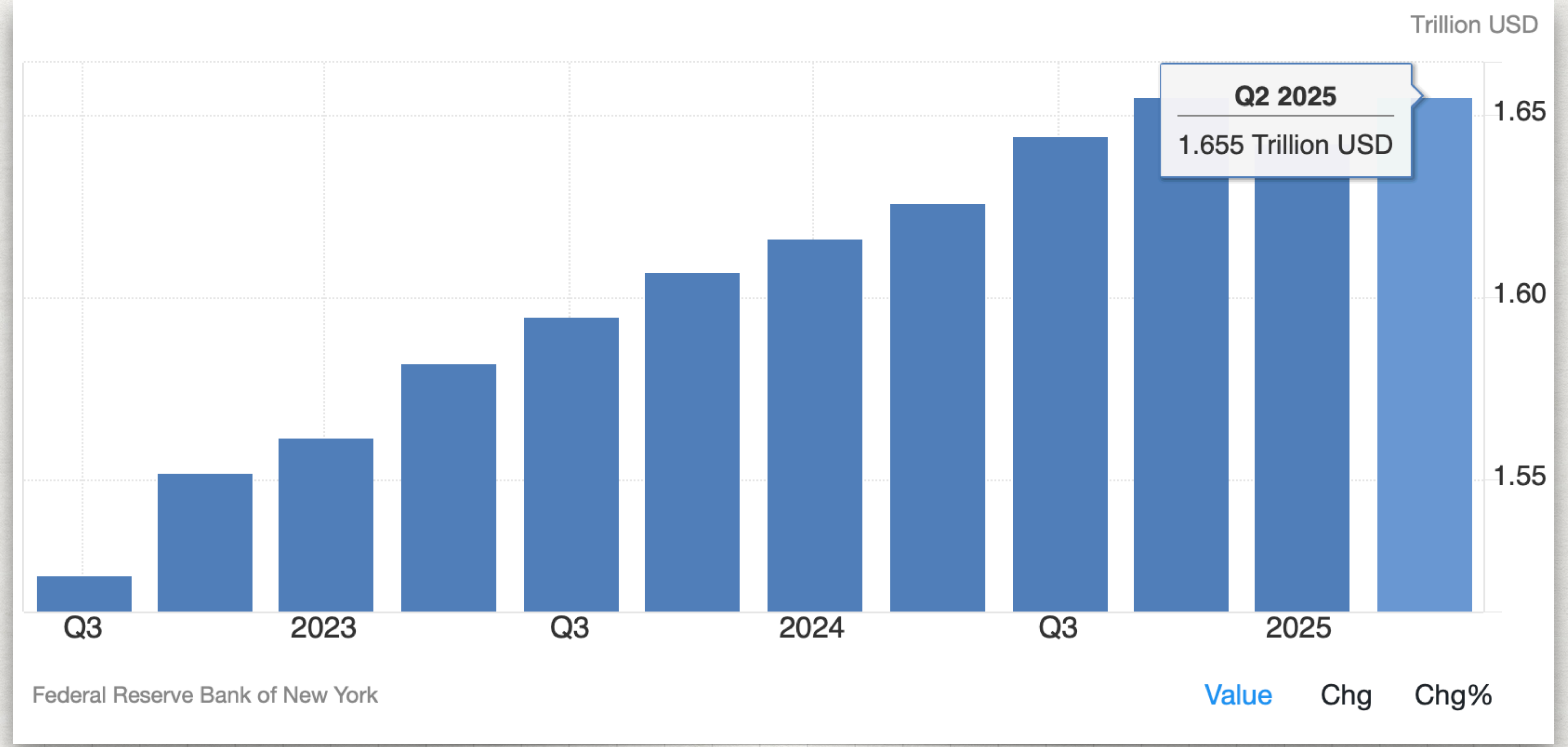


*https://www.statista.com/topics/1685/mortgage-industry-of-the-united-states/

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

AUTO LOANS

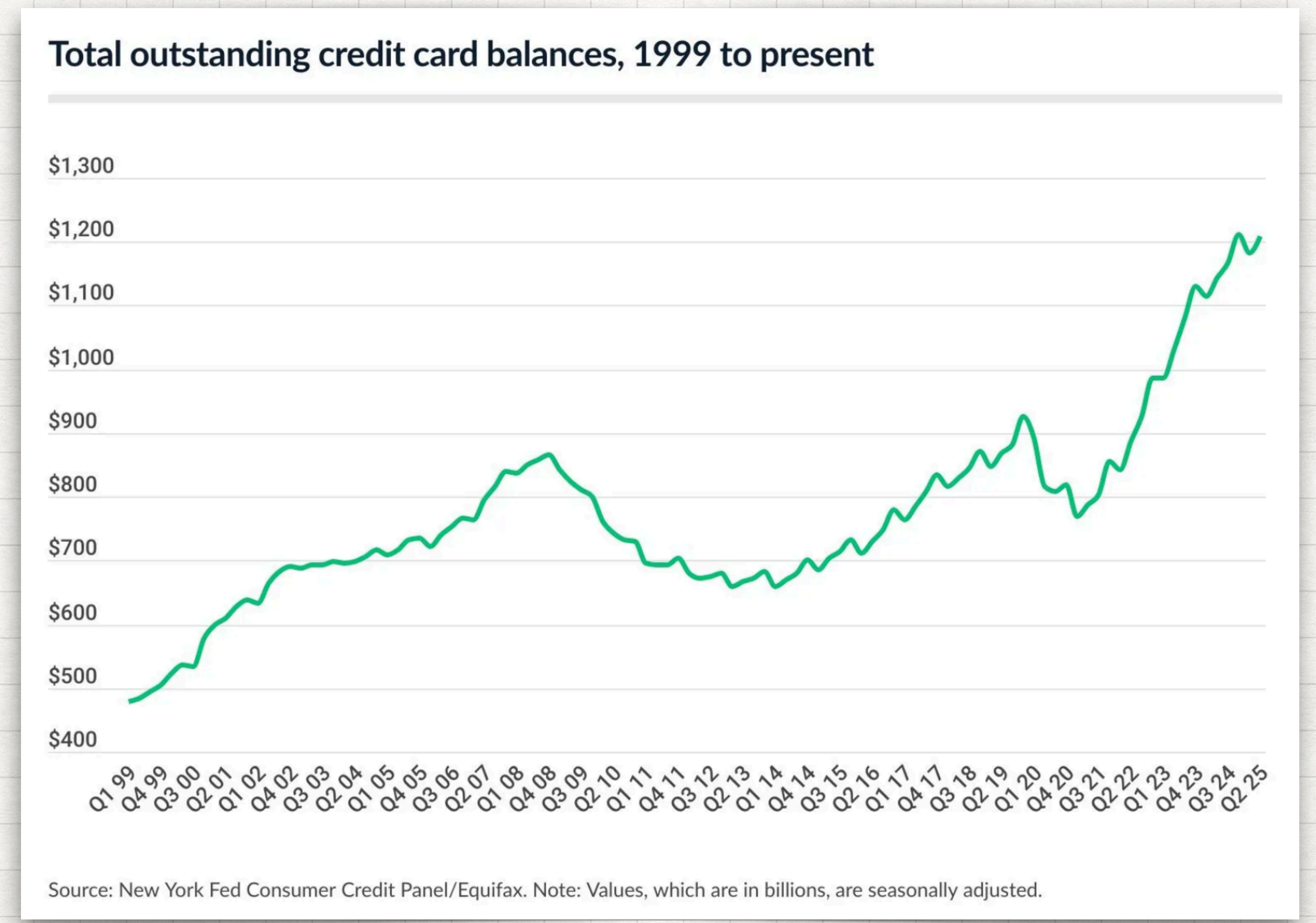
- $1.67 Trillion (as of Q2 2025)
- Secured loan against a vehicle, typically acquired at purchase.
- Wide variety of terms. Interest rates can be fixed or variable.
- Typically 3-5 years, fixed rate.
