Zurich University
of Applied Sciences

School of
Management and Law

Workshop II: Economic Methods

Experimental economics

Building Competence. Crossing Borders.

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Experimental Economics

- ex•per•i•ment
  - Middle English 14th century
  - from Anglo-French esperiment
  - from Latin experimentum
  - from ex-periri, "to try out“
- Merriam-Webster: *an operation or procedure carried out under* ***controlled conditions*** *in order to discover an unknown effect or law, to test or establish a hypothesis, or to illustrate a known law*
- also, as verb and noun, more casual: *try something new, what has not been tried/observed before*

Nobel Prize in Economics, 2002

Daniel Kahneman: “for the introduction of insights from psychological research into economics, in particular with regard to judgements and decisions under uncertainty”. Kahneman’s research is based on psychological experiments and questionnaires. **Founder of behavioral economics**.

Vernon Smith: “for the use of laboratory experiments as a tool in empirical economic analysis, in particular, for the study of different market mechanisms”. **Founder of experimental economics**.

Motives and uses of experiments

1. Testing theories
2. Elicitation of preferences
3. Goods, risk, fairness, time
4. Exploring boundedly rational behavior
5. Establish empirical regularities as a basis for new theories
6. Theory free comparison of institutions
7. Policy advice
8. Teaching experiments

Components of an Experiment

- **Environment**:
  - Preferences, technologies, initial endowment
  - implemented by appropriate monetary incentives.

- **Institution** (Rules of the game)
  - Feasible actions
  - Sequence of actions
  - Information conditions

- Lab experiments often (implicitly or explicitly) define a game.
  => Game theory and experimental economics are strongly related

- **Framing** of instructions is important (neutral or context related)

Example Experiment: Electricity markets with a high share of renewables

- **Experimental aim:** To understand how the potential for strategic bidding behaviour in an electricity market might change with a higher renewable share.
- **Preliminary experimental runs:** Initial runs last week in Sydney with UNSW students
- **Today:**
  - Experimental procedure
  - Experimental instructions
  - Trial phase
  - You give it a go!
  - Preliminary results from UNSW students
  - Your preliminary results
  - Concluding thoughts

Experimental procedure

1. Recruitment of students – electronic system: Orsee
2. Participants enter room, randomly assigned to individual computer terminals
3. Participants read a Participant Information Statement and sign an Informed-Consent form.
4. Participants read instructions
5. All participants answer comprehension questions correctly
6. Trial phase (10 mins)
7. Experiment (30 periods)
8. Randomly select one period for pay-out
9. Calculate payouts, participants complete questionnaire
10. Pay students, collect receipts.

Instructions

- Participants will be paid cash
  - Amount depends on participant decisions and on the decisions of the other participants.
  - Provides an incentive for behaviour we want to observe
  - (You won't be paid today!)
- You are an electricity trader
  - You try to sell units of electricity together with two other randomly assigned participants.
  - All three in your group offer supply quantities at various prices.
  - Demand randomly determined by the computer, and known to you and the other traders.
  - Computer determines the market price and the quantities offered by each trader of your group.

Instructions

– Two types of technologies:

Technology type	Maximum capacity	Production costs
CHEAP	120 units	$10 /unit for the first 80 units $50 /unit for units 81 – 120
EXPENSIVE	40 units	$50 /unit

– Four possible scenarios:
  1. All have the CHEAP technology
  2. All have the EXPENSIVE technology
  3. Someone has the CHEAP and two have the EXPENSIVE technology
  4. Two have the CHEAP and someone has the EXPENSIVE technology

You will **know** what you and the other two participants have

Instructions – Example 1

Technology type	Maximum capacity	Production costs
CHEAP	120 units	$10 /unit for the first 80 units $50 /unit for units 81 – 120
EXPENSIVE	40 units	$50 /unit

- Suppose you have the EXPENSIVE technology.
- Can supply a maximum of 40 units of electricity.
- Each unit of electricity costs $50.
- Supplying 10 units costs you:
  - 10 x $50 = $500
- Supplying 40 units costs you:
  - 40 x $50 = $2,000

Instructions – Example 2

Technology type	Maximum capacity	Production costs
CHEAP	120 units	$10 /unit for the first 80 units $50 /unit for units 81 – 120
EXPENSIVE	40 units	$50 /unit

