FIN 4500
Chapter 8
Hedging with Derivatives

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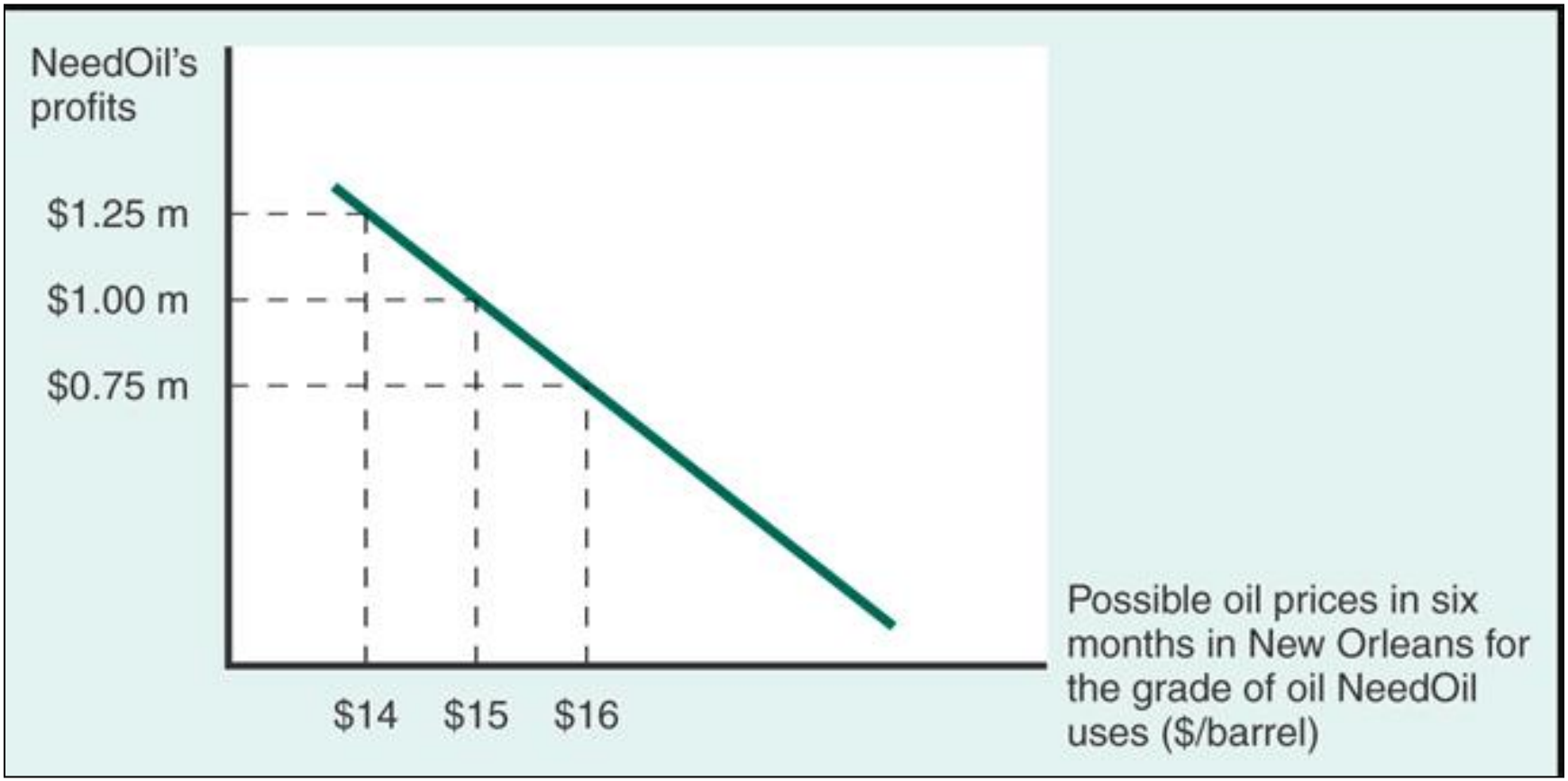
- Hedging with options
- Hedging with forwards/futures
- Derivatives vs insurance
- Institutional arrangements

8.1 Hedging Using Derivatives

- Important part of modern risk management
  - Examples of the types of risk that are hedged
    - commodity prices
    - interest rates
    - exchange rates
- Derivative markets are huge

Exposure Diagrams



- Higher oil price → Lower NeedOil profits

Hedging Oil Price Risk with Call Options

- Thus → **NeedOil has oil price risk**
  - To reduce its oil price risk, NeedOil signs a contract with OPTCO:
    - OPTCO pays NeedOil in six months

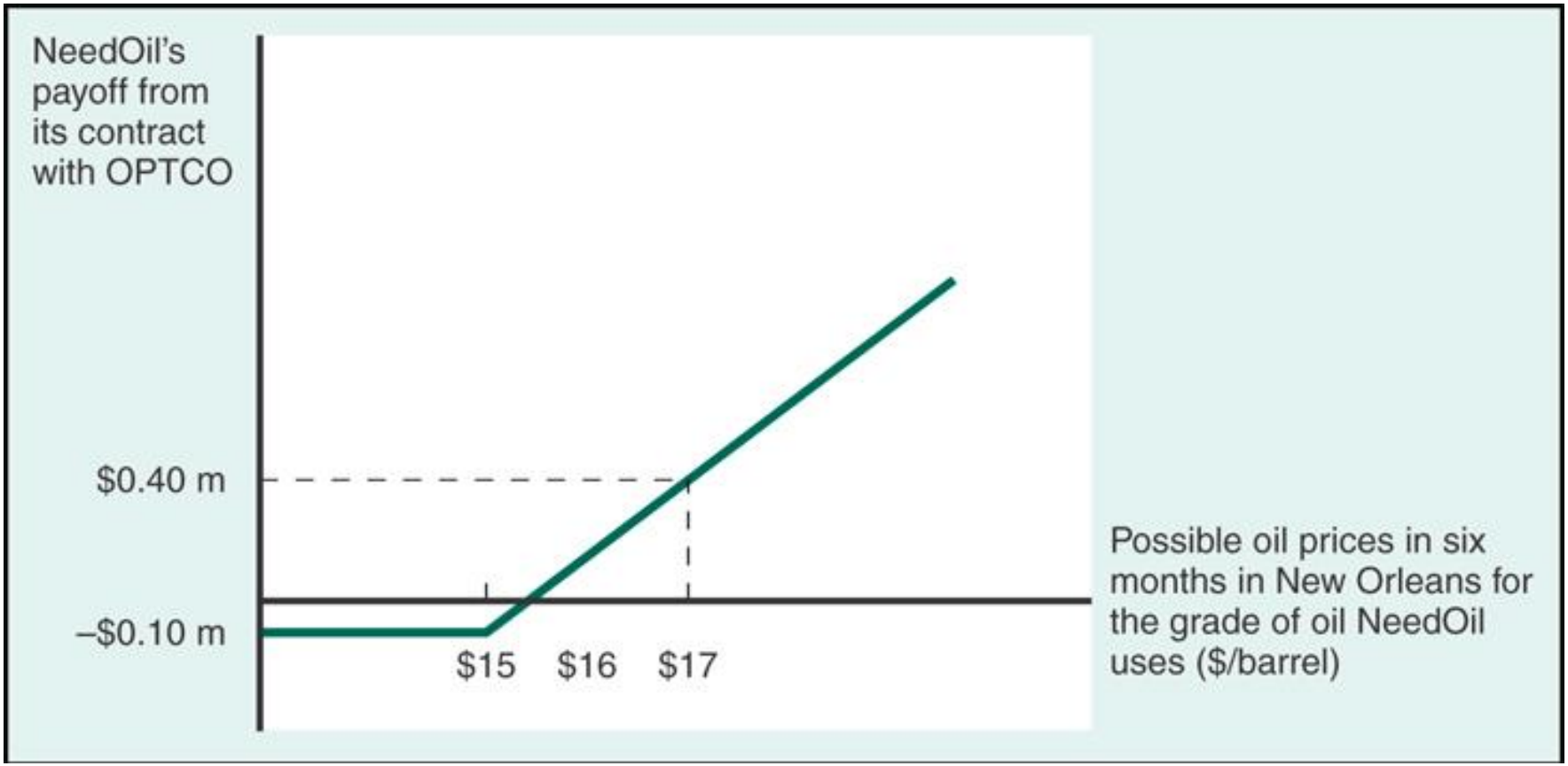
      $250{,}000 * (P_{oil} - \$15)$ if $P_{oil} > \$15$

