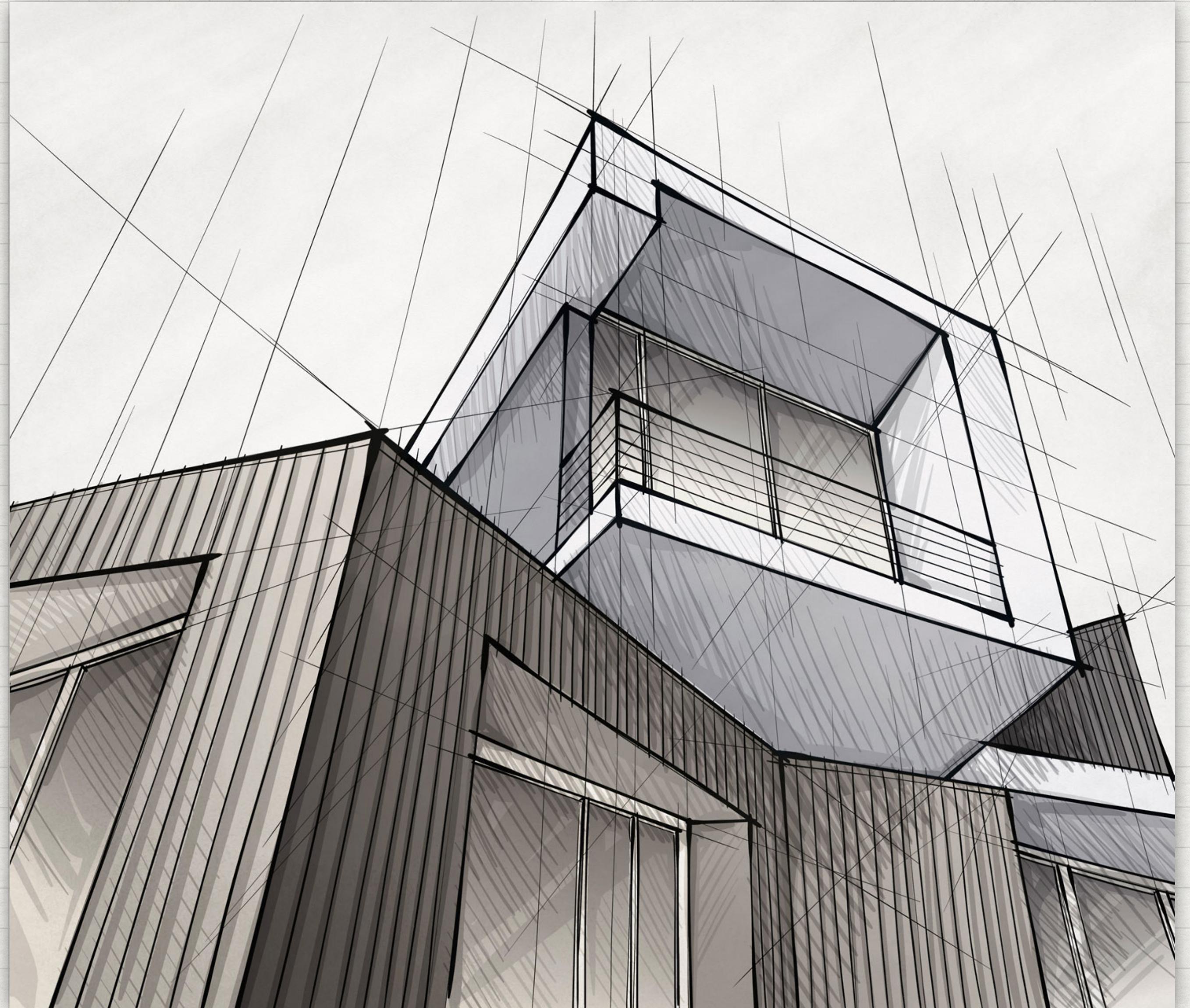


CS 007: SESSION 6

PERSONAL FINANCE FOR ENGINEERS



CS 007

ALL ABOUT DEBT

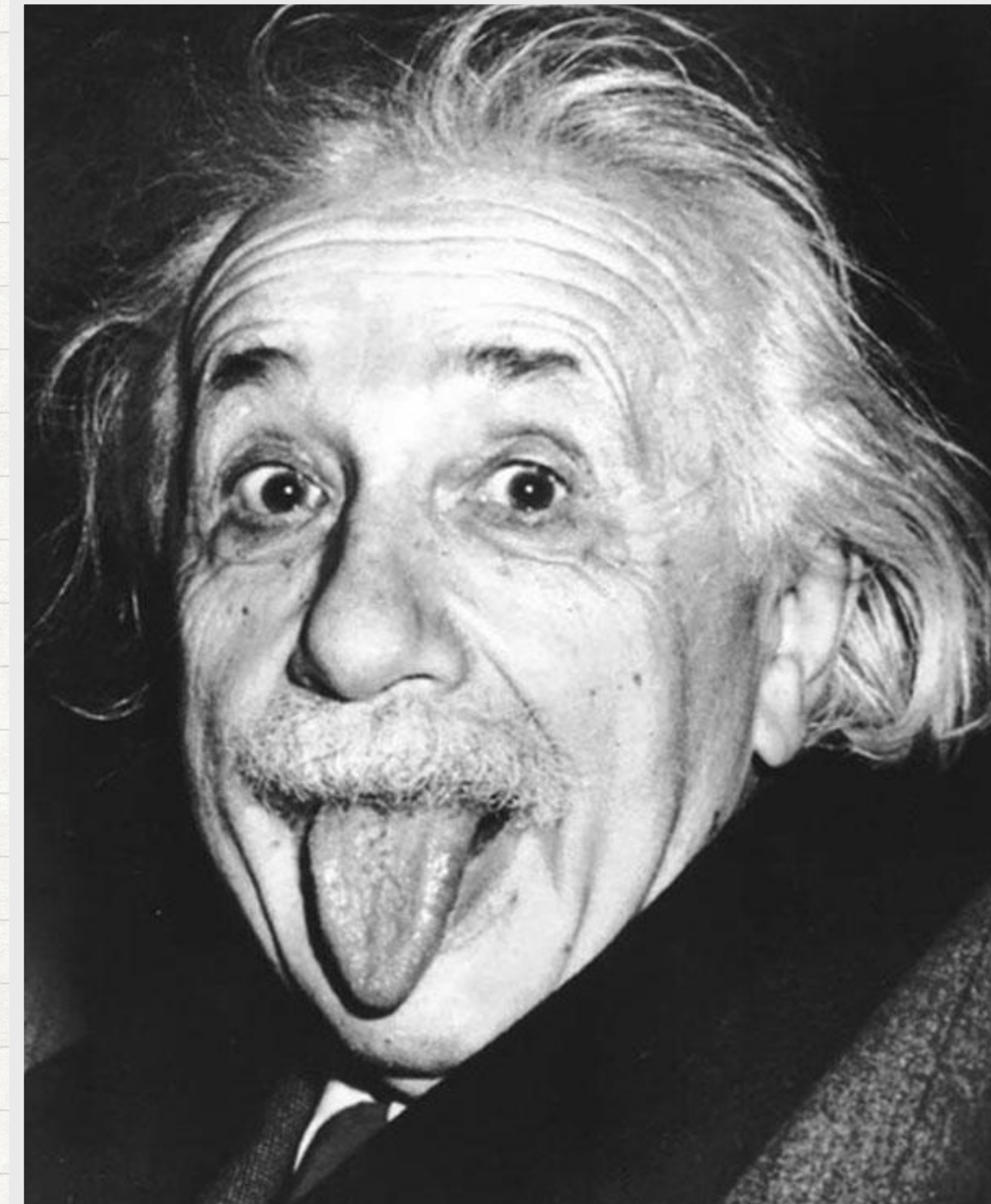


COMPOUNDING

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 = $(1 + \text{Periodic Rate})^{\text{Number of Periods}} - 1$

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!

