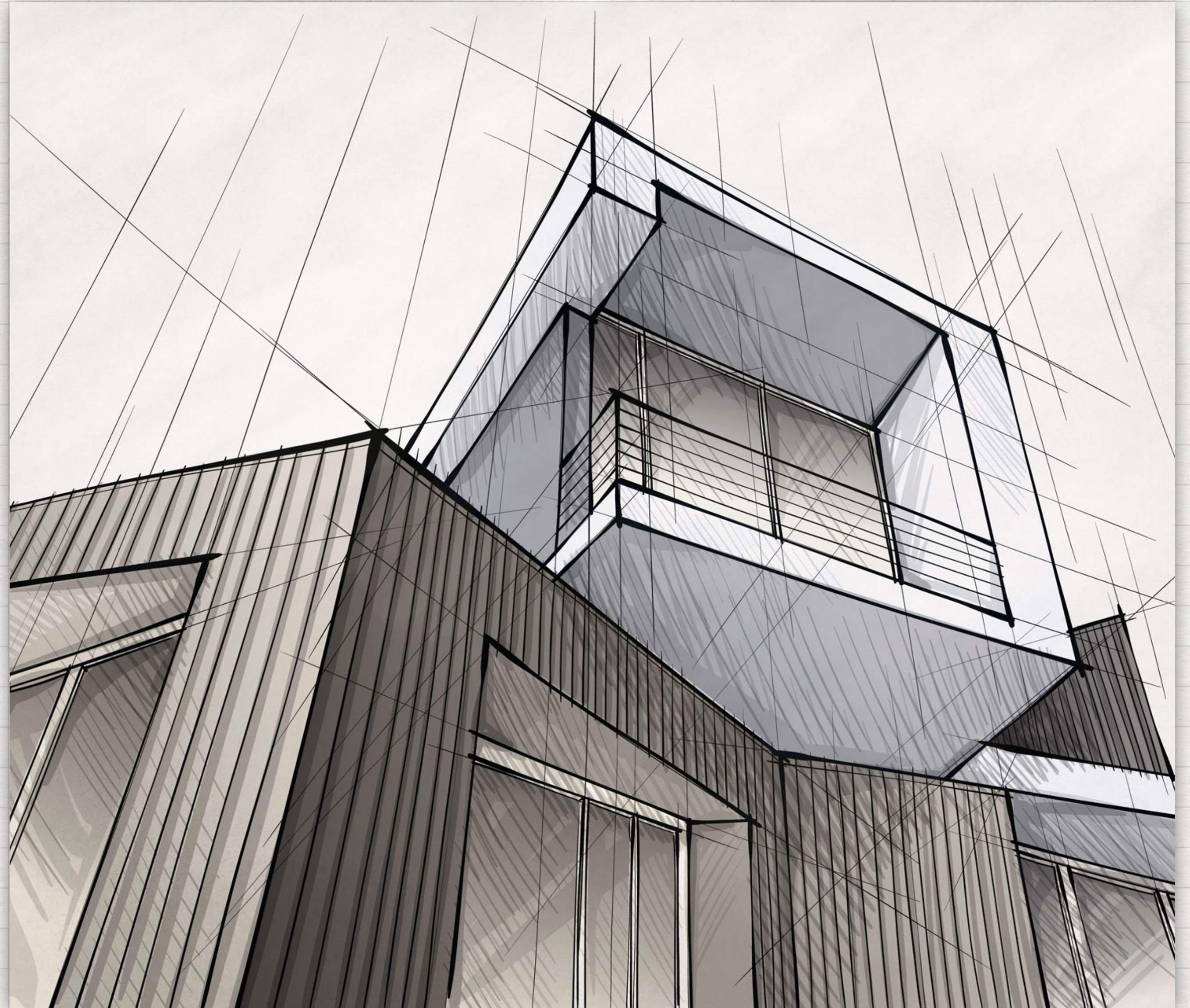


CS 007: SESSION 10

PERSONAL FINANCE FOR ENGINEERS



CS 007

ADDITIONAL TOPICS



SURVEY RESULTS

- Lot of agreement in the free-form entries on survey.
- A few outliers
 - Taxes
 - Climate
 - How to get started
 - More on investing!
- The survey confirms: VC/PE, Crypto, Derivatives

✓ 2

Do you want to cover any of the following topics on December 2nd?

44 out of 44 people answered this question (with multiple choice)

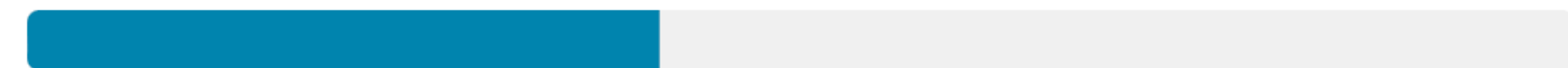
Private Equity / Venture Capital 32 resp. 72.7%



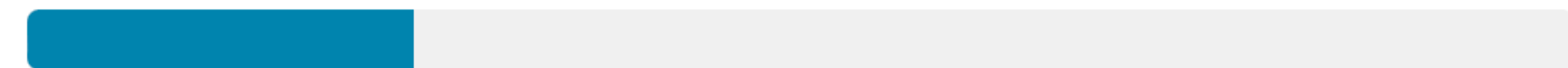
Bitcoin / Ethereum / Cryptocurrencies 22 resp. 50%



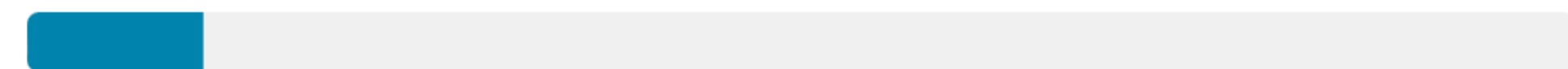
Derivatives (Options) 18 resp. 40.9%



Life Insurance 11 resp. 25%



Charitable Giving & Donor Advised Funds 5 resp. 11.4%



VENTURE CAPITAL & PRIVATE EQUITY

what are they, why do they exist

WHAT IS PRIVATE EQUITY?

- Private equity (PE) is composed of funds & investors that are not publicly traded that **invest directly in private companies or buyout public companies.**
- Technically includes venture capital, but commonly refers to **funds that invest in established companies.**
- Focus is on **long term, illiquid investments.**
- Funds can be used to buy out former investors, fund new development, make acquisitions, expand working capital, establish control to change management and company structure.
- A **private equity firm** typically has multiple funds that can vary in size and approach.
- Funds are structured as partnerships with **general partners** that make investment decisions, and **limited partners** who provide capital.



