MANCHESTER 1824

The University of Manchester

Markets, Risks, and Contracts

Important Acknowledgement:

These notes on Kirschen/Strbac (Chapter Section 2.4) are based on slides prepared by Daniel Kirschen (U Manchester) with edits by Leigh Tesfatsion (Iowa State U).

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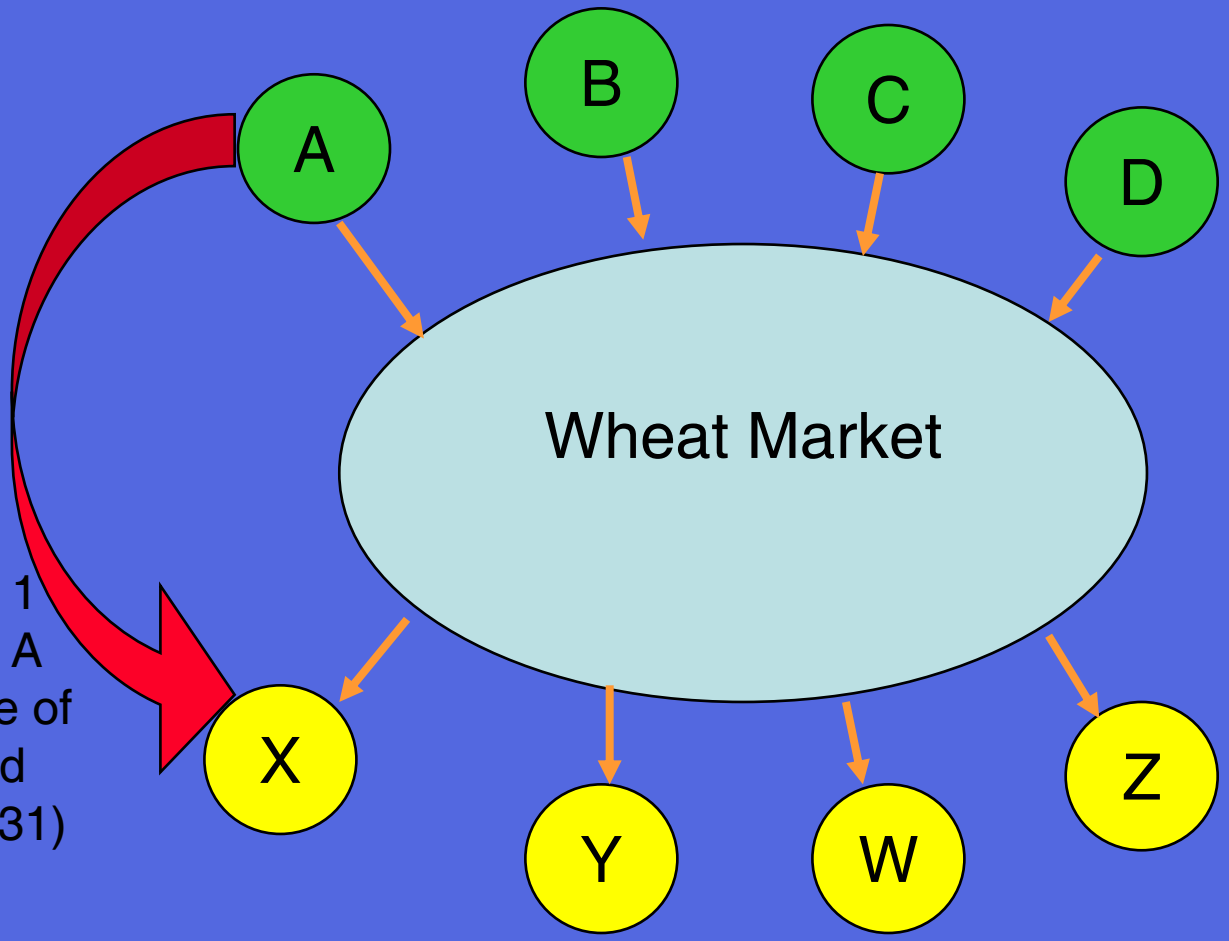
1. Glossary of Standard Market Terms

- Asset = Anything of durable value
- Physical asset
  - Assets that have physical substance, such as buildings, equipment, automobiles, embodied skills,…
- Financial asset
  - Claims against physical assets, such as corporate bonds, stock shares, mortgages, money,…
- Commodity
  - *Modern Usage:* Anything of value available for purchase and sale in standardized form (e.g., cell phone minutes)
  - Physical commodity = Commodities taking the form of services or physical assets

- Purely financial contract
  - Does not involve any physical delivery



Purely financial contract

(e.g., bet on May 1 between persons A and X that the price of wheat will exceed $5/bushel by May 31)

- **Spot trades**
  - An immediate trade, with both delivery and payment taking place "on the spot" (no long-term formal relationship established between buyer/seller).
  - ***Examples:*** Milk purchase at grocery, haircut purchase from barber
- **Forward contracts**
  - Personalized contracts between parties for the ***future*** delivery of something of value at a pre-determined price.
  - Since forward contracts are not standardized with regard to quantity and quality measurement, they are typically sold in over-the-counter markets rather than through centralized exchanges
- **Futures contracts**
  - Standardized ("securitized") contracts between parties for the ***future*** delivery of some commodity at a pre-determined price
  - Focus on commodities (standardized quantities/qualities) facilitates formation of markets for these contracts in the form of centralized exchanges.