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

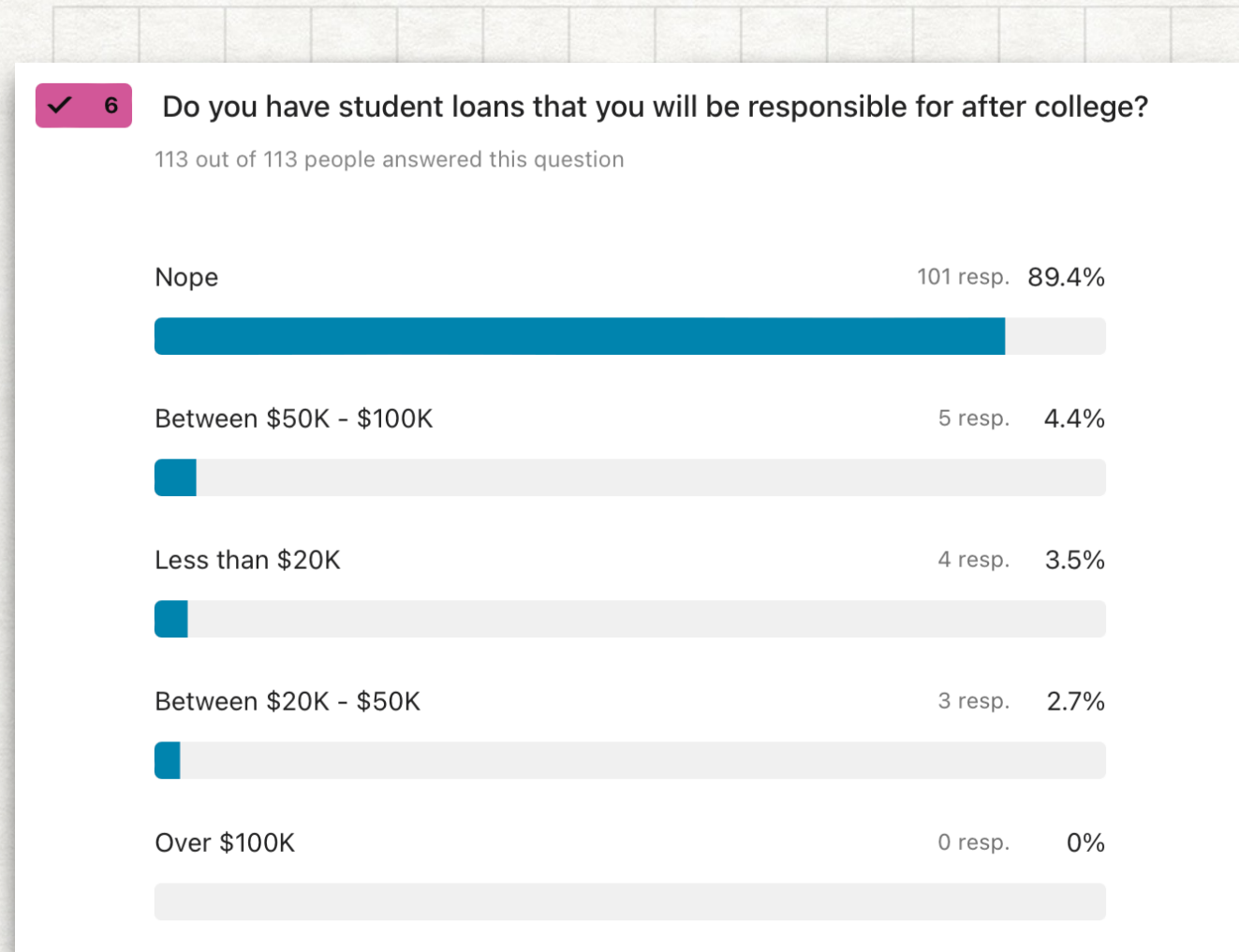
TYPES OF DEBT

student loans, mortgage, auto, credit cards

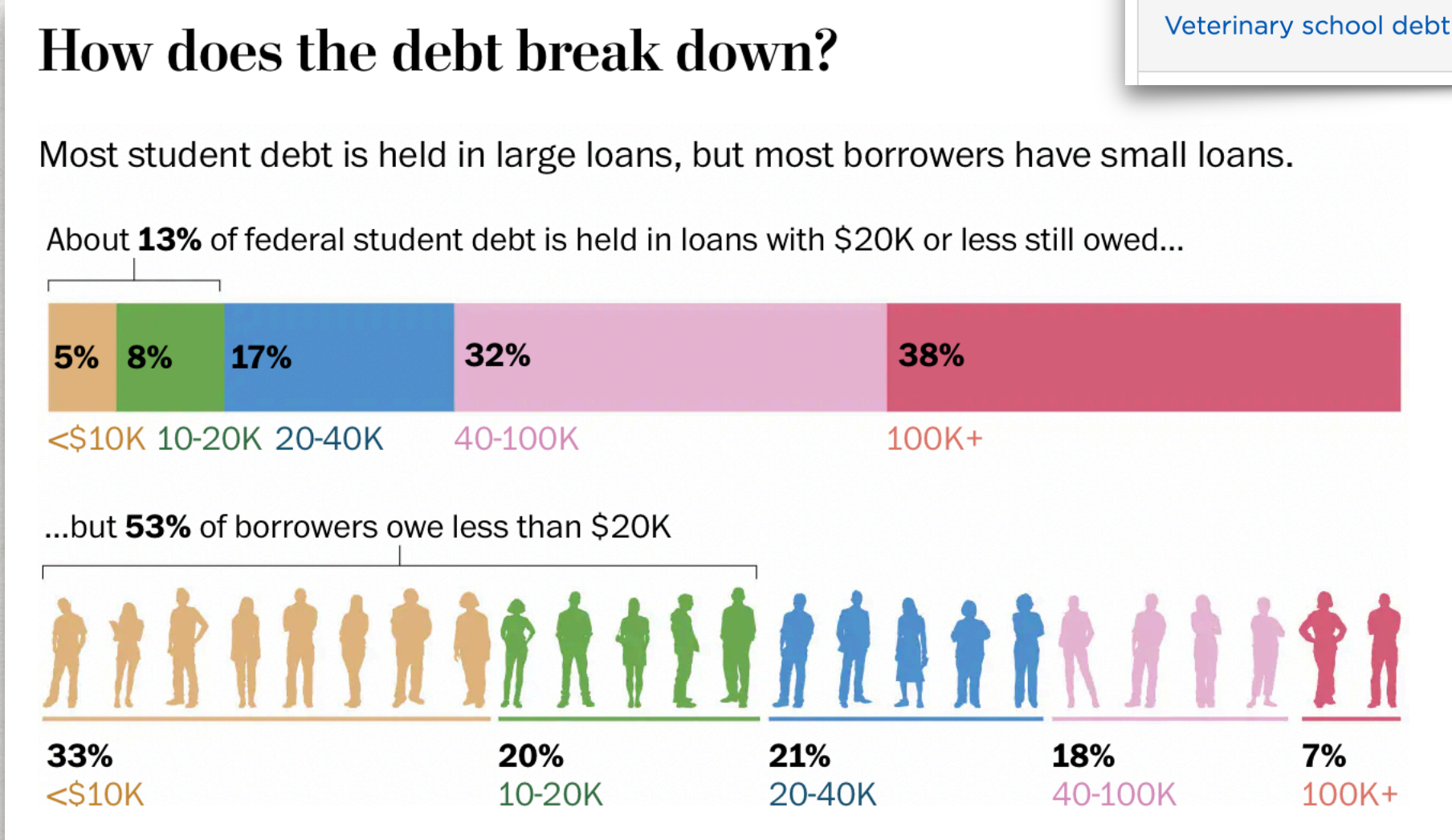
6: STUDENT LOANS THAT YOU ARE RESPONSIBLE FOR?

- National student loan debt at: \$1.75 Trillion*
- 54% of the Class of 2021 graduated with student debt. Average debt of \$29,100*
- Average US household w/ student debt has \$55,347 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!

* <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/>



Debt type	Average debt
Bachelor's degree debt	\$29,400
Graduate school loan debt	\$88,220
Parent PLUS loan debt	\$29,526
Law school debt	\$132,740
MBA student debt	\$66,740
Medical school debt	\$206,924
Dental school debt	\$296,500
Pharmacy school loan debt	\$167,711
Nursing school student debt	Associate Degree Nursing: \$23,302. Bachelor of Science in Nursing: \$28,917. Master of Science in Nursing: \$49,047.
Veterinary school debt	\$147,258