- Rates vary significantly across providers, auto manufacturers use financing to influence demand.
- Leasing vs. Buying
- Qualification: credit score



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

CREDIT CARDS

- $1.21 Trillion (Q2 2025)
- 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 (!)



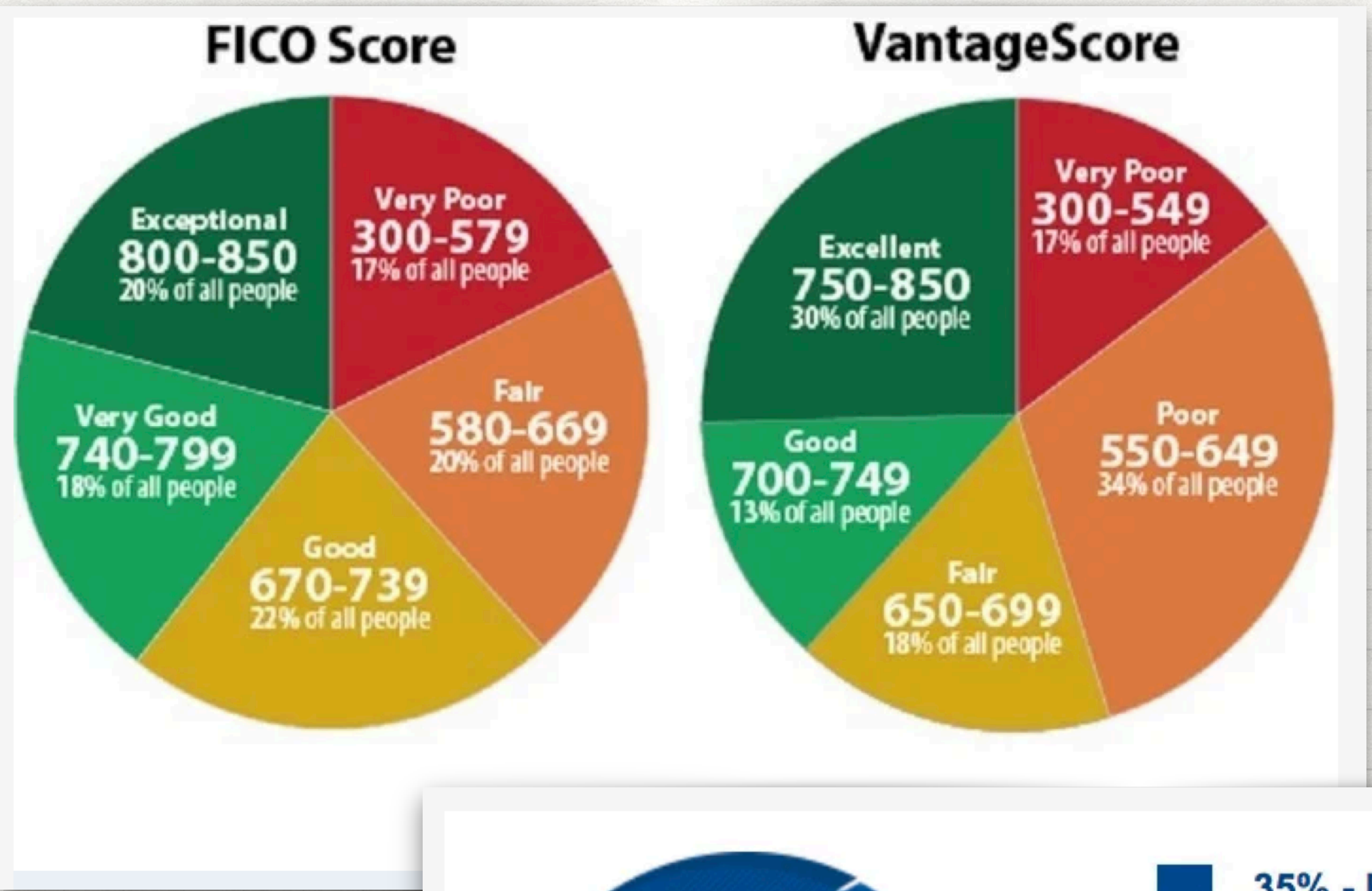
* *https://www.newyorkfed.org/newsevents/news/research/2025/20250213*
* *https://www.lendingtree.com/credit-cards/credit-card-debt-statistics/*