- Financial market
  - A market for some type of financial asset
- Real market
  - A market for some type of non-financial commodity
- Spot market
  - A market for any commodity for which all trades are spot trades
- Forward market
  - A market for forward contracts
- Futures market
  - A market for futures contracts

- **Primary market**
  - A market for the ***first-time*** purchase and sale of an asset, e.g., newly produced homes, newly issued stock shares, etc.
- **Secondary market**
  - A market for the ***resale*** of previously sold assets, e.g., a used car market, the New York Stock Exchange Euronext (resale of previously sold stock shares and other financial assets)

✸ ***NOTE:*** The distinction between primary/secondary markets is irrelevant for items that have no durability, hence no possibility of resale.

- **Risk**
  - Deviation from an expected outcome (“variance”)
- **Investor**
  - Lends assets to borrowers in an attempt to secure a financial return on these assets
- **Hedger**
  - Trades in financial assets to protect wealth (total net asset value) against risk
- **Speculator**
  - Engages in commodity trades in an attempt to profit from anticipated future price changes
  - Typically willing to bear high risk in hopes of large gain

2. Concept of Risk

- Risk = Deviation from an expected outcome ("variance")
- Future is uncertain
- Uncertainty translates into risk
- Doing business means accepting some risks
- Willingness to accept risk varies:
  - Venture capitalist vs. old-age pensioner
- Ability to control risk varies:
  - Professional versus novice stock traders

Sources of Risk for Power Systems:

- *External risk*
  - Failure to produce or deliver because of cataclysmic external event affecting the power system
    - Weather, earthquake, war
- *Technical risk*
  - Failure to produce or deliver because of technical problem occurring within the power system
    - Power plant outage, congestion in the transmission system
- *Price risk*
  - Having to buy at a price higher than expected
  - Having to sell at a price lower than expected

Managing Risks:

- Excessive risk hampers economic activity
  - Not everybody can survive short term losses
  - Society benefits if more people can take part
    - Business should not be limited to large companies with deep pockets
- How can risk be managed ?
  1) Reduce the risk
  2) Share the risk (risk pooling & risk spreading)
  3) Re-allocate the risk from one bearer to another

1) Reducing Risk

- Reduce consequences of natural catastrophes
  - Design systems to be able to withstand rare events
  - ***Example:*** Enough crews to repair a power system after a hurricane
  - Reduces the extent of damage should the catastrophic event occur
- Reduce frequency/consequences of technical problems
  - ***Example:*** Security margins on transmission lines
  - Increases the daily cost of operations (***Example:*** Keep power flow low enough on all lines so that no thermal line limit is exceeded if any one line goes down = “N-1 security constraints”)
  - Limits costs of problems (e.g., line loss) when they occur

1) Reducing Risk… Continued

- Give those with ability to reduce risk the incentive to reduce risk, and vice versa
  - ***Example:*** Power plant owners and transmission system operators/owners
  - Can reduce outages of plants/lines by proper maintenance and suitable investments in new generation/transmission capacity
- Avoid unnecessary volatility in system outcomes
  - ***Example:*** Make sure market rules do not encourage "artificial" volatility in electricity markets (e.g., price spikes due to exercise of market power)

✸ **NOTE:** Risk reduction can reduce expected gain!

- ***Example:*** Excessive concern with grid security can lead to excessive reduction in grid power flows and inability to service load

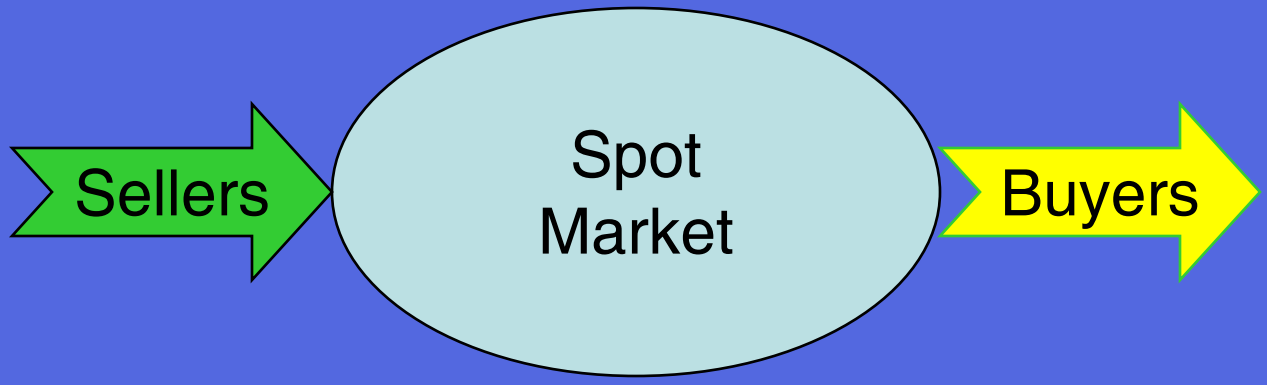
2) Sharing Risk

- ***Risk pooling (e.g., via insurance markets)***
  - Each member of a group is susceptible to a risk
  - Each member pays a small amount to compensate the few who end up actually suffering loss
  - Consequences of a catastrophic event that randomly affects a few individuals are borne by a larger group
- ***Risk spreading (e.g., via financial markets)***
  - Bearer of a large risk (e.g., a corporation investing in a new power plant) sells stock shares to finance a loan
  - Risk is spread across the entire group of stock holders