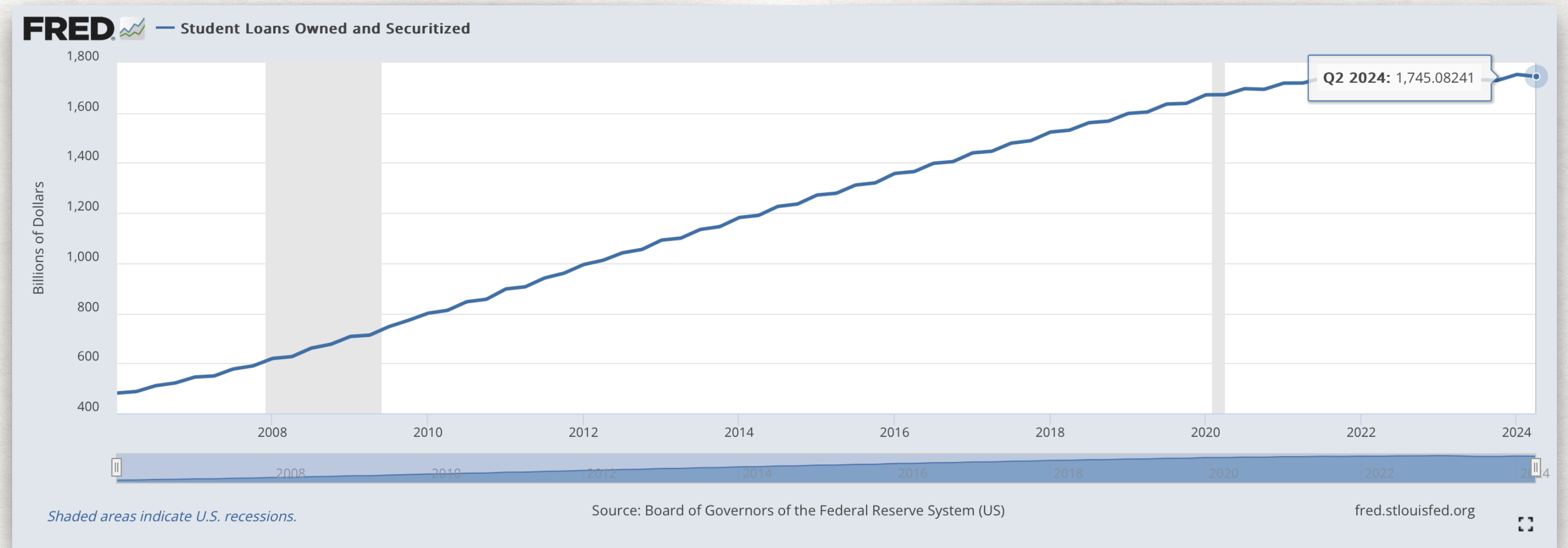


STUDENT LOANS

- \$1.75 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

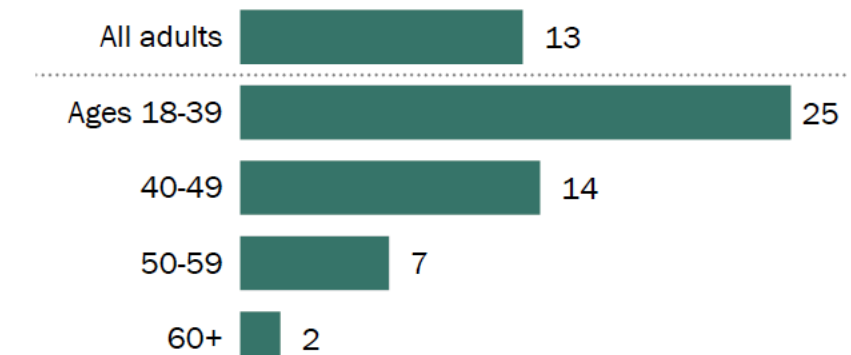
* <https://fred.stlouisfed.org/series/SLOAS>

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



A quarter of U.S. adults under 40 have student loan debt

% of U.S. adults with outstanding student loan debt from their own education

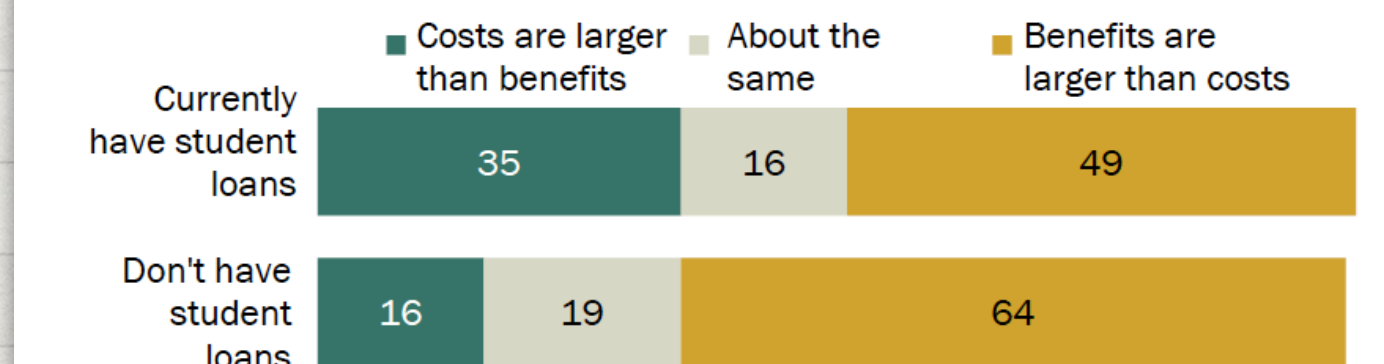


Source: Pew Research Center analysis of Federal Reserve Board's 2023 Survey of Household Economics and Decisionmaking.

PEW RESEARCH CENTER

About a third of student loan holders say the financial costs of their bachelor's degree outweigh the benefits

Among those ages 25 to 39 with at least a bachelor's degree, % who say that, thinking of the lifetime financial benefits and costs of their degree, the ...

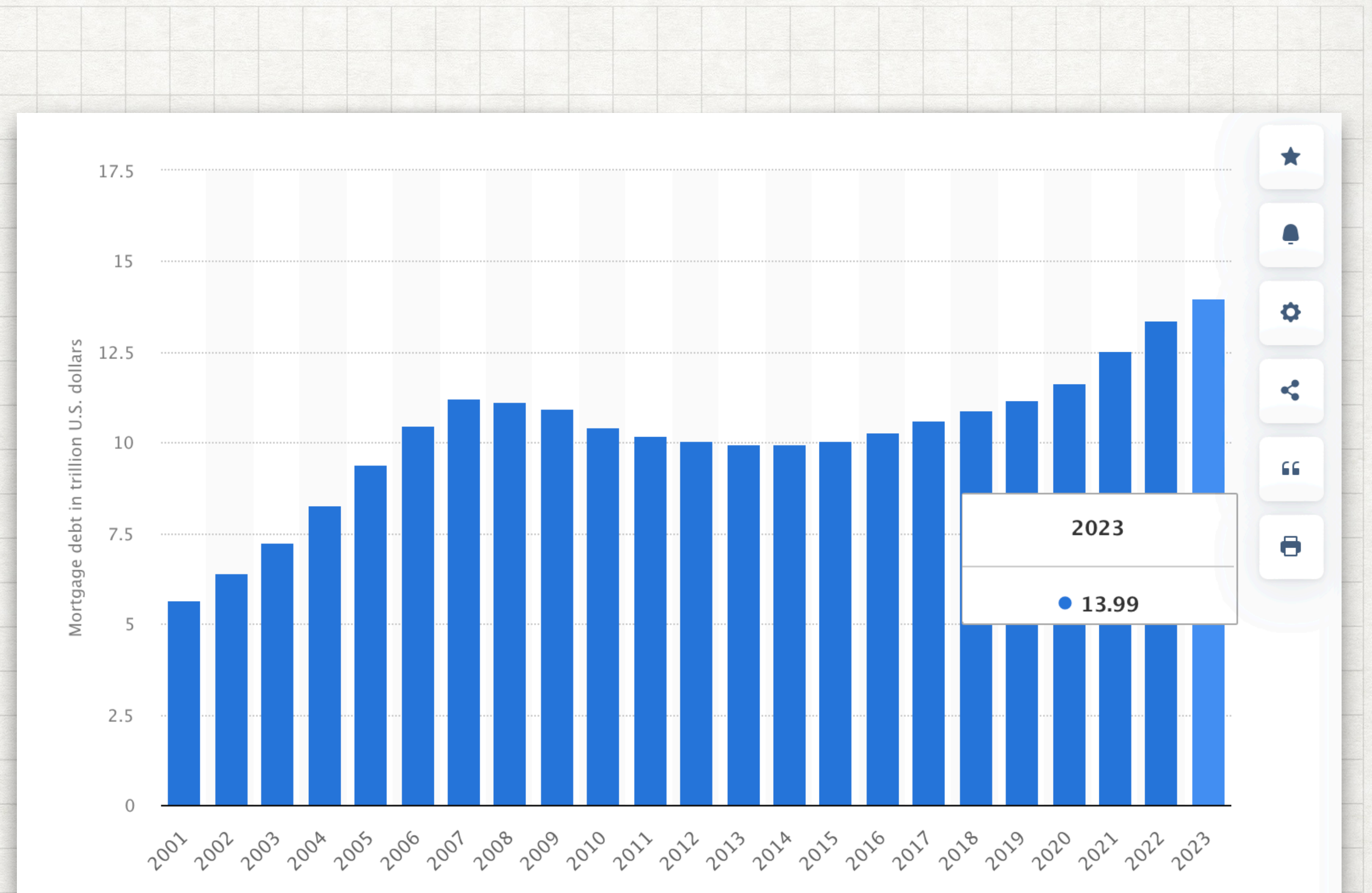


Note: Share reporting that the financial costs are larger than the benefits include those saying they are much larger and somewhat larger. Share reporting that the financial benefits are larger than the costs include those saying they are much larger and somewhat larger.
Source: Pew Research Center analysis of Federal Reserve Board's 2023 Survey of Household Economics and Decisionmaking.