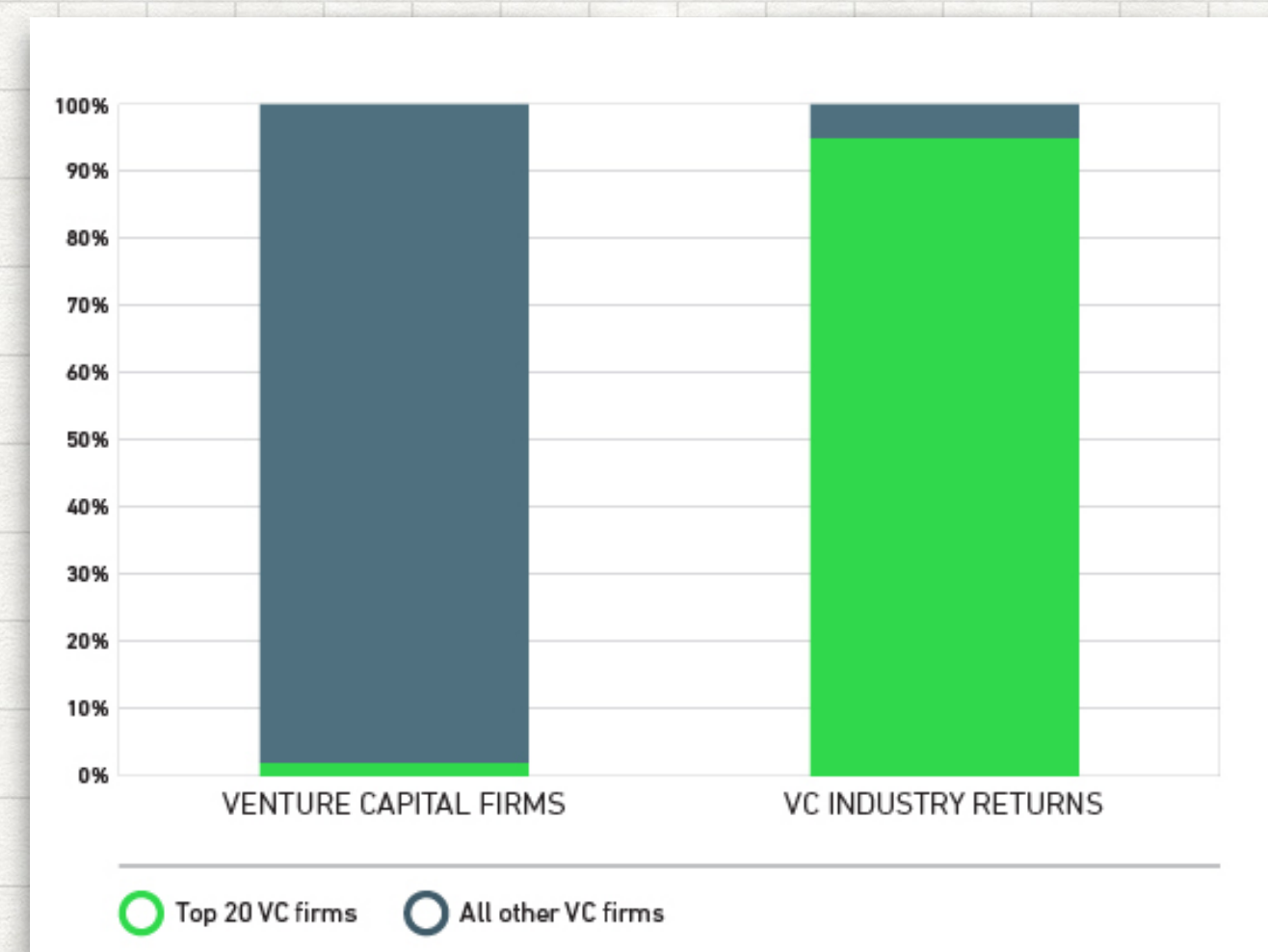
WHAT IS VENTURE CAPITAL?

- Venture capital (VC) is a type of private equity focused on financing small, early-stage, emerging companies with high growth potential.
- Companies are funded in a phased model where more capital is provided as the company executes, eliminating risk and increasing value.
- Originated with wealthy families in the first half of the 20th century.
- Closely associated with the exponential growth of technology companies in Silicon Valley in the 1970s & 80s. Early successes include **Digital Equipment Corporation, Apple Computer & Genentech.**
- ERISA changes in 1978 opened the door for pension funds to invest in venture capital. Industry went from \$750M in 1978 to \$31B by end of the 1980s.

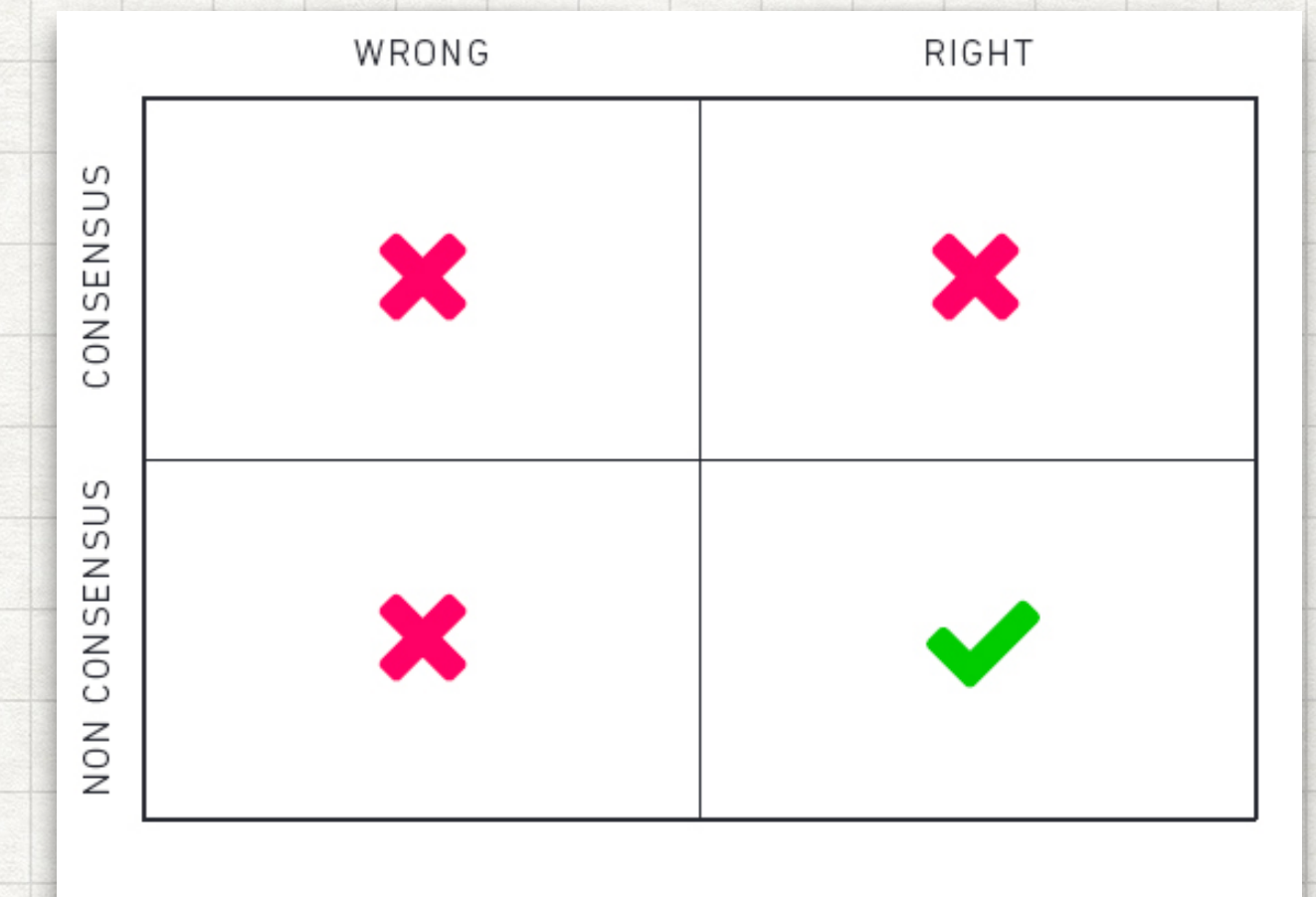


HOW DO VENTURE CAPITALISTS MAKE MONEY?

- Rounds are typically referred to as pre-seed, seed, A, B, C, etc. They receive a special class of shares called "**preferred**" that have extra rights & privileges, but cost more than "**common**"
- Venture capital firms typically receive capital back only in the case of a **liquidity event**, an IPO or an acquisition.
- It can take anywhere from 5-10 years for a venture investment to become liquid.
- Top 20 VC firms (out of approximately 1000) generate about 95% of the industry's returns.
- Limited partners typically expect a significant premium over the stock market to compensate for the additional risk & illiquidity of venture capital.
- 80% of a typical venture capital fund returns are generated by 20% of the investments (William Sahlman).
- As a result, winners have to be very large to return the fund, let alone a venture-class compounded return. A company worth \$1B is a very successful company, but 20% of that company is only worth \$200M. To just return a \$1B fund, you'd need 5 of those. To return 3x the fund, you'd need 15.
- To find investments that 10x your money, you have to be **non-consensus** and **right**. (Howard Marks)



VC Firm Returns



Howard Marks 2x2 Matrix

Biggest problem? You can't get your money into the Top 20 firms.

CRYPTO

basics & common questions

WHAT IS BITCOIN?

- **Bitcoin** is a **cryptocurrency**, a digital asset designed to work as a medium of exchange.
- Paper by **Satoshi Nakamoto** (who is unknown) published on 10/31/2008, *"A System for Electronic Transactions Without Relying on Trust"*
- Network went live in January 2009 with first open source client & bitcoins. Satoshi mined the first block ever ("the genesis block")
- **Blockchain** is a cryptographically secure, distributed ledger for transactions.
- Fixed supply, constrained to 21M total possible. **Scarcity is designed into the system.**
- Bitcoin are issued as rewards for "mining", which is the process of adding compute to the network.



WHY IS BITCOIN INTERESTING?