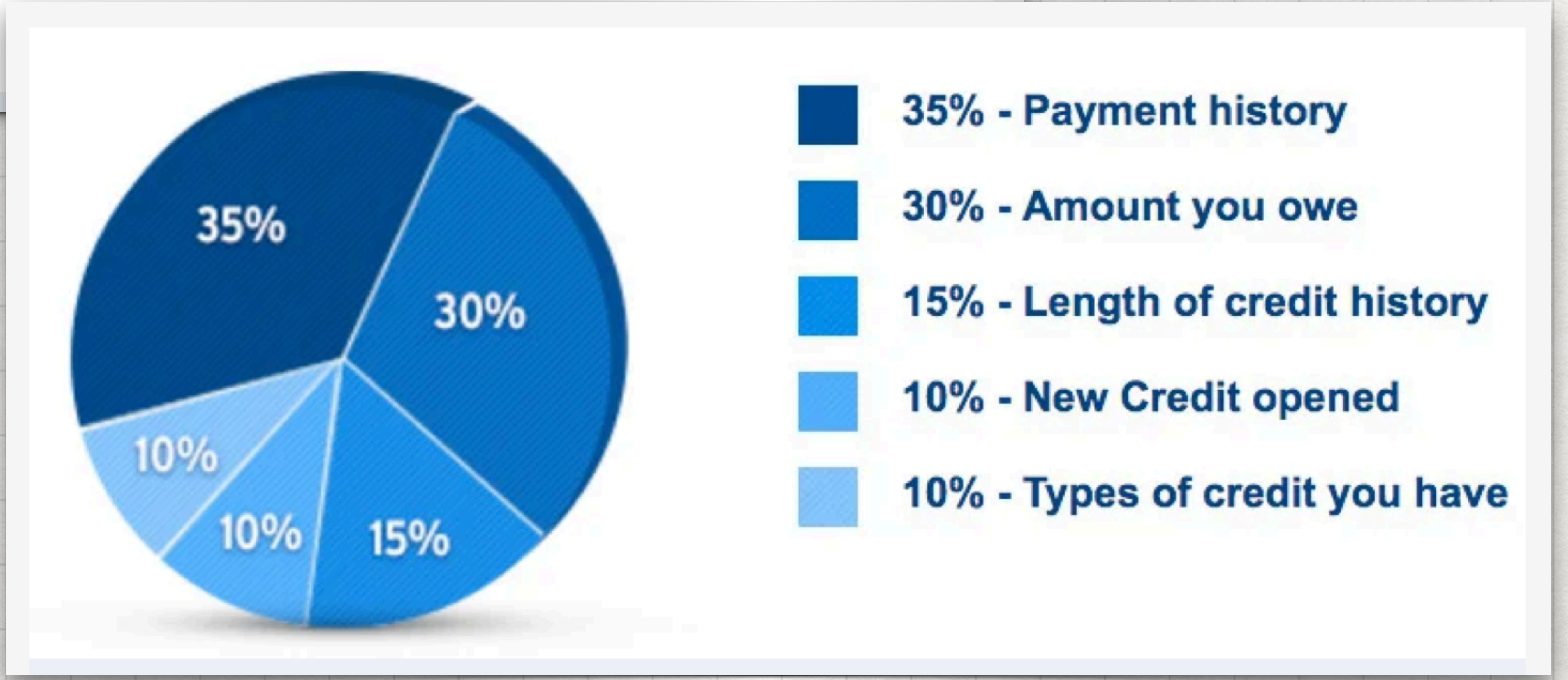
CREDIT SCORES

your borrowing record & why it matters

WHAT'S A CREDIT SCORE

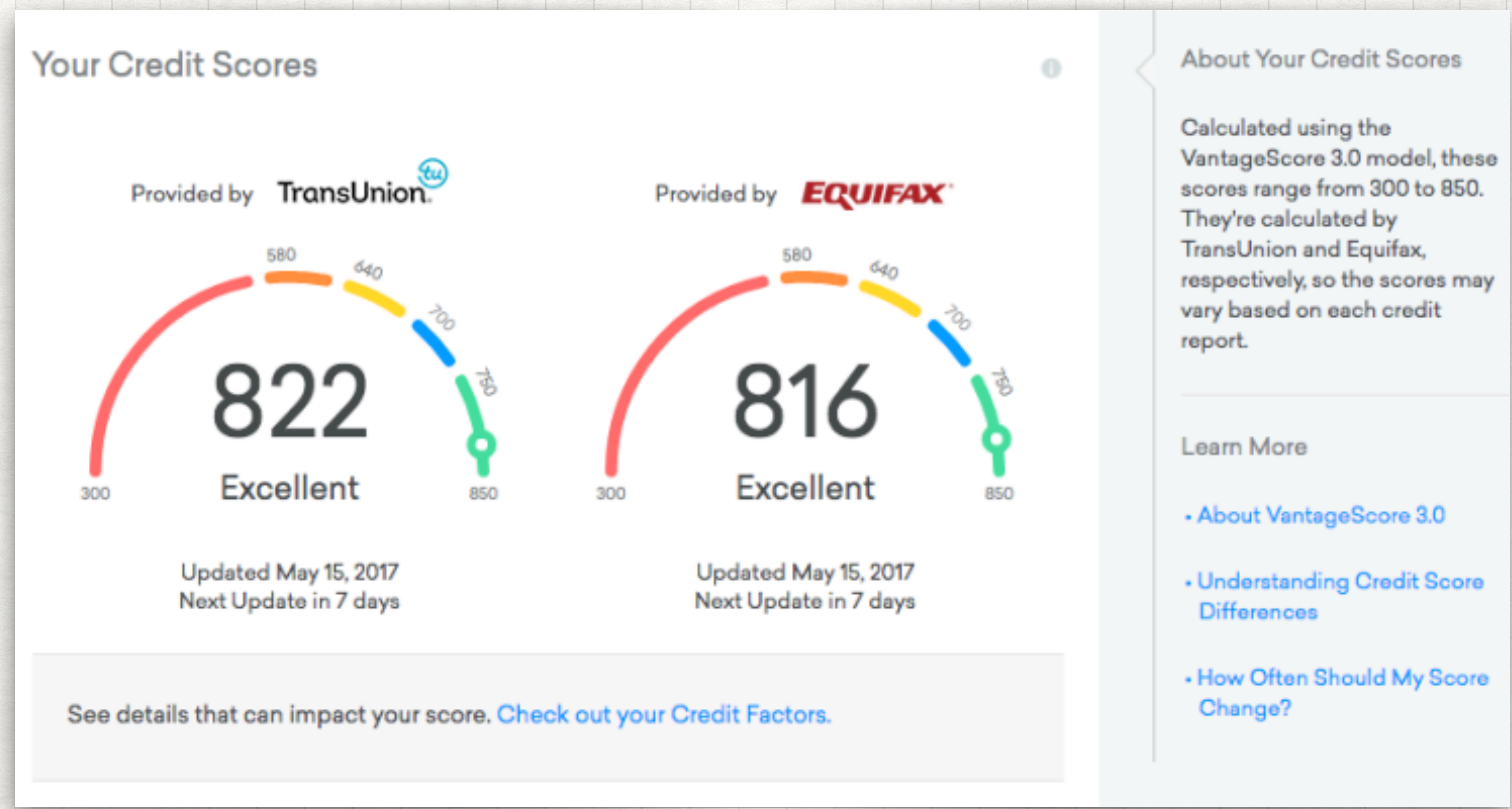
- Lenders report to 3 major centralized credit agencies when you apply for debt, receive debt, and when you pay off debt.