      0 if $P_{oil} < \$15$

    - NeedOil pays OPTCO $100,000 today -- cost

- NeedOil: contract buyer
- OPTCO: contract seller

NeedOil's Payoff from the call option



NeedOil's Profit (Calculation)

- What are NeedOil's profits (ignore discounting)?

if oil price = $14 ==>

profits from operations	= $1,250,000
profits from OPTCO contract	= -$100,000
total profits	= $1,150,000

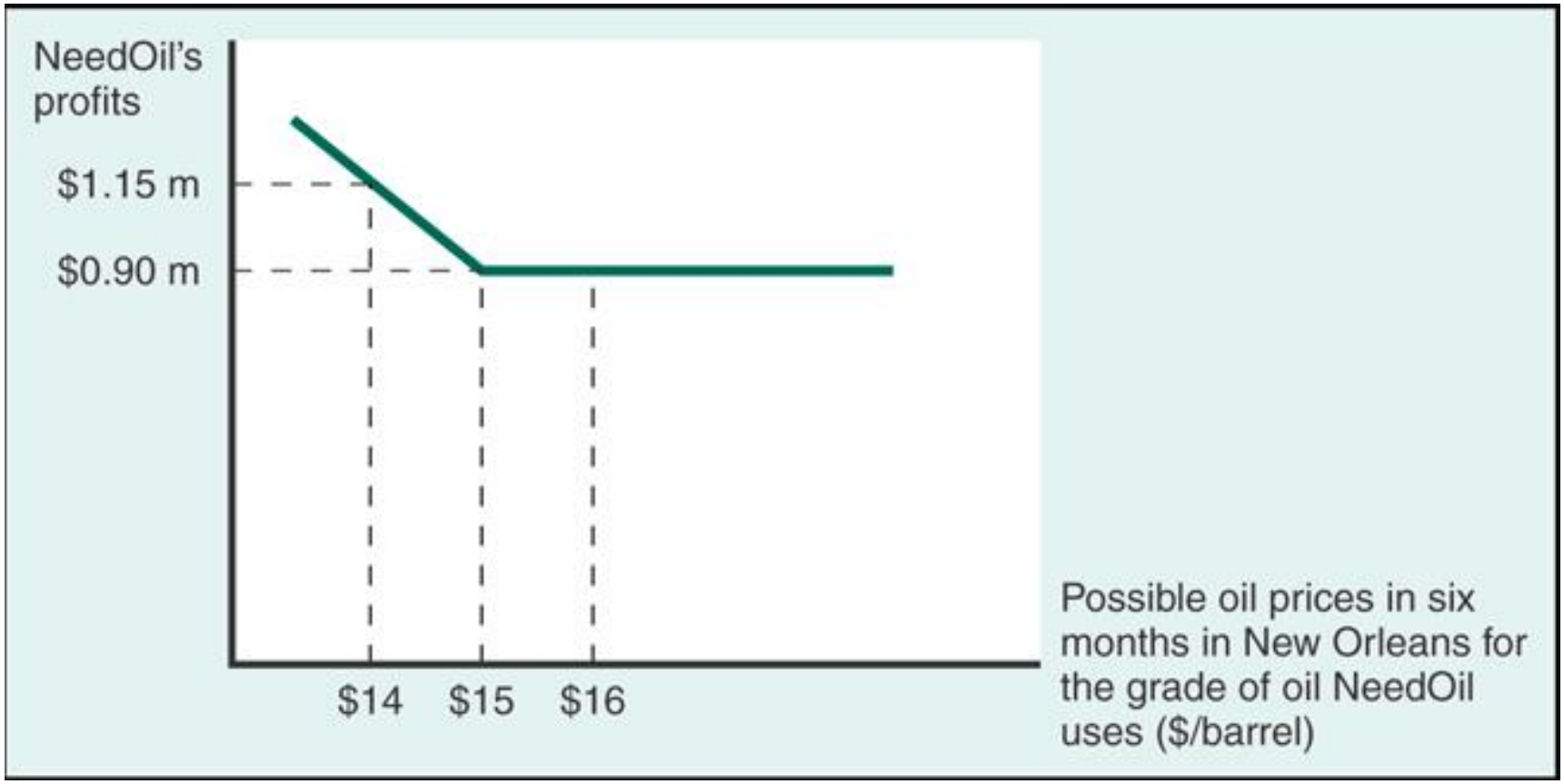
if oil price = $15 ==>

profits from operations	= $1,000,000
profits from OPTCO contract	= -$100,000
total profits	= $900,000

if oil price = $16 ==>

profits from operations	= $750,000
profits from OPTCO contract	= $150,000 (250k – 100k)
total profits	= $900,000