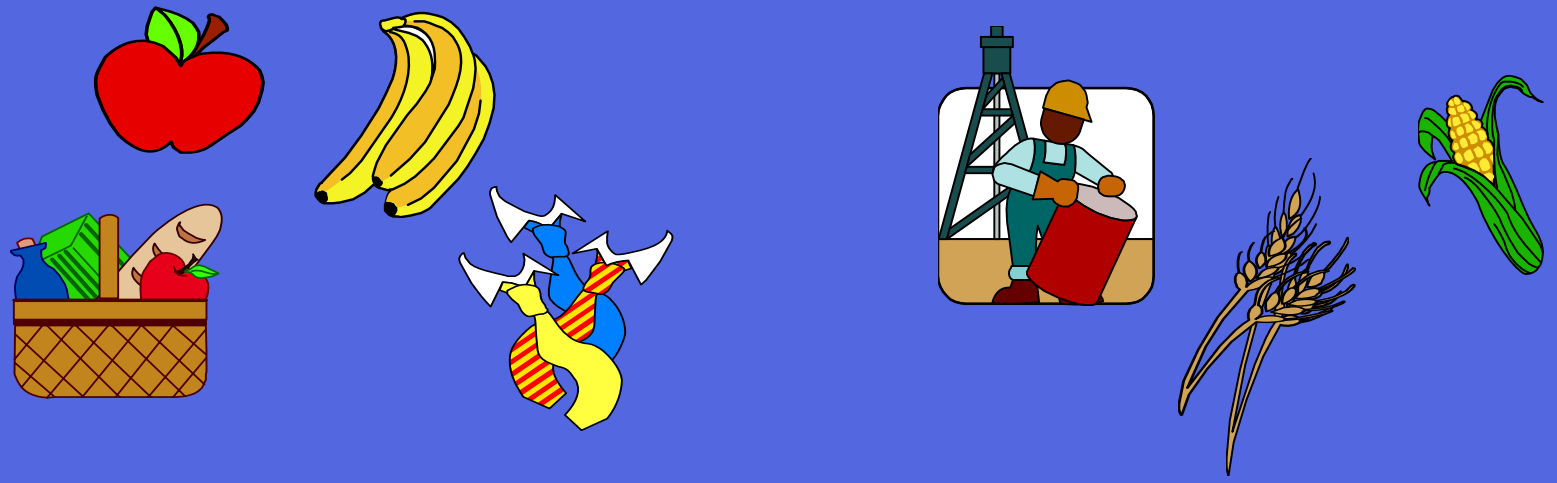
3) Re-Allocating Risk

- Possible if some agent A is more willing or able to accept risk than another agent B
  - For example, suppose loss is catastrophic for A but not for B
  - This could hold because A unable to offset loss, but B able to offset loss against gains in other activities
- ***Power Market Example:*** Undiversified traders with generation and/or load obligations who wish to hedge their price risk vs. speculators with diversified portfolios of financial contracts

3. Using Contracts to Hedge Spot Market Risk



- Spot Market = Immediate market, “On the Spot”
  - Immediate agreement on price
  - Immediate agreement on quantity
  - Immediate delivery
  - Immediate payment



- Examples of spot trades
  - Standard grocery store purchases (physical commodities)
  - Purchase of shares in General Motors (financial asset)
  - Dental visits (service)
  - Electric power (physical commodity) as sold in real-time electric power markets
- Spot markets can be formal or informal

Advantages/Disadvantages of Spot Trades:

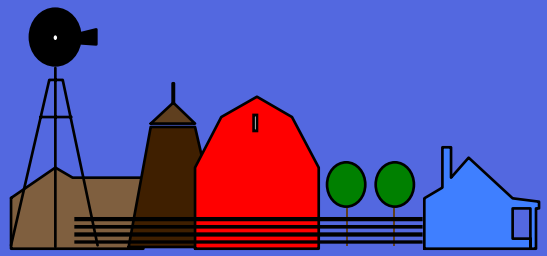
- Advantages:
  - Simple
  - Flexible
  - Immediate
- Disadvantages
  - Prices can fluctuate widely based on circumstances
  - ***Examples:***
    - Effects of frost in Brazil on price of coffee beans
    - Effects of Middle East troubles on the price of oil
    - Effects of unanticipated changes in “load” (demand) on real-time price of electric power!

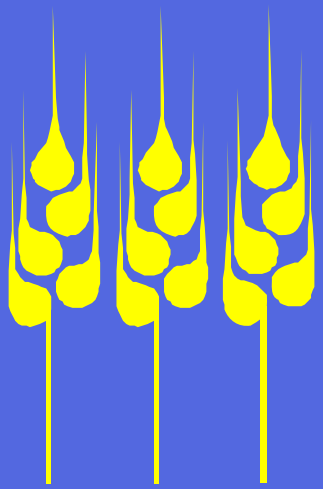
Spot Market Risks:

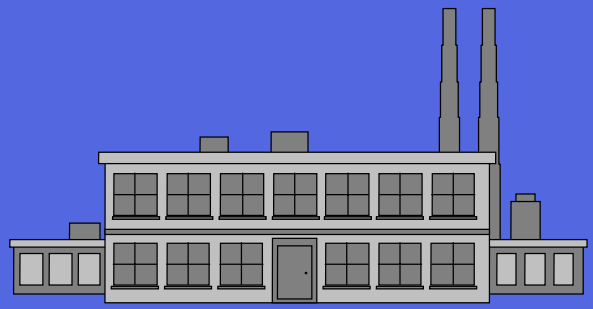
- Problems with wide price fluctuations
  - Sellers might have to sell at prices lower than expected
  - Buyers might have to buy at prices higher than expected
  - “Price risk”
- Market might not have much depth (“thinness”)
  - Not enough sellers ➔ market is short (on supply)
  - Not enough buyers ➔ market is long (on supply)
- Sellers with relatively large capacities in short markets tend to have lots of ability to move the market price in their favour (“market power”) because their capacity is essential to meet buyer demands.

