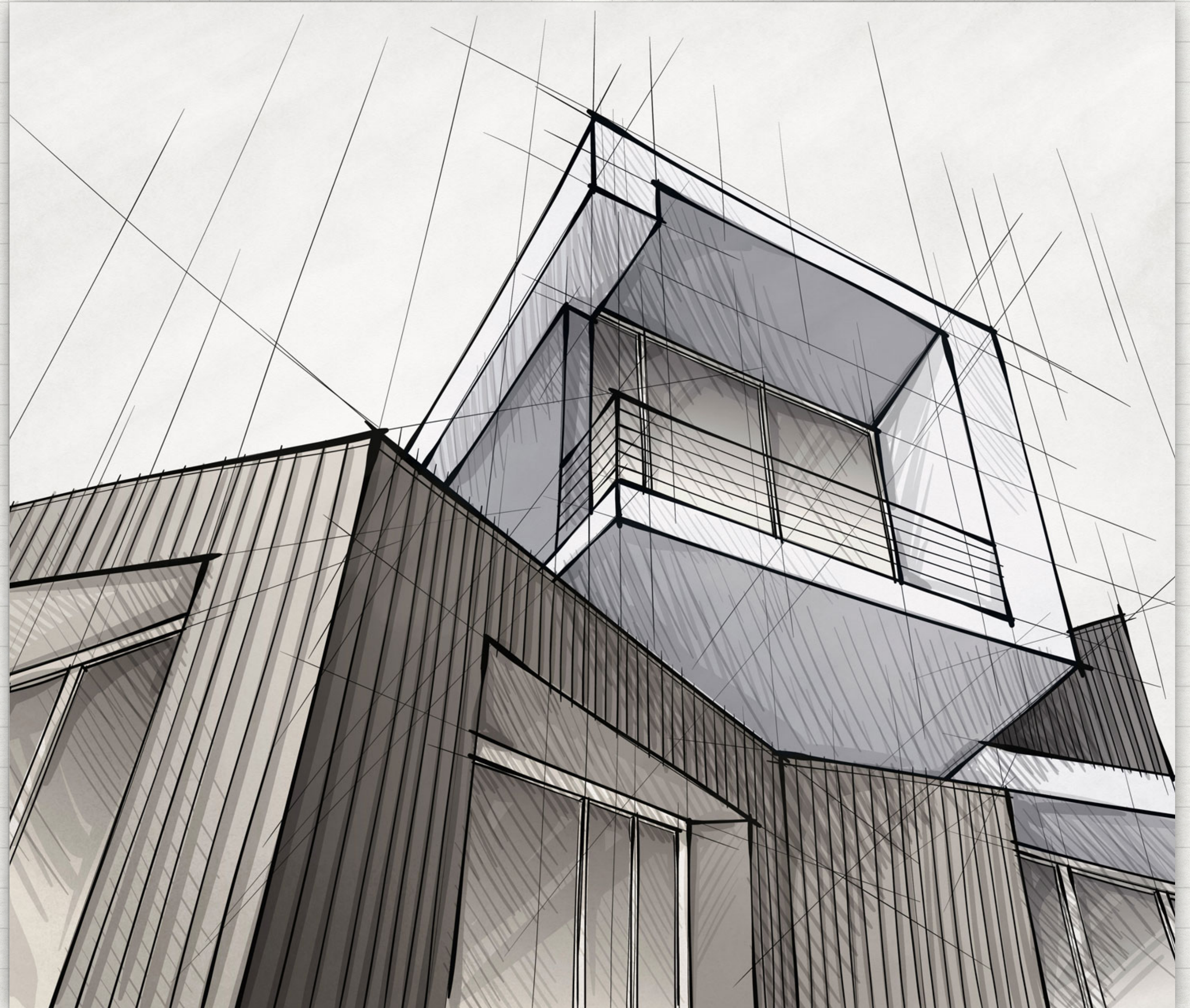


CS 007: SESSION 6

# PERSONAL FINANCE FOR ENGINEERS





CS 007

# ALL ABOUT DEBT





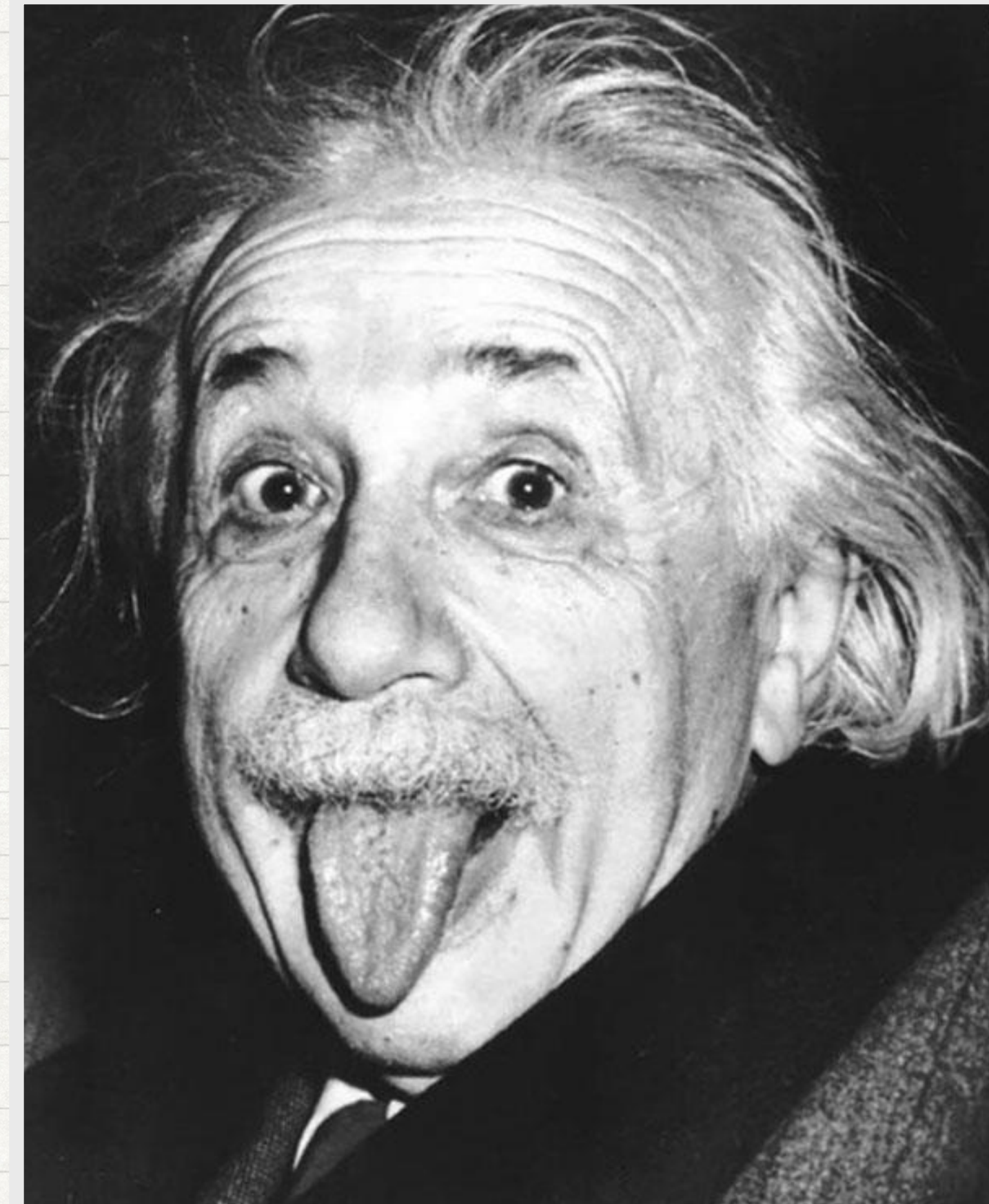
# COMPOUNDING

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



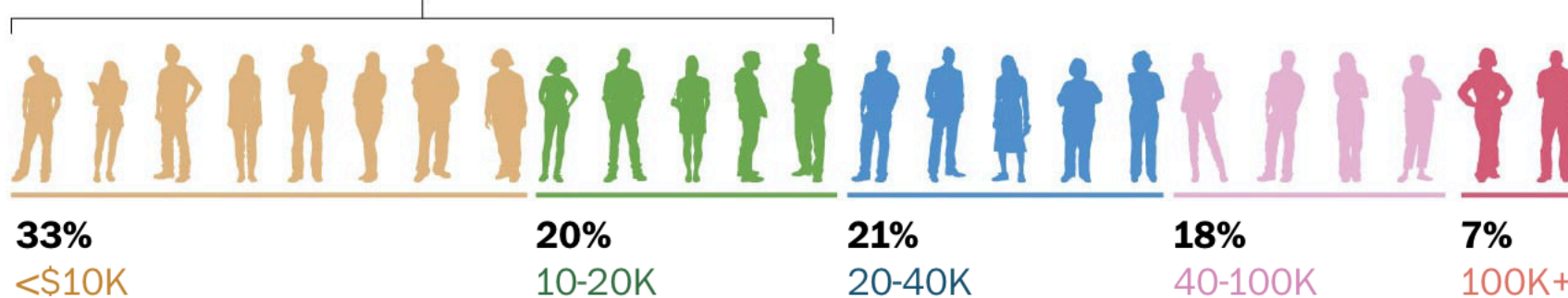
# 6: STUDENT LOANS THAT YOU ARE RESPONSIBLE FOR?

- National student loan debt at \$1.59T
- 45 million student loan borrowers.
- Average debt for per borrower in 2021 was \$39,351.
- 25% of borrowers default in 1st five years of repayment.

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/>

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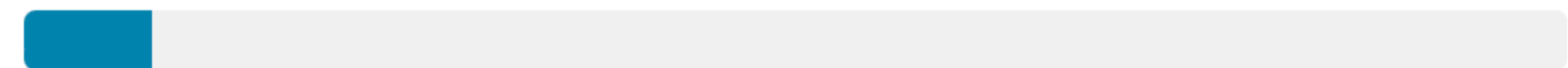
Do you have student loans that you will be responsible for after college?

168 out of 168 people answered this question

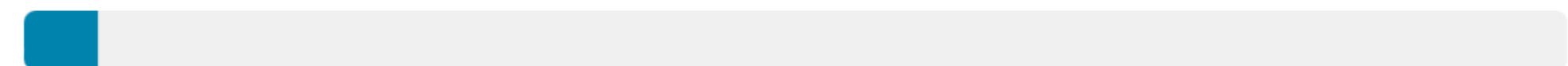
Nope 136 resp. 81%



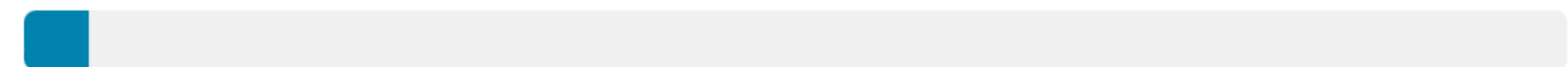