- Suppose you have the CHEAP technology.
- Can supply a maximum of 120 units of electricity.
- Supplying 60 units costs you:
  - 60 x $10 = $600
- Supplying 100 units costs you:
  - 80 x $10 + 20 x $50 = $1,800

Instructions – Decision Screen

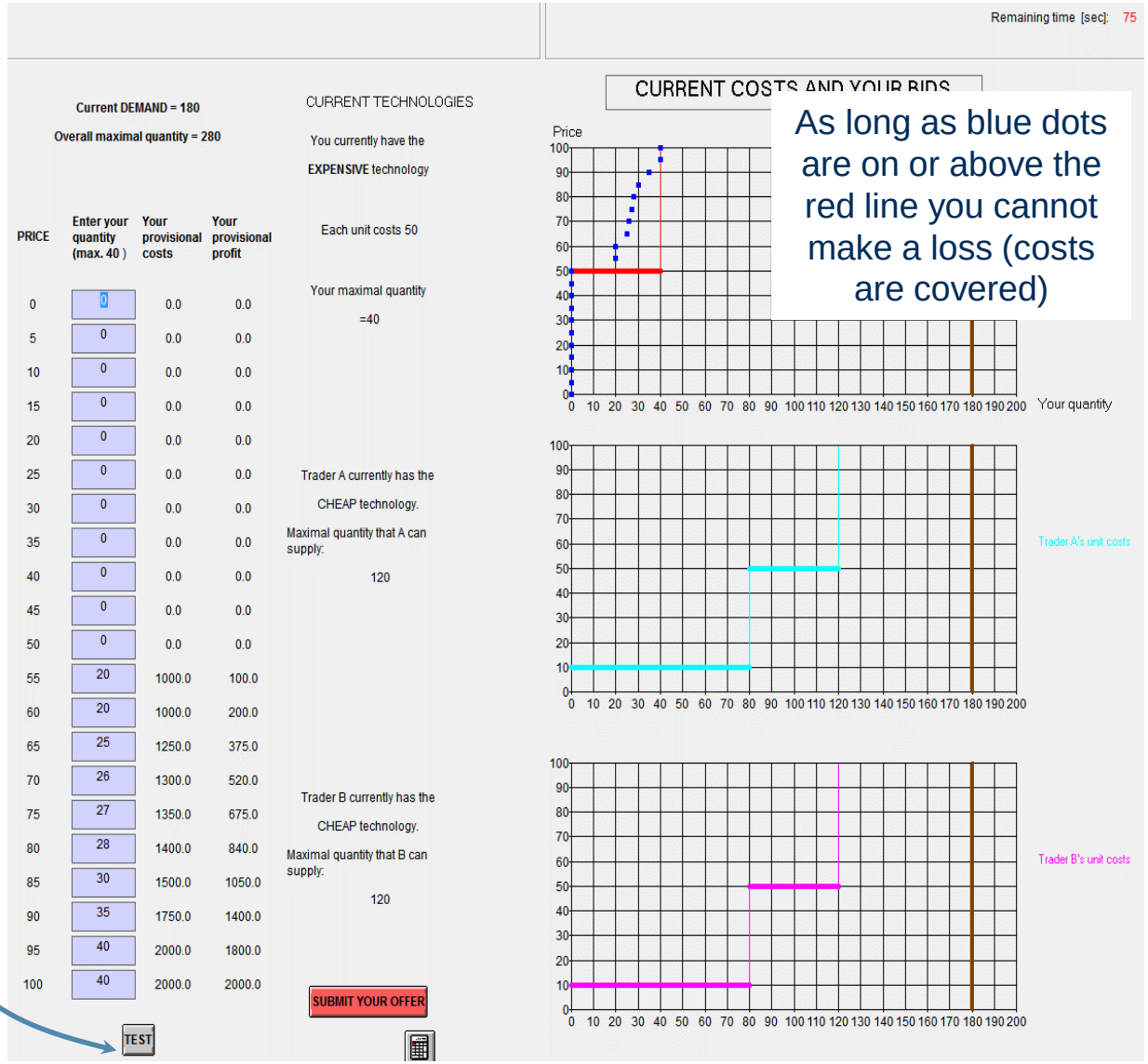
In each period you decide how many units of electricity you want to supply at different possible prices.