  e.g. “load pocket” GenCos under congested conditions

Example: Buying and selling wheat

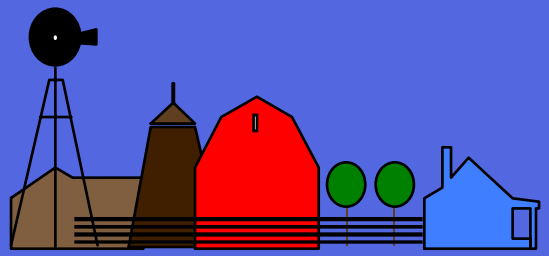


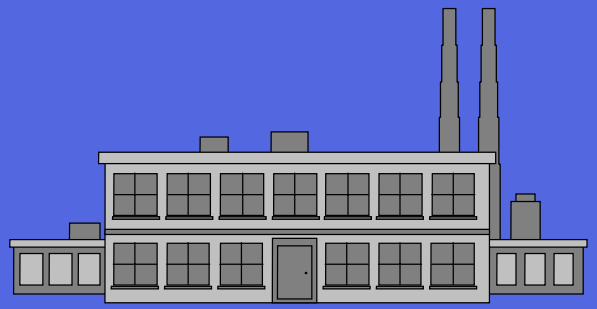




- Farmer produces wheat
- Miller buys wheat to make flour
- Farmer faces risk of bad weather affecting harvest
- Miller faces risk of breakdown of his flour mill
- Neither farmer nor miller ***controls*** the price of wheat

Harvest time:





- If price of wheat is **low**:
  - Possibly devastating for the farmer (seller)
  - Good deal for the miller (buyer)
- If the price is **high**:
  - Good deal for the farmer (seller)
  - Possibly devastating for the miller (buyer)

What should they do?

- **Option 1:** Accept the spot price of wheat
  - Equivalent to gambling on weather, equipment breakdowns, …
- **Option 2:** Agree ahead of time on a price that is acceptable to both parties
  - Forward contracting

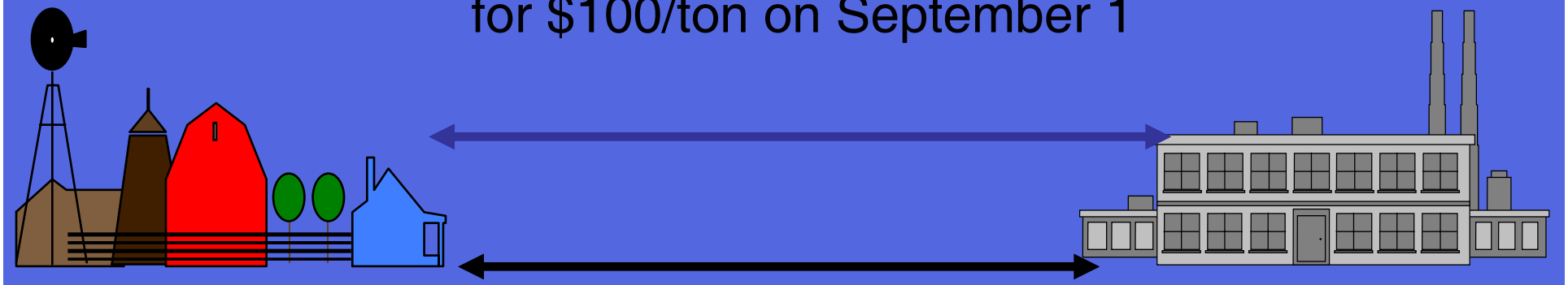
Forward Contract:

- Agreement Specifies:
  - Date and location of future delivery
  - What is to be delivered
  - What price is to be paid (“forward price”)
  - Time and location of payment
  - Penalty imposed if either party breaks contract

- Forward contracts are “***firm contracts”***
  - Delivery not contractually conditioned on future events

Example of a Forward Contract:

Contract (June 1):
Farmer promises to deliver to
General Mills 1 ton of wheat
for $100/ton on September 1