- Building a good credit score is essential for qualifying for most loans. It can affect other services too, as it is used for identity verification.
- Issues that affect credit score: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





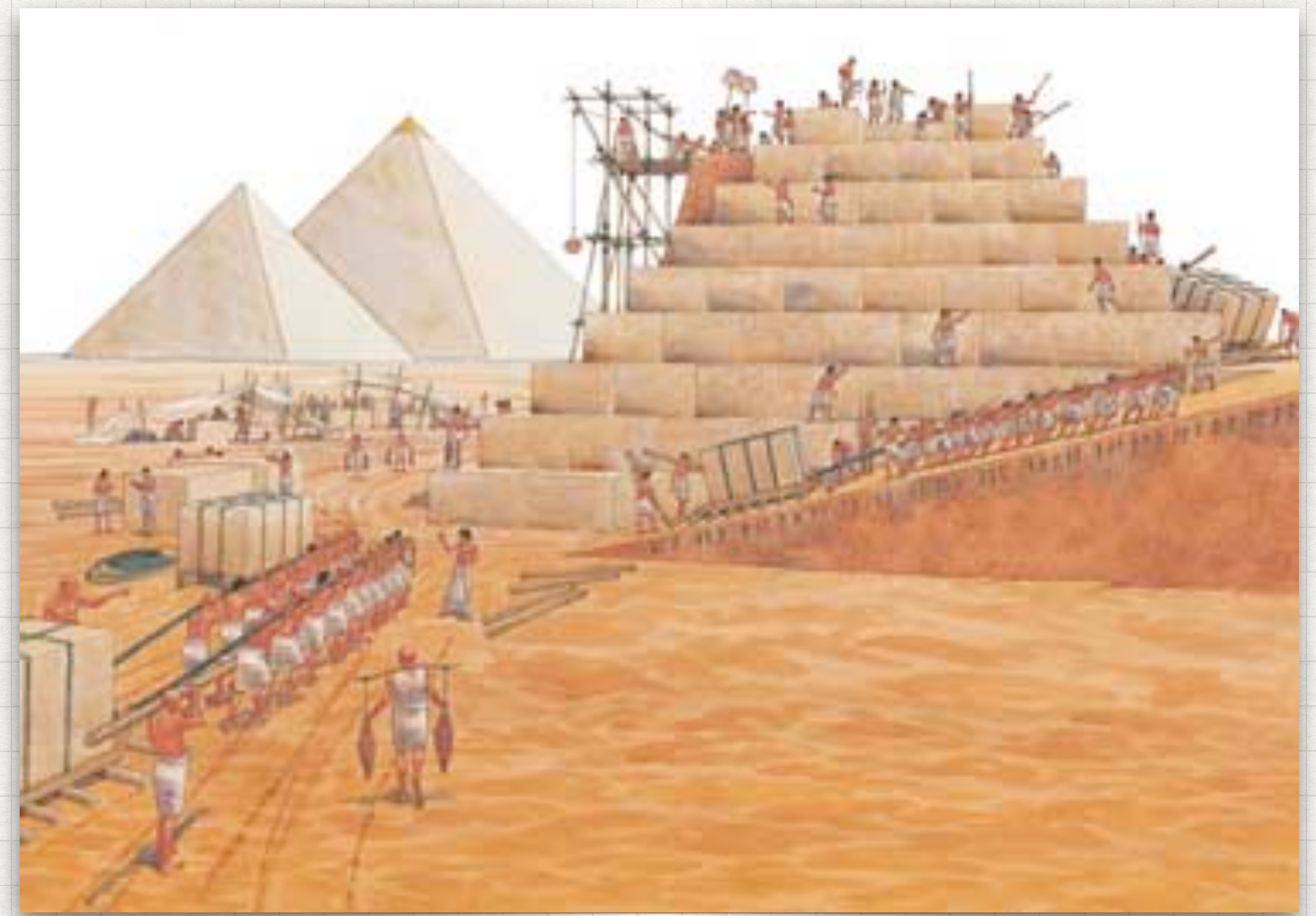
WHY DO CREDIT SCORES MATTER?