The computer will determine a single market price and only the quantity you entered at that price is relevant to determine your market supply

Your quantity offer at a higher price should not be smaller than your quantity offer at a lower price.

For each given price, enter your quantities here

Push "Test" to visualize your bids, and to calculate your provisional costs and profits



As long as blue dots are on or above the red line you cannot make a loss (costs are covered)

Instructions – Market price calculation

- **The market price:** the first price for which the aggregate supply at that price equals or exceeds the demand.
- **Example:**

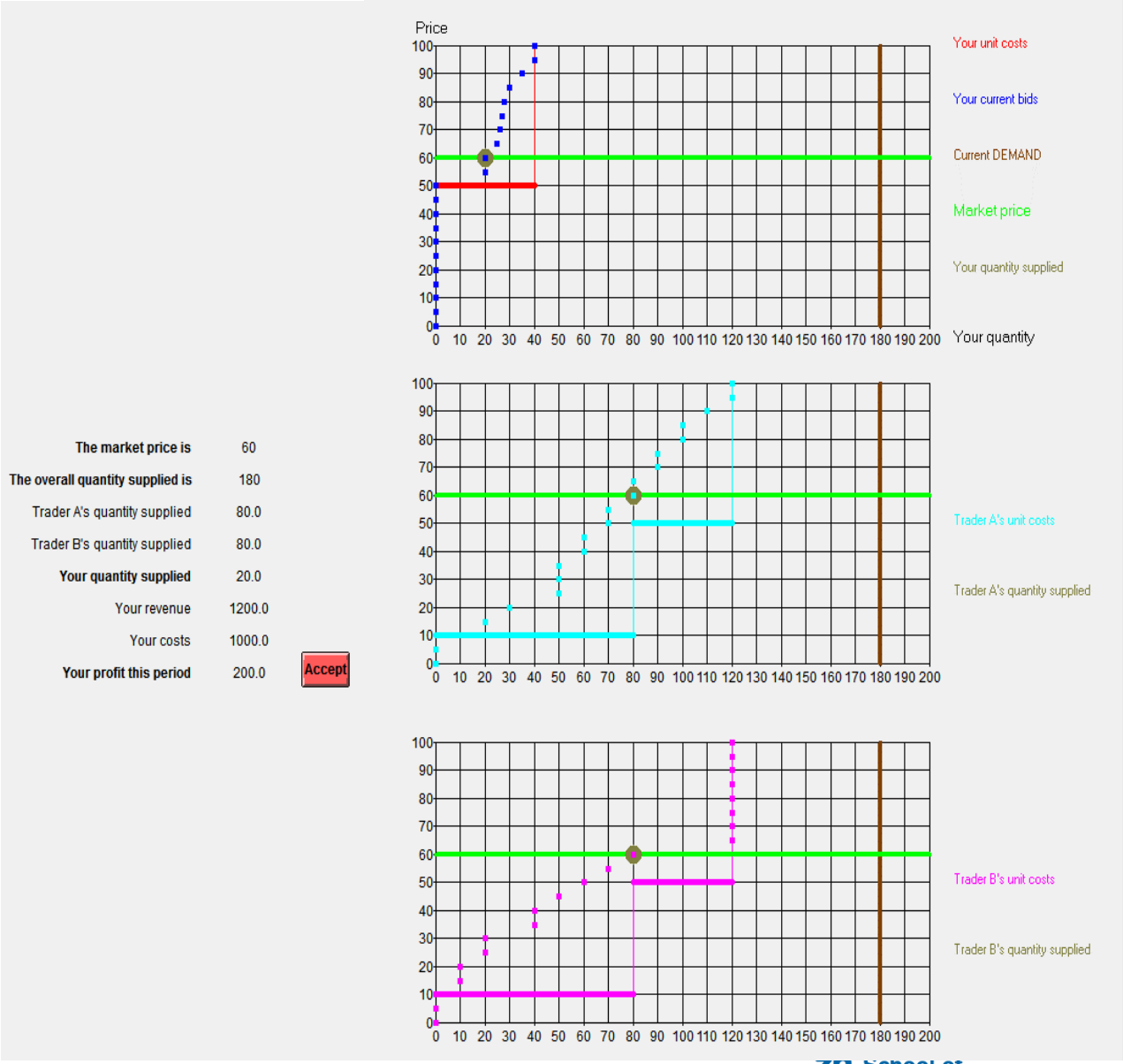
PRICE	Your offer	Trader A	Trader B	Aggregate Supply
$0	0	10	10	0 + 10 + 10 = 20
$5	40	40	40	40 + 40 + 40 = 120