NeedOil's Profit



- Compare with previous figure about profits

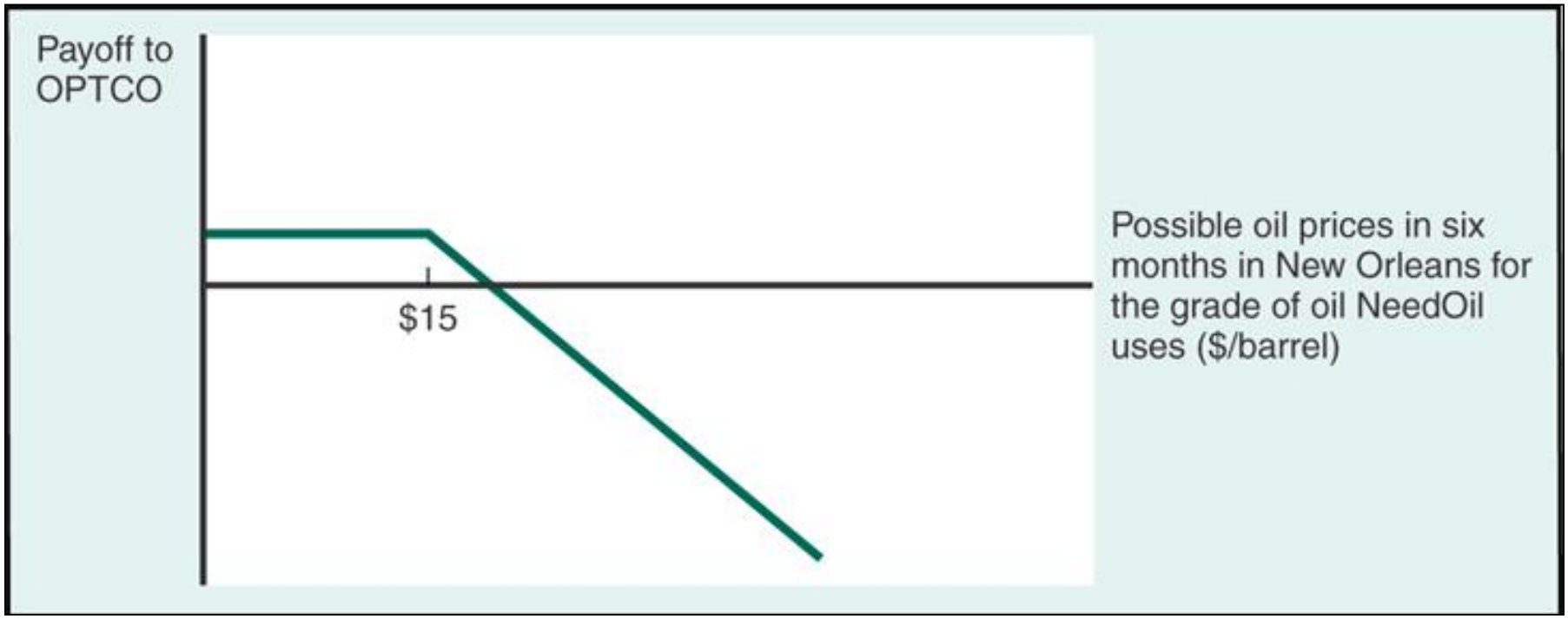
Call Option

- NeedOil's contract with OPTCO is an example of a derivative contract, called a **call option**.
  - A **derivative contract** is a contract whose payoff or value is derived from the value of some other asset or index.
  - The asset on which the **derivative contract is based** is called the **underlying asset**.

- A call option contract pays the purchaser of the option a positive amount if the underlying asset exceeds the **exercise price**.
  - The **option price** is the amount paid for the option.
  - For every call option buyer, there is a call option seller.

- NeedOil: contract buyer
- OPTCO: contract seller

Payoff to **Seller** of the Call Option



Put Options

- Put **option contract** buyer receives a positive payoff only if the value of the underlying asset **falls below** the exercise price.
- Put: A right to sell (stocks or commodities) at a given price.

Cash Settlement versus Physical Delivery

- Some options are **settled in cash** (like the ones NeedOil used)
- Other options are settled with the **physical delivery of the underlying asset**
  - Example: call option on oil 1,000 barrels with exercise price of $15
  - If oil price at expiration = $18, then the option buyer would **exercise** the option to buy 1,000 barrels for $15 a barrel
  - Depending on needs, the investors (or firms) will **choose** between contracts of cash settlement vs. physical delivery

Basis Risk

- Basis risk refers to the uncertainty in the relationship between the **variable being hedged** and the **derivative contract payoff being used to hedge**

- Examples:
  - Grade of the underlying asset used differs from the grade on which the contract is based
  - Firm takes delivery in New Orleans, derivative contract is based on New York prices

- A risk created by derivatives contracts

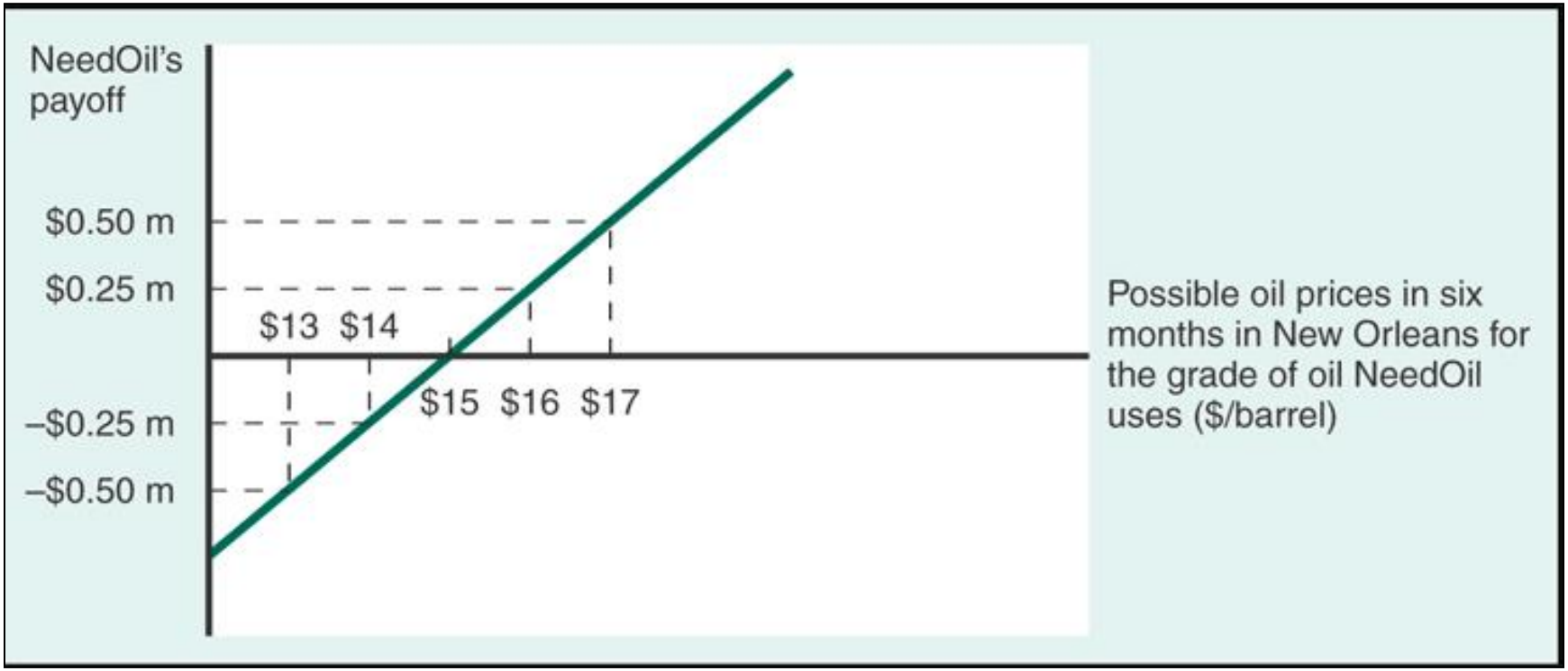
8.2 Hedging with Forward Contracts

- **Alternative** method of hedging: Contract with F-CO
  - **Forward contract**

  - What's the difference between forward and options?
  - Forward: No payments upfront – no original cost
  - Forward: A forward contract is an obligation – the buyer have to buy the assets at the price on that date no matter what is the real price
  - Option: Example – Buy a Costco Membership card, you could choose to buy things in Costco, or anywhere else