Farmer

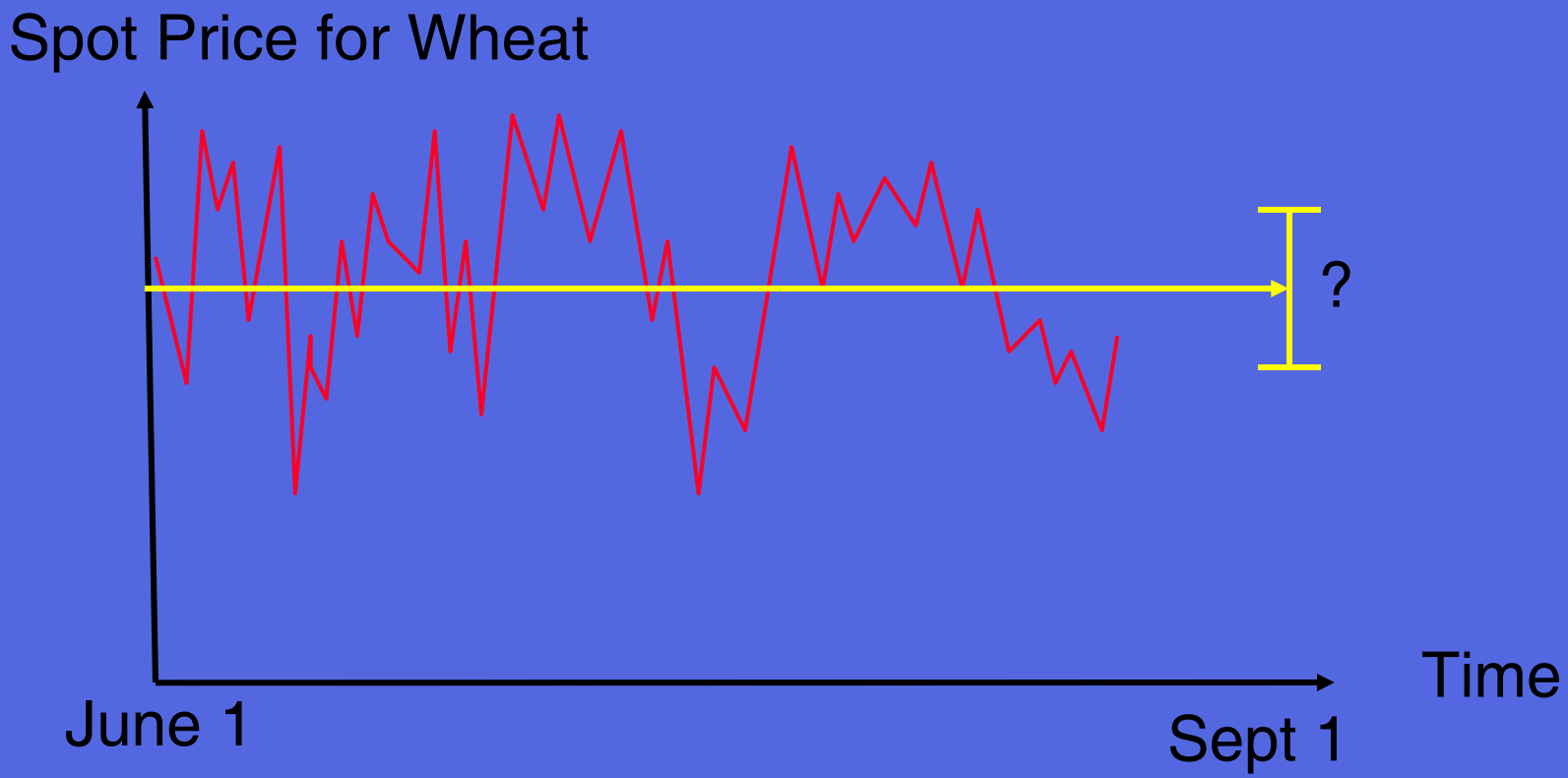
Delivery Date (September 1):
Farmer delivers 1 ton of wheat
General Mills pays $100/ton
Spot price = $90/ton

Net gain to farmer = $10

Net loss to General Mills: $10

General Mills

How is a forward price mutually determined?



- Both parties consider possible future situations
- Both forecast what the spot price is likely to be

Case 1:

- Farmer forecasts that spot price for wheat on September 1 will be $100/ton
- Miller forecasts that spot price for wheat on September 1 will be $100/ton
- Both can agree on a forward (September 1) price for wheat of $100/ton

Case 2:

- Farmer forecasts that the spot price for wheat on September 1 will be $90/ton
- Miller forecasts that the spot price for wheat on September 1 will be $110/ton
- They can easily agree on a forward price lying somewhere between $90/ton and $110/ton
- Exact forward price specified in the forward contract will depend on negotiation ability

Case 3:

- Farmer forecasts that the spot price for wheat on September 1 will be $110/ton
- Miller forecasts that the spot price for wheat on September 1 will be $90
- Agreeing on a forward price is likely to be difficult
- Whether a deal is struck will depend on each party's idea about possible divergence of the actual September 1 spot price from the expected September 1 spot price and the degree to which this "risk" is viewed as costly (undesirable).
- For example, a "risk averse" farmer might agree to a forward price below his expected future spot price in order to avoid risk

Sharing Risk:

- The two parties to a forward contract share the risk that the forward price differs from their expectations
- Difference between forward price and spot price at time of delivery represents a “gain” for one party and a “loss” for the other
- However, in the meantime they have been able to get on with their business
  - Buy new farm machinery
  - Sell the flour to bakeries

4. Attitudes Towards Risk

Risk Premium = An amount that a party to a contract is willing to pay simply to reduce risk

Suppose that the farmer and miller have the same price forecast P^e for the Sept 1 spot price, but the *actual* Sept 1 spot price P is uncertain (subject to variation).

- Case (a): Suppose the farmer and miller have the ***SAME*** degree of aversion to risk
  - Then neither the farmer nor the miller has a bargaining advantage when negotiating the forward price P^f
  - Consequently, $P^f = P^e$

Case (b): Suppose the farmer (wheat seller) is ***MORE*** risk averse than the miller (wheat buyer)

- Miller (buyer) can then negotiate a forward price P^f ***lower*** than the commonly expected future spot price P^e
- Farmer (seller) will agree to a lower P^f (rather than have no forward contract at all) because he gains more than the miller from reduced risk
- $[P^e - P^f] > 0$: The ***farmer's risk premium***