PEW RESEARCH CENTER

MORTGAGES

- \$20.2 Trillion in the US.
\$14 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

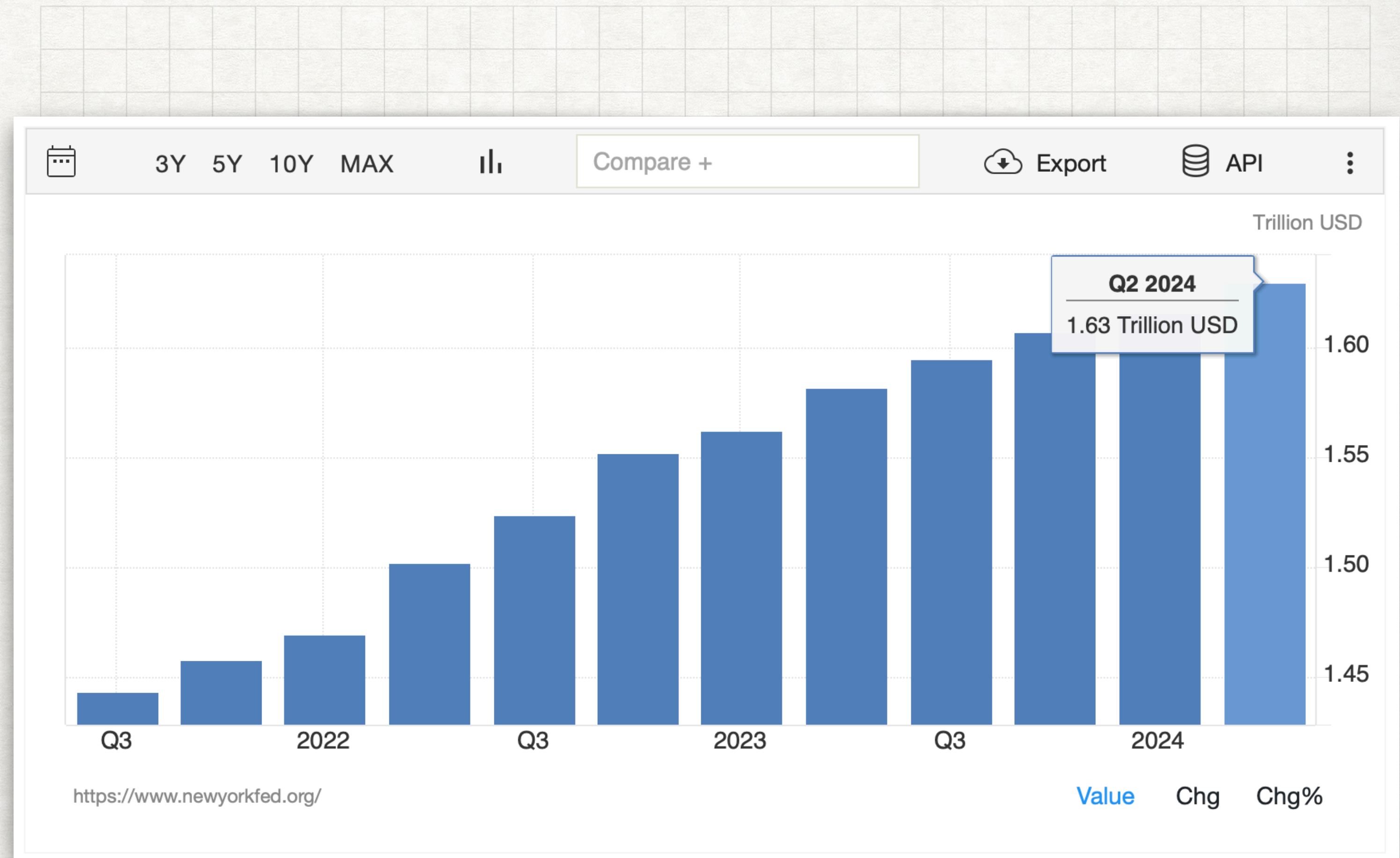


*<https://www.statista.com/topics/1685/mortgage-industry-of-the-united-states/>

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

AUTO LOANS

- \$1.63 Trillion (as of Q2 2024)
- 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



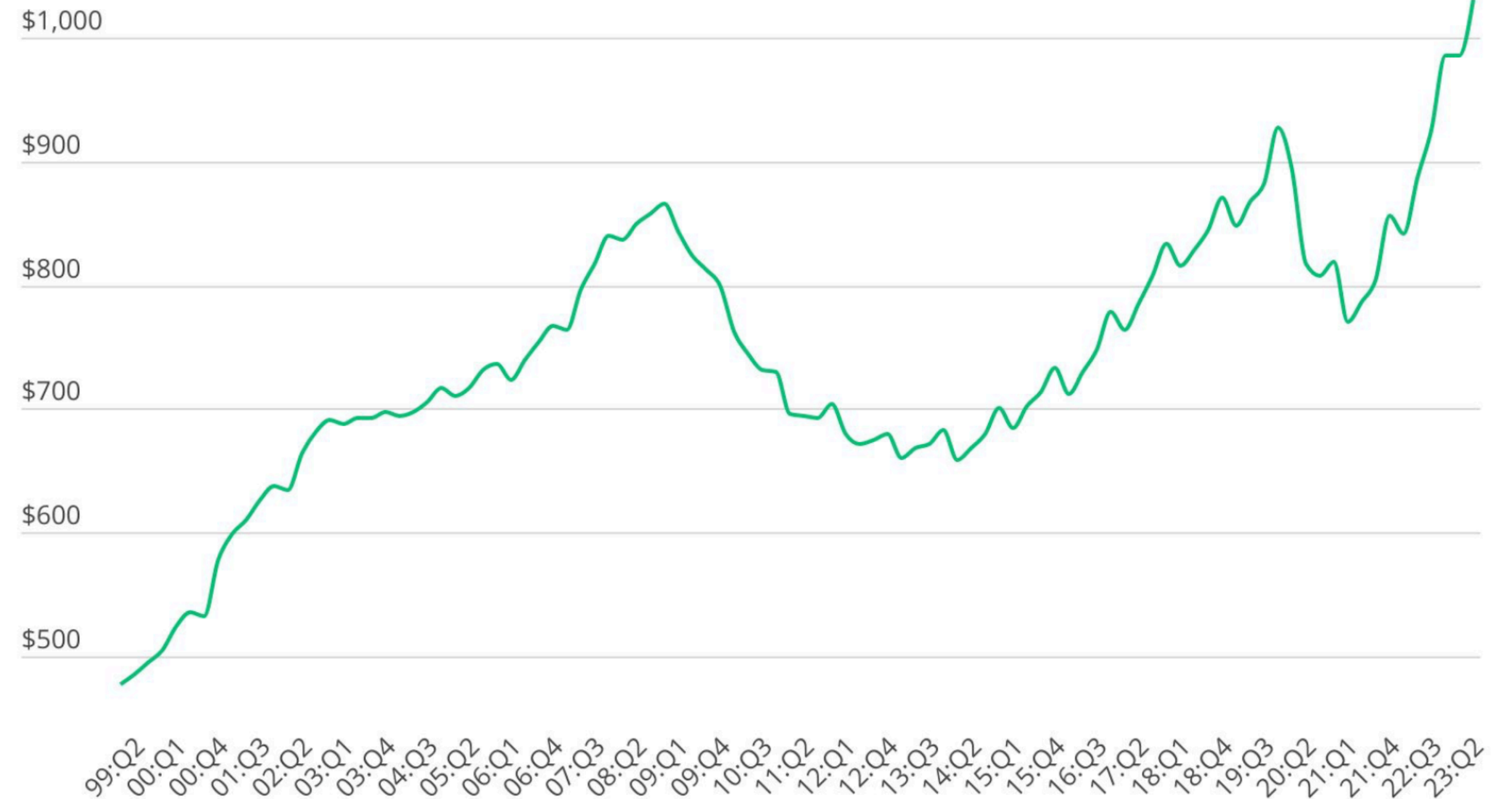
* <https://tradingeconomics.com/united-states/debt-balance-auto-loans>