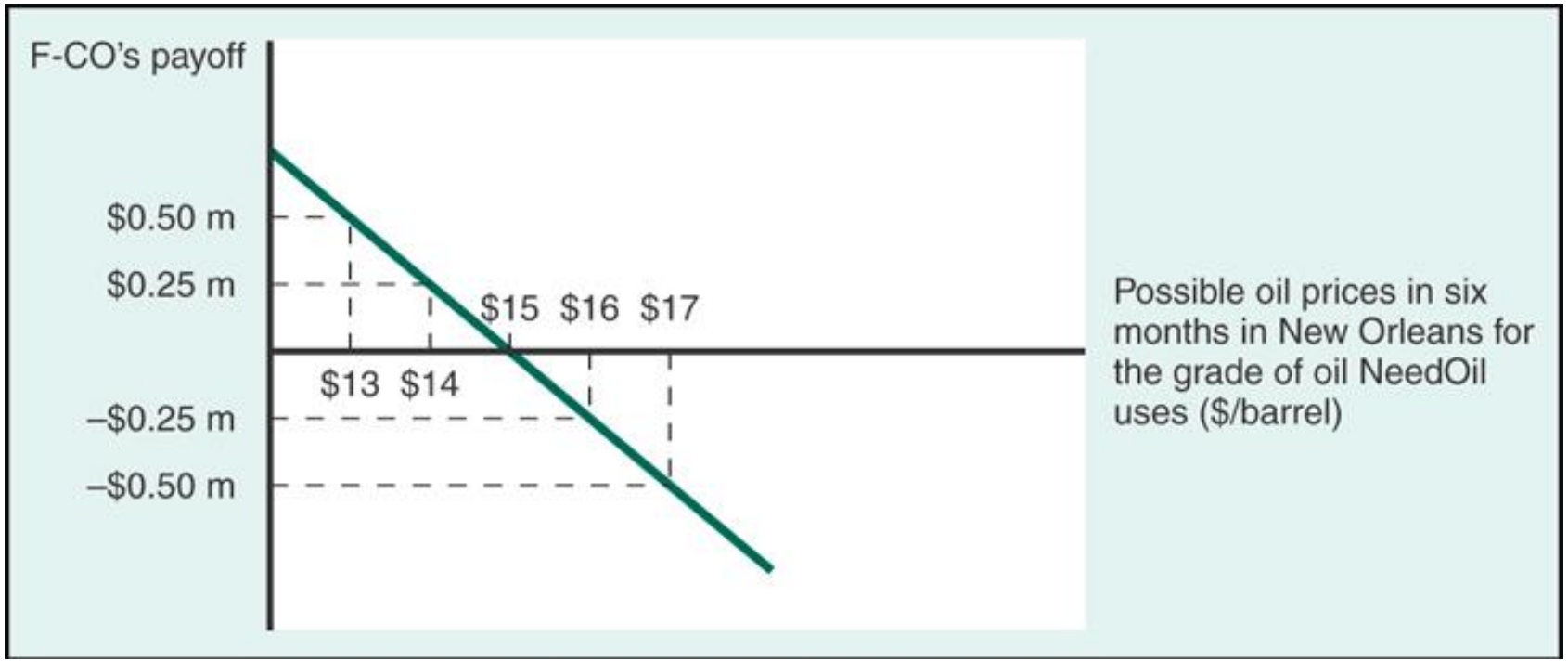
- **Example:**
  - NeedOil pays F-CO if the price of oil **falls below** $15
    - NeedOil expects a **higher** oil price
  - Payoffs in six months:
    - If $P_{oil} > 15$ ➔ F-CO pays \$250,000 x (P_{oil} - 15) to NeedOil
    - if $P_{oil} < 15$ ➔ F-CO receives \$250,000 x (15 - P_{oil}) from NeedOil
  - No payments upfront – no original cost
  - A forward contract is an obligation

Hedging with Forward Contracts



- **Buy** a forward contract; or say **take a long position** in the forward contract

Hedging with Forward Contracts



- **Sell** a forward contract – take a **short** position in a forward contract

Hedging with Forward Contracts

- A **forward contract or a futures contract** gives the buyer (NeedOil) a **symmetric** payoff

- Equal to the difference between the actual price of the underlying asset and some pre-determined price
  - Actual price - Pre-determined price

- Called the **forward price** or **futures price**.

Forward/Futures Prices

- Demand and supply of contracts determines the forward price
- Provided people can trade the underlying asset and the forward contracts, traders will always demand more contracts or supply more contracts unless
- Cost of carry relationship is true:
  - **Forward price = spot price at time t + cost of carry**

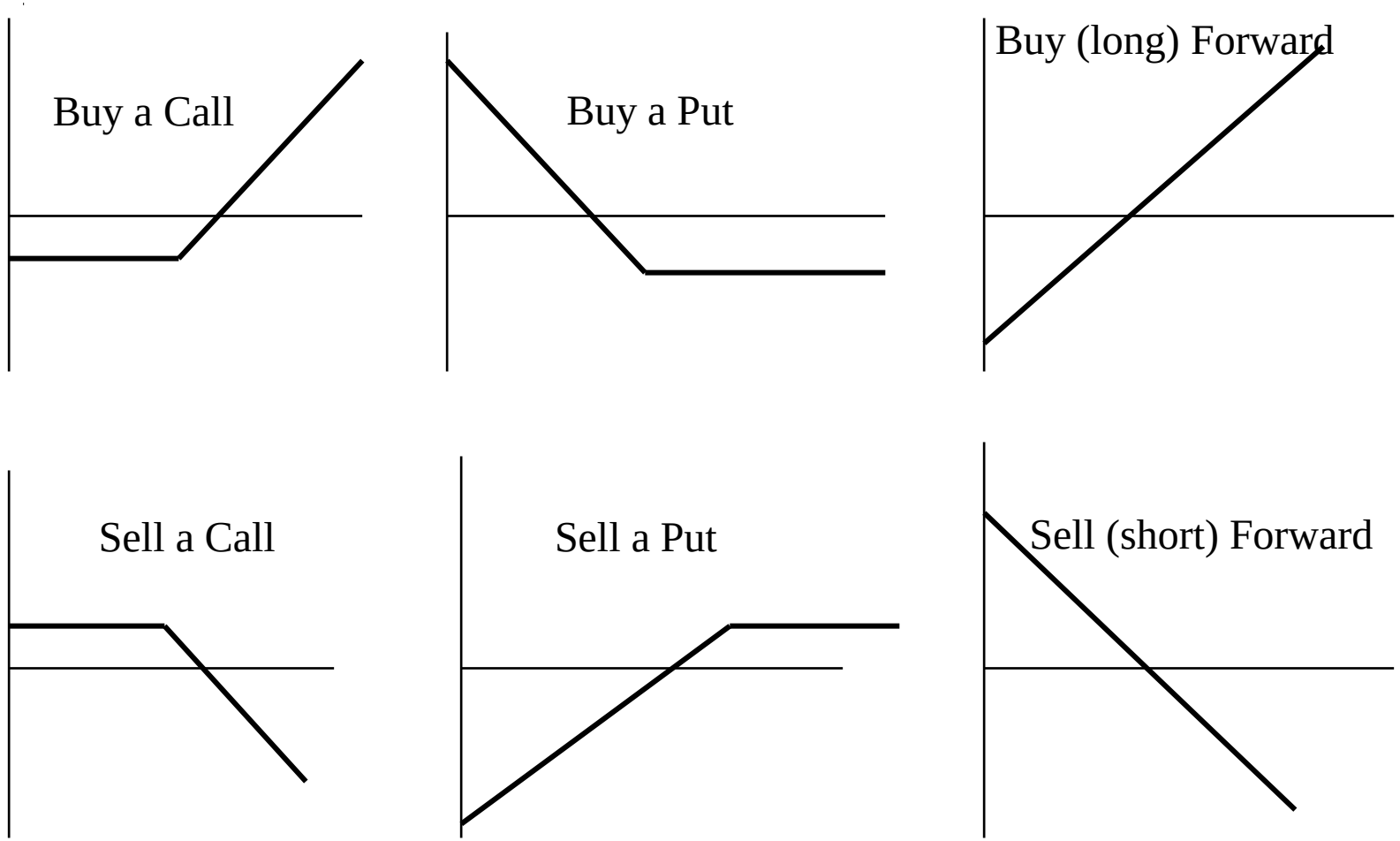
Example of the Cost of Carry Relationship