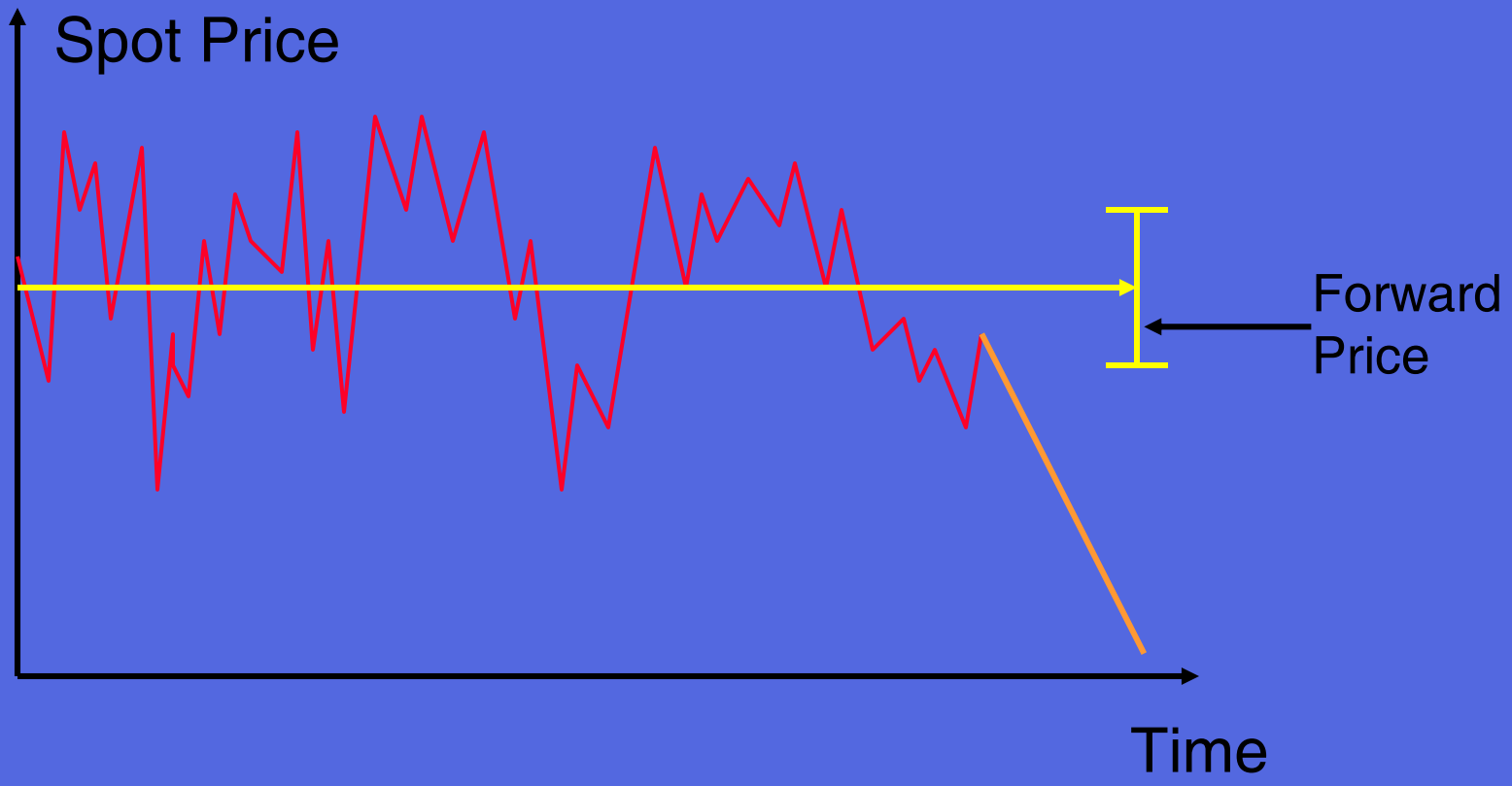
- Case (c): Suppose the miller (wheat buyer) is ***MORE*** risk averse than the farmer (wheat seller)
  - Farmer (seller) can then negotiate a forward price P^f ***higher*** than commonly expected future spot price P^e
  - Miller (buyer) will agree to a higher P^f (rather than no contract at all) because he gains more than the farmer from reduced risk
  - $[P^f - P^e] > 0$: The ***miller's risk premium***

Risk Premiums and Forward Markets:

- Since there are numerous farmers and millers, forward markets for wheat can be organised covering various different future delivery dates and delivery locations

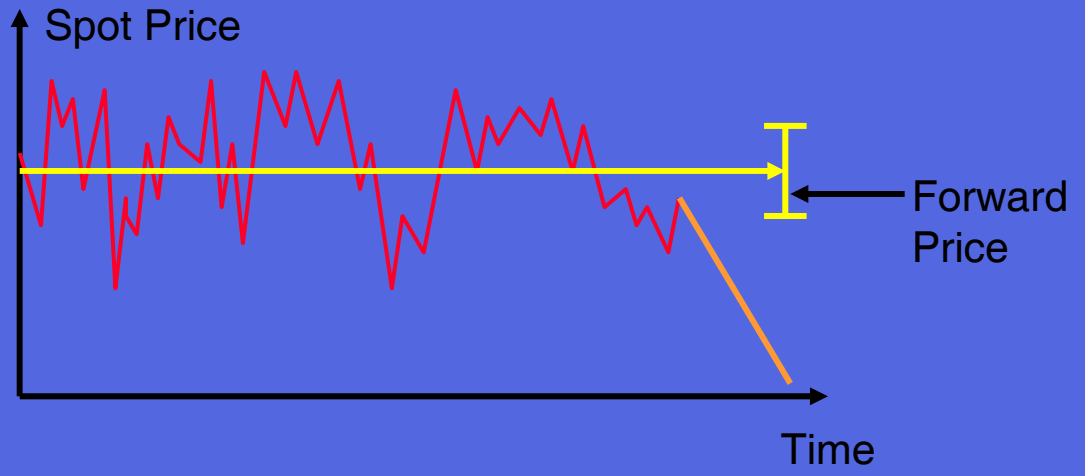
- The forward price for wheat determined in any such market will represent the aggregated expectations of farmers and millers regarding the future spot price for wheat, plus or minus a risk premium

What if...



- Suppose that millers are LESS risk averse than farmers
- Forward price below the expected spot price
- But actual spot price turns out to be much lower than forward price because of a bumper harvest

What if...