- Publicly transparent & uncensored distributed ledger for financial transactions.
- A digital asset that cannot be freely copied, with enforced scarcity.
- A “digital store of value”
- **Byzantine Generals’ Problem**
Original paper describing from 1982*
Satoshi explanation from 2008**
- Cryptographically secure.
- Network with the highest value (as measured by coin-based market capitalization)



Solutions for achieving Byzantine fault tolerance



Proof-of-work



Proof-of-Stake



Delegated Proof-of-Stake

* <https://www.microsoft.com/en-us/research/publication/byzantine-generals-problem/>

** <https://www.mail-archive.com/cryptography@metzdowd.com/msg09997.html>

*** <https://cointelegraph.com/learn/articles/how-does-blockchain-solve-the-byzantine-generals-problem>

WHAT IS ETHEREUM?

- Ethereum is a decentralized platform that runs smart contracts.
- Blockchain-based distributed computing.
- Launched 2014.
- Ether is the digital asset.
- Supply of Ether not limited. Built in inflation of 18m (max) per year, but staking & burning now lowering supply.
- Big multi-year migration to “Proof of Stake” executed in 2022.

The Merge

On September 15th, 2022 06:42:42 UTC, at block 15537393, [The Merge](#) was completed, moving Ethereum from Proof of Work (PoW) to Proof of Stake (PoS). Amazon Managed Blockchain's Ethereum Mainnet nodes run on the Ethereum PoS network.

The Merge upgrades Ethereum's consensus from PoW to PoS by merging Ethereum Mainnet with the Beacon Chain Proof of Stake system. This upgrade improved the sustainability of Ethereum by lowering energy consumption and was part of Ethereum foundation's ongoing upgrades to improve scalability, security, and sustainability as described [here](#).



HOW MUCH IS BITCOIN WORTH?

- First bitcoin transaction was on May 22, 2010, purchasing two Papa John's pizzas for 10,000 BTC.
- In five days, price of BTC went from \$0.008 to \$0.08, a gain of 1000%.
- Bitcoin was less than \$1,000 on 1/1/2017
 - Bitcoin was \$11,600 on 12/4/2017
 - Bitcoin was \$3,896 on 12/3/2018
 - Bitcoin was \$7,314 on 12/1/2019
 - Bitcoin was \$17,597 on 11/17/2020
 - Bitcoin was \$50,615 on 12/6/2021
 - Bitcoin was \$17,015 on 12/5/2022
 - Bitcoin was \$41,249 on 12/6/2023
 - Bitcoin was \$95,348 on 12/2/2024
- Is there a fundamental basis for valuing Bitcoin?
How do you value an asset that generates no cash flow?

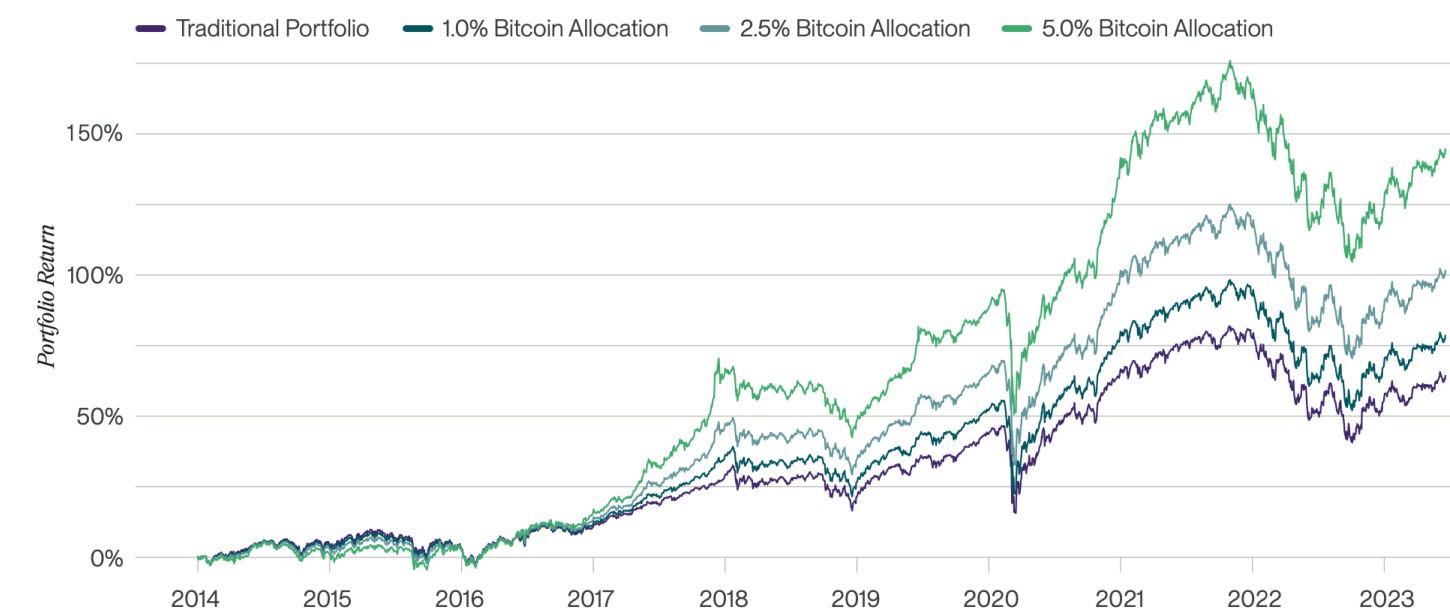


WHAT WOULD BITCOIN LOOK LIKE IN A DIVERSIFIED PORTFOLIO?

- As of the end of 2023:****
 - Global equity markets: ~\$115T
 - Global bond markets: ~\$140.7T
- Bitcoin is currently valued at ~\$2T
- Bitwise Investments estimates** the correlation of Bitcoin to only 0.08 with Equities (VTI), 0.02 with Bonds (BND).
- Bitwise Investments*** has a portfolio simulator that allows you to view how your portfolio would have performed w/ either Bitcoin or the Bitwise 10 Index.
- Increasing possibility that cryptocurrency becomes an asset class, long term.

Figure 1:

Traditional Portfolio With and Without Quarterly-Rebalanced Bitcoin Allocations



Source: Bitwise Asset Management with data from IEX Cloud. Data from January 1, 2014 to June 30, 2023.

Past performance does not predict or guarantee future results. Nothing contained herein is intended to predict the performance of any investment. There can be no assurance that actual outcomes will match the assumptions or that actual returns will match any expected returns. Historical performance of sample portfolios has been generated and maximized with the benefit of hindsight. The returns do not represent the returns of an actual account and do not include the fees and expenses associated with buying, selling and holding funds or crypto assets. Performance information is provided for informational purposes only.

Table 1:

Portfolio Performance Metrics (Assuming Quarterly Rebalancing)

Portfolio	Cumulative Return	Annualized Return	Volatility (Annualized Std. Dev.)	Sharpe Ratio	Maximum Drawdown
Traditional 60/40 Portfolio	64.34%	5.38%	10.59%	0.290	22.67%
Traditional Portfolio + 1.0% Bitcoin	78.56%	6.31%	10.65%	0.373	23.31%
Traditional Portfolio + 2.5% Bitcoin	101.57%	7.67%	10.88%	0.488	24.26%
Traditional Portfolio + 5.0% Bitcoin	144.68%	9.90%	11.61%	0.645	25.87%

Source: Bitwise Asset Management with data from IEX Cloud. Data from January 1, 2014 to June 30, 2023.

Past performance does not predict or guarantee future results. Nothing contained herein is intended to predict the performance of any investment. There can be no assurance that actual outcomes will match the assumptions or that actual returns will match any expected returns. Historical performance of sample portfolios has been generated and maximized with the benefit of hindsight. The returns do not represent the returns of an actual account and do not include the fees and expenses associated with buying, selling and holding funds or crypto assets. Performance information is provided for informational purposes only.

Please note:
this is not an endorsement for Bitwise Investments. Adam Nash is a seed investor & advisor to the company.

* <https://www.bitwiseinvestments.com/resources>

** <https://bitwiseinvestments.com/tools/correlations>

*** <https://s3.amazonaws.com/static.bitwiseinvestments.com/Research/Bitcoins-Role-in-a-Traditional-Portfolio-08-2023.pdf>

**** <https://www.sifma.org/resources/research/statistics/fact-book/#:~:text=Global fixed income markets outstanding,+3.3% Y/Y.>

DERIVATIVES

futures & options

WHAT IS A DERIVATIVE?

- A **derivative** is a security that is dependent upon one or more underlying assets.
- A derivative can be created by a unique contract or standardized for trading on exchanges.
- The most common standardized derivatives are: **futures & options**
- They are often used for **hedging** or **speculation**.
- The overall notional value for derivatives was estimated at **\$618 Trillion in 2022**, more than 6x the size of global GDP.



