ECE 307 – Techniques for Engineering Decisions

Forward Contracts

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RISK

- There are many definitions of risk; we use the conceptual definition from Webster's dictionary that *risk is the possibility of suffering loss*
- Different people measure risk using various specific metrics
- All rational market players aim to minimize the risks they are facing

RISK

- In actual markets, players use various financial tools to keep their risks below a certain level
- Such actions constitute *risk management* and are carried out using financial instruments called *risk management tools*
- Financial derivatives are among the most widely used risk management tools in financial markets

FINANCIAL DERIVATIVES

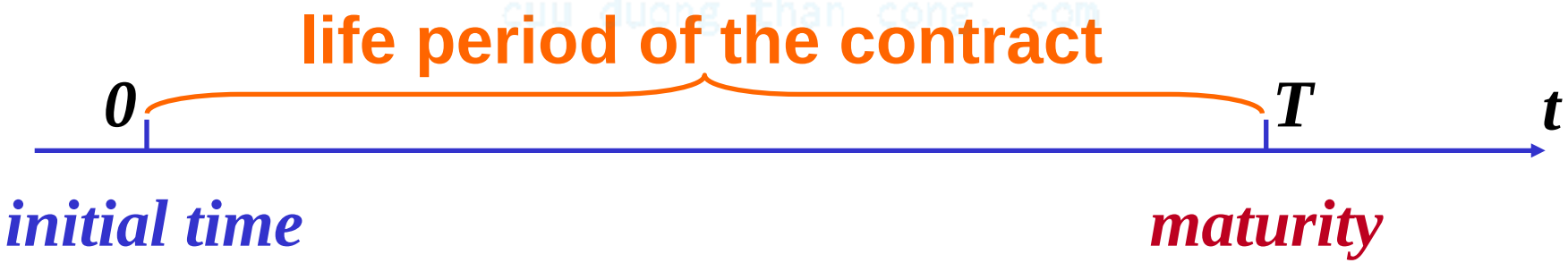
- Basic definition: a derivative is a financial tool whose value depends on the value of other, more basic underlying variables
- The basic derivatives we examine are
  - forward contracts
  - future contracts
  - options
    - puts
    - calls

EXAMPLE : A FLOUR CONTRACT

- A farmer in Illinois and a restaurant in Wisconsin enter into a contract on January 1, 2008, under which the farmer agrees to sell 1 *ton* of flour for *$* 400 to the restaurant on September 1, 2008
- The contract involves two parties
  - the farmer is the *issuer* of the contract and holds a *short position*
  - the restaurant is the *holder* of the contract and has a *long position*

EXAMPLE : A FLOUR CONTRACT

- The contract is signed on January 1 with the actual sale occurring on September 1
  - we call January 1 the *initial time* of the contract and denote it by $t = 0$, the origin of the time line
  - we call September 1 the *maturity* of the contract and denote it by $t = T$



EXAMPLE : A FLOUR CONTRACT

- This contract is on the trading of a single specified commodity – the flour; we call the 1 *ton* of flour the *underlying asset*

- The contract provides the holder with
  - the delivery of the underlying asset at T
  - the fixed price for the asset at the so-called *delivery price* and denote it by K

EXAMPLE : A FLOUR CONTRACT

- In the absence of a forward contract, the restaurant needs to buy the flour from the spot market at an uncertain price to meet its needs; this price can be high so that the restaurant bears price risks
- With the forward contract, the price is fixed and known and therefore the holder is protected from price risks
- This forward contract is a *physical contract* since the delivery of the asset is involved

EXAMPLE : A FLOUR CONTRACT

- We assume the existence of a *spot market price* s_T for flour at time T so that one can buy or sell the flour at that *spot price*
- The flour forward contract may be signed as a *purely financial contract* with the flour as the underlying asset, the maturity time T of September 1, 2003 and the specification of the following payments:

EXAMPLE : A FLOUR CONTRACT

- if $s_T > K$, the issuer reimburses the holder the difference $s_T - K$
- if $s_T < K$, the holder must make payment to the issuer at the amount of $K - s_T$

- These payments constitute the *payoff* of the financial contract
- Thus, the net price to the holder is the *delivery price* K independent of the market outcome