- If Demand = 100
  - If the price is $0, aggregate supply is 20 (insufficient to meet demand), price must be > $0
  - If the price is $5, aggregate supply is 120, which exceeds demand.
- Therefore, the market price is $5.
- If the aggregate supply > demand, each trader supplies proportional to offers
  - In this example, each trader supplies 100/3 = 34 (rounded up)
- Your revenue = 34 x $5 = $170
- Your costs = 34 x $10 = $340 or 34 x $50 = $1700 (depending upon technology)

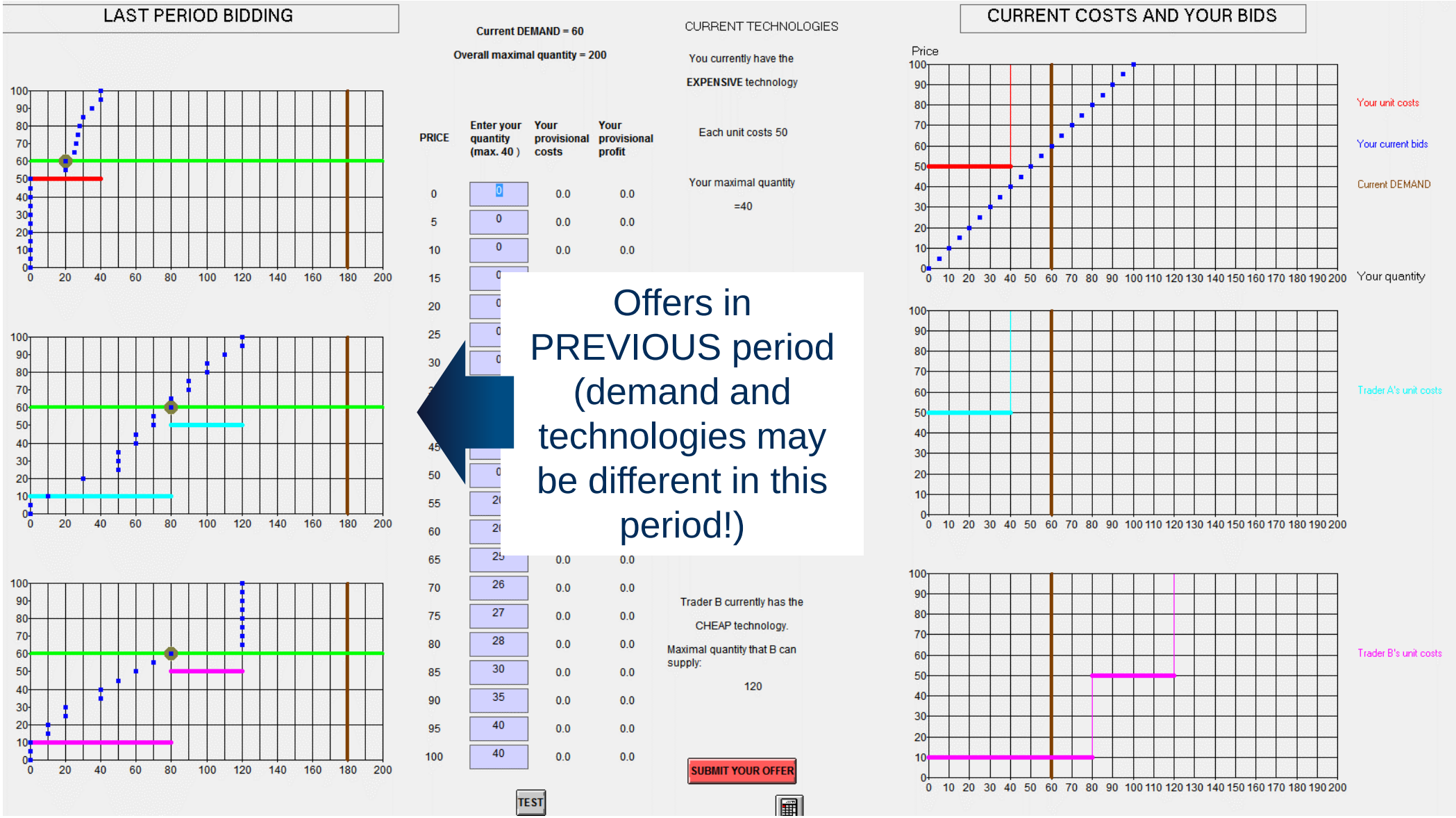
Instructions – Results Screen

- Market price is $60
- Quantity supplied: 20
- Revenue: 20 x $60 = $1200
- Costs: 20 x $50 = $1000
  - EXPENSIVE technology
- Profit: $1200 – $1000 = $200

- Click “Accept” when you’re finished looking at the results.