- Farmers breathe a sigh of relief…
- Millers take a big loss
- The following year the millers ask for a much bigger premium (much lower forward price)
- Is agreement between the farmers and the millers going to be possible?

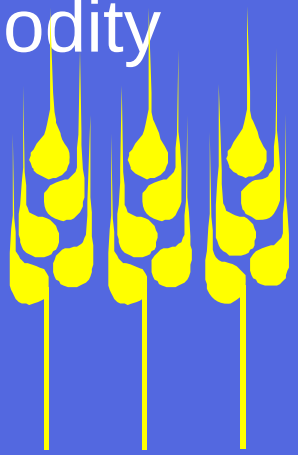
5. Risk Diversification Through Futures Contracts

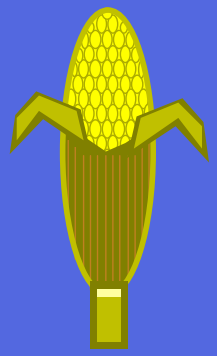
Dangers of Undiversified Risk:

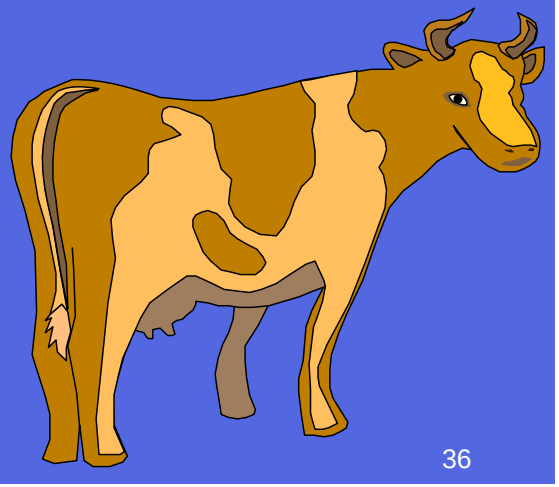
- Farmers and millers deal only in wheat
- Their risk is undiversified
- Can only offset “good years” against “bad years”
- Risk remains high
- Reducing the risk further would help business

Benefits of Diversification:

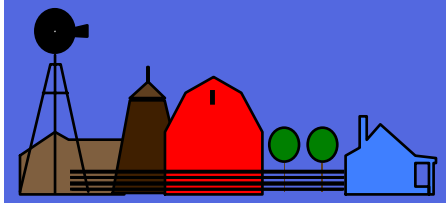
- Diversification = Engage in trades that involve more than one commodity
- Helps to hedge against risks associated with any one commodity

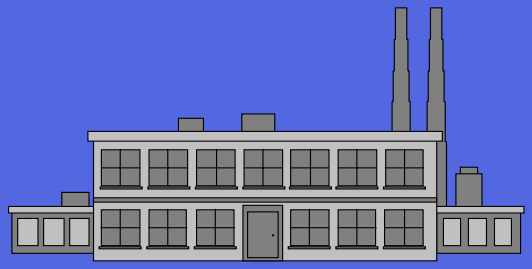






Physical Participants vs. Speculators





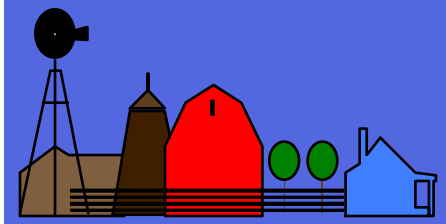
- "Physical participants" (Kirschen/Strbac term, 2.4.3, p. 37)
  - Can produce, consume, and/or store a physical commodity
  - Face undiversified risk since they trade only in this one commodity
- Speculators (as defined by Kirschen/Strbac, 2.4.3, p. 36)
  - Do not produce, consume, or store physical commodities
  - Hence do not take **delivery** of physical commodities
  - Engage in commodity trades in an attempt to secure gain from anticipated future price movements

Speculators…Continued:

- Speculators can help reduce costs of physical participants by sharing risks (less risk averse).
- But speculators must balance their physical commodity positions on date of delivery
  - Quantity bought must equal quantity sold because speculators do not produce, consumer, or store physical commodities
  - Must buy or sell from spot market as necessary to achieve this balance

◆ **Futures contracts ("futures") enable speculators to share risks while ensuring balanced physical commodity positions.**

Futures Contract Illustration:



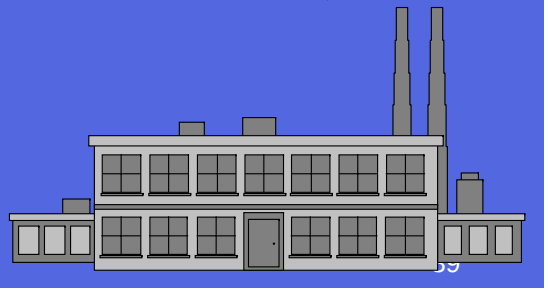
2 tons at $110/ton

2 tons at $90/ton

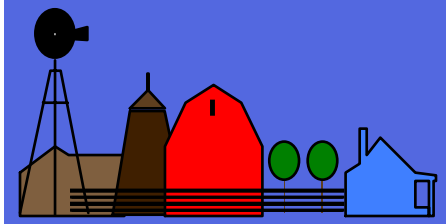
1 ton at
$95/ton

1 ton at
$115/ton

Wheat future contracts bought/sold
on June 1, each requiring
delivery on September 1