Derivatives are financial weapons of mass destruction.

— *Warren Buffett* —

AZ QUOTES

WHAT IS A FUTURE?

- A future is a **contract for the future sale** of a commodity at a pre-determined time & price.
- Original use cases included **farming & shipping**.
- First exchange in feudal Japan, **Dojima Rice Exchange**.
- Futures are settled by delivery of the underlying goods, on the date and at the time specified.
- **Clearinghouses** ensure that contract payments are fulfilled.



WHAT IS AN OPTION?

- An option is the right to either buy or sell a security by a future date.
- European options can only be exercised on the expiration date.
- American options can be exercised anytime up to the expiration date.
- A call option is the right to buy
- A put option is the right to sell

3 33 333	25,12	27,94	17,19	-0,06	-0,14%
3 33 333	17,32	17,12	17,19	+0,56	1,91%
3 33 333	41,27	38,96	42,14	+0,17	3,52%
3 33 333	27,72	25,96	27,07	+0,26	0,89%
3 33 333	22,18	22,73	21,18	-1,14	-4,08%
3 33 333	28,78	25,18	27,33	+13,53	3,32%
3 33 333	97,22	96,73	96,51	+0,82	0,54%
3 33 333	25,32	25,78	25,32	+0,41	1,62%
3 33 333	29,81	27,18	29,81	+0,28	1,33%
3 33 333	31,47	31,47	31,47	0	0%

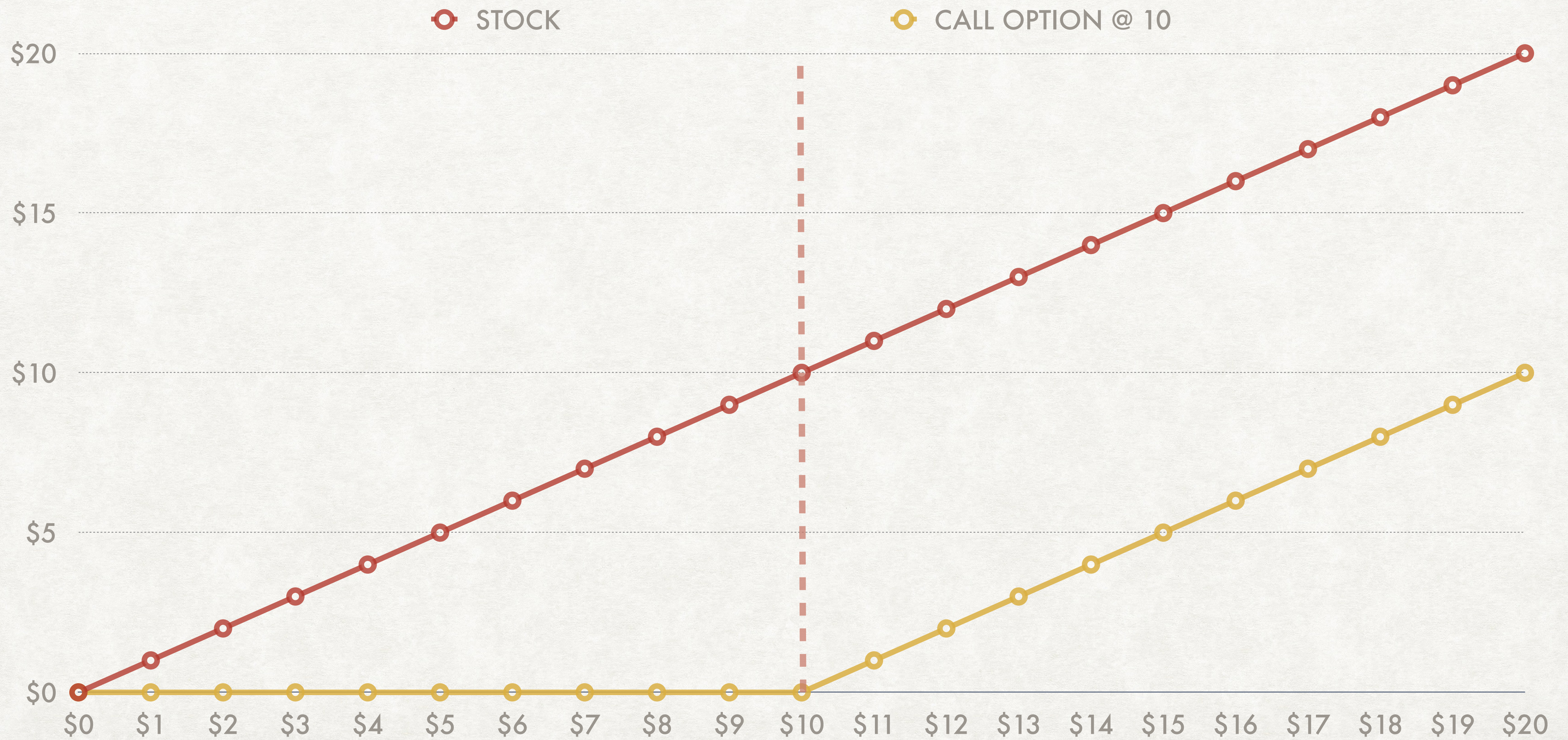
HOW DO YOU VALUE AN OPTION?

- There are multiple factors that affect the value of a stock option.
 - Current stock price
 - Intrinsic value
 - Time to expiration
 - Volatility
 - Interest rates
 - Cash dividends
- **Black-Scholes** was developed in 1973 by Fischer Black, Robert Merton & Myron Scholes.
- “**Fair Value**” often refers to the Black-Scholes value for a derivative, although there are other methods to calculate the value of a derivative.
- The price of an option is called the **premium**, and is quoted as a per share price even though options trade in blocks of 100.



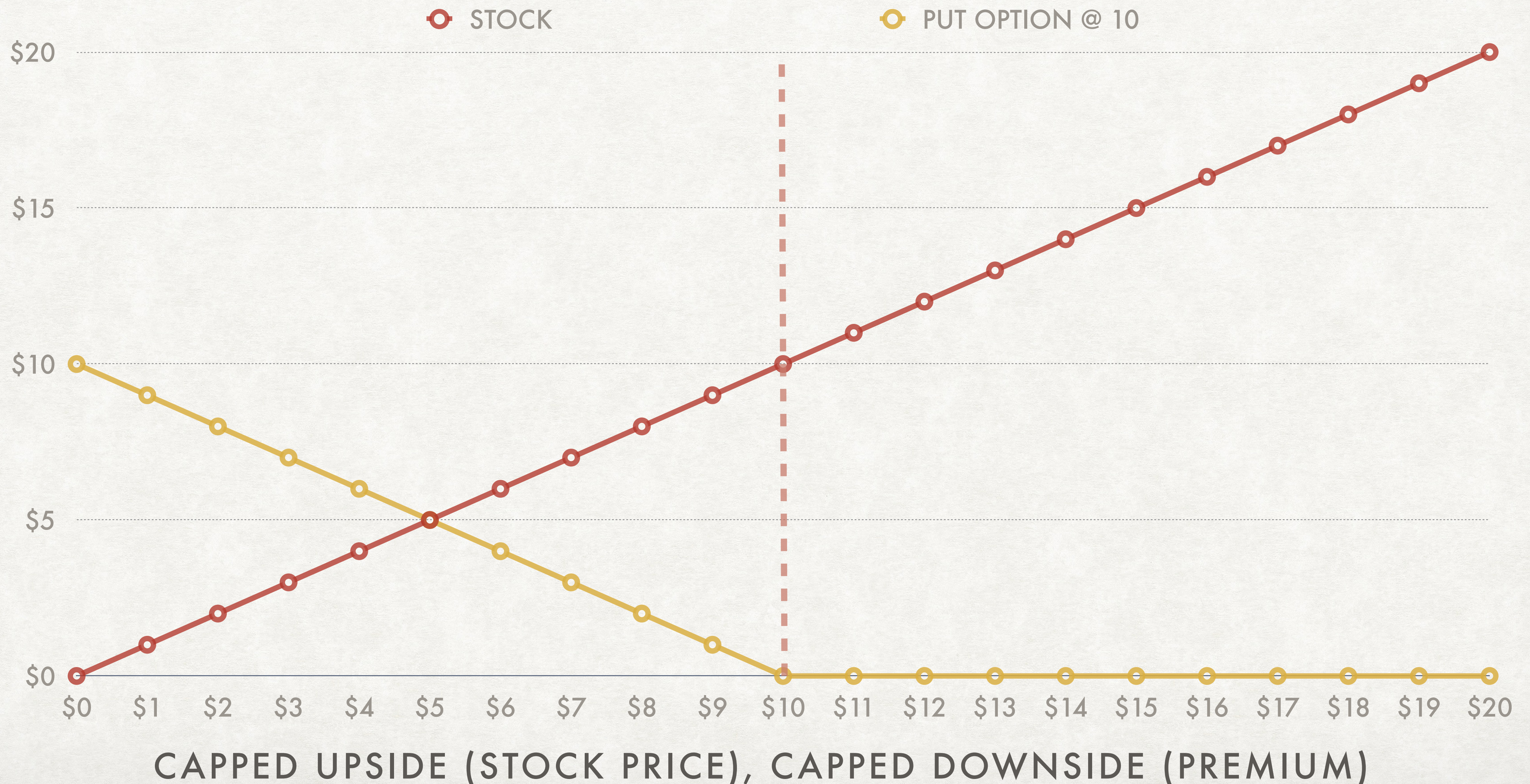
$$\frac{\partial V}{\partial t} + \frac{1}{2}\sigma^2 S^2 \frac{\partial^2 V}{\partial S^2} + rS \frac{\partial V}{\partial S} - rV = 0$$