Instructions – Next Period



Offers in PREVIOUS period (demand and technologies may be different in this period!)

Instructions – Trial Phase

trial1 out of 1

Remaining time [sec]: 595

Current demand: 60
100
180

Your technology: CHEAP / EXPENSIVE

Trader A's technology: CHEAP / EXPENSIVE

Trader B's technology: CHEAP / EXPENSIVE

Apply

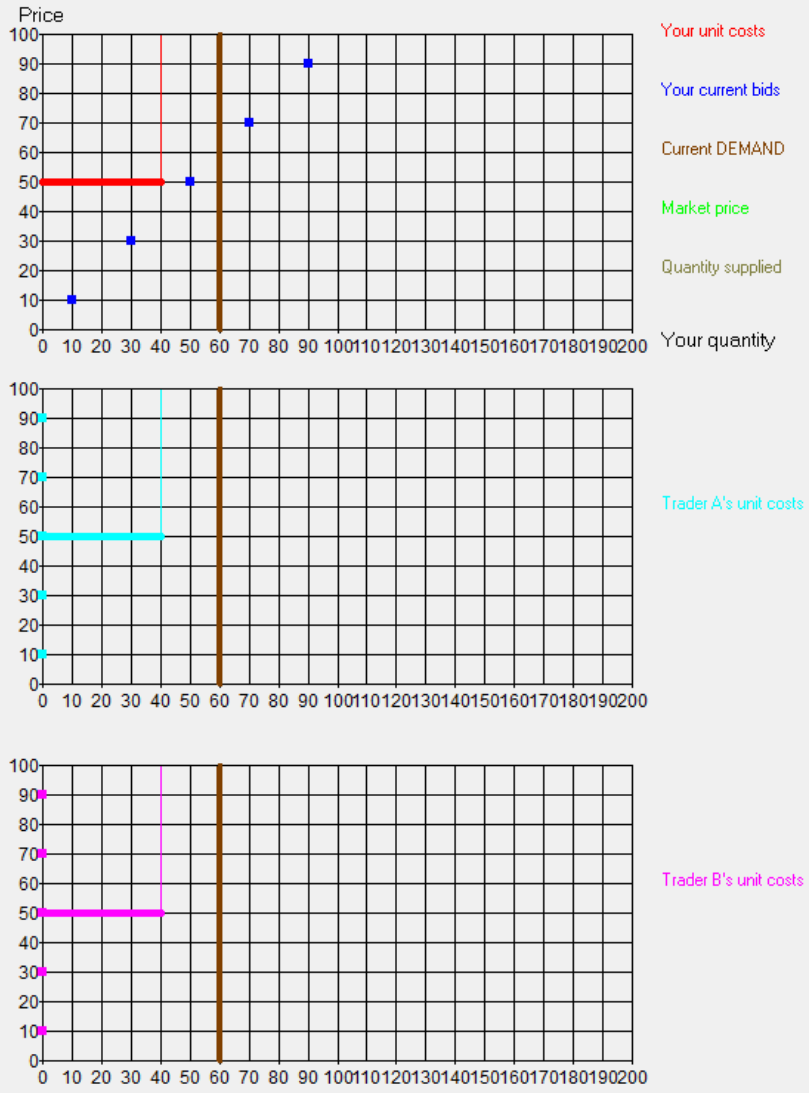
Current demand 60

Overall maximal quantity 120

	You	Trader A	Trader B
Technology	EXPENSIVE	EXPENSIVE	EXPENSIVE
Max. quantity	40	40	40
PRICE			
10	0	0	0
30	0	0	0
50	0	0	0
70	0	0	0
90	0	0	0