EXAMPLE : A FLOUR CONTRACT

- Since the issuer can sell the flour in the spot market, its net price also equals K
- Therefore, this purely financial contract provides the same function as the *physical contract* to both the issuer and the holder
- Typically, the forwards are purely financial contracts and not involve physical deliverability

FORWARD CONTRACTS

- A forward contract is a **binding** agreement to buy or sell an asset at a designated future time at a specified price
- An asset is a general term for any good, commodity or service
- The buyer is said to hold a *long position* and the seller holds a *short position*
- The specified price is called the *delivery price*

FORWARD CONTRACTS

- A forward contract is settled at *maturity* – the designated future time at which the purchase/ sale is made
- The holder of the *short position* delivers the asset to the holder of the *long position* in return for the cash payment of the *delivery price*
- The value of the forward contract is a function of the *market price* of the asset and its *maturity*

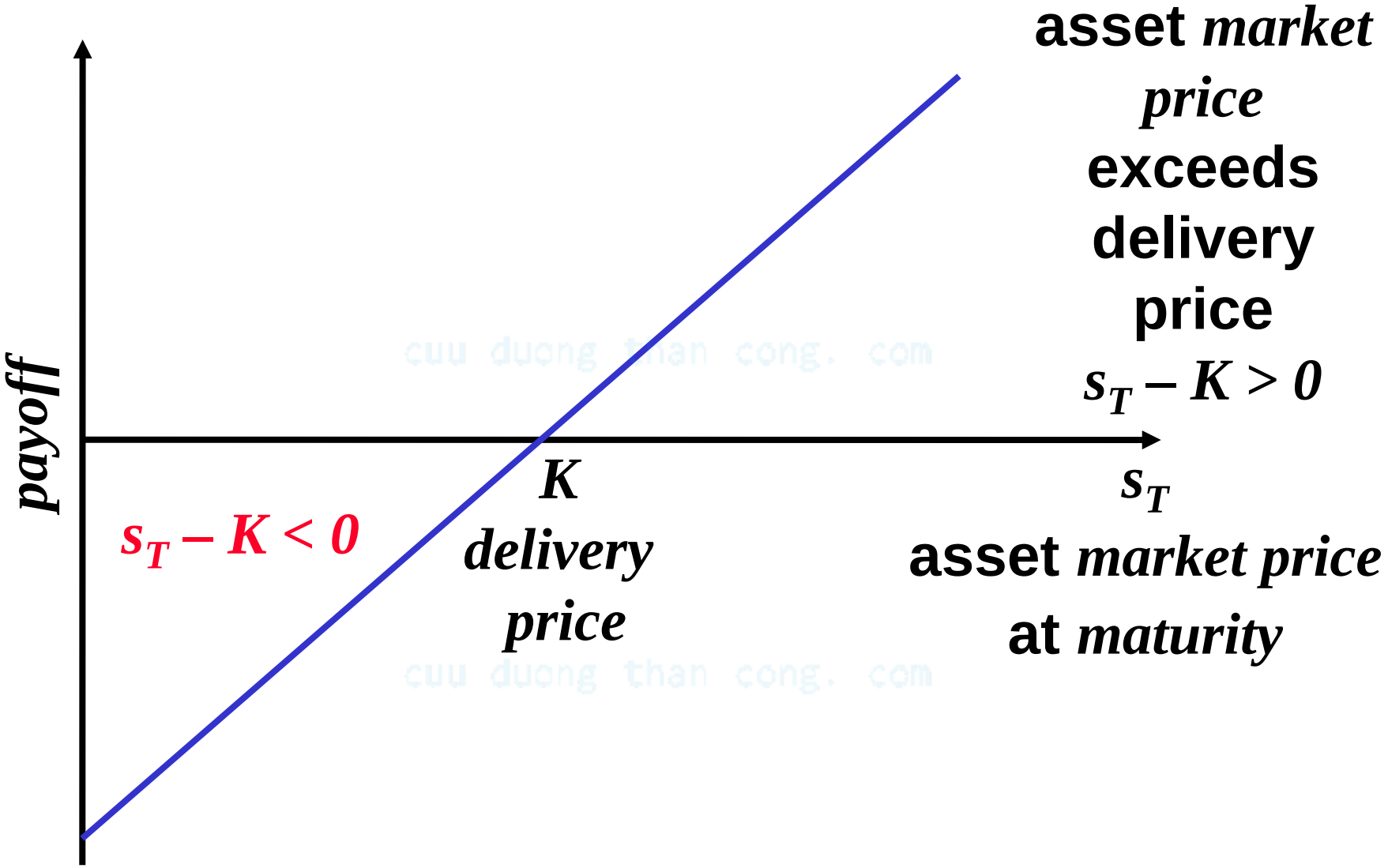
FORWARD VALUE AND PRICE

- The value of a forward contract is *0* for both the *short* and the *long* positions at the time the contract is signed; thereafter, its value may be positive, *0* or negative