- 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

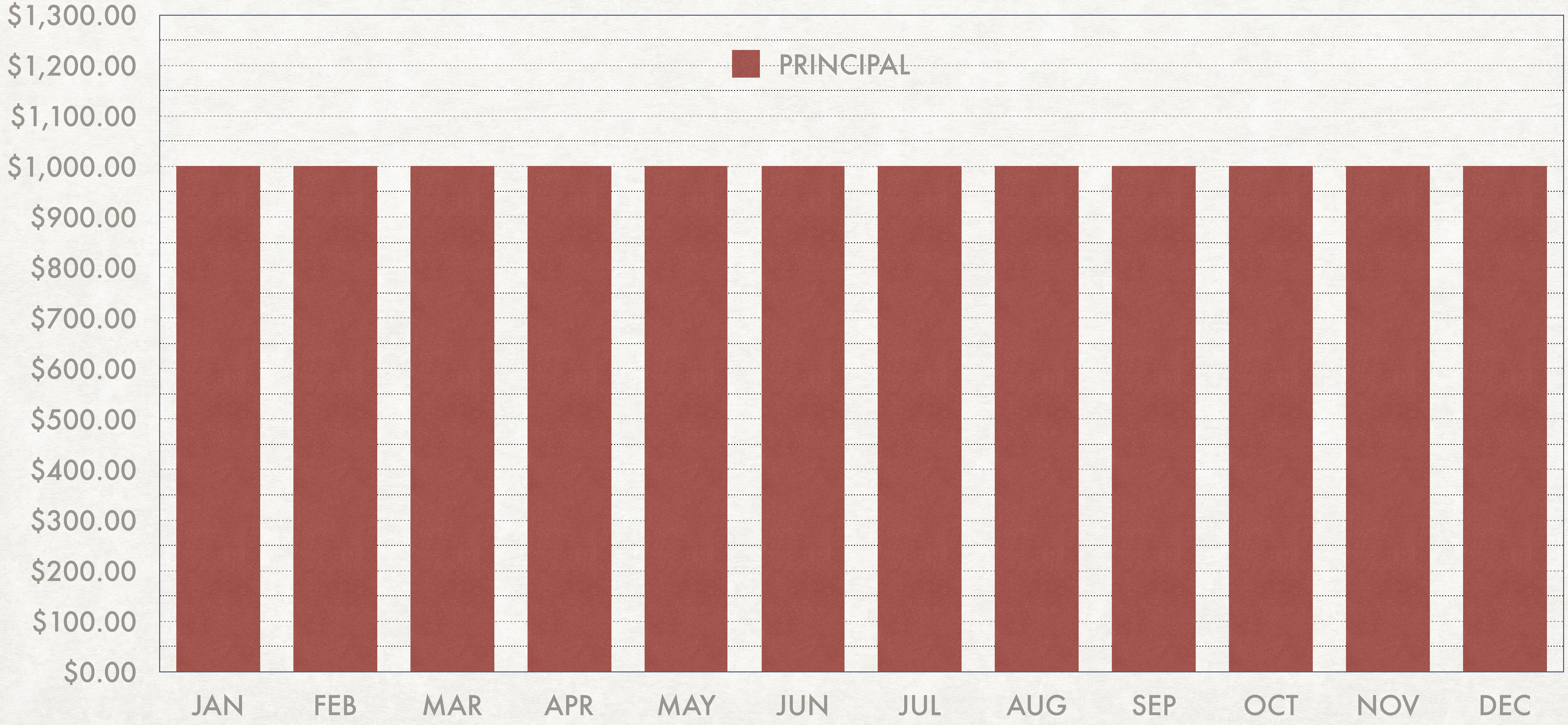


LOANS & RATES

how much will you owe?