Less than \$20K 14 resp. 8.3%



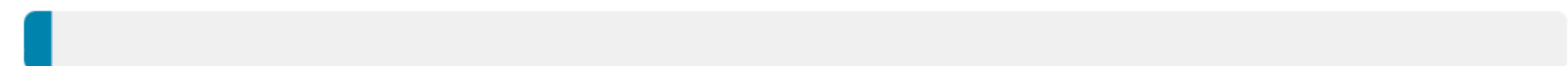
Between \$50K - \$100K 8 resp. 4.8%



Between \$20K - \$50K 7 resp. 4.2%



Over \$100K 3 resp. 1.8%





# STUDENT LOANS

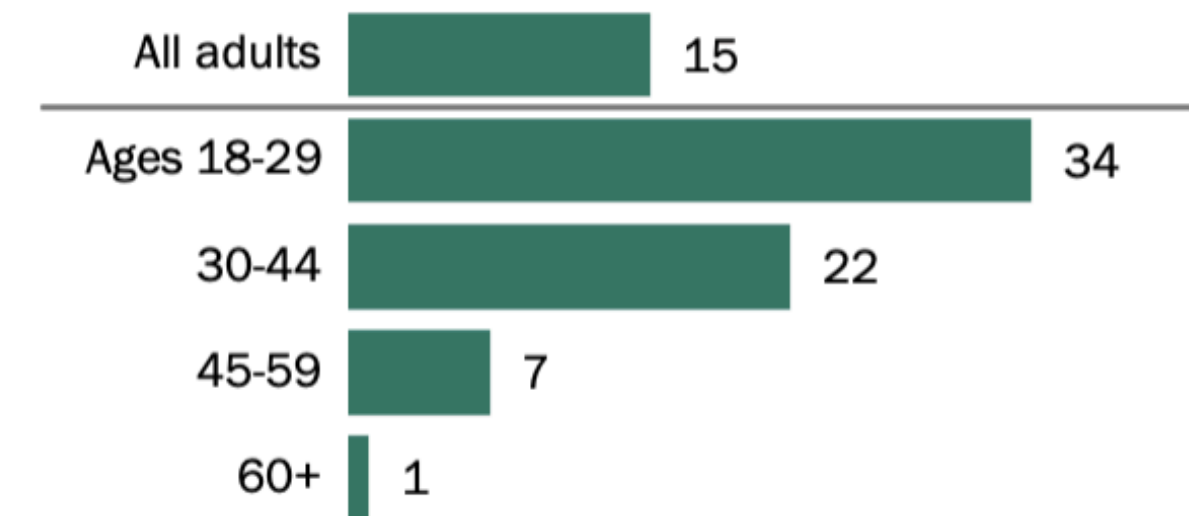
- \$1.73 Trillion in the US, and growing rapidly. \*
- Unsecured loan provided to fund education & some related expenses
- Loan programs for students & parents. Financial need based.
- Interest rates can be fixed or variable.  
Significant difference in undergrad vs. grad
- Rates are much lower than 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/>

## About one-third of those ages 18 to 29 currently have student loan debt

*% of adults saying they currently have outstanding student loan debt for their own education*

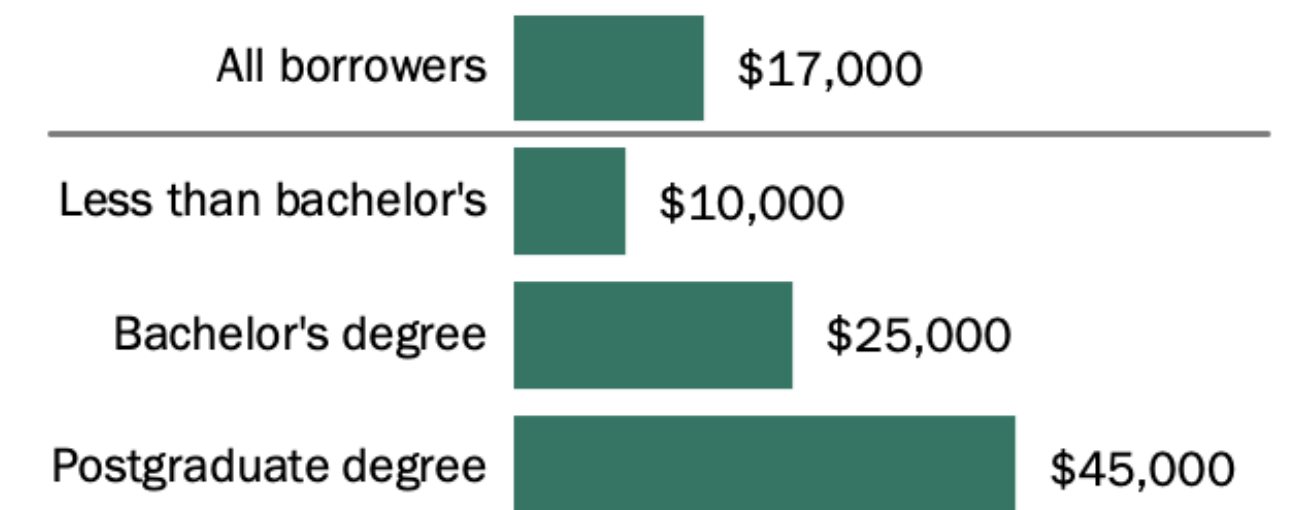


Source: Pew Research Center analysis of Federal Reserve Board's 2018 Survey of Household Economics and Decisionmaking.