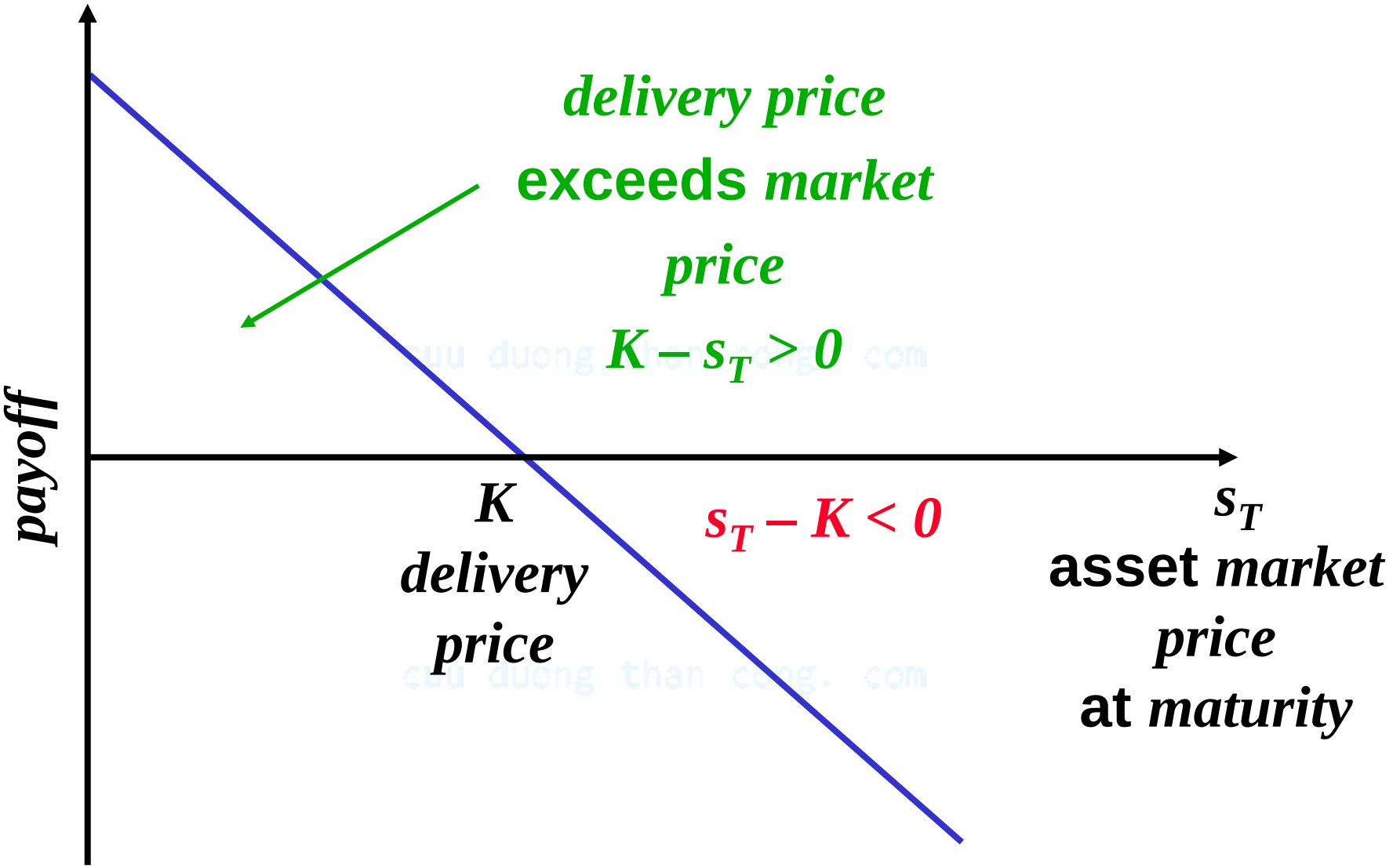
FORWARD VALUE AND PRICE

- The *forward price* of a forward contract is the *delivery price* that makes the forward contract have *0* value
- By definition, the *forward price* equals the *delivery price* at the time of contract signing; thereafter, the *delivery price* remains fixed but the *forward price* may change as a function of the *market price* and *maturity* of the contract

