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Lesson 1 Time-State Claims

Economics of Finance

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School of Economics, UNSW

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What is finance?

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Finance deals with payment now, payment in the future and uncertainty.

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- Key factors: *Time & Uncertainty.*

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Example: an apple tree

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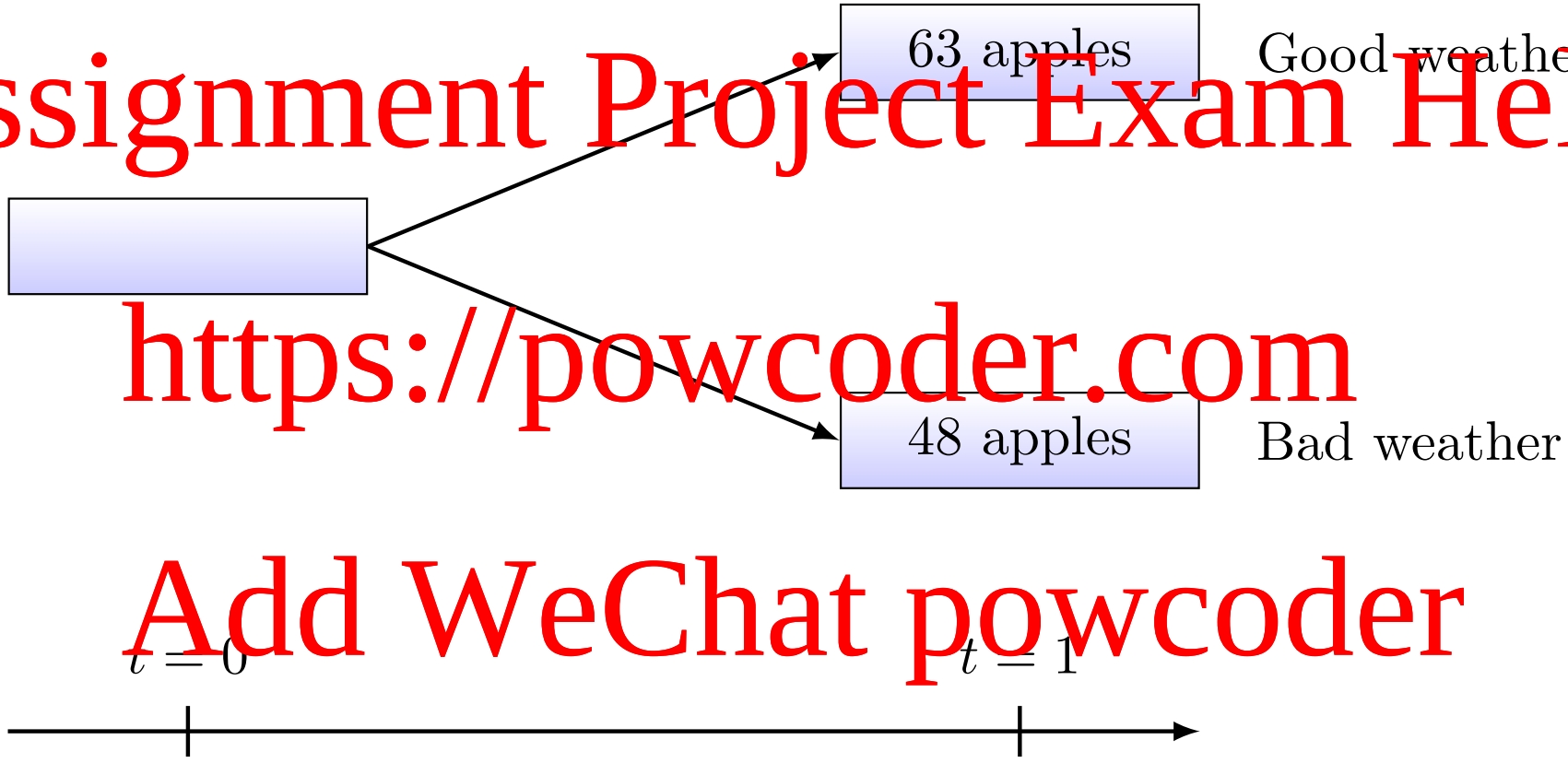

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Two time periods: $t = 0$, $t = 1$, spring – no apples and fall – uncertain apples.

Why do we care?