PEW RESEARCH CENTER

## Median amount of outstanding student debt varies widely by education level

*Median reported outstanding student loan debt in 2016, among those with student loan debt, by educational attainment*



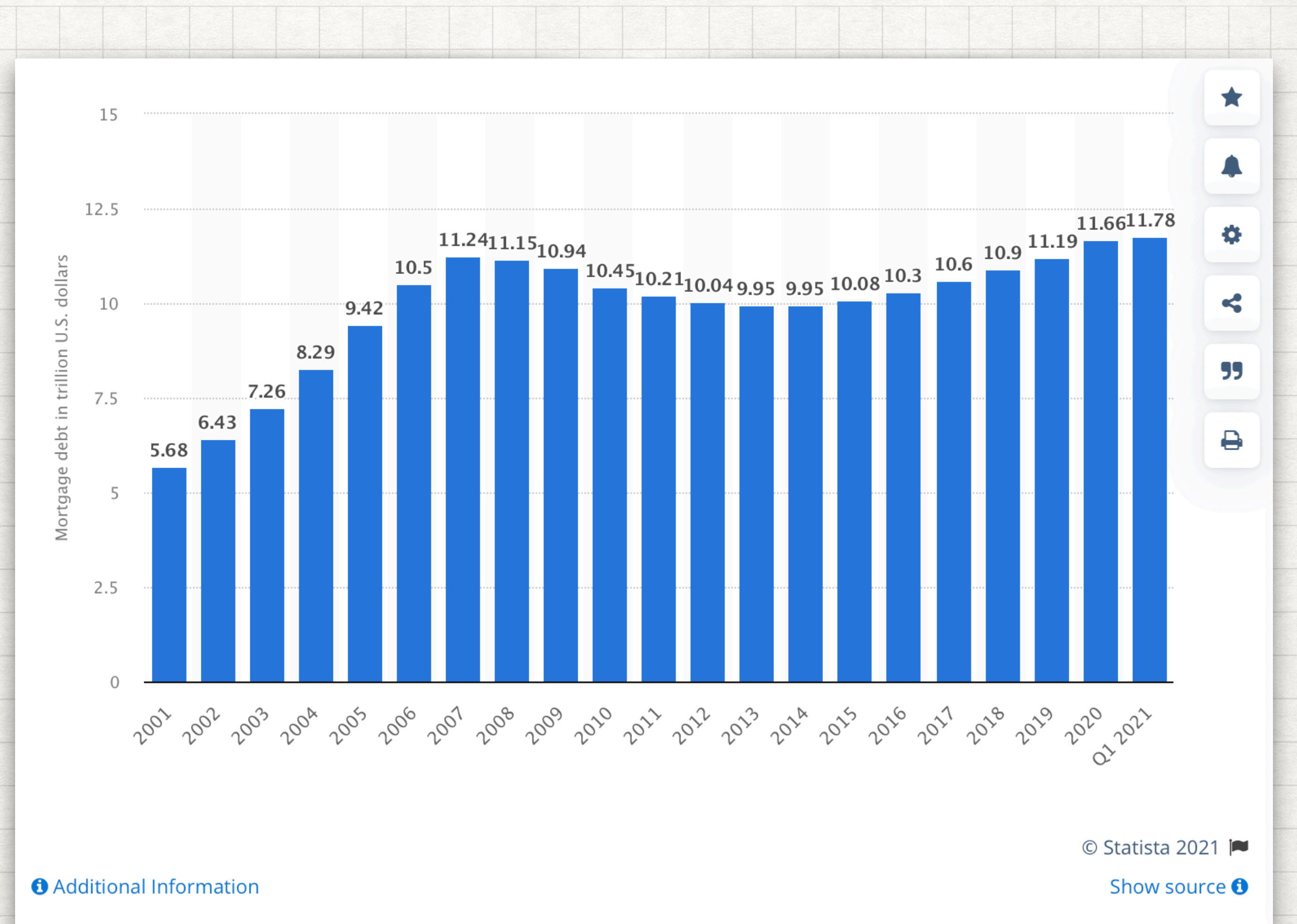
Source: Pew Research Center analysis of Federal Reserve Board's 2016 Survey of Household Economics and Decisionmaking.

PEW RESEARCH CENTER



# MORTGAGES

- \$18 Trillion in the US. \$12.5 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



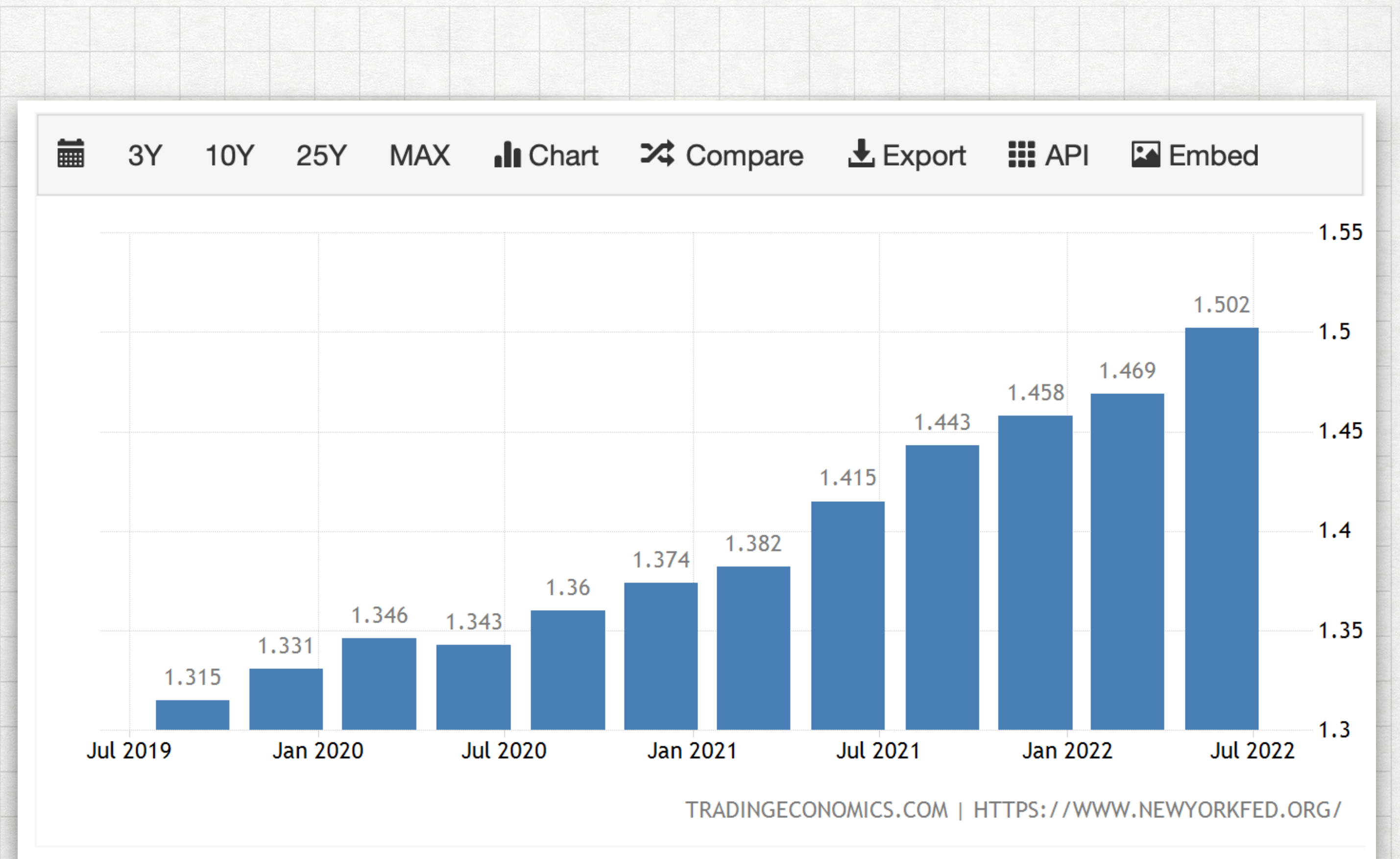
\*<https://www.statista.com/topics/1685/mortgage-industry-of-the-united-states/>