SIMPLE LOAN

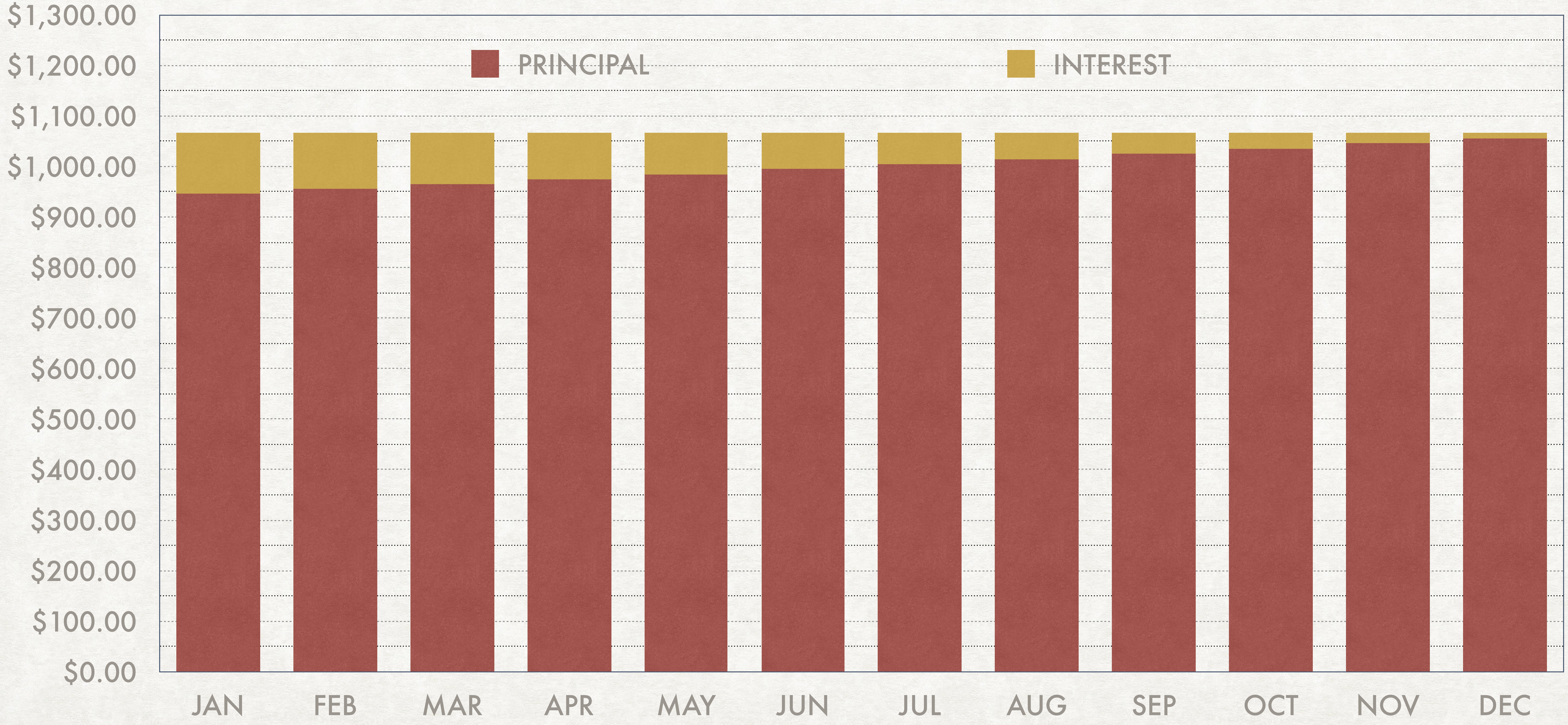
$12,000 AT 0% INTEREST FOR 1 YEAR



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)