FORWARD CONTRACT *PAYOFF* : *LONG POSITION*



FORWARD CONTRACT *PAYOFF* : *SHORT POSITION*



EXAMPLE : FOREIGN EXCHANGE

May 8, 1995 spot and forward foreign exchange for British £ and U.S. $

spot	1.6080
30 – day forward	1.6076
90 – day forward	1.6056
180 – day forward	1.6018

EXAMPLE : FOREIGN EXCHANGE

- Investor signs a 90-day contract on May 8, 1995 for £ 1,000,000
- Investor pays $ 1,605,600 in 90 days and receives £ 1,000,000
- Consider two cases:

case	s_{90}	investor *payoff* ($s_{90} - K$) in $
1	1.6500	1,650,000 – 1,605,600 = 44,400
2	1.5500	1,550,000 – 1,605,600 = – 55,600

- The investor *payoff* represents the investor's total gains ($s_T - K > 0$) or total losses ($s_T - K < 0$)

FUTURES CONTRACTS

- A *futures contract* is a *standardized forward contract* that is, typically, traded on an exchange; the exchange provides a mechanism that guarantees the honoring of the contract by the two parties
- A key aspect in which a futures contract differs from a forward contract is that an exact delivery date is not specified; typically, the futures contract specifies the delivery month

EXAMPLE : WHEAT FUTURES CONTRACT

- Traded on the Chicago Board of Trade (CBT)
- Size: 5000 bushels
- Delivery months: March, May, July, September, and December
- Maturity: up to 18 months in the future
- Quality: grades of wheat specified by CBT
- Delivery locations: specified by CBT

FORWARD vs. FUTURES CONTRACTS

forward contract	*futures contract*
customized	standardized
private bilateral agreements	publicly traded on an exchange
one specified delivery period	range of delivery dates
settled at maturity (end of contract)	settled daily
long position takes delivery; *short position* gets cash settlement	typically contracts are closed out prior to maturity and do not involve delivery

FINANCIAL DERIVATIVES : FORMAL DEFINITION

- A *financial derivative* $\mathcal{D}$ is a financial instrument that derives its values from a *related* or *underlying asset*

- Financial derivative attributes are
  - the *underlying asset* S
  - the *maturity time* T
  - the *payoff function* $f^{\mathcal{D}}(g)$

POSITIONS AND MATURITY TIME

- Two parties are involved in a financial derivative
  - the issuer: *short position*
  - the holder: *long position*
- The *maturity* is the derivative expiration time T
- The derivative may be exercised at
  - anytime $t \in [0, T]$ for *American* derivatives
  - only $t = T$ for *European* type derivatives
- We focus on the use of *European* derivatives (in electricity T is chosen to be the time of energy need)

THE UNDERLYING ASSETS AND ASSET MARKETS

- The derivative is written on the price movement of a traded *underlying asset* S
- The *underlying asset* may be any good, service or variable whose value is well-defined, such as a stock, a bond, a commodity, currency, or a financial contract