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



# AUTO LOANS

- \$1.5 Trillion (as of Q2 2022)
- 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>

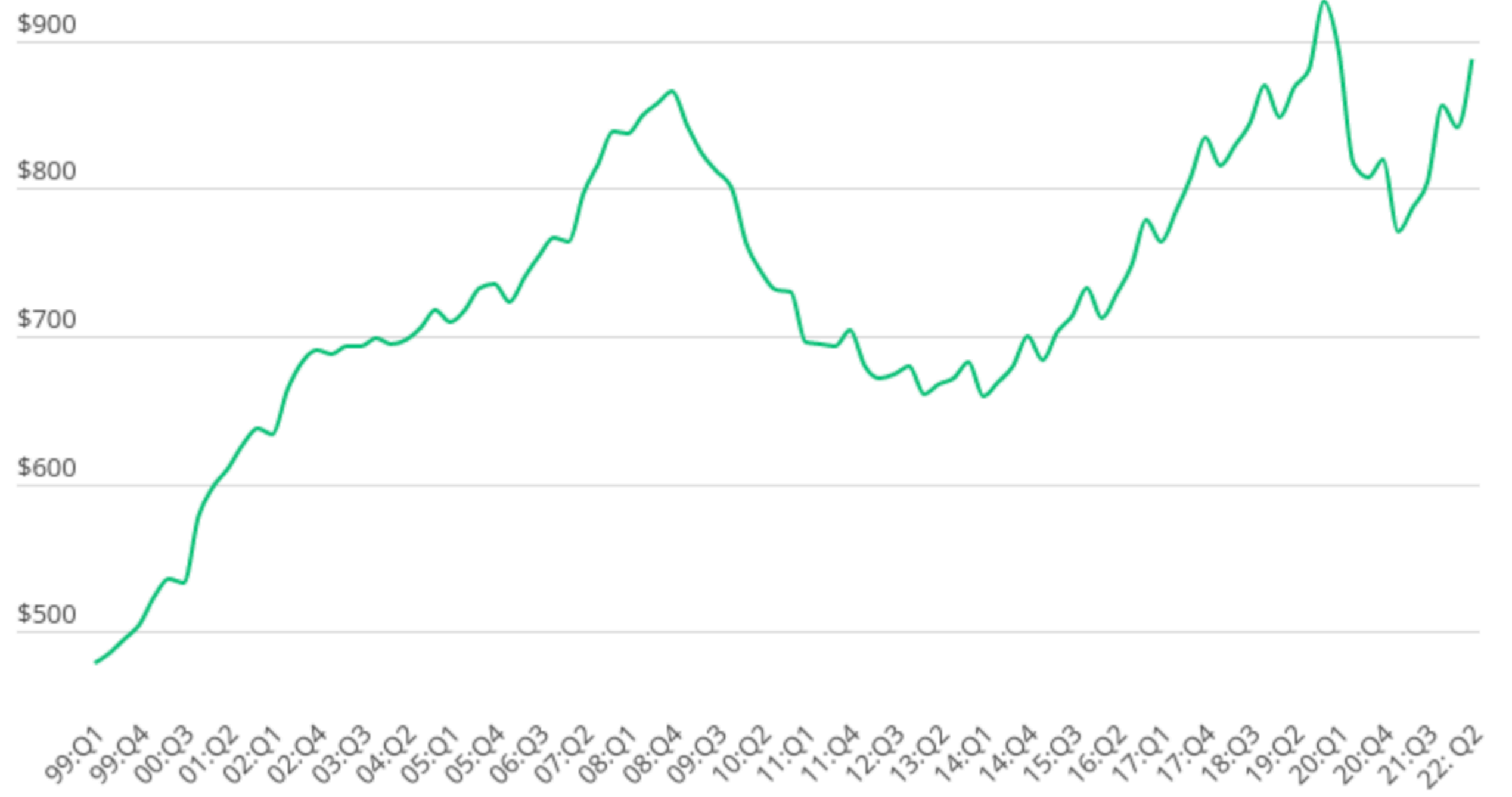


# CREDIT CARDS

- \$890B (Q2 2022)
- 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



\* <https://www.newyorkfed.org/newsevents/news/research/2022/20220802>

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



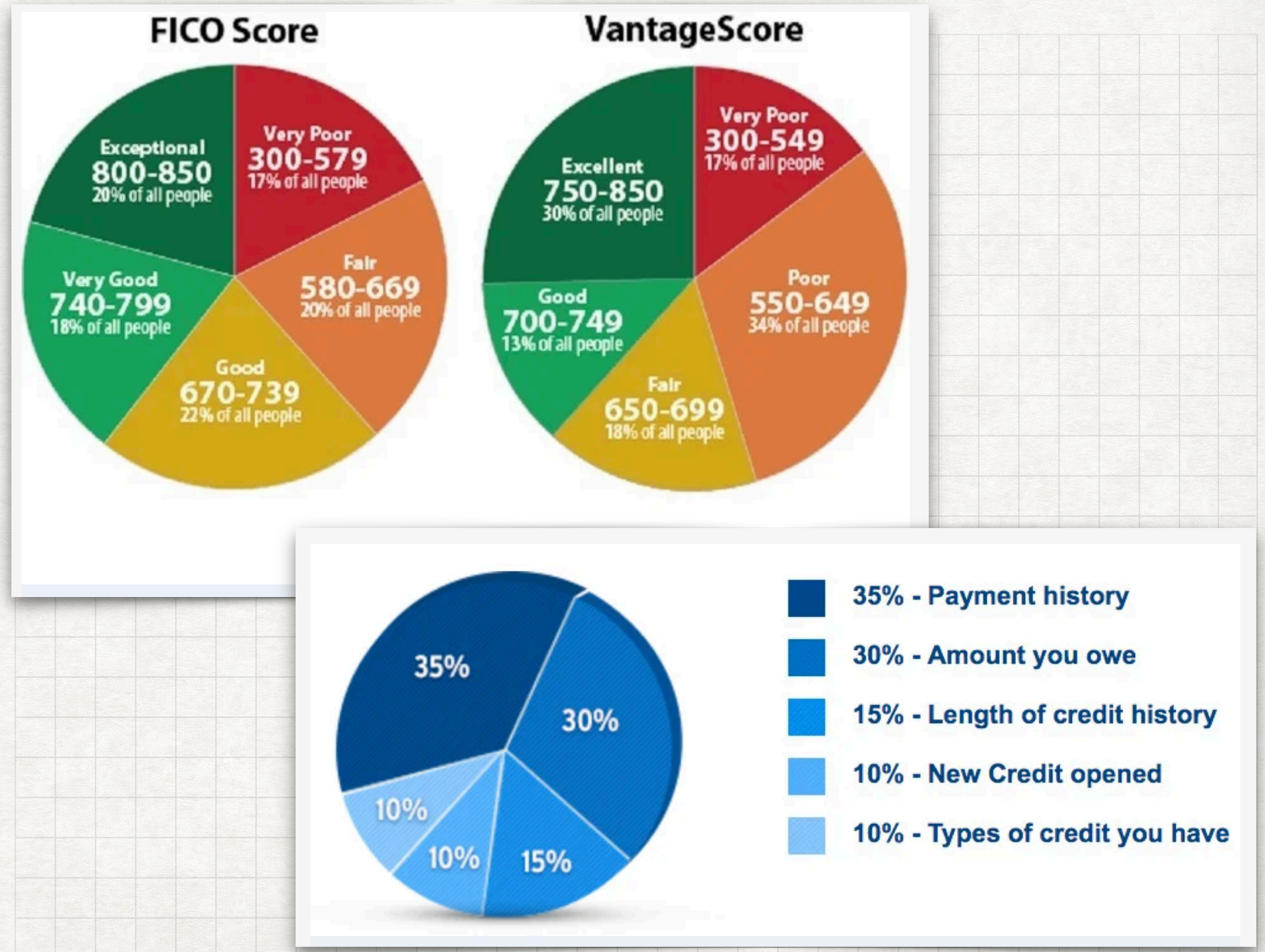
# CREDIT SCORES

your borrowing record & why it matters



# WHAT'S A CREDIT SCORE

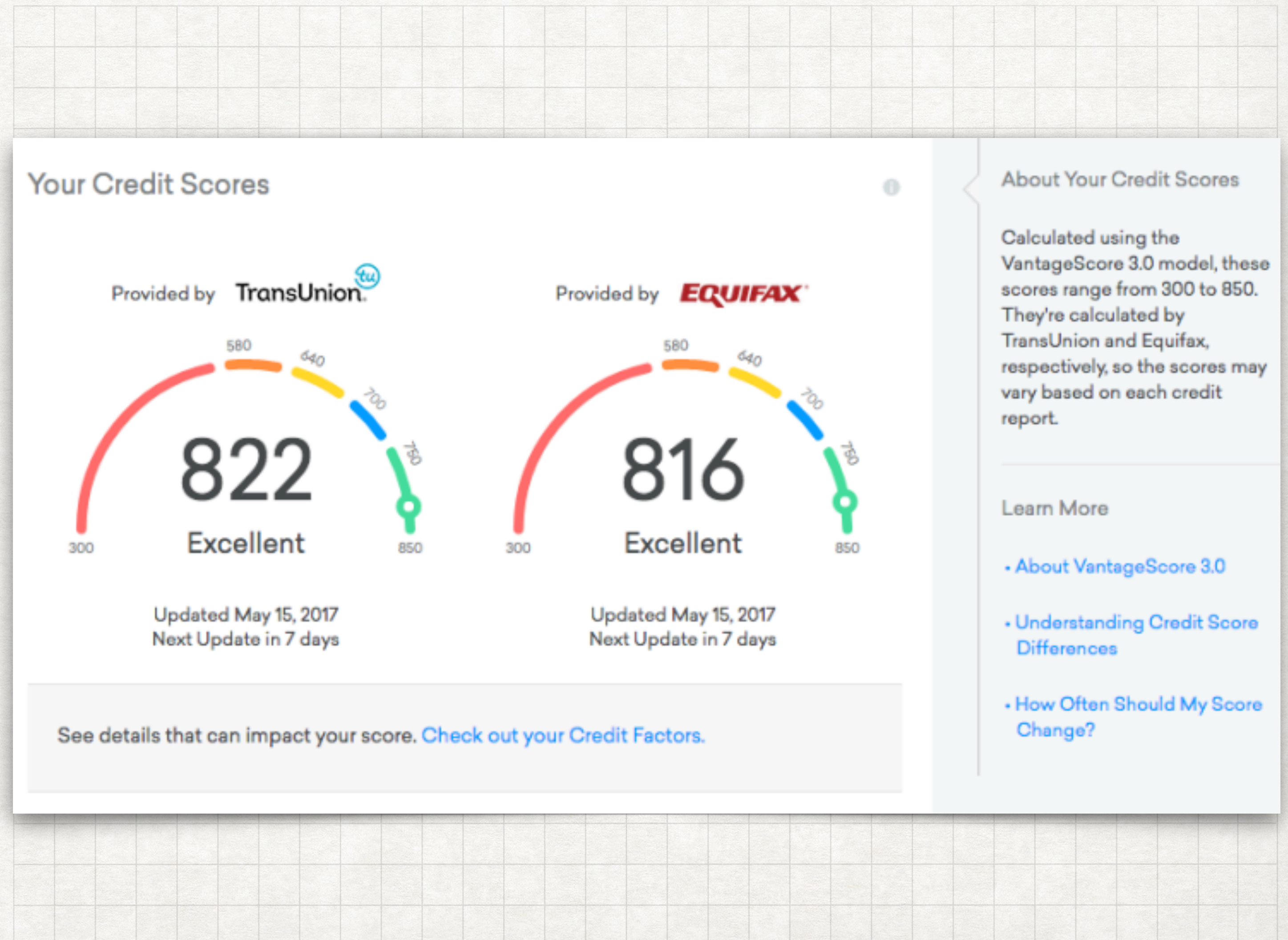
- Lenders report to 3 major centralized credit agencies when you apply for debt, receive debt, and when you pay off debt.