CREDIT CARDS

- \$1.14 Trillion (Q2 2024)
- 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>

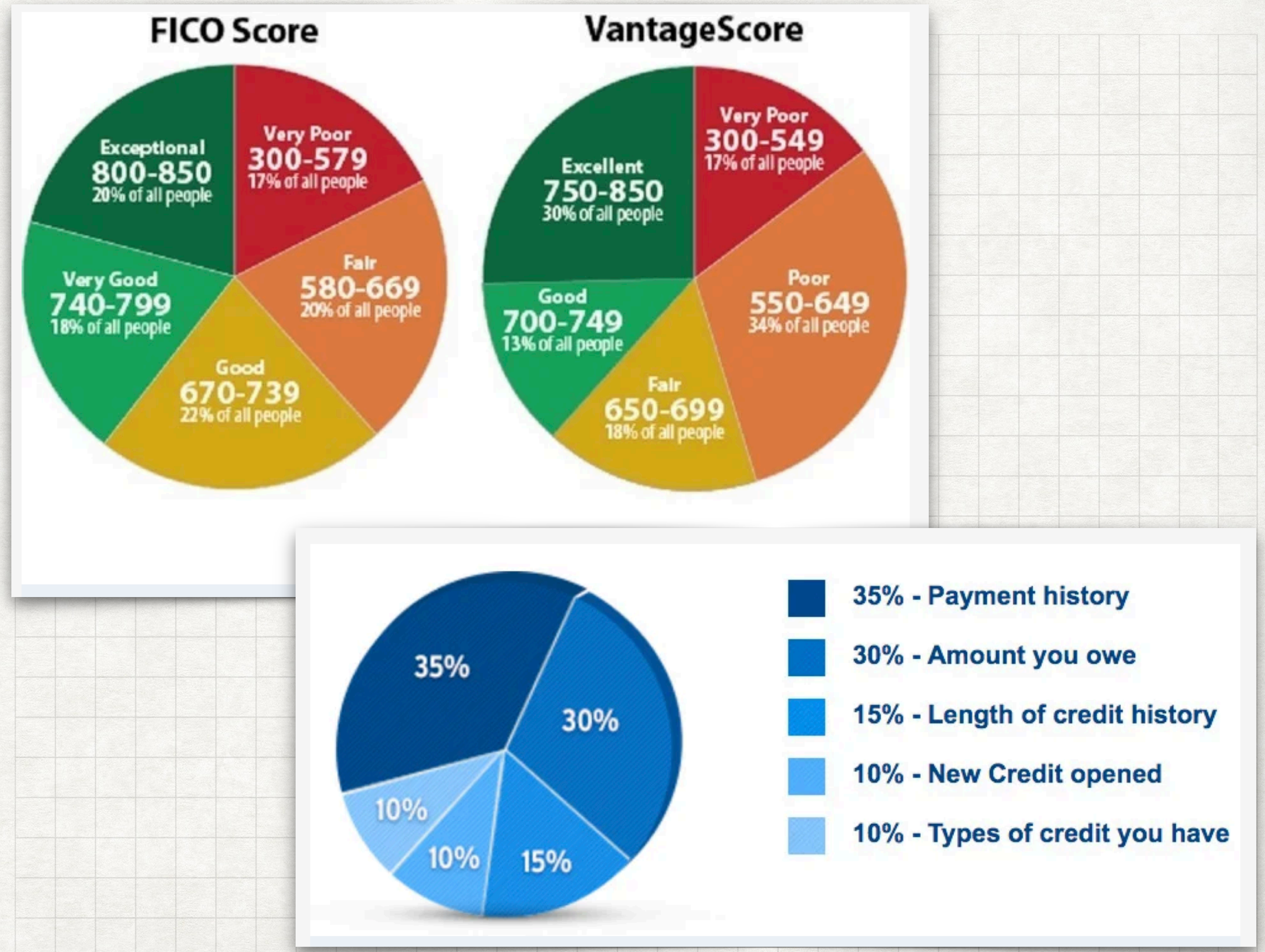
* <https://www.lendingtree.com/credit-cards/credit-card-debt-statistics/>