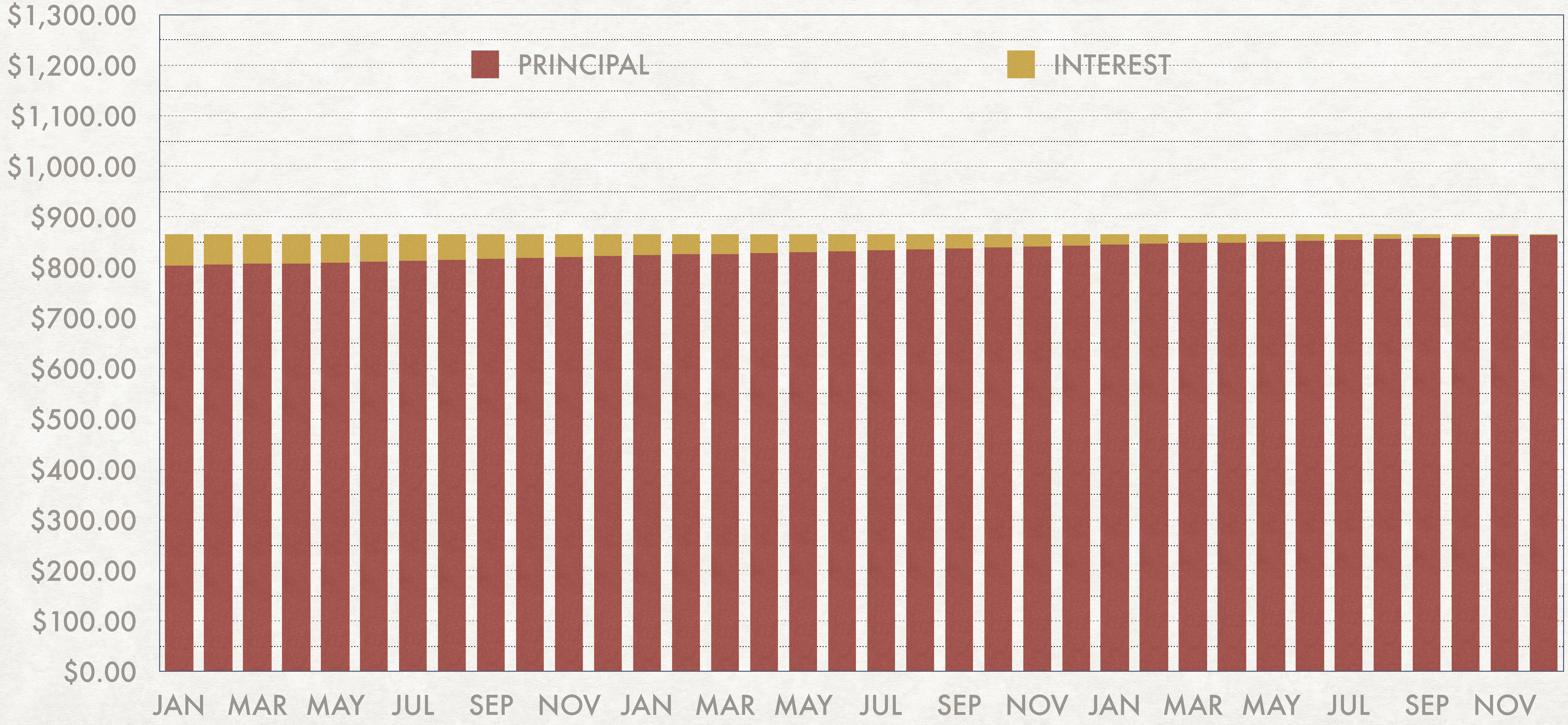
$$A = P\frac{r(1+r)^n}{(1+r)^n - 1}$$

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

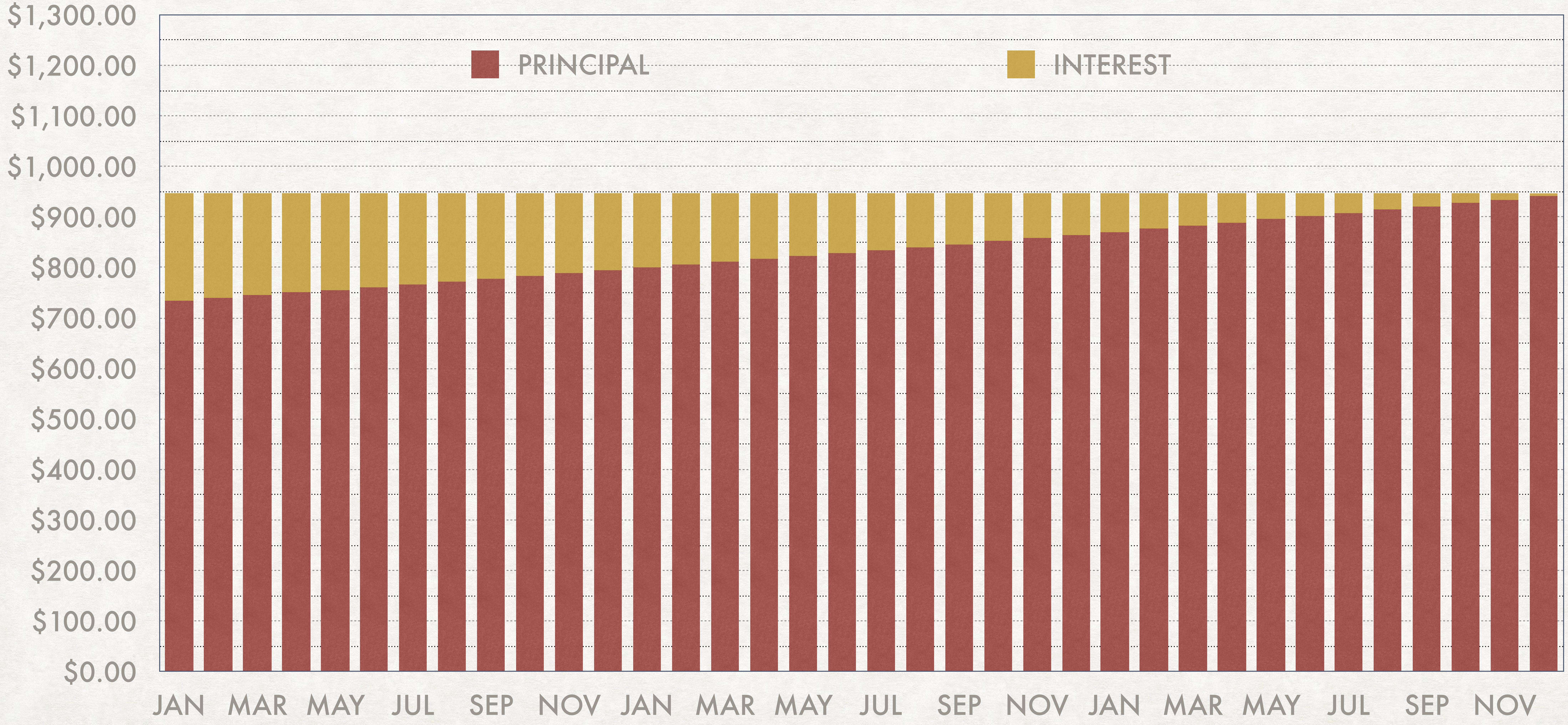
$30,000 AT 2.5% INTEREST FOR 3 YEARS



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

SAMPLE AUTO LOAN

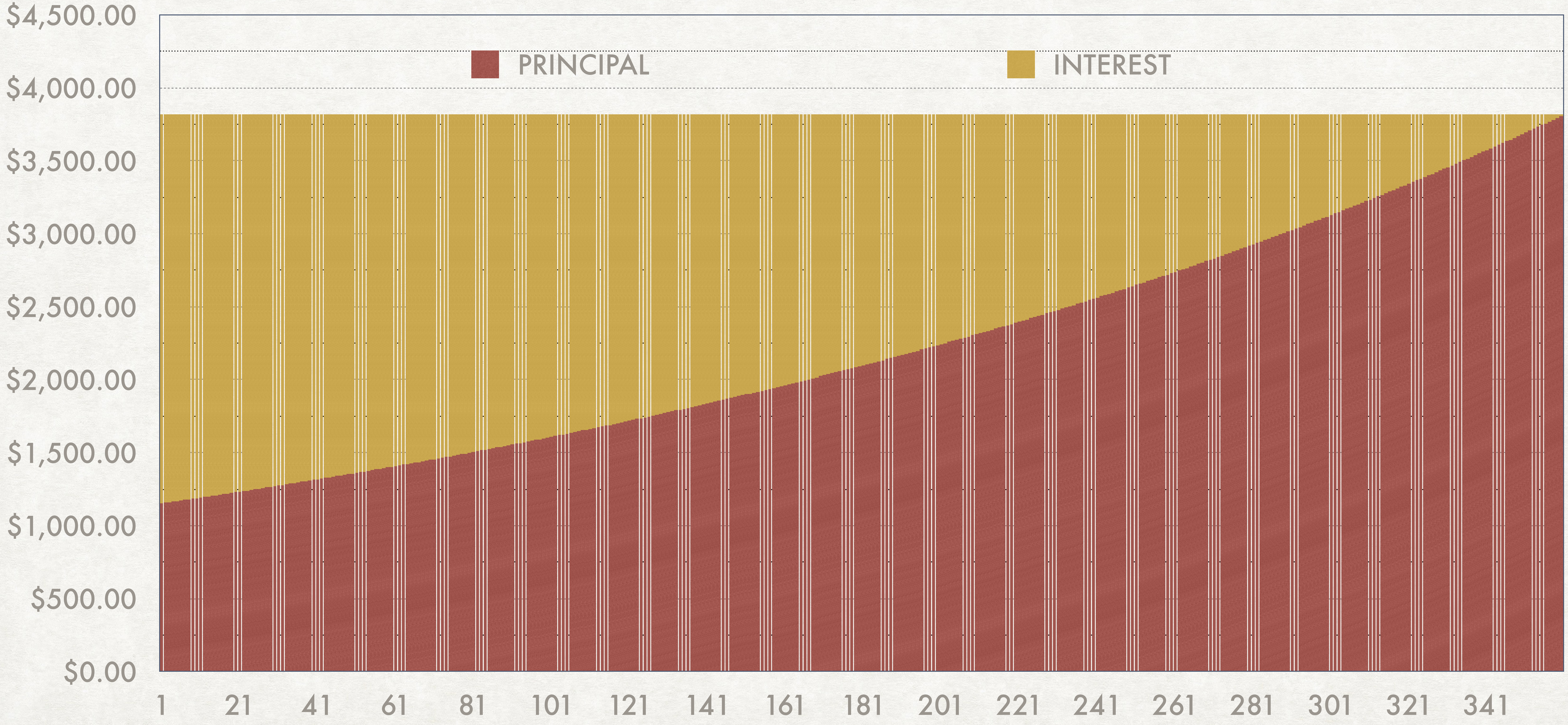
$30,000 AT 8.5% INTEREST FOR 3 YEARS



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.