- Building a good credit score is essential for qualifying for most loans. It can affect other services too, as it is used for identity verification.
- Issues that affect credit score: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





# WHY DO CREDIT SCORES MATTER?

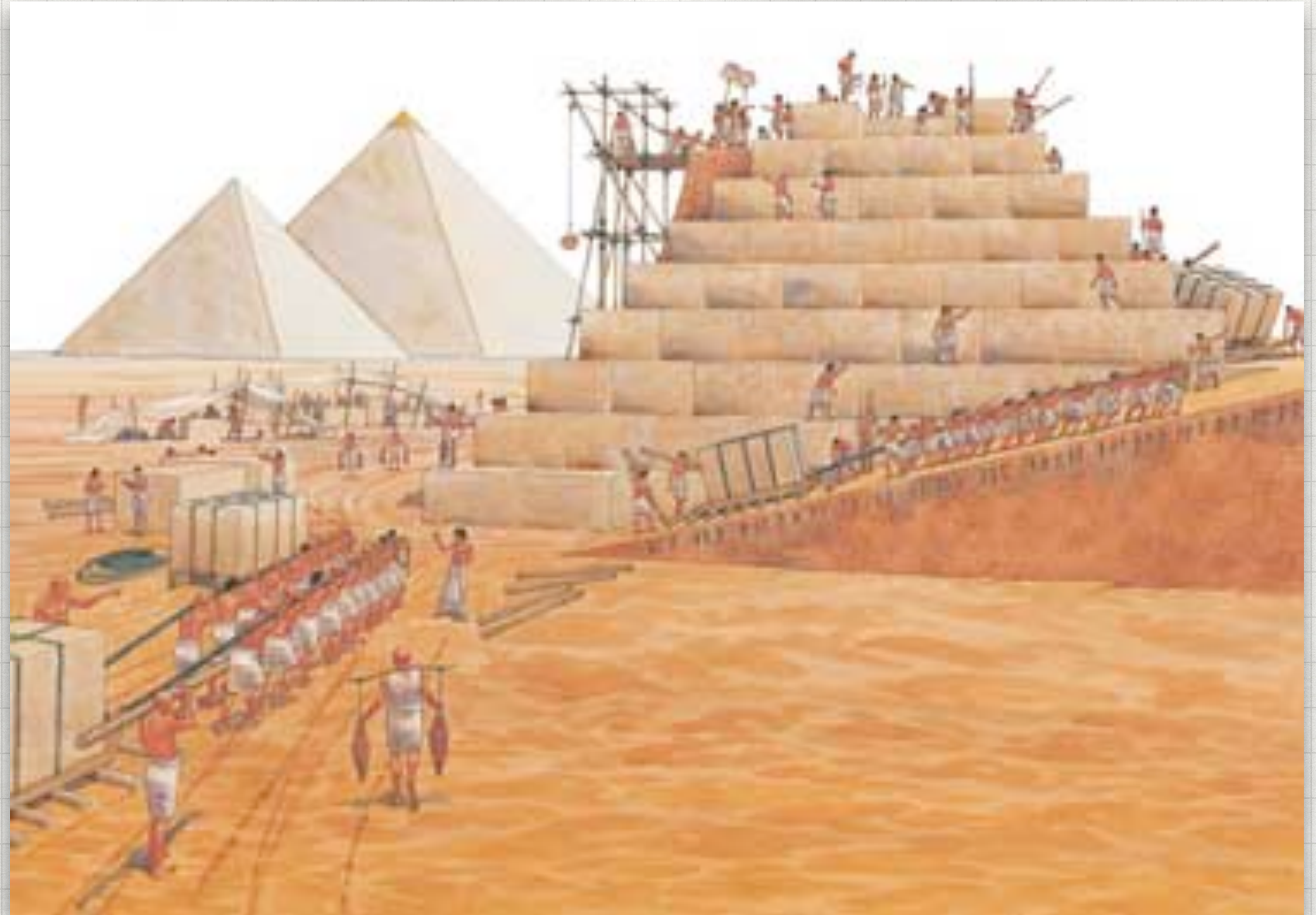
- Critical component in qualifying for new loans and the rate they are set at.
- Many products & services (like wireless & cable plans) utilize them as well to assess credit risk.
- Often utilized for identity verification purposes.
- Particularly difficult for new immigrants to build.
- Seems like a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