- Assume
  - spot price of oil is $16 a barrel,
  - the interest rate equals 9%,
  - cost of storing and insuring oil for one year is 1%,
  - 1-yr forward price = $16 + $16 * (0.09 + 0.01) = $17.60

Example of the Cost of Carry Relationship

- Suppose the 1-yr forward price = $18.00 and the cost of carry equals $17.60
  - Then, you could sell (take a short position) a forward contract (agree to sell oil in one year) at the $18.00 price.
  - Simultaneously,
    - Borrow 16 dollar and buy oil today
    - store and insure the oil for 1 year for a total of cost of $17.60 a barrel
    - at the end of the year, you would make $0.40 regardless of what happens to the price of oil (i.e., there is no risk).
  - Therefore, $18.00 is not a price that will clear the market

Derivatives Building Box



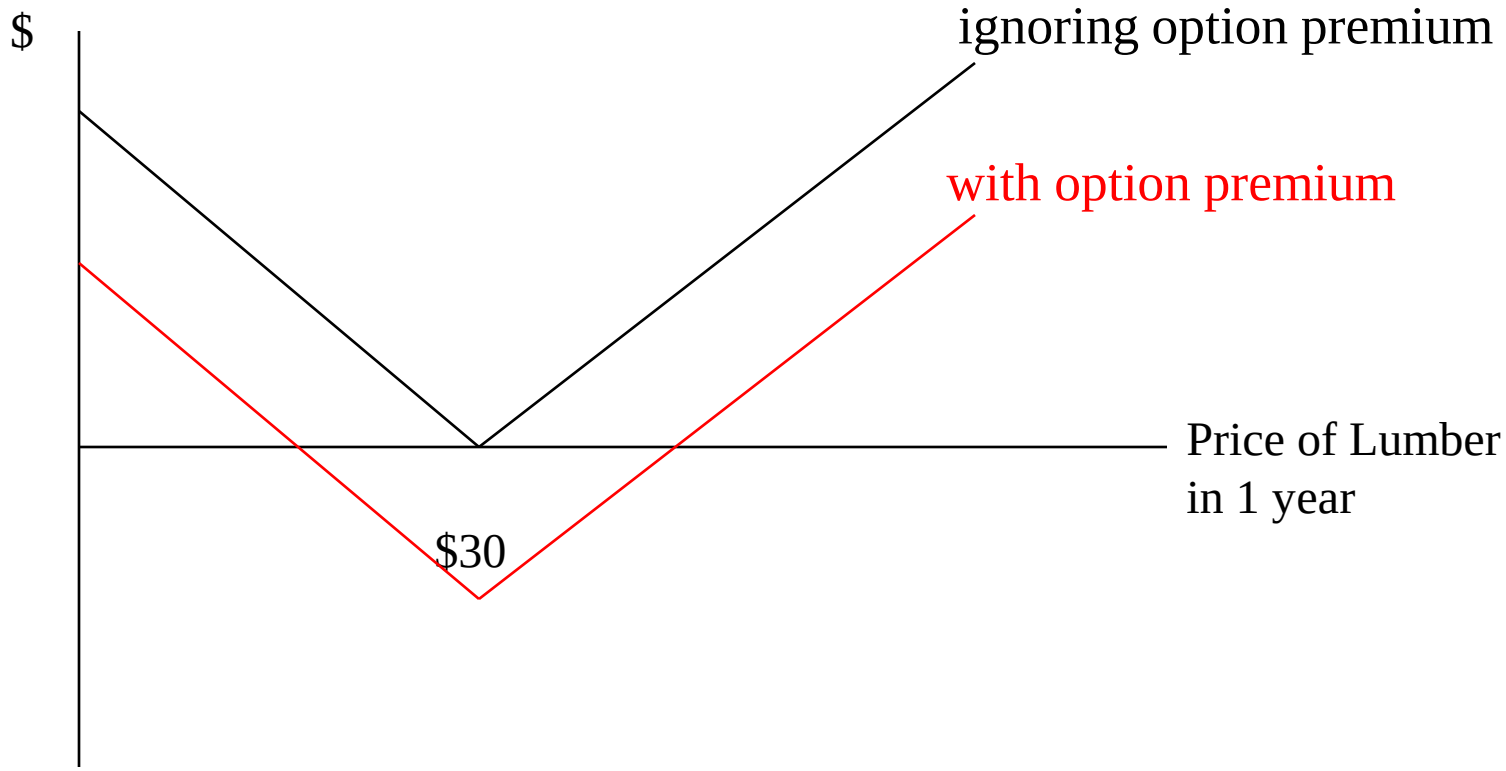
Notes

- X-axis does not have to be the price of a stock or a security

- It can be the amount of losses, temperature, the amount of rain fall
  - Weather derivatives