Wheat trades on morning of September 1 at spot price $100/ton



sold 2 tons at $110/ton
sold 2 tons at $90/ton

bought 2 tons at $110/ton
bought 1 ton at $95/ton
sold 1 ton at $115/ton

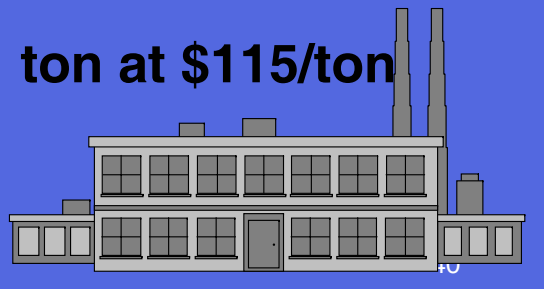
delivers 4 tons

sells 2 tons
at $100/ton

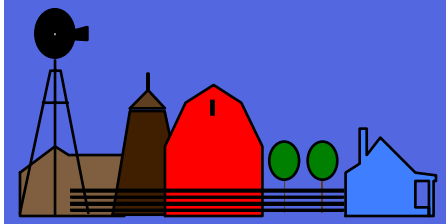
bought 2 tons at $90/ton
sold 1 ton at $95/ton

sells 1 ton at
$100/ton

bought 1 ton at $115/ton



"Opportunity Cost" Net $ Gains and Losses on Sept 1 from Futures/Spot Trades in Comparison With Spot-Trade-Only Outcomes



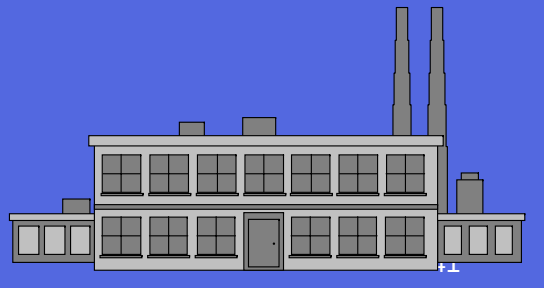
sold 2 tons at $110/ton
sold 2 tons at $90/ton
net gain: $ 0

bought 2 tons at $110/ton
bought 1 ton at $95/ton
sold 1 ton at $115/ton
sold 2 tons at $100/ton
net gain: $ 0

bought 2 tons at $90/ton
sold 1 ton at $95/ton
sold 1 ton at $100/ton
net gain: $15

September 1 Spot Price = $100/ton

net loss: $15
bought 1 ton at $115/ton
bought 3 tons at $100/ton



Importance of Information:

- In the previous example, the speculators are dealers who own some of the wheat before delivery to the miller
- They carry price risk -- the risk of a change in the spot price of wheat -- during this ownership period
- Need deep pockets
- Without additional information, this is pure gambling
- Information helps speculators make profits

Examples of Relevant Information:

- Long term weather forecast and its effects on future wheat harvest, hence on the farmer's ***supply of wheat***
- Long term forecasts regarding retail demand for bread
- Effects of retail bread demand on miller's need for flour, hence on the miller's ***demand for wheat***

6. Risk-Hedging Through Options

- Spot trades, forward & future contracts

  ➔ unconditional ("firm") delivery

- Options ➔ conditional delivery
  - ***(European) Call Option*** **=** Right (not obligation) to *buy* a specified quantity at a specified unit price on a specified future expiry date
  - ***(European) Put Option*** **=** Right (not obligation) to *sell* a specified quantity at a specified unit price on a specified future expiry date

- Two types of prices associated with each option contract:
  - ***Exercise (or strike) price*** **=** Specified unit price on expiry date
  - ***Option fee (or premium)*** **=** Price paid for the option itself on the day of option purchase, either through contractual arrangement (e.g., bilateral trade) or in a market at a price determined by demand and supply.

European Call Option: Example

[exercise price = $100/ton, quantity = 8 tons,
expiry date = Day D, option fee = F]

- Call option value on day D = [spot price – $100] x 8 if spot price > $100, otherwise $0
- If the spot price on day D is $90, then the call option value on day D is $0 and the call option is not exercised.
- If the spot price on day D is $110, then the call option value on day D is $10 x 8 = $80 and the call option is exercised.
- Call option holder makes a positive profit from his call option purchase if and only if the call option value on day D exceeds the option fee F.

European Put Option: Example

[exercise price = $100/ton, quantity = 8 tons, expiry date = Day D, option fee = F]

- Put option value on day D = [$100 – spot price] x 8 if $100 > spot price, otherwise $0.
- If the spot price on day D is $90, then the put option value on day D is $10 x 8 = $80 and the put option is exercised.
- If the spot price on day D is $110, then the put option value on day D is $0 and the put option is not exercised.
- Put option holder makes a positive profit from his put option purchase if and only if the put option value on day D exceeds the option fee F.

Two-Way Contract for Difference (CFD):

- Combination of a call and a put option for the same strike price ➔ Two-way CFD will always be exercised as long as the market price deviates from the strike price.
- ***Example:*** Buyer agrees to buy 50 tons of wheat from seller at a price of $100/ton on a future day D

Case 1:

- Day D spot price = $110/ton
- Buyer pays $5500 for 50 tons on Day D spot market
- Seller receives $5500 for 50 tons on Day D spot market
- Seller pays buyer $500
- Buyer ***effectively*** pays $5000, in accordance with CFD
- Seller ***effectively*** receives $5000, in accordance with CFD

Case 2:

- Day D spot price = $90/ton
- Buyer pays $4500 for 50 tons on Day D spot market
- Seller gets $4500 for 50 tons on Day D spot market
- Buyer pays seller $500
- Buyer effectively pays $5000, in accordance with CFD
- Seller effectively gets $5000, in accordance with CFD

- CFDs can insulate traders from actual market prices
- Sometimes additional financial contracts are needed to ensure full insulation (e.g., for markets with nodal pricing)