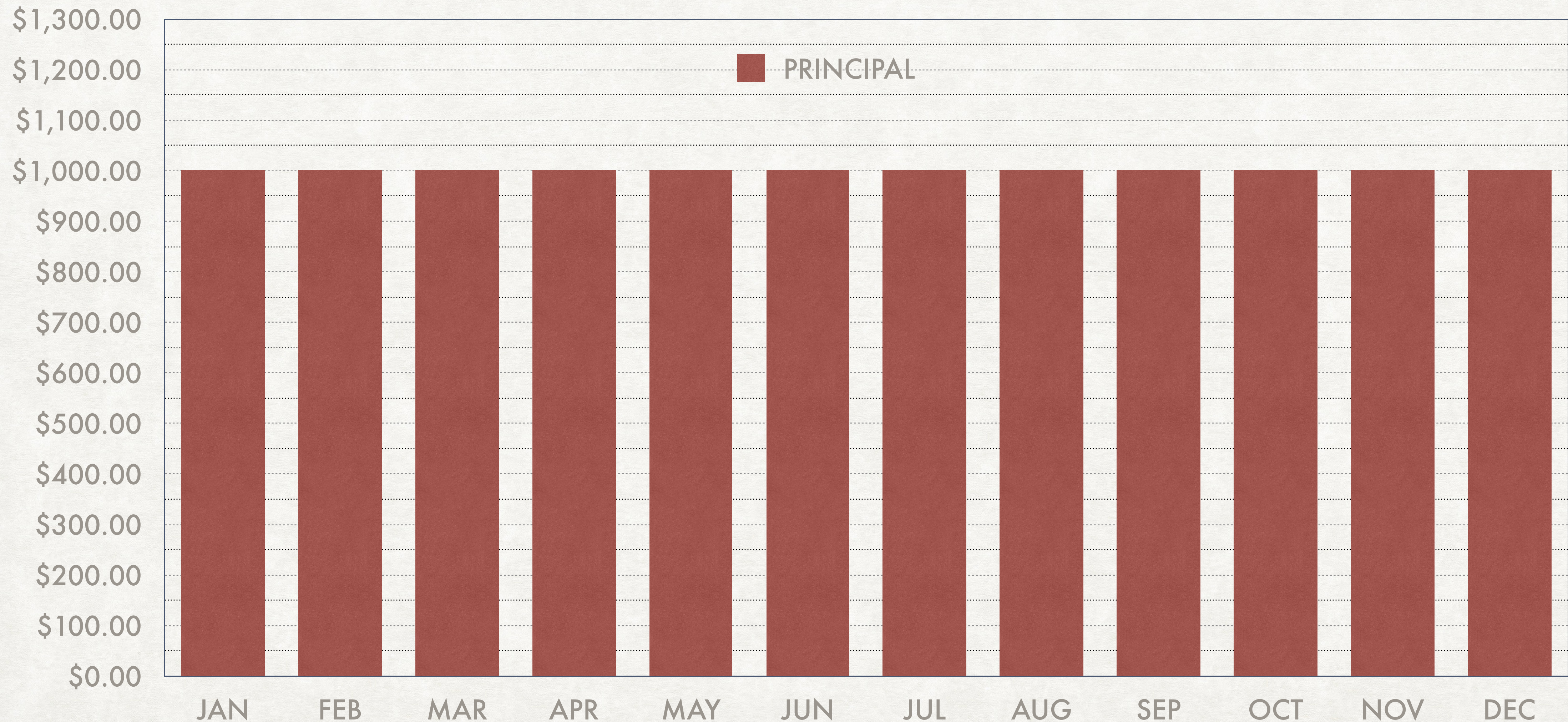
# LOANS & RATES

how much will you owe?