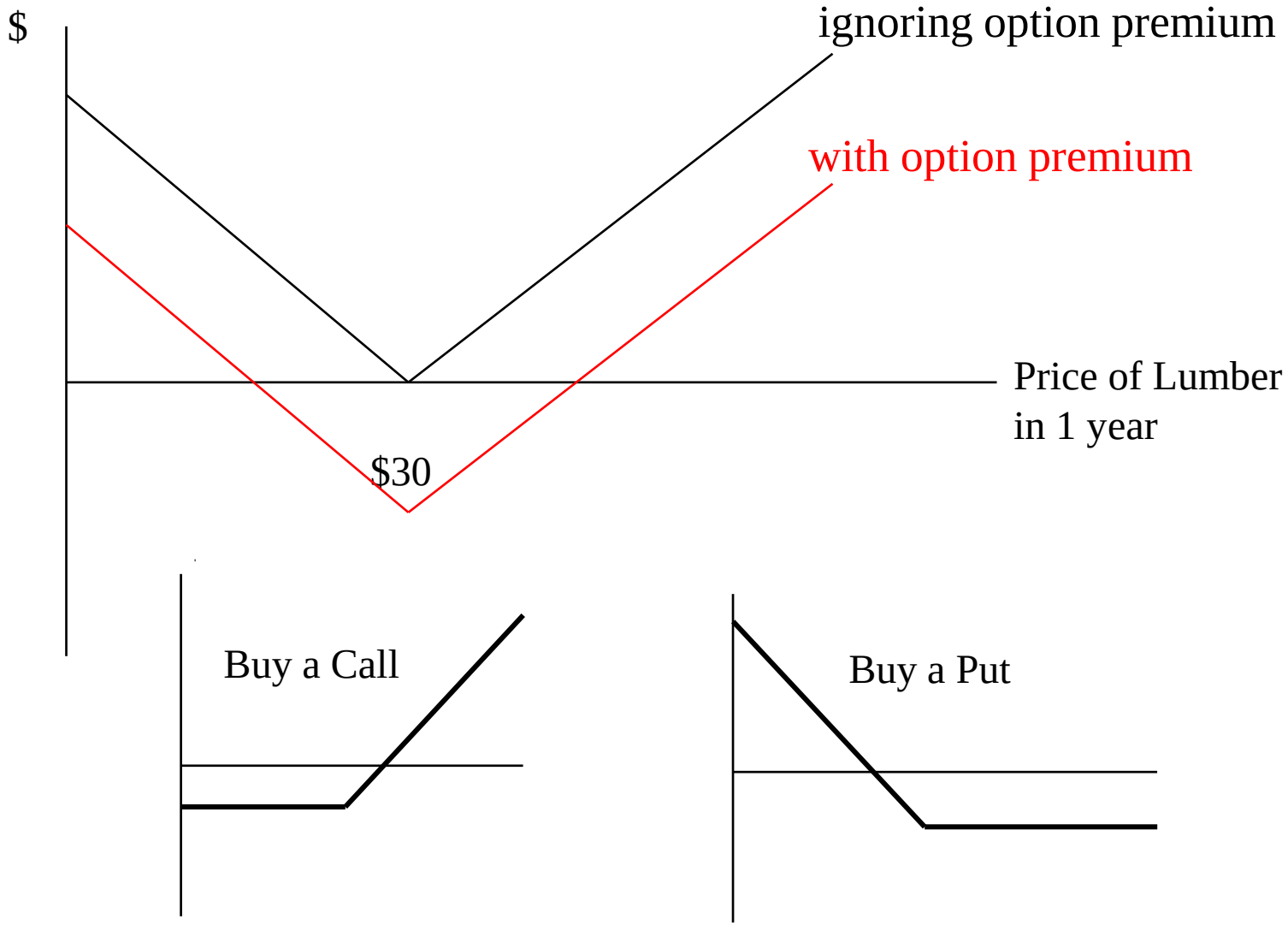
Constructing Desired Payoffs

- How would you obtain this payoff?



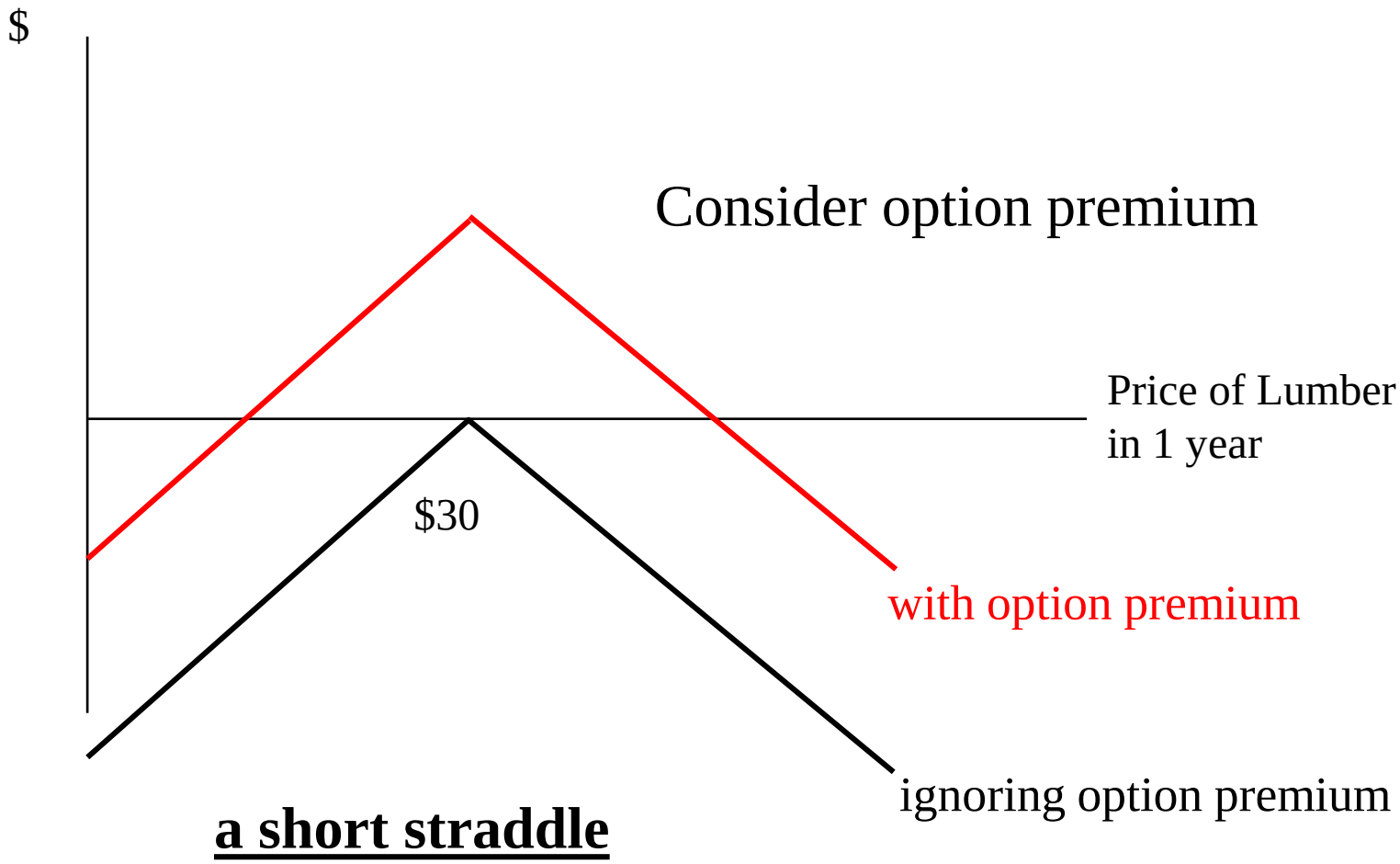
A long straddle

- Purchases both a long call and a long put on the same underlying asset with the same expiration date and strike price