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Types of questions relevant for finance:

- How much apple does an apple tree worth?→ *Pricing Problem*
- How do we optimise our future apple stream? → *Portfolio Problem*

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Financial contract: an Arrow-Debreu paradigm (theory)

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Kenneth Arrow and Gerard Debreu introduced the concept of (state-) contingent contract

> *'A contract for the transfer of a commodity [specifying], in addition to its physical properties, its location and date, an event on the occurrence of which the transfer is conditional.'*

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Gerard Debreu, *Theory of Value*, The Cowles Foundation Monograph, 1959

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In short, a financial contract is a *Time-state claim*.

A simple environment

Key elements: Discrete time & discrete states

Two time periods:

- Time 0 - today
- Time 1 - a year from now

Two possible states of the world:

- G: good weather
- B: bad weather

These states of the world are:

- mutually exclusive (no state that is both good and bad)
- exhaustive (one and only one of the states will occur)

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An all-apple economy

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Suppose the only commodity traded in this economy is apple

- No money *per se*;
- Apple is the unit of account (*numeraire*)

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Why apples?

- Consumable (it's good);
- Countable, and perfectly divisible (it is measurable);
- Non-storable (timing matters!).

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State-contingent production

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The only type of productive investment is: APPLE TREE

The tree will produce:

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- 63 apples if the weather is good
- 48 apples if the weather is bad

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Elementary claims

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There are two elementary *time-state* claims:

- One apple at time 1 if the weather is GOOD
- One apple at time 1 if the weather is BAD

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We will refer to these claims as:

- GA - 'Good weather apples',
- BA - 'Bad weather apples'

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Similarly, we will refer to a present apple as 'PA'.

Atomic security

We interchangeably refer to a claim as a *security*. A security is a certificate of the following form:

```
I, Jane Smith, promise to deliver to the bearer of
this certificate one apple at the end of year 1 if
and only if the weather during the year has been
good.
```

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- Implicitly we assume that a credit agency has established that the security is AAA, i.e. default free.
- Atomic security is an atomic time-state claim (also known as basic Arrow-Debreu security, 'primitive' security)

Dealers (opportunities to trade)

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- Dealer G trades 0.285 PA for 1.0 GA or vice versa;
- Dealer B trades 0.665 PA for 1.0 BA or vice versa;
- Party A trades 6 GA for 3 BA or vice versa;

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Looks like we can make some profit out there. How?

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Arbitrage

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An *arbitrage* provides a positive net payoff in at least one time and state and no negative net payoff in any time and state.

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The payment matrix

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- each row represents a transaction;
- each column represents a time-state combination;

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	PA	GA	BA
Party A			
Dealer B			
Dealer G			
Net			

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Arbitrage strategy

We now construct a set of transactions which implements an arbitrage.

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Step 1: Go to Party A, and sign a contract swapping 6GA with 3BA;

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	PA	BA	GA
Party A	0	3	–6
Dealer B			
Dealer G			
Net			

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This creates a position of $-6GA$ and $3BA$ on your balance sheet.

Dealer B

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Step 2: Go to Dealer B, and sell $3BA$ to her. In return, receive a credit of

$$3 \times 0.665 = 1.995PA.$$

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	PA	BA	GA
Party A	0	3	-6
Dealer B	$3 \times 0.665 = 1.995$	-3	0
Dealer G			
Net			

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This transaction close out the position of BA.

Dealer G

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Step 3: Go to Dealer G, and buy $6GA$ from her. Pay

$$6 \times 0.285 = 1.710PA.$$

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	PA	BA	GA
Party A	0	3	-6
Dealer B	$3 \times 0.665 = 1.995$	-3	0
Dealer G	$-6 \times 0.285 = -1.710$	0	6
Net			

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This transaction close out the position of GA.

Summary

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To finish off, summarize the transactions:

	PA	BA	GA
Party A	0	3	-6
Dealer B	$3 \times 0.666 = 1.998$	-3	0
Dealer G	$-6 \times 0.285 = -1.710$	0	6
Net	0.285	0	0

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Our strategy is creating a profit without any lost in any state. By definition, this is an *arbitrage*.

Several ways to arbitrage

Step 1: Go to Party A, sign a contract swapping 6GA with 3BA

Step 2: Go to Dealer B, and sell $3BA$ to her. In return, receive a credit of

$$3 \times 0.665 = 1.995PA.$$

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Step 3: Go to Dealer G, and use all the of $1.995PA$ you received to buy GAs from her

$$1.995PA/0.285 = 7GA$$

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	PA	BA	GA
Party A	0	3	−6
Dealer B	$3 \times 0.665 = 1.995$	3	0
Dealer G	$-7 \times 0.285 = -1.995$	0	7
Net	0	0	1

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This is still an *arbitrage* as there is a net profit in GA.
It will be realised only if GA happens.