# SIMPLE LOAN

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

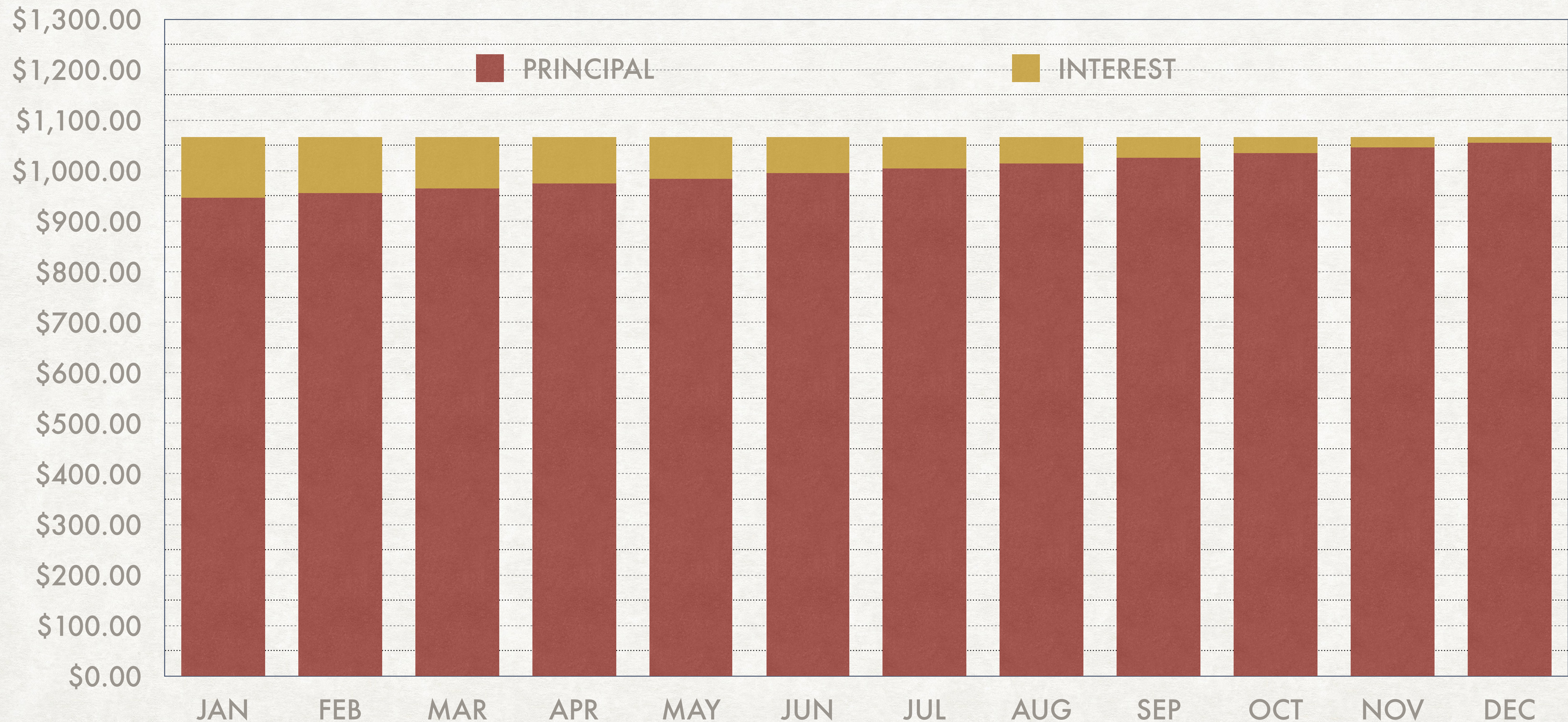


PAYMENT = \$1,000 PER MONTH



# 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)

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

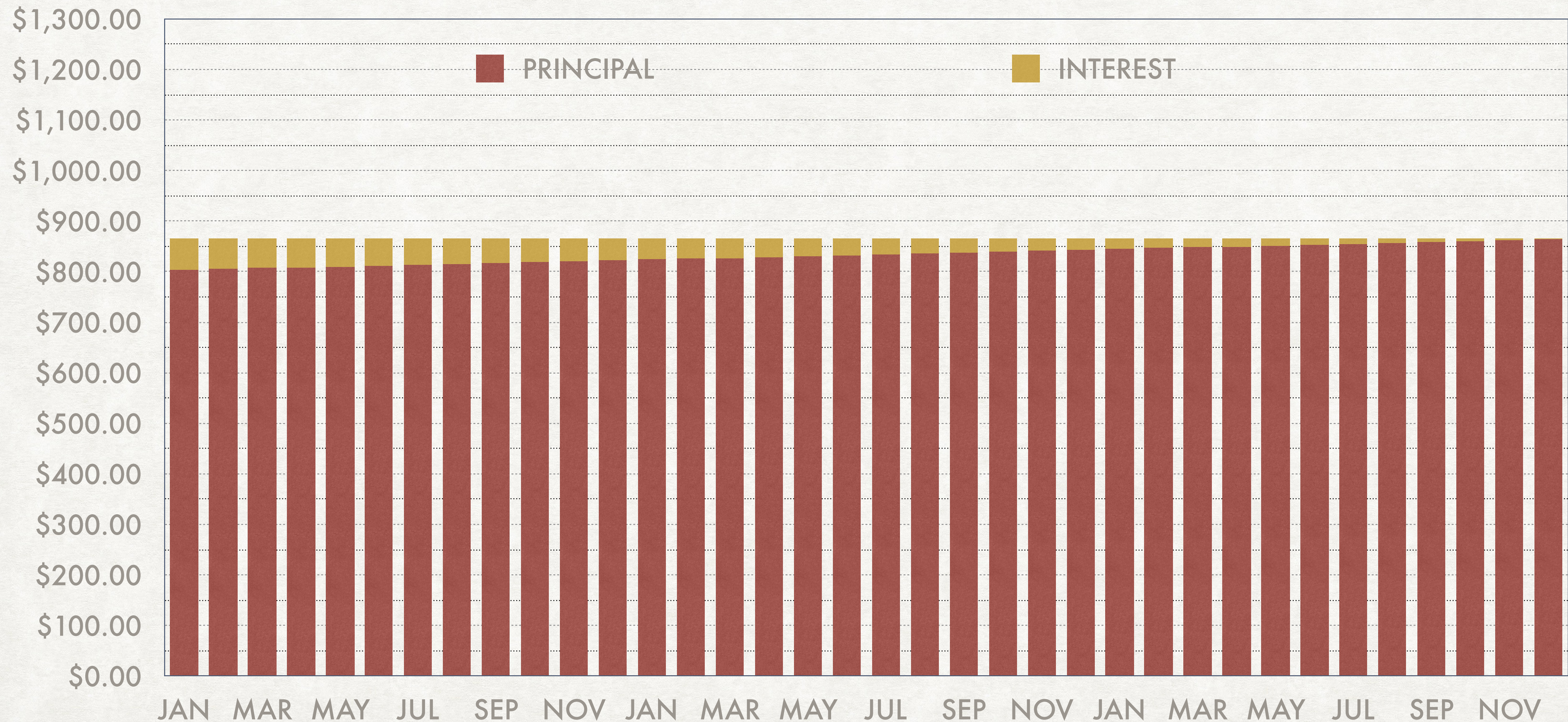
where

- $A$  = 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

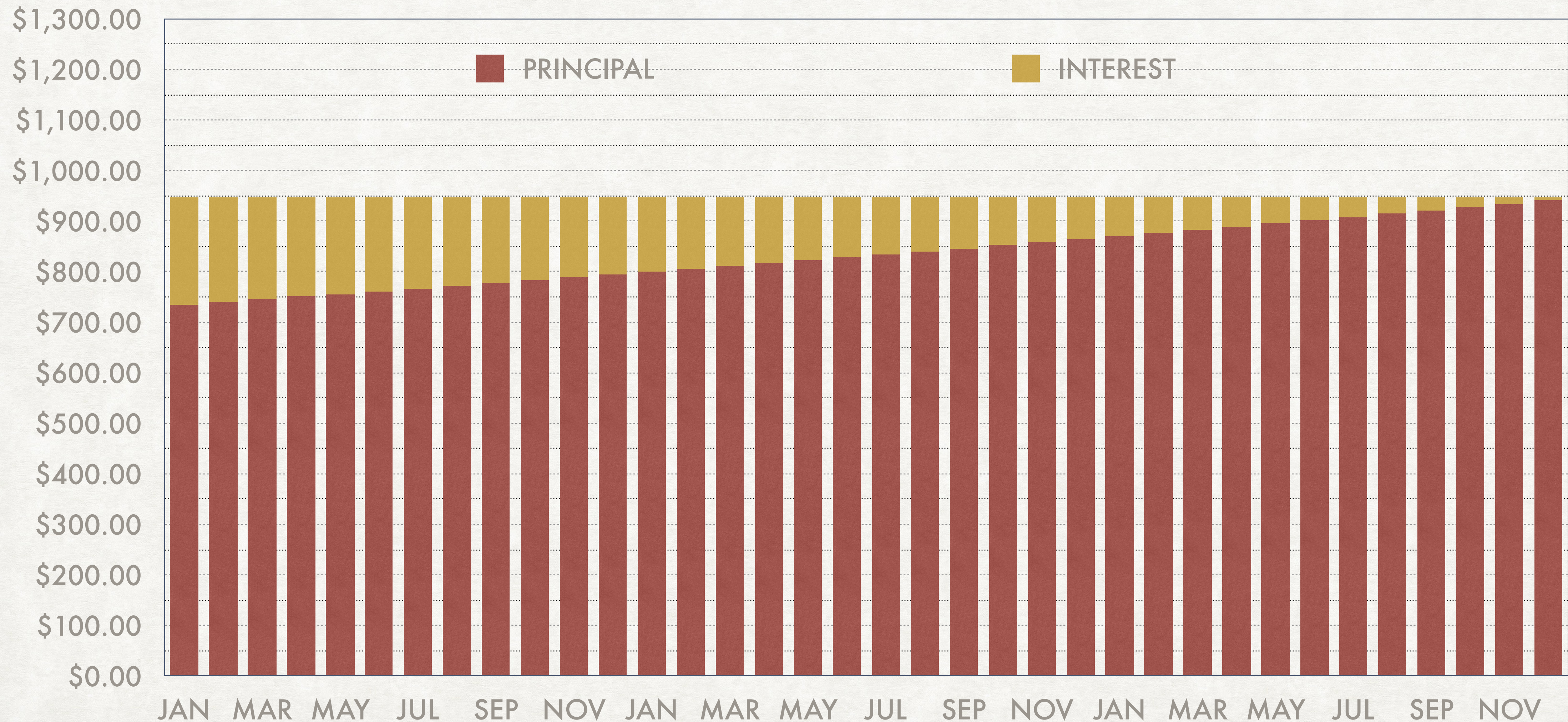


PAYMENT = \$865.84.19 PER MONTH. FIRST MONTH = \$62.50 INTEREST.