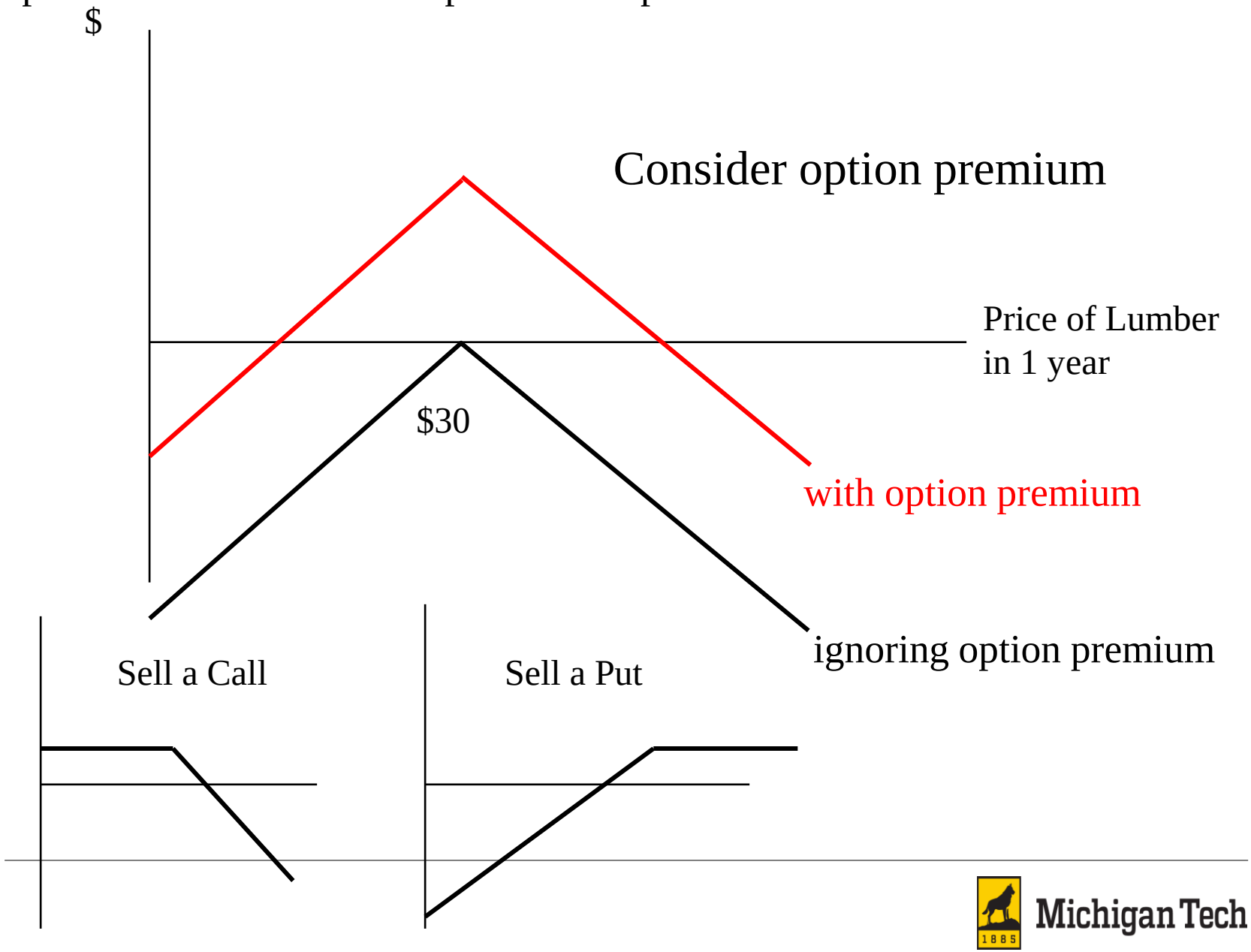


Constructing Desired Payoffs

- How would you obtain this payoff (ignoring the cost of the options)



- An options strategy comprised of selling both a call option and a put option with the same strike price and expiration date



Constructing Desired Payoffs

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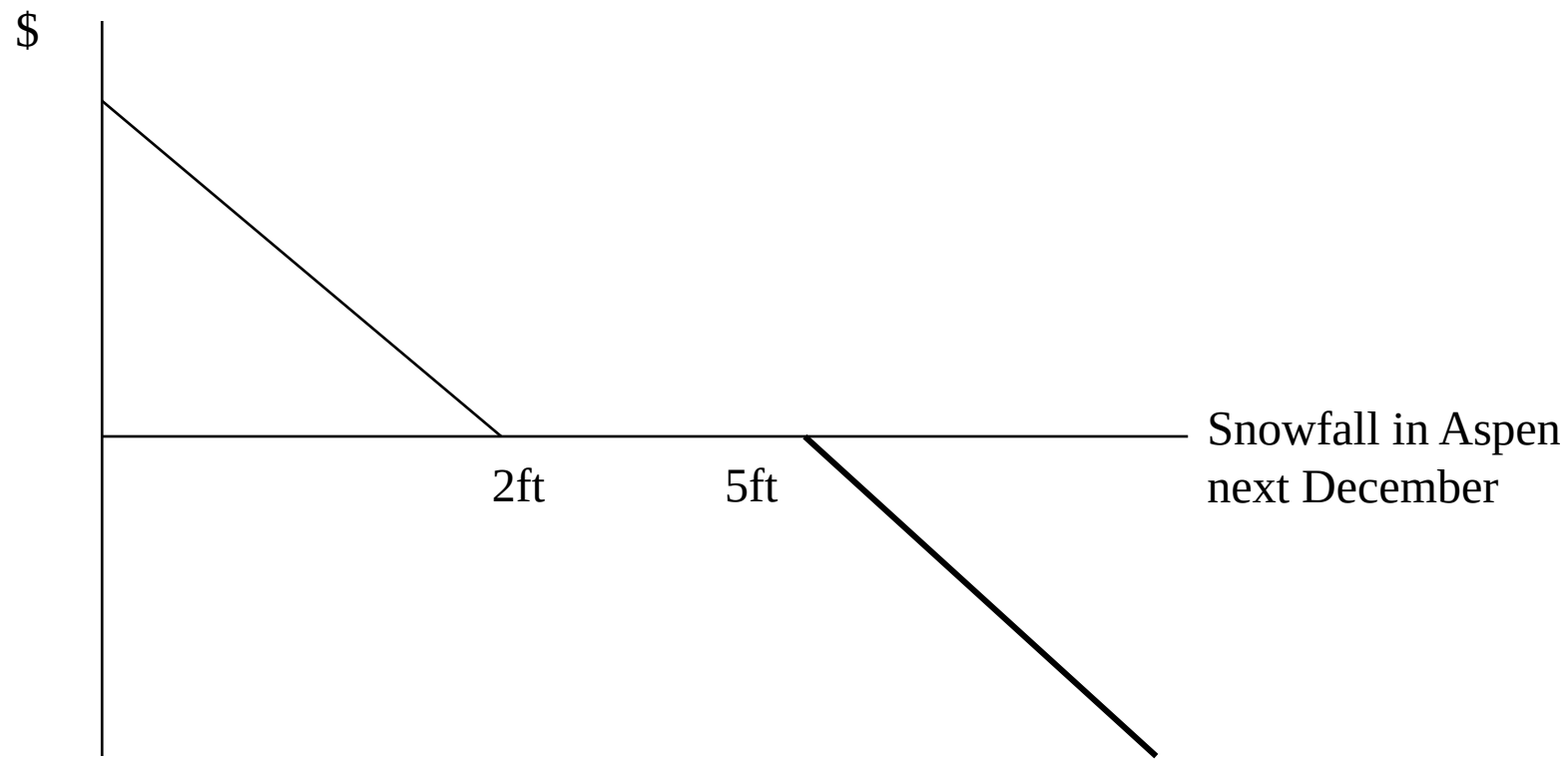