EXAMPLE: BUYING A CALL OPTION (INTRINSIC VALUE)

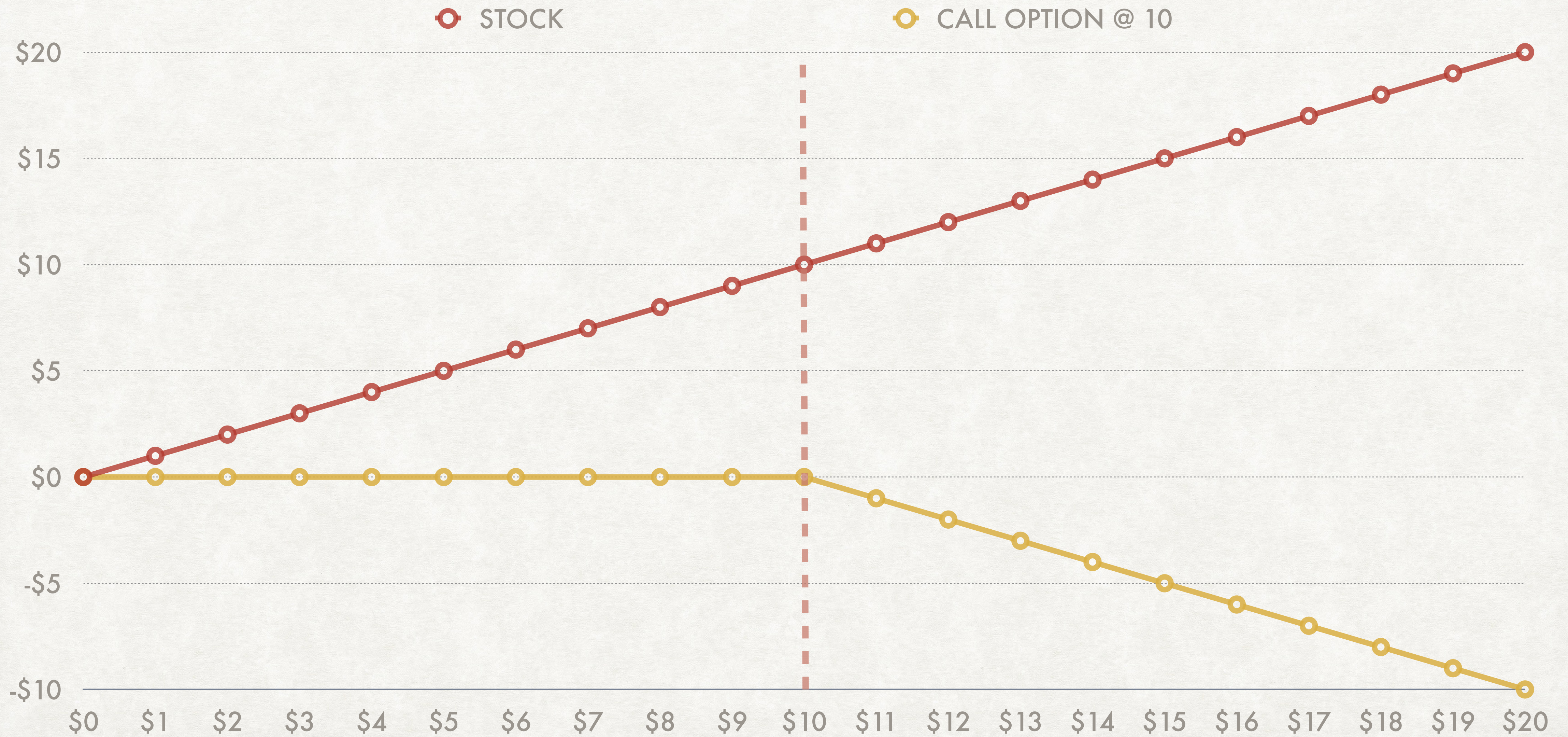


UNLIMITED UPSIDE, CAPPED DOWNSIDE (PREMIUM)

EXAMPLE: BUYING A PUT OPTION (INTRINSIC VALUE)

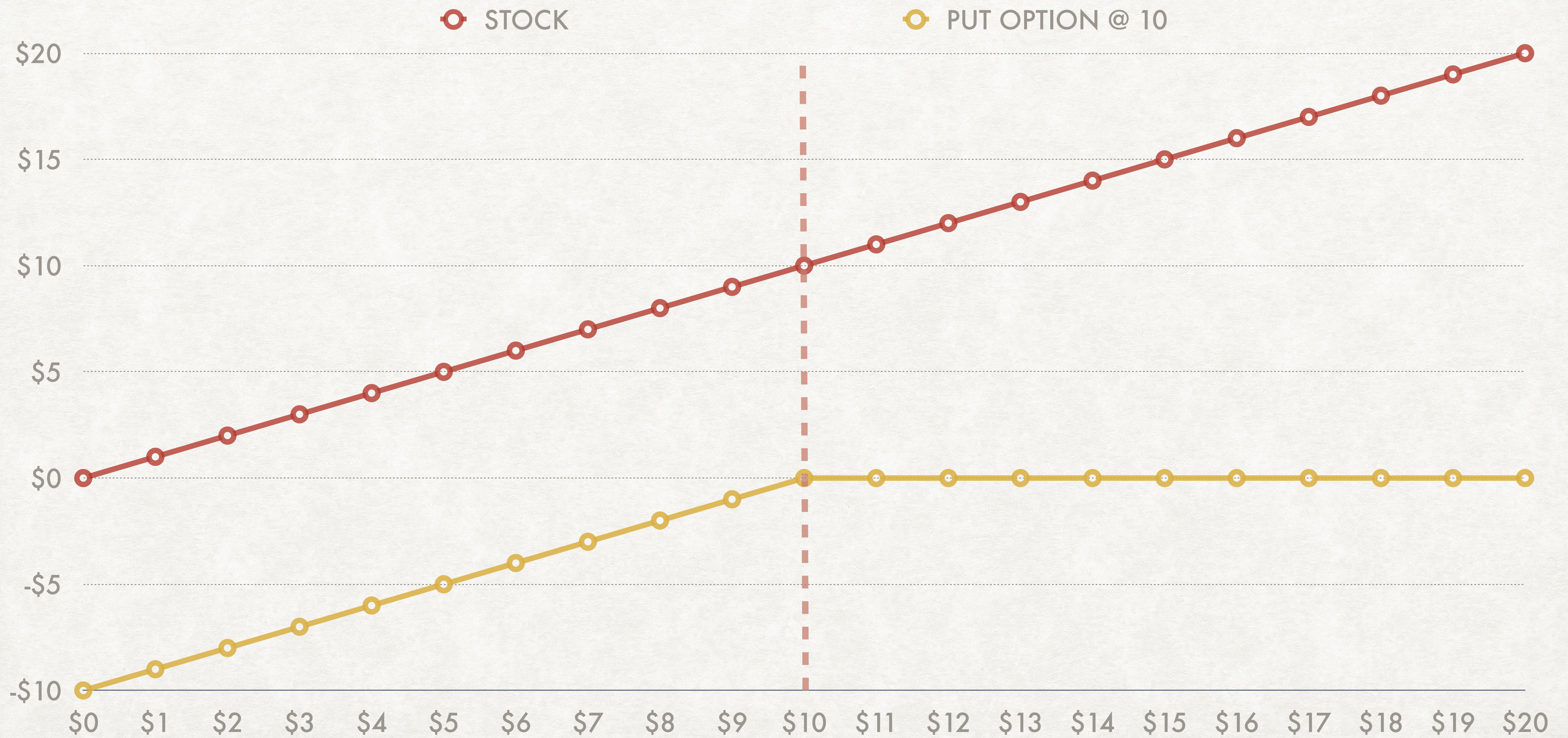


EXAMPLE: SELLING A CALL OPTION (INTRINSIC VALUE)