# SAMPLE AUTO LOAN

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

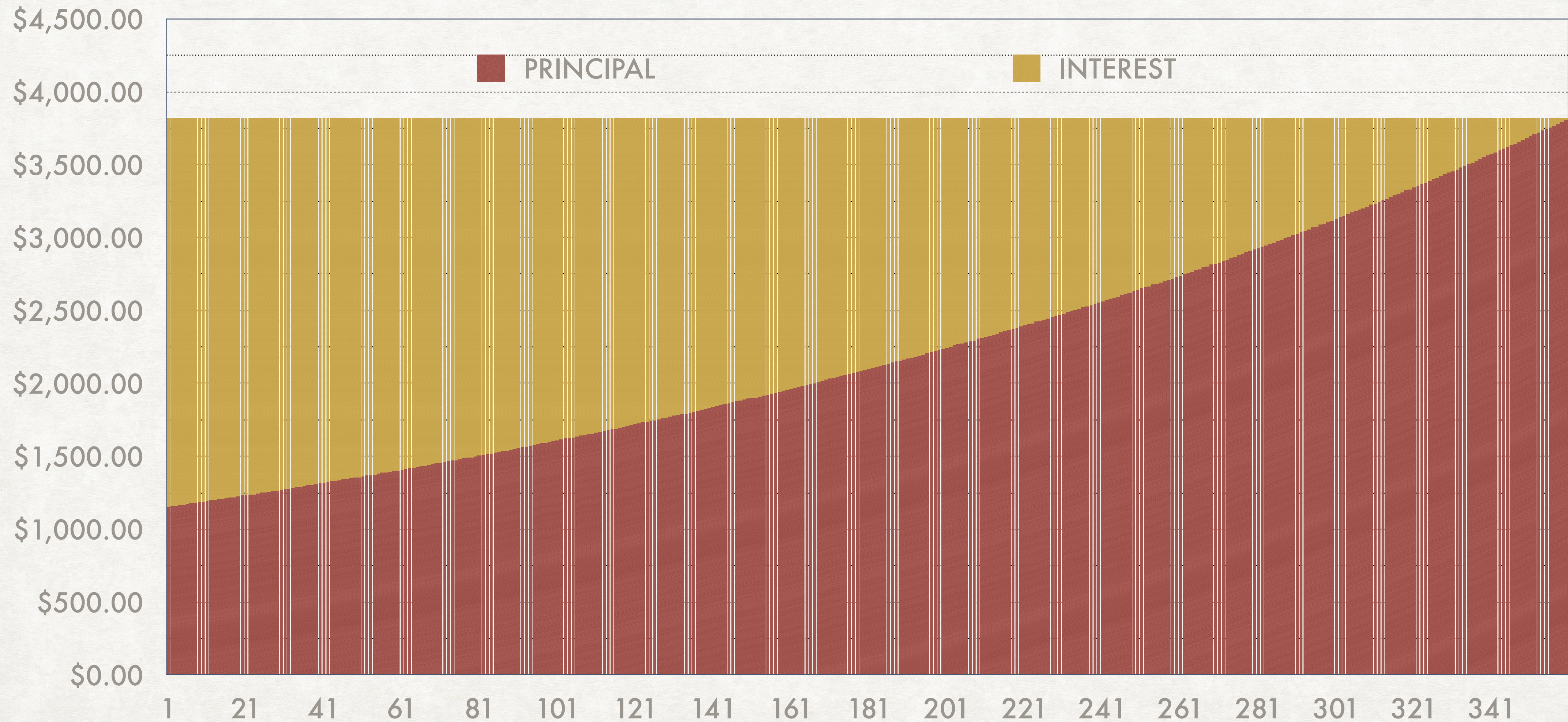


PAYMENT = \$947.03 PER MONTH. FIRST MONTH = \$212.50 INTEREST.



# 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

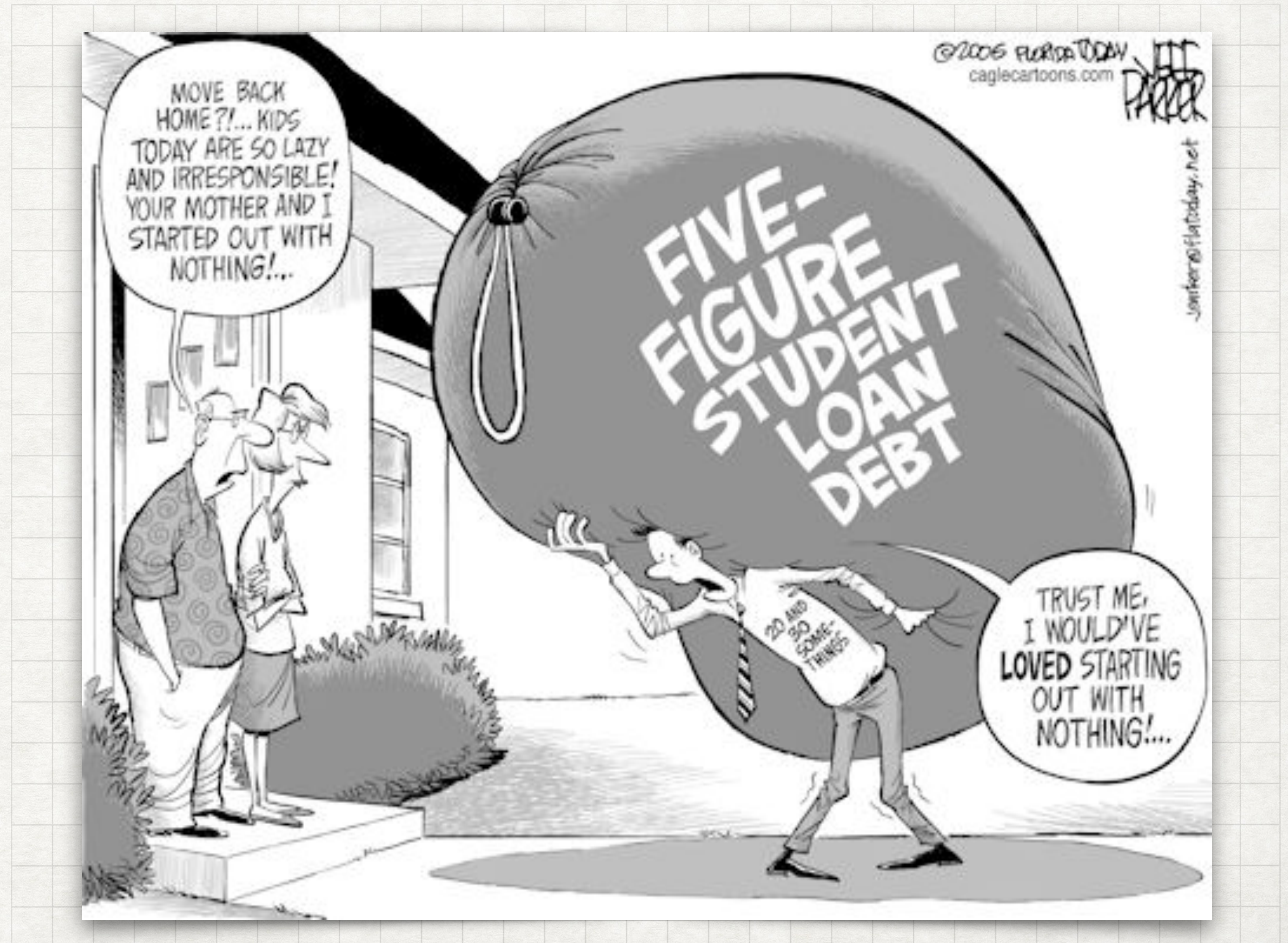
ASSUME \$2,000 IN DEBT PAYMENT PER MONTH

*\* 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