Payoffs

The market price is	1234
The overall quantity supplied is	0
Your quantity supply	0.0
Your revenue	0.0
Your costs	0.0
Your profit this period	0.0
Trader A's quantity supply	0.0
Trader A's revenue	0.0
Trader A's costs	0.0
Trader A's profit this period	0.0
Trader B's quantity supply	0.0
Trader B's revenue	0.0
Trader B's costs	0.0
Trader B's profit this period	0.0



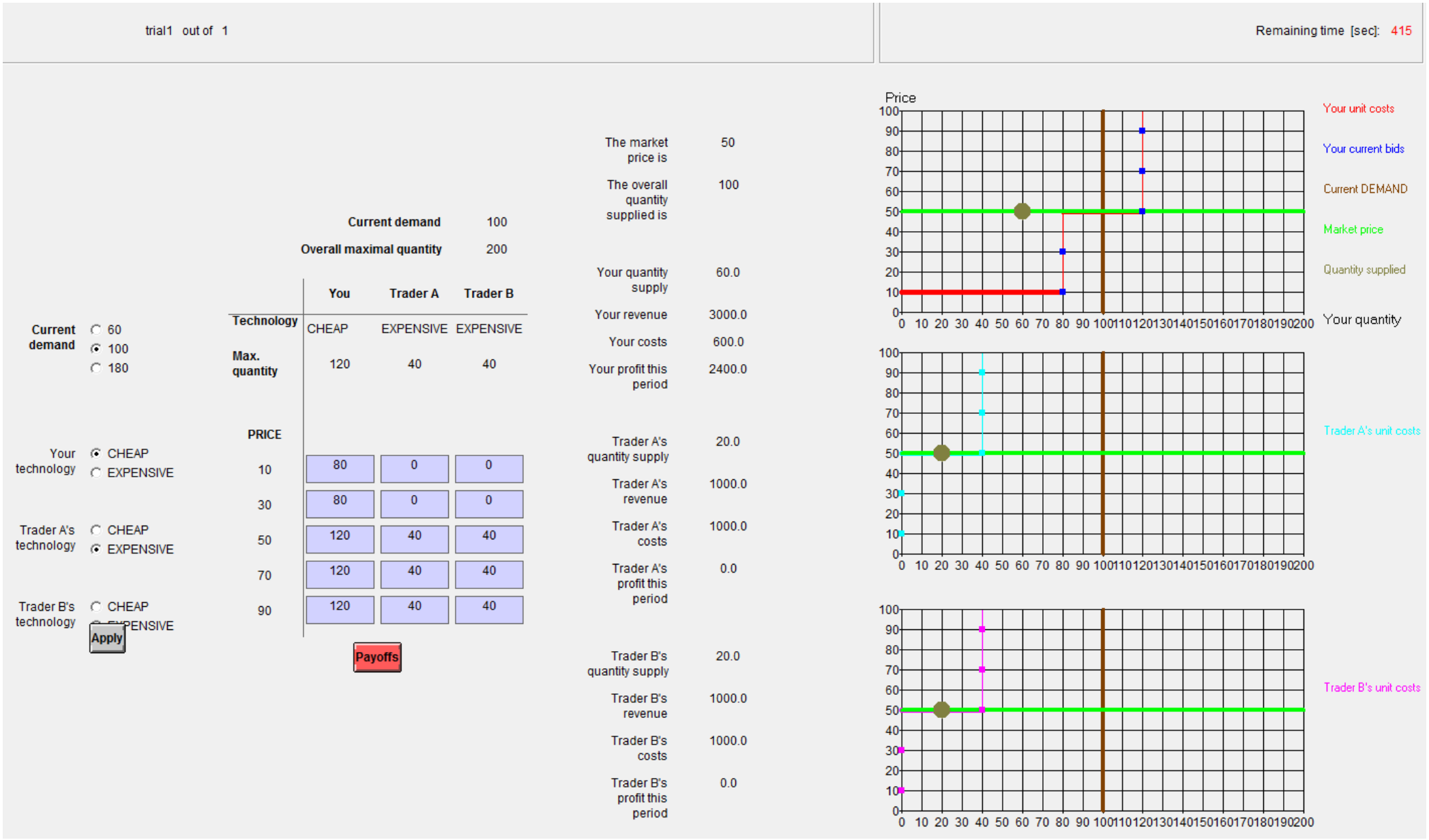
Questions?

- Any Questions?
- Lets try the experiment!