CREDIT SCORES

your borrowing record & why it matters

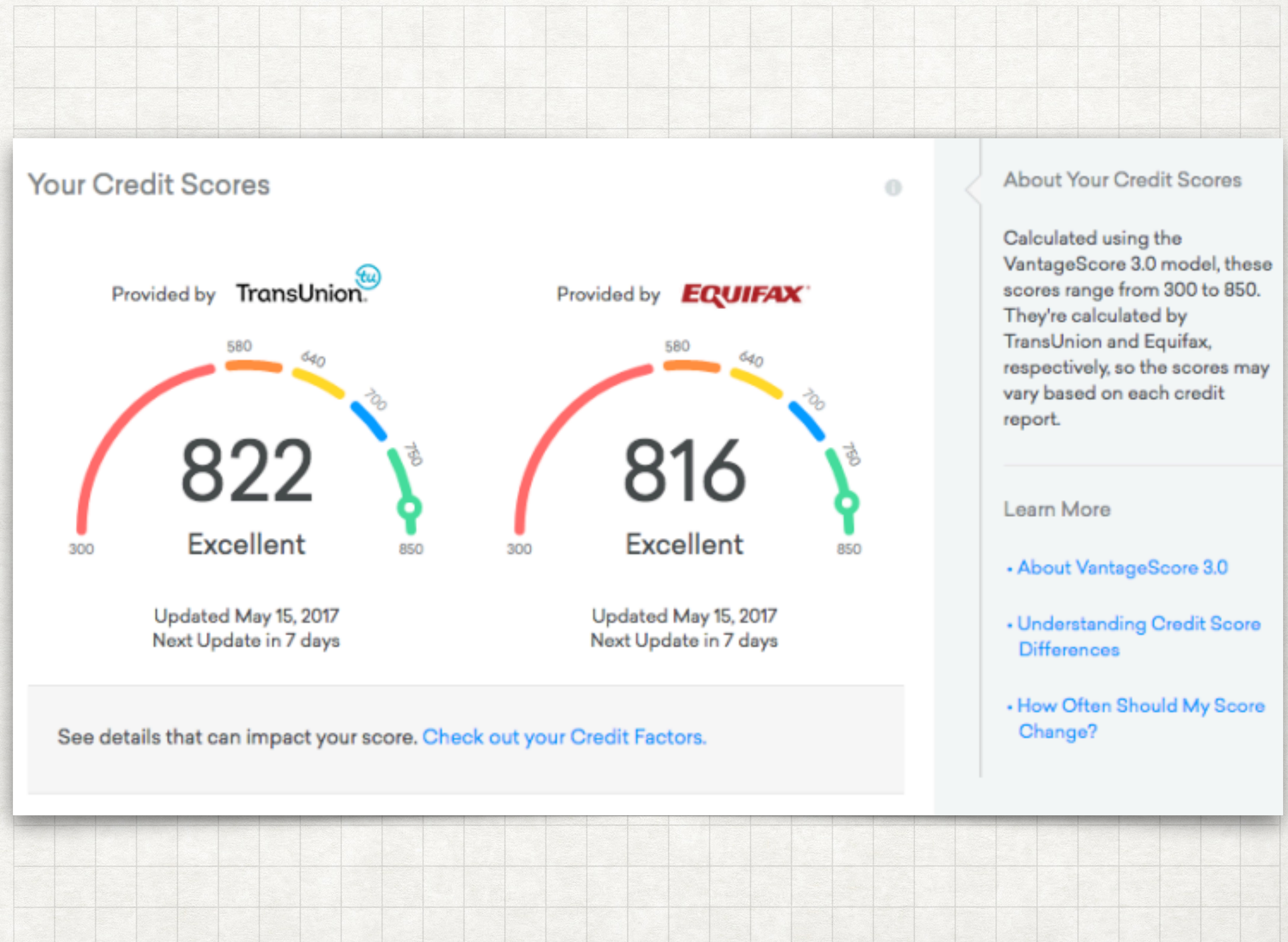
WHAT'S A CREDIT SCORE

- 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>



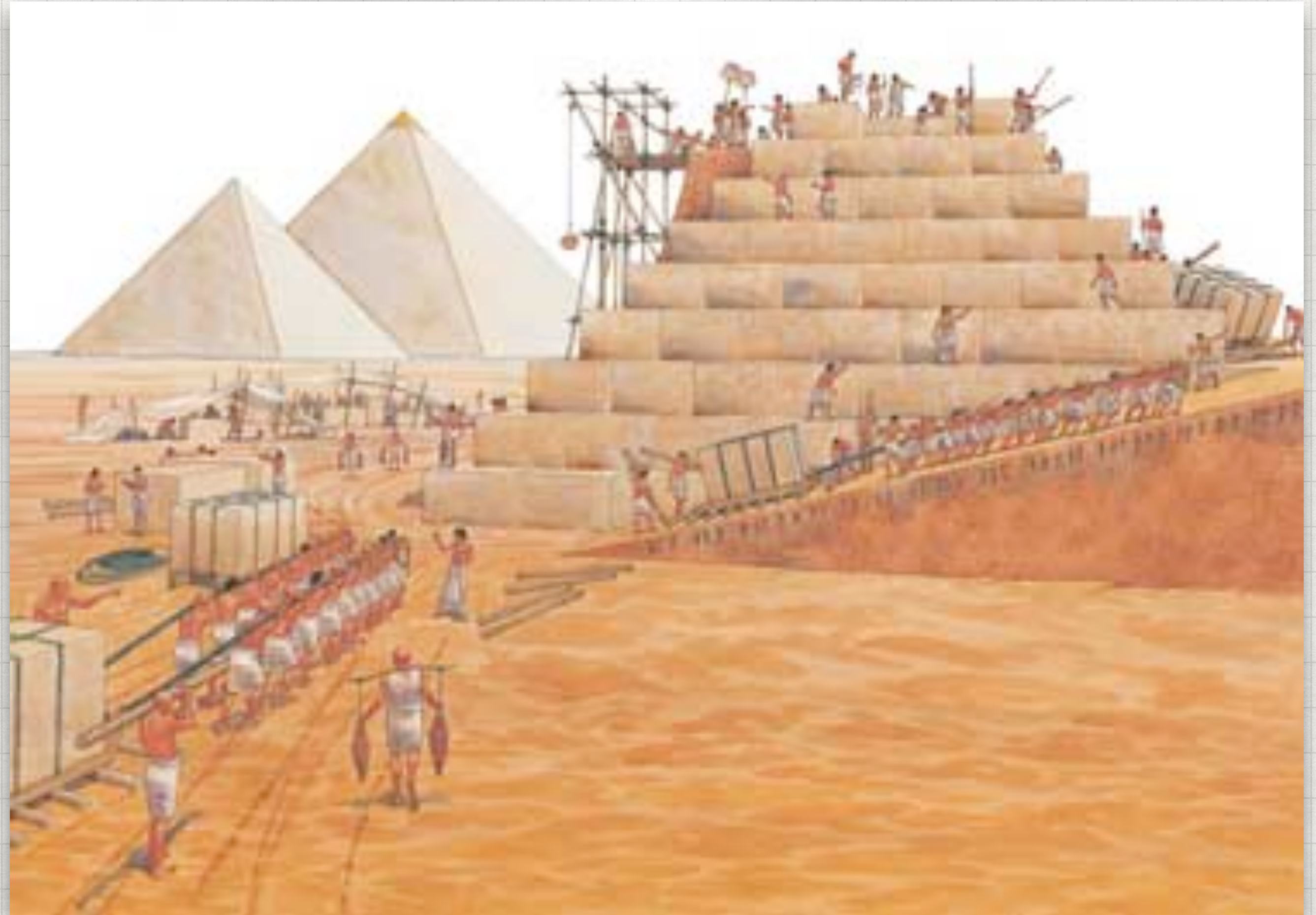
WHY DO CREDIT SCORES MATTER?

- 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

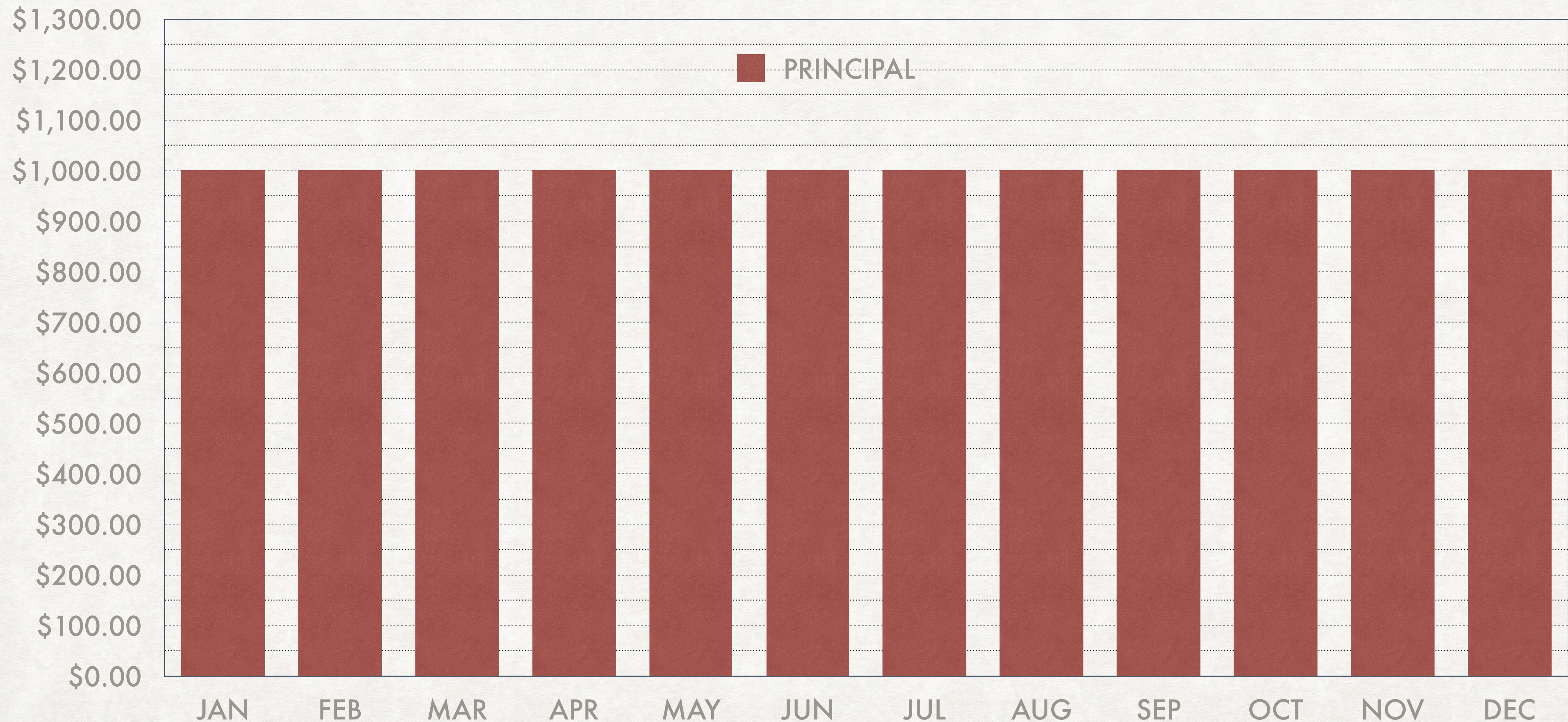


LOANS & RATES

how much will you owe?