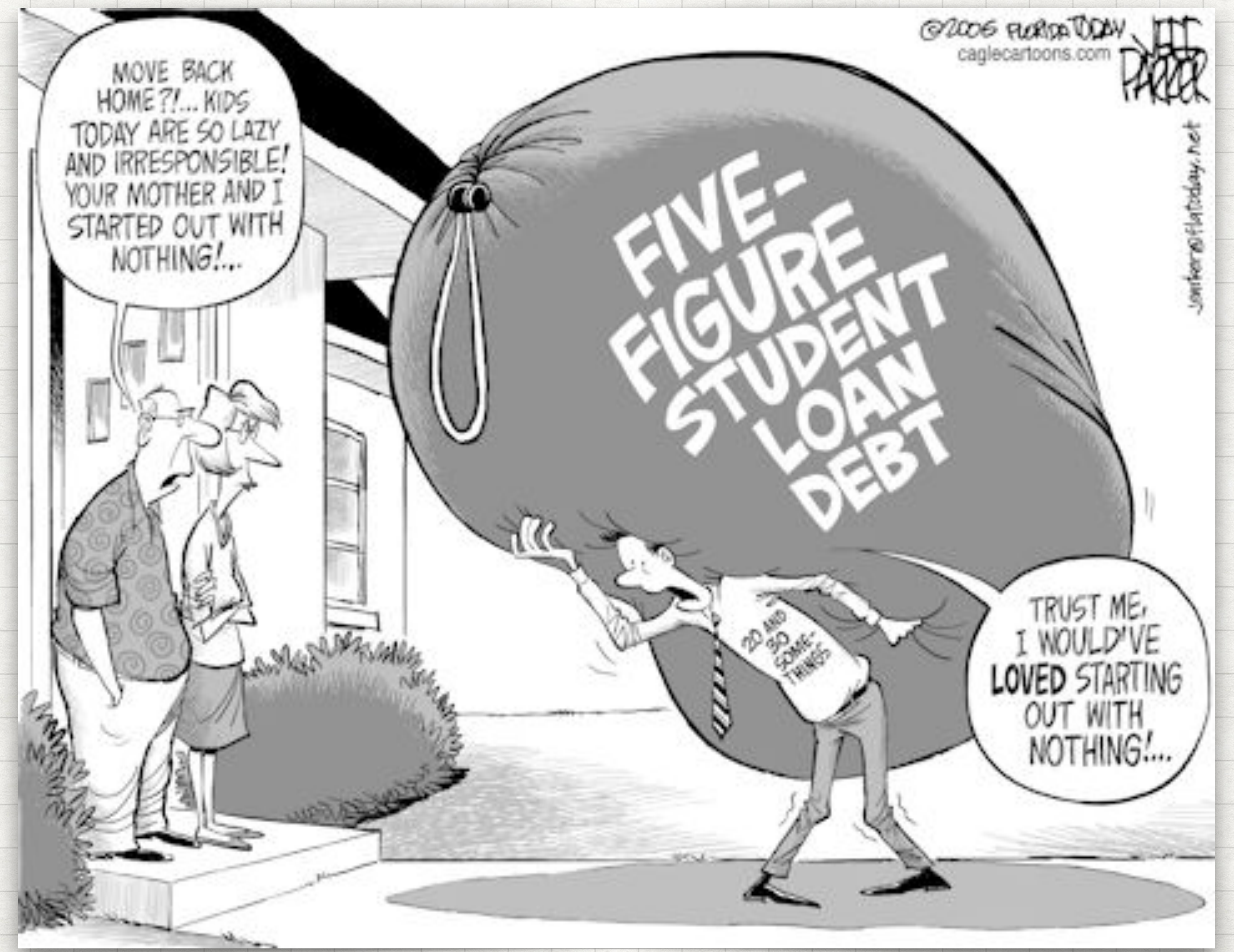
	Student Loan 1	Student Loan 2	Credit Card	Auto Loan
Amount	$6,000	$8,000	$10,000	$20,000
Rate	2.5%	4.5%	22.9%	1.9%
Min Pmt	$200	$250	$120	$450
Term	10yrs	10yrs	~	3yrs
Peanut Butter	$500	$500	$500	$500
Snowball	$1180	$250	$120	$450
Optimal	$200	$250	$1100	$450

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.



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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