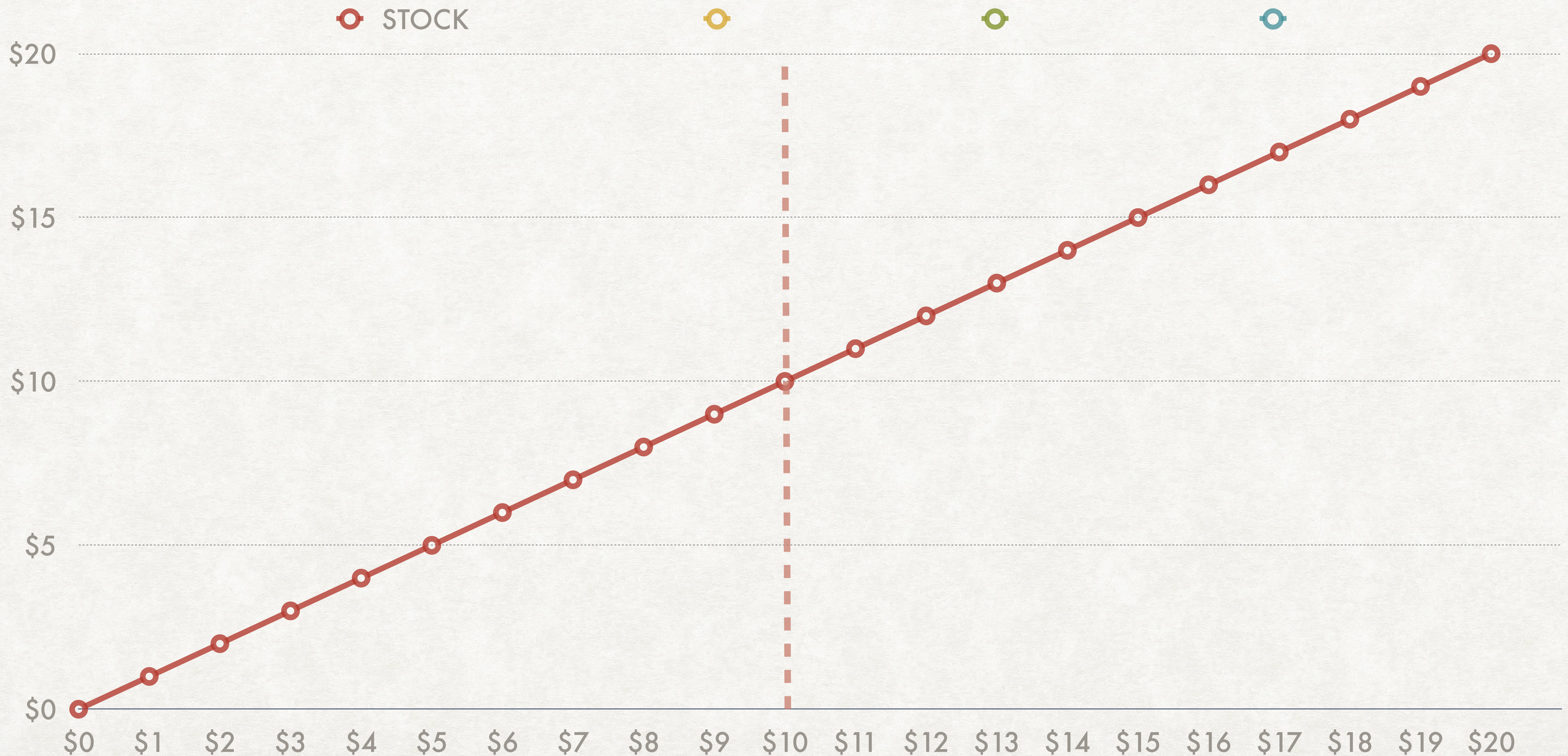
CAPPED UPSIDE (PREMIUM), UNLIMITED DOWNSIDE

EXAMPLE: SELLING A PUT OPTION (INTRINSIC VALUE)



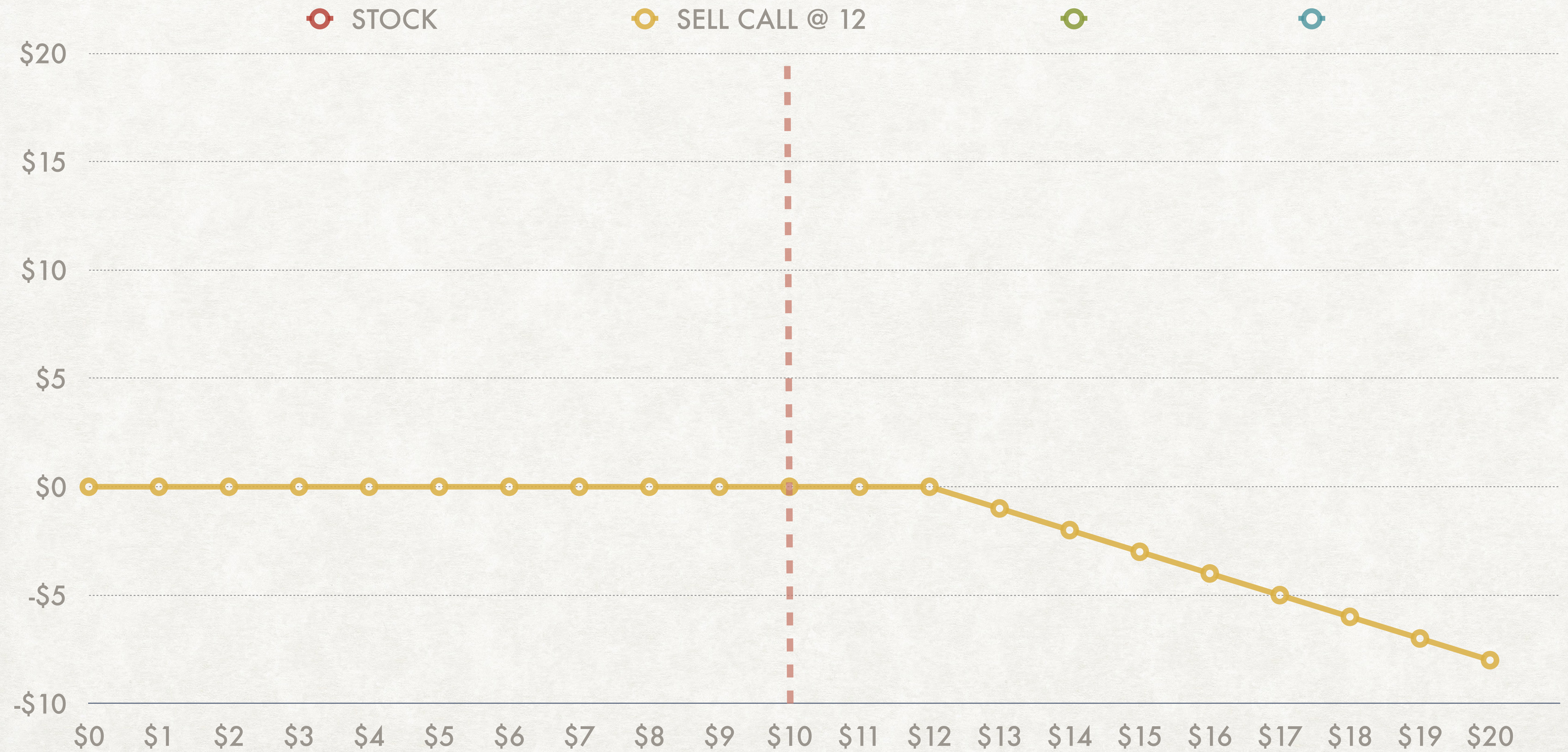
CAPPED UPSIDE (PREMIUM), CAPPED DOWNSIDE (STRIKE PRICE)