SIMPLE LOAN

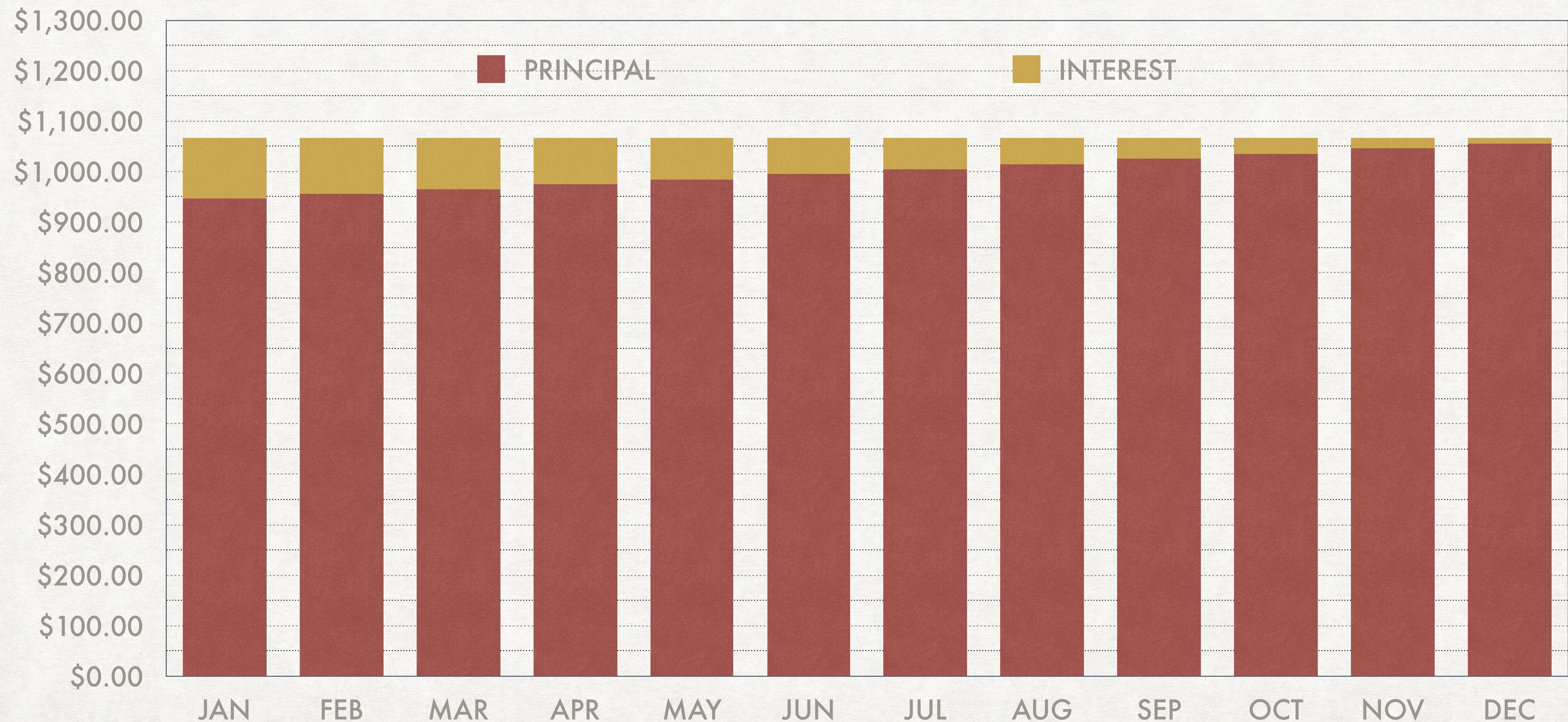
\$12,000 AT 0% INTEREST FOR 1 YEAR



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)