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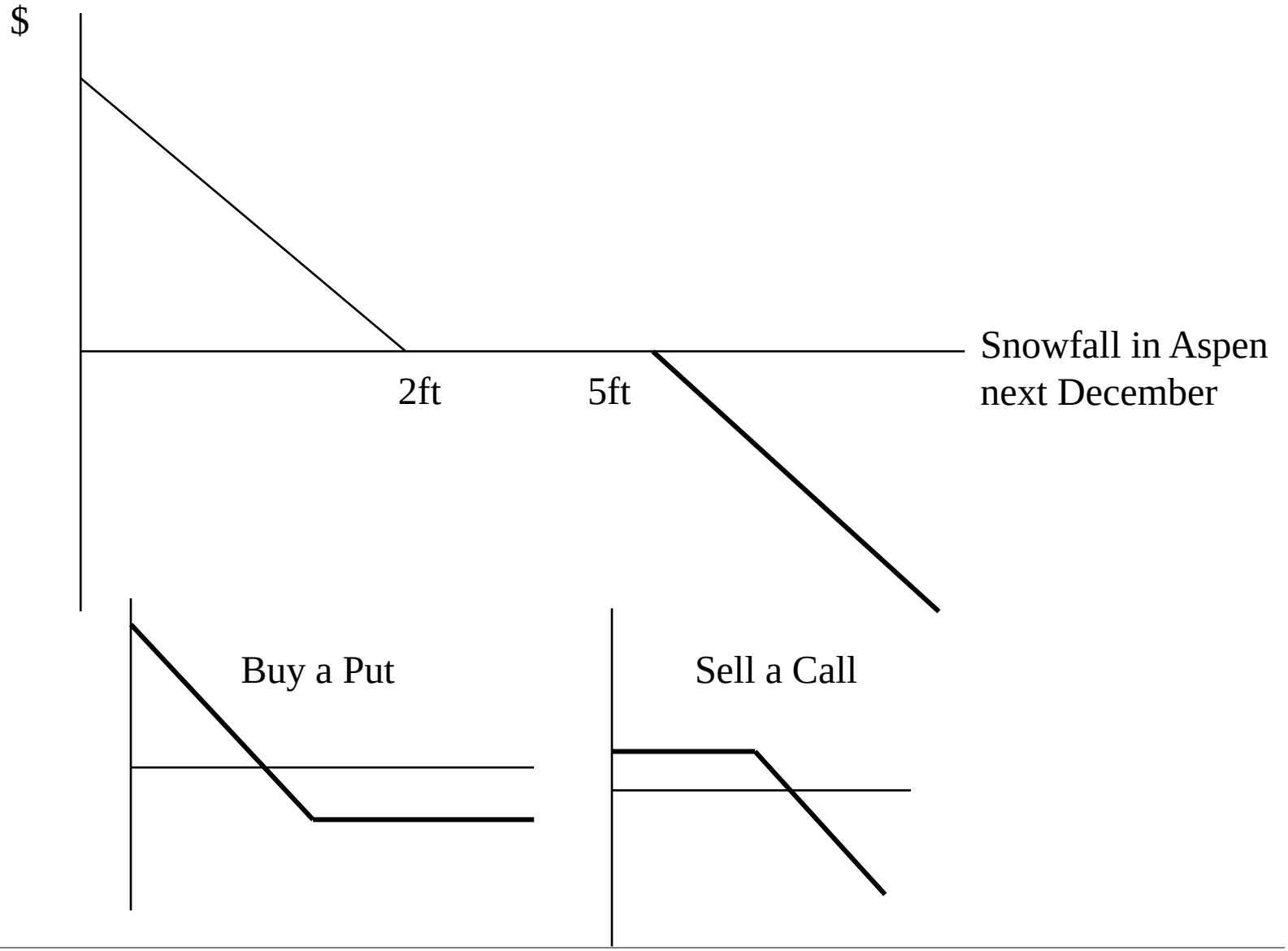
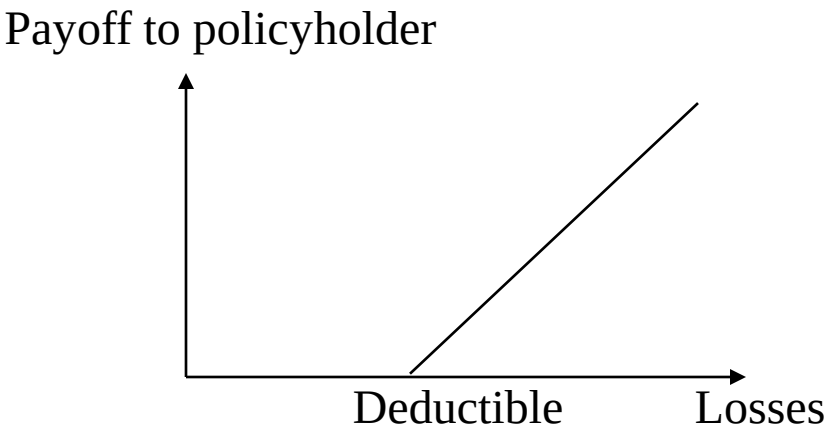


8.3 Derivatives vs Insurance

- Insurance payoff to policyholders



- Insurance is a **call** option on **property losses**
  - Higher loss, higher cash inflow from call
- Insurance is a **put** option on the policyholder's **property value**
  - Property value decreases in property losses
  - Lower property value, higher cash inflow from put

Derivatives vs Insurance: **Different Risks**

- Derivative contracts
  - Usually used to hedge risk arising from unexpected changes in **market** prices
    - **Market prices affect many firms**

- Insurance contracts
  - Usually for risk arising from losses specific to the insured

Derivatives vs Insurance: **Contracting Costs**

- Contracts are used to transfer risk
  - Insurance contracts
    - Considerable **contracting costs**
      ==> greater **moral hazard** problems with insurance
      ==> contracts with retention (deductibles, limits, etc.)
  - Derivative contracts - **little**, if any
    - The underlying asset is an aggregate (market) index

Derivatives vs Insurance: **Basis Risk**

- What is a basis risk?
  - The uncertainty in the relationship between the **variable being hedged** and the **derivative contract payoff being used to hedge**

- **Insurance contracts** are based on **firm specific factors (insurable risk)**
  - Involve **less** basis risk than derivative contracts on market risks

Derivatives vs Insurance: **Liquidity**

- Derivative markets generally are **more liquid** than insurance markets
  - **A liquid market** exists when someone can sell or buy an asset quickly with little price concession.

- **Low liquidity for insurance contracts**

Derivatives vs Insurance: **Capital Costs**

- Derivative: when prices change, there tend to be winners and losers
  - ➔ Firm values often are negatively correlated (winner and loser)
    - ➔ Risk can be eliminated with just two parties (call and put)

- Insurance: In contrast, the liability and property losses tend to be independent across firms.
  - ➔ Reduce risks by diversification with many participants
    - ➔ Insurers need to hold capital, which adds to the cost of insurance

Derivatives vs Insurance: Summary

Summary of Main Differences

Characteristics	Derivatives	Insurance
Type of risk hedged	Market price risk	Firm specific risk
Contracting costs (due to moral hazard, illiquidity)	Low	High
Basis risk	High	Low

8.4 Institutional Arrangement: OTC vs Exchanges

- Over-the-Counter versus Exchange Traded Derivatives
  - An **over-the-counter (OTC) transaction** resembles a **privately** negotiated contract between two firms.
  - **e.g., forward contracts**

  - **Exchange traded derivatives** are **standardized contracts** with the terms established by the exchanges.
    - tend to be **more liquid**
    - lower counterparty risk
    - **e.g., futures contracts**

Institutional Arrangement: Counterparty Risk

- The greater liquidity also is due in part to the method used to ensure performance
  - With OTC contracts, firms assess the default risk (or credit risk) prior to engaging in a contract
  - With exchange traded contracts, default risk is reduced by using:
    - performance bonds, called margin
    - daily marking to market

Institutional Arrangement: Example

- Required margin = 20% of the position's value
- When value of position = $1,000
  - You must post margin =
- If futures price falls so the value equals $900
  - New required margin =
- amount lost on position is subtracted from margin
  - You must add: required margin – lost amount =
- Margin and marking to market imply that you can trade anonymously, which increases liquidity

Institutional Arrangement: Example Solution

- Required margin = 20% of the position's value
- When value of position = $1,000
  - You must post margin = 20%*$1000 = $200 (so the least amount you need to deposit in the account is $200)

- If futures price falls $100, so the value of your position equals $1000 - 100 = $900
  - New required margin = $900*20% = $180

- Remaining amount in your margin account = $200 – 100 = $100
- Amount lost on position is subtracted from margin
  - You deposited $200, but the value drop $100
  - There are only $100 left in your account
- You must add: required margin – remaining amount = 180 - 100 = $80
- Margin and marking to market imply that you can trade anonymously, which increases liquidity