COMBINATIONS: A ZERO COST COLLAR (INTRINSIC VALUE)



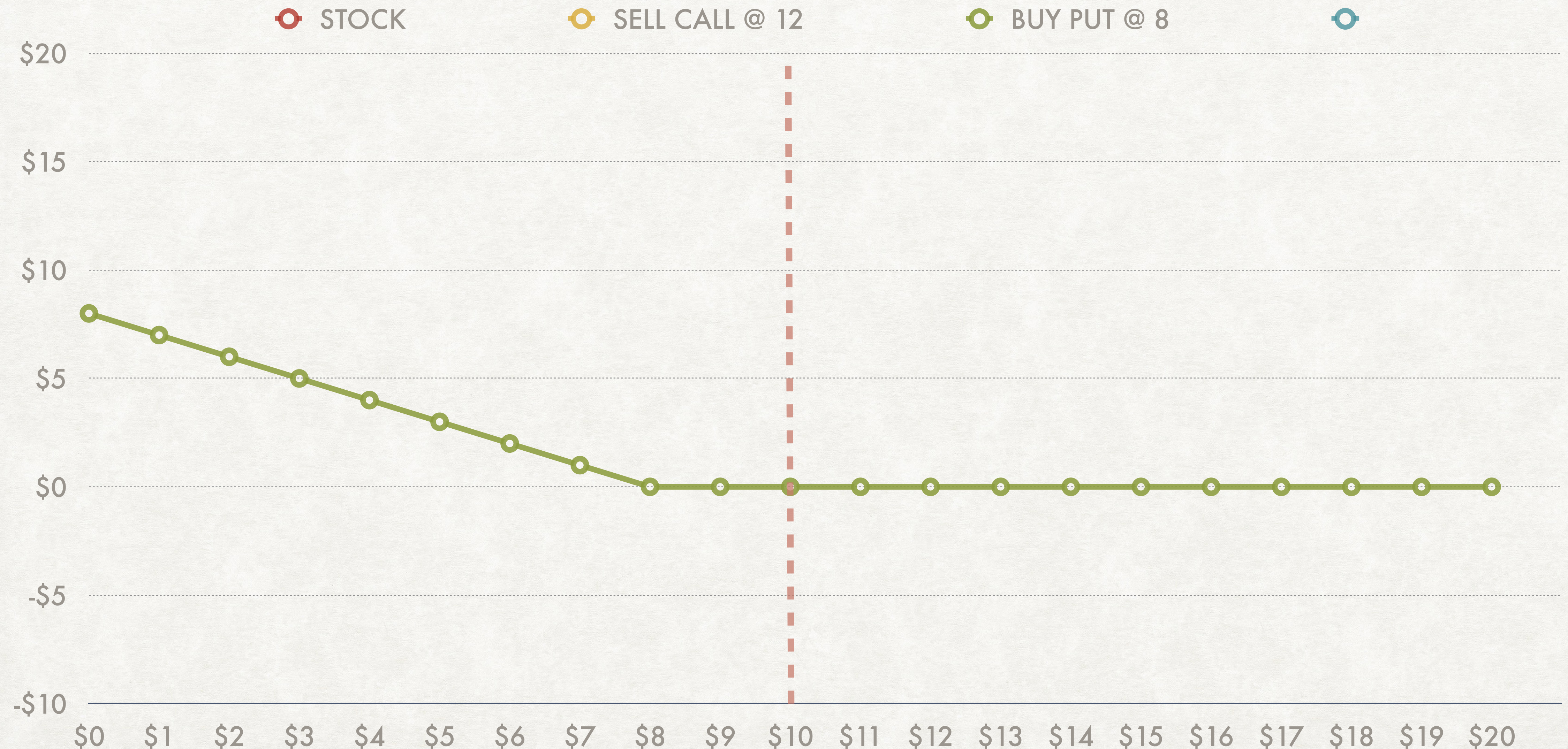
ASSUME YOU HAVE STOCK YOU WANT TO HOLD, BUT PROTECT DOWNSIDE

COMBINATIONS: A ZERO COST COLLAR (INTRINSIC VALUE)



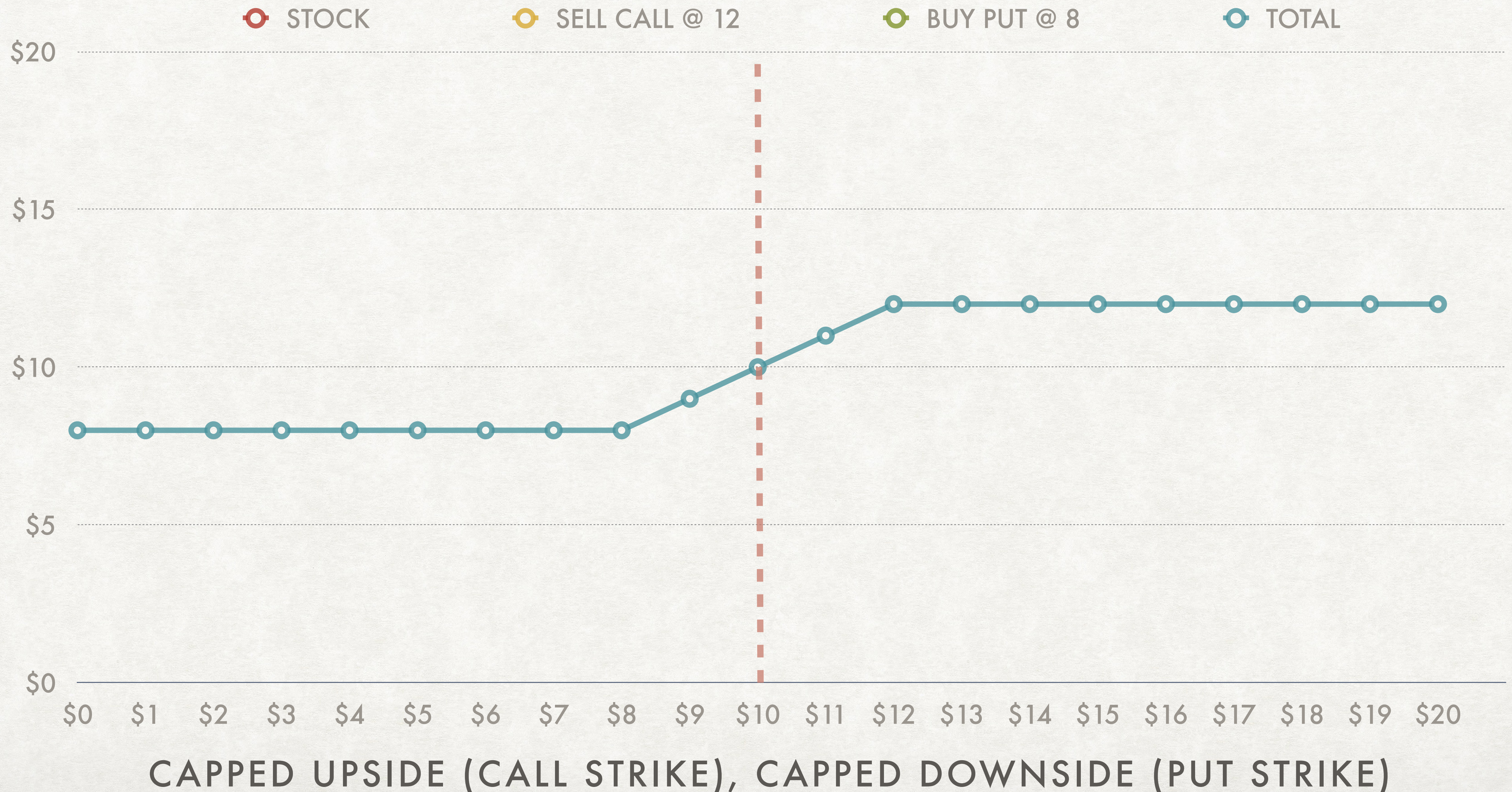
SELLING CALL GIVES YOU CASH TO BUY PUT, BUT LIMITS UPSIDE TO 12

COMBINATIONS: A ZERO COST COLLAR (INTRINSIC VALUE)