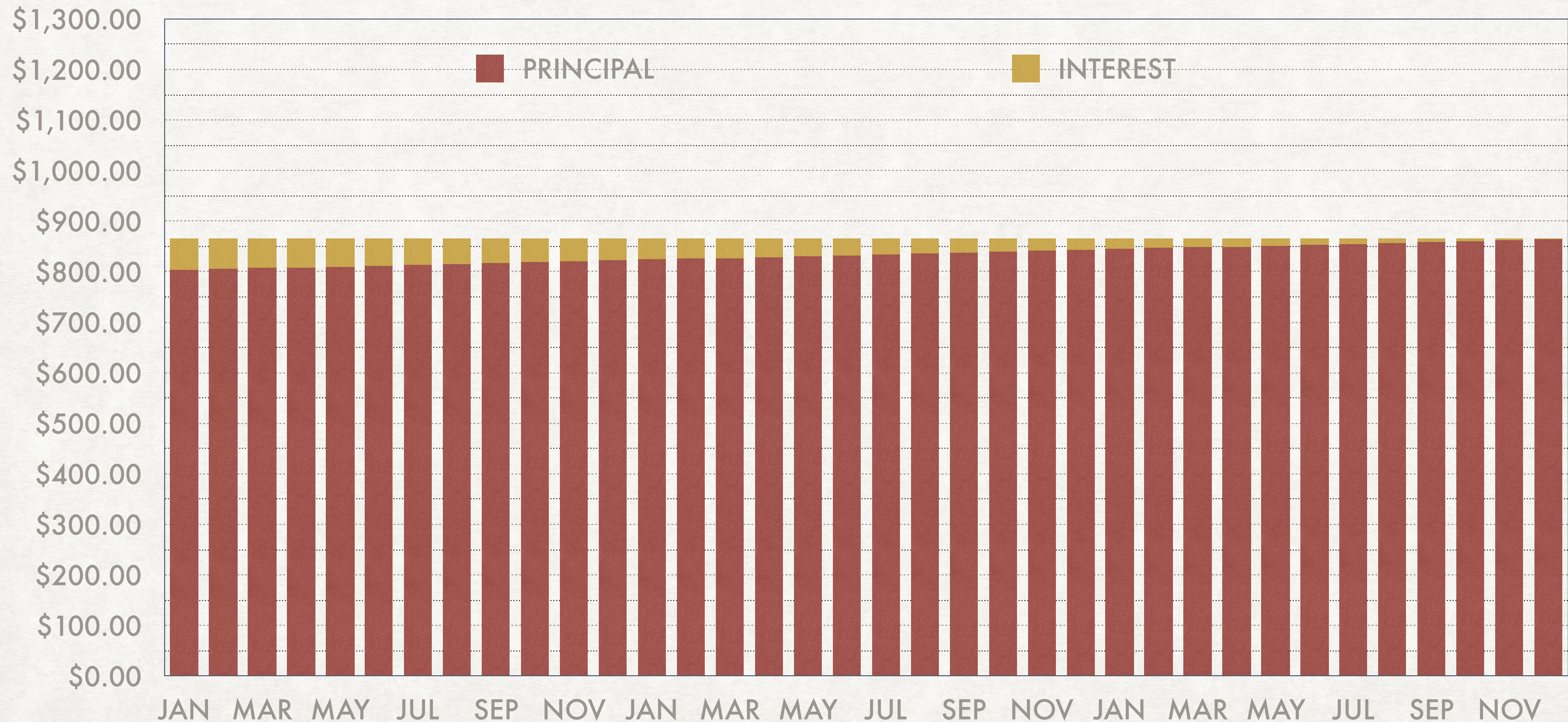
$$A = P \frac{r(1+r)^n}{(1+r)^n - 1}$$

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

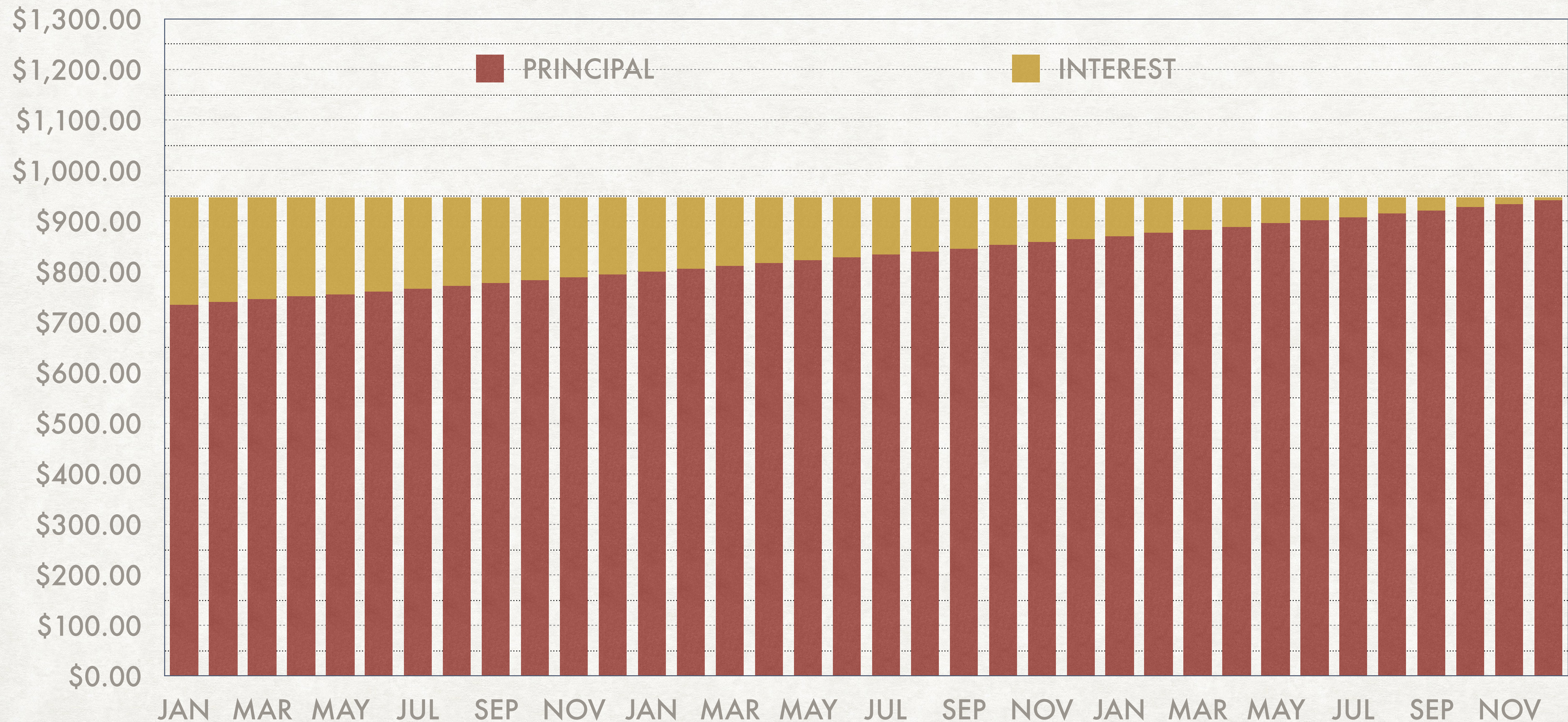
\$30,000 AT 2.5% INTEREST FOR 3 YEARS



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

SAMPLE AUTO LOAN

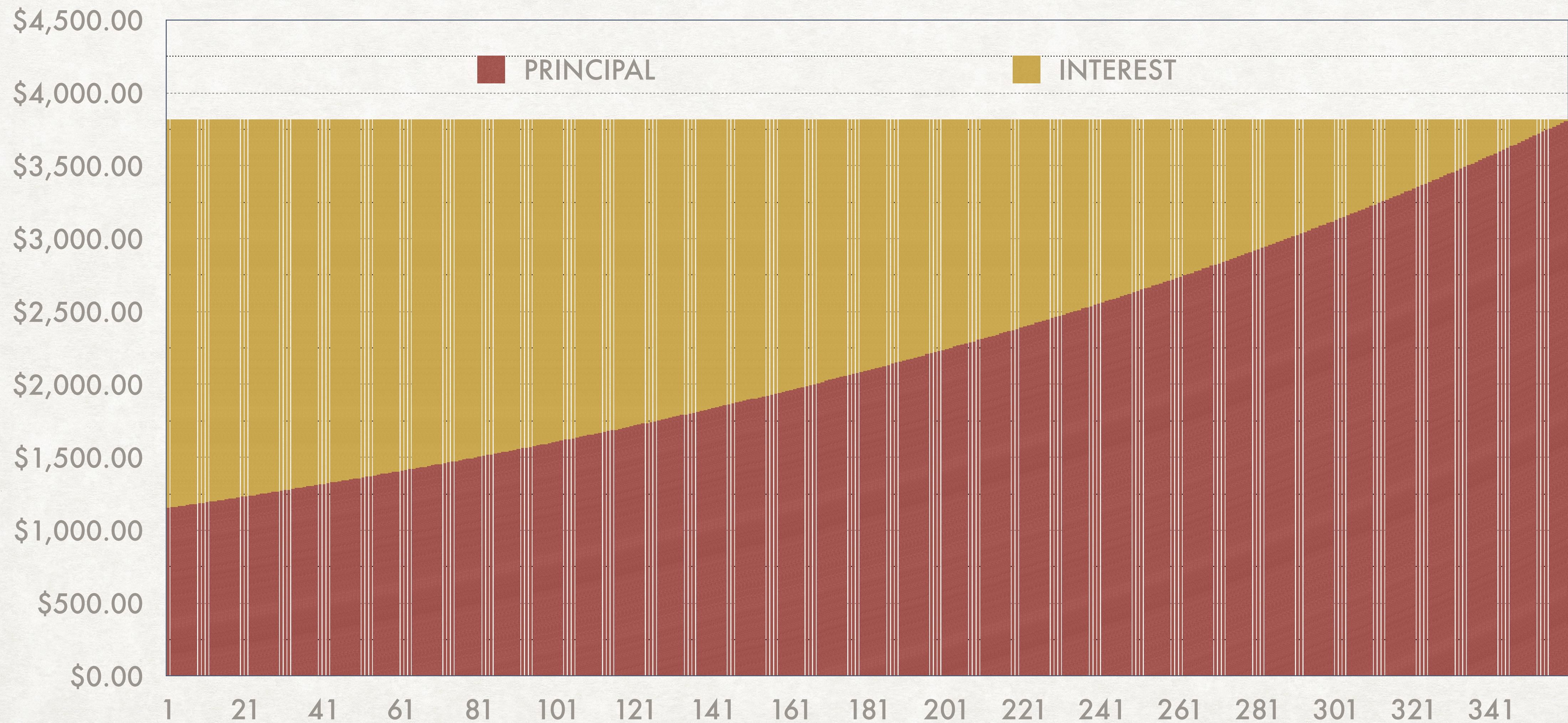
\$30,000 AT 8.5% INTEREST FOR 3 YEARS



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. Minimize 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.

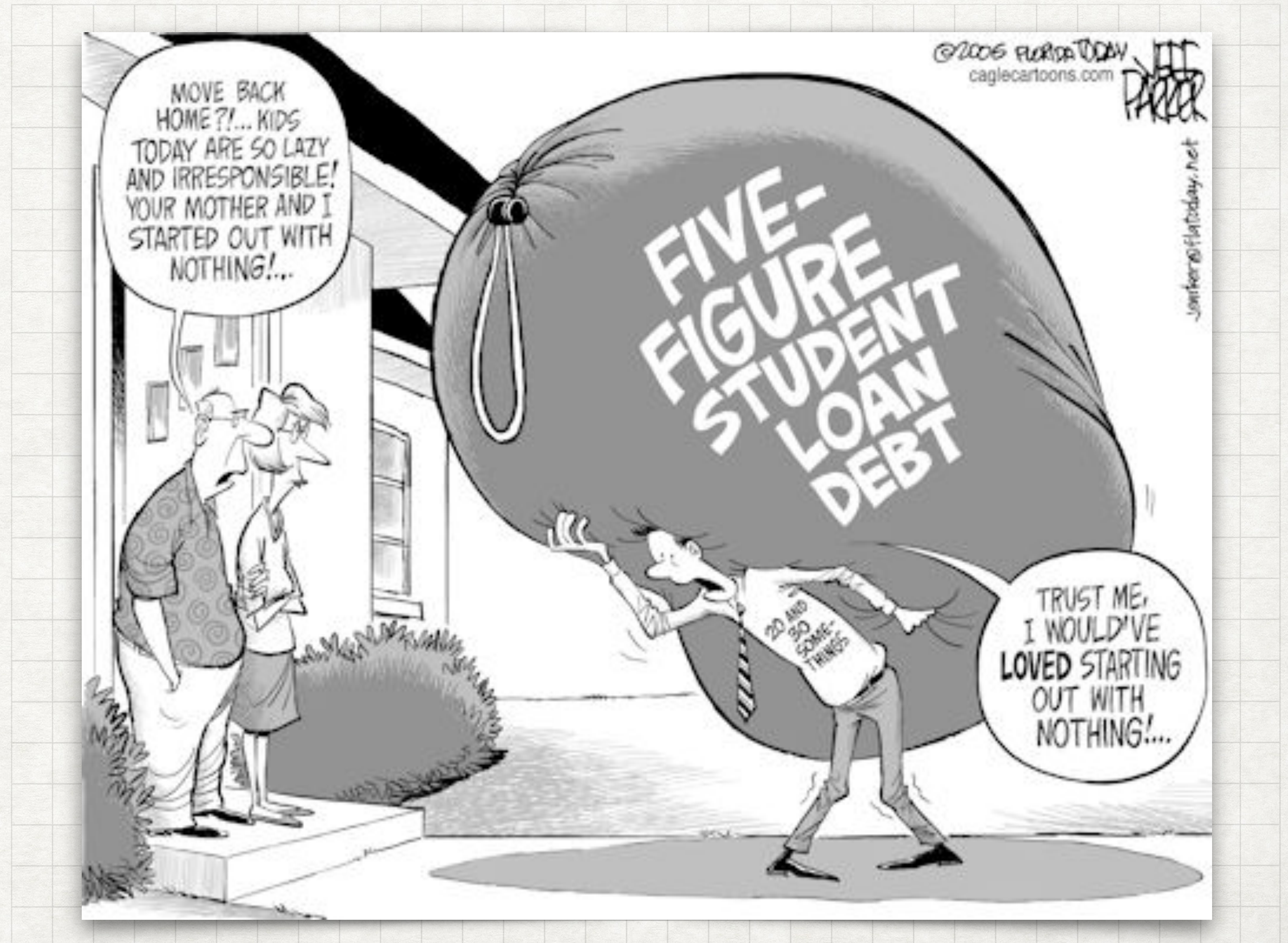
	Student Loan 1	Student Loan 2	Credit Card	Auto Loan
Amount	\$6,000	\$8,000	\$10,000	\$20,000
Rate	2.5%	4.5%	22.9%	1.9%
Min Pmt	\$200	\$250	\$120	\$450
Term	10yrs	10yrs	~	3yrs
Peanut Butter	\$500	\$500	\$500	\$500
Snowball	\$1180	\$250	\$120	\$450
Optimal	\$200	\$250	\$1100	\$450

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