THE UNDERLYING ASSETS AND ASSET MARKETS

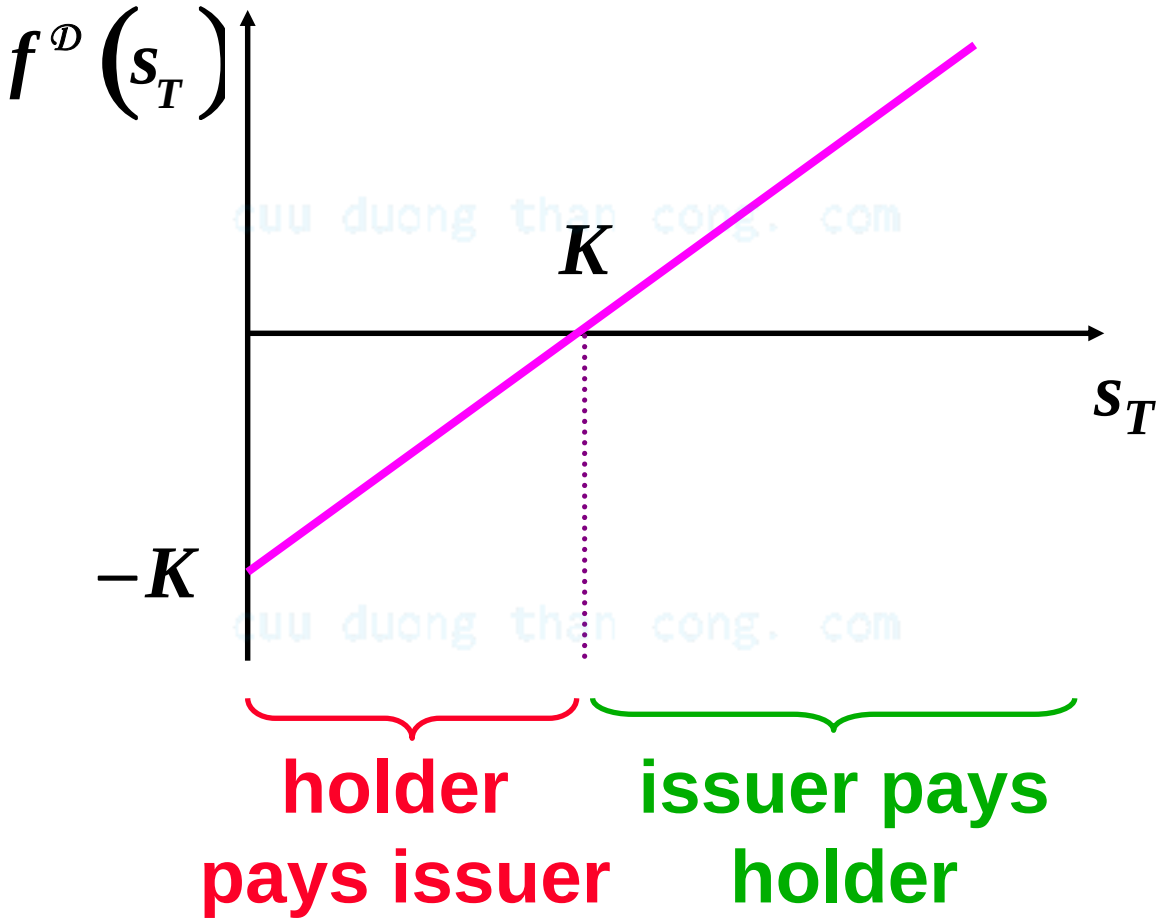
- We assume the existence of spot markets for the underlying asset at all times during the contract life; at any time t, a single spot price s_t exists for the particular asset S
- Short selling is allowed in the asset markets, i.e., the investor may borrow an asset from a bank and sell it, with the *obligation* to buy the asset at a later time to return it to the bank

PAYOFF FUNCTION OF THE DERIVATIVES

- Each derivative specifies a payment of the *payoff* from the issuer to the holder; the value of the *payoff* is computed using $f^{\mathcal{D}}(g)$
- The *payoff* is a function of the *underlying asset* price; for *European* derivatives, it is simply a function of s_T

PAYOFF EXAMPLE : THE FLOUR CONTRACT

$$f^{\mathcal{D}}(s_T) = s_T - K$$



RIGHTS AND *OBLIGATIONS*

- In the forward flour contract example, the contract must be exercised at time T: the holder of the contract **must** buy the flour from the issuer who **must** deliver it at time T
- The *payoff* of the forward is either nonnegative or negative, so that *two-sided* payments may exist
- Forward contracts impose ***obligations*** on both the issuer and the holder

RIGHTS AND *OBLIGATIONS*

- There exist other types of derivatives, for which, the holder has the option to choose whether or not to exercise the contract
  - the holder has the *right* but not the *obligation* to exercise the contract
  - the issuer has the *obligation* to perform as the contract dictates
- Such derivatives are called *options*