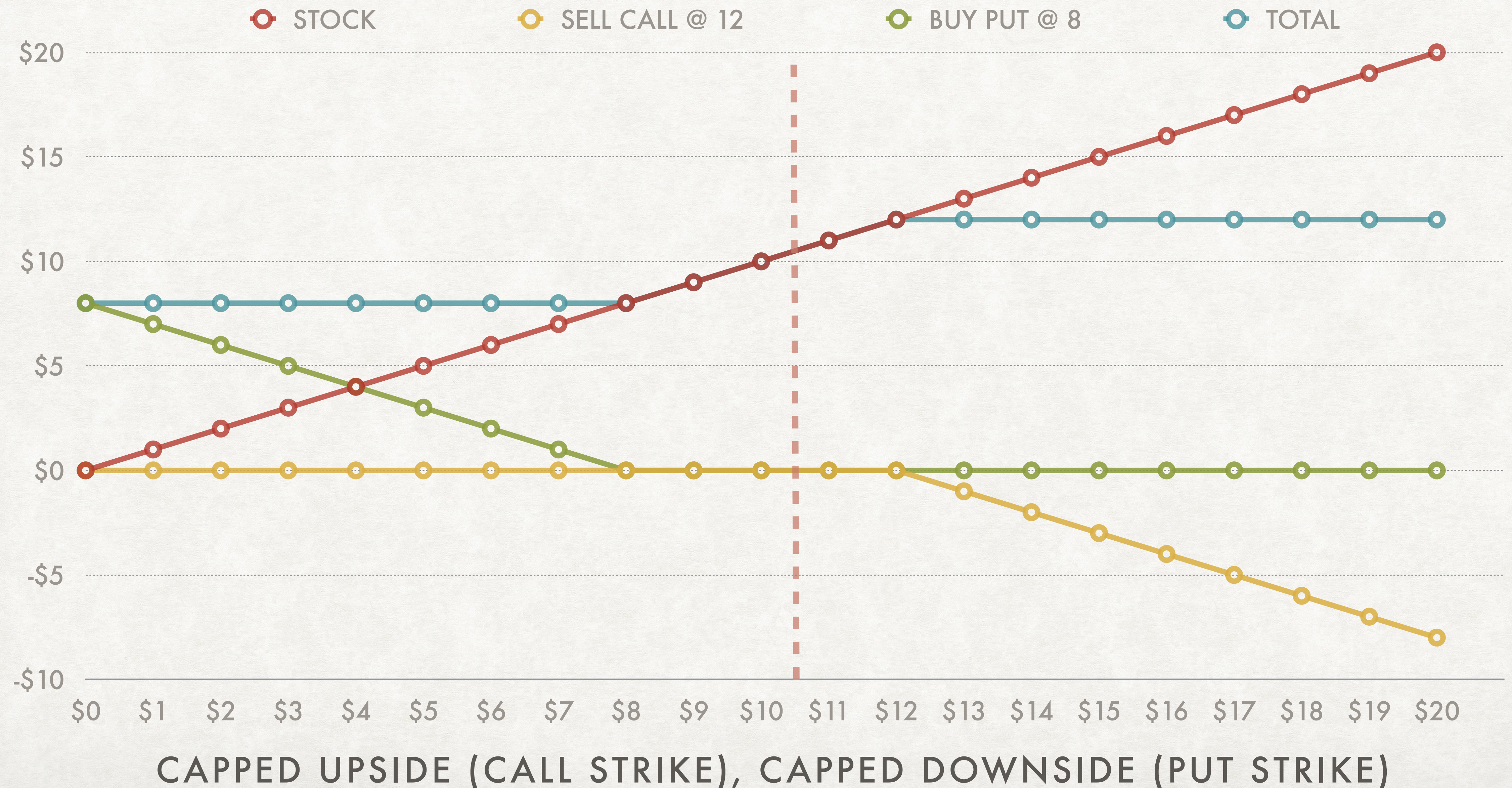


PUT GIVES YOU INSURANCE IF THE STOCK FALLS BELOW 8

COMBINATIONS: A ZERO COST COLLAR (INTRINSIC VALUE)



COMBINATIONS: A ZERO COST COLLAR (INTRINSIC VALUE)



CS 007

QUESTIONS

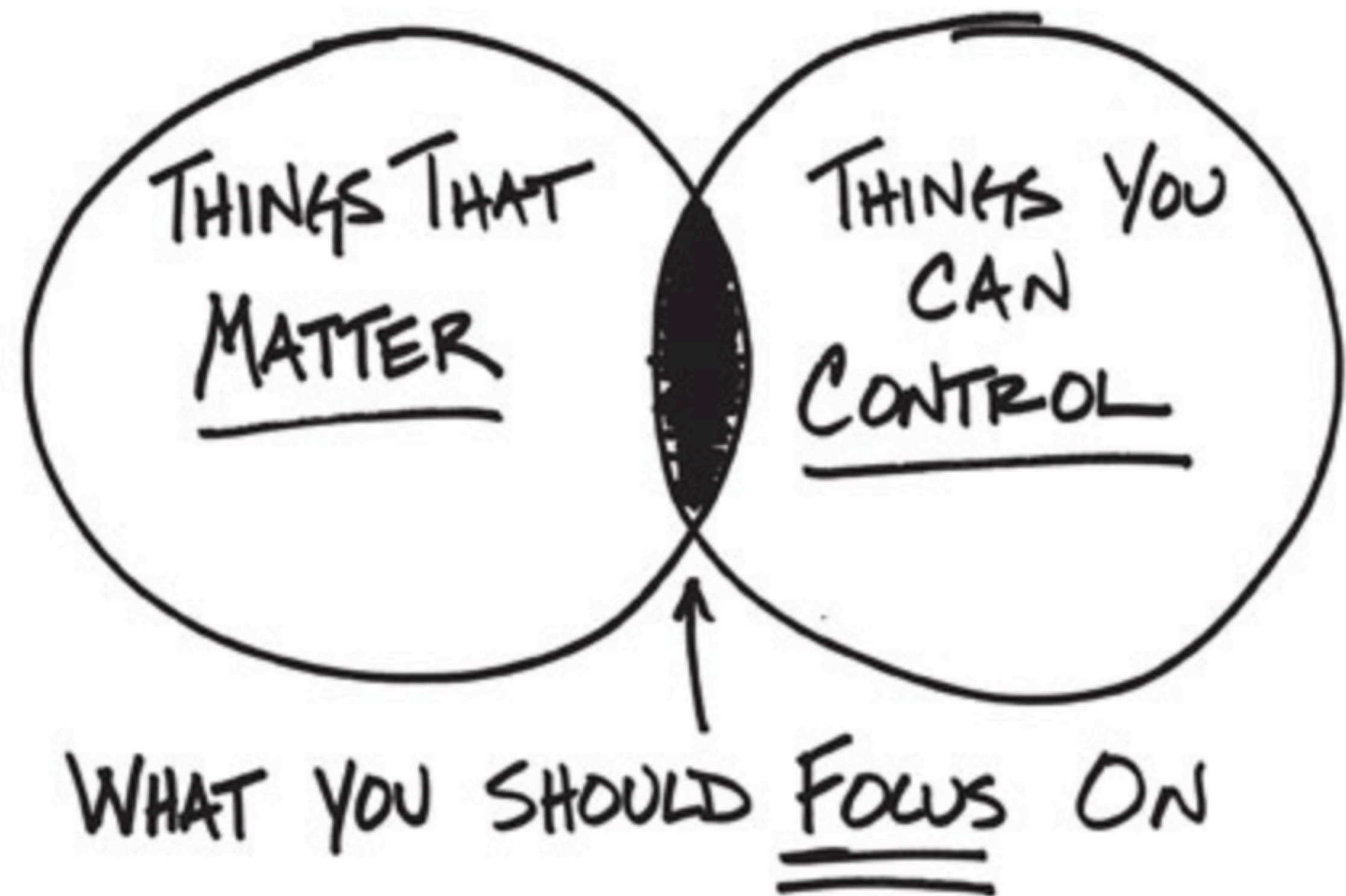


FINAL THOUGHTS

wrapping up

FIRST SLIDE: WHY PERSONAL FINANCE?

- Poorly covered in secondary school & university curricula, even at top schools.
- Not technically difficult, but the signal-to-noise ratio is terrible.
- Massive impact on your life.
- Affects everyone.



BEHAVIORGAP.COM

LAST SLIDE: THINGS TO DO AFTER THIS CLASS

- **Keep thinking actively** about your financial plans and decisions.
- **Discuss personal finance** and related topics with your friends & family.
- Don't be afraid to make decisions, and **learn from your mistakes**. Better to make them when the dollars are small and your responsibilities are few.
- **Be skeptical** of any quick and easy paths to financial success.
- Always remember: good investing is boring.
- Please join the **CS 007 alumni group**, a private list for students who have taken this class and want a safe place to discuss personal finance questions.