How does this represent a high renewables market?

- Each trader has a portfolio of wind and gas
  - 80 MW wind
  - 40 MW gas
- If assigned expensive technology:
  - Only your gas turbines are available in this period, there is no wind
- If assigned cheap technology:
  - Your wind is available in this period (as well as gas turbines)
- Key questions:
  - Does variability of wind generation across the market create additional opportunities for exercise of market power? (increasing asymmetry?)
  - Explore impacts of increasing uncertainty
    - Does increasing uncertainty discourage strategic behaviour?

Example – Short-run marginal cost (SRMC) offers



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Example – Strategic Bidding

trial1 out of 1

Remaining time [sec]: 511

Current demand: 60 / 100 / 180

	Current demand	100
	Overall maximal quantity	200

	You	Trader A	Trader B
Technology	CHEAP	EXPENSIVE	EXPENSIVE
Max. quantity	120	40	40
PRICE			
10	0	0	0
30	0	0	0
50	0	40	40
70	0	40	40
90	120	40	40

Your technology: CHEAP / EXPENSIVE

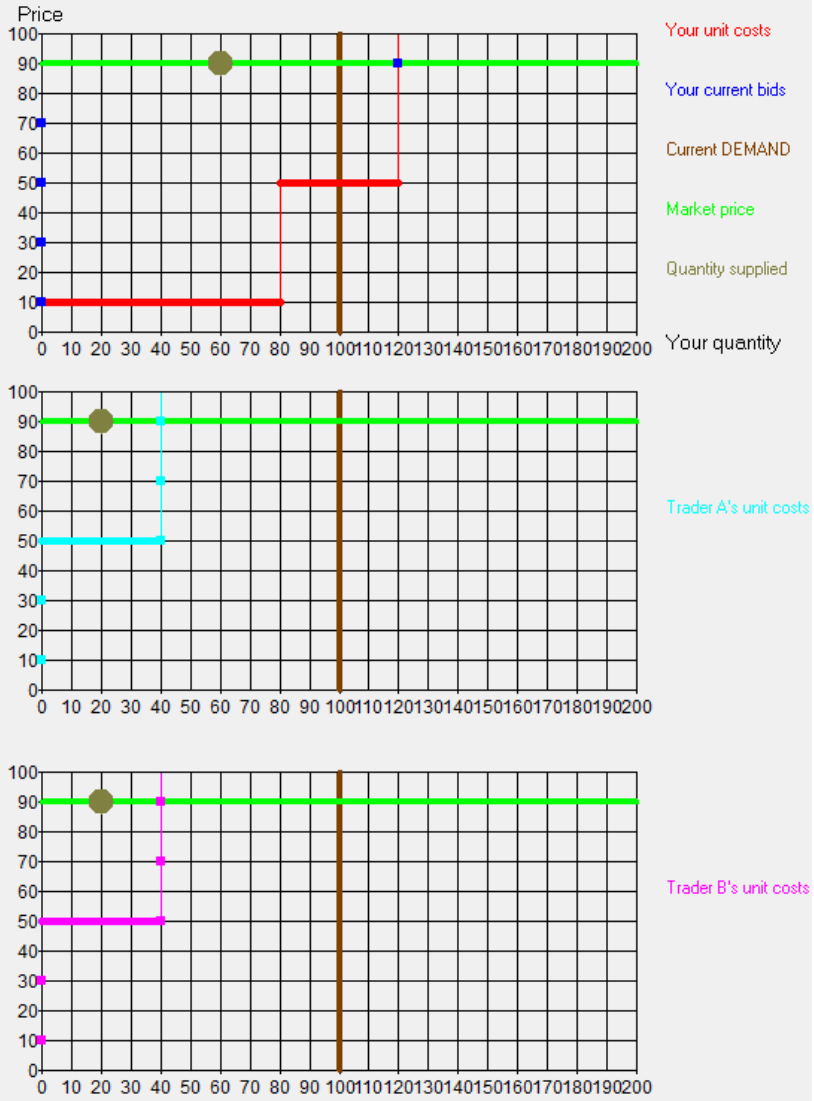
Trader A's technology: CHEAP / EXPENSIVE

Trader B's technology: CHEAP / EXPENSIVE

Apply

Payoffs

The market price is	90
The overall quantity supplied is	100
Your quantity supply	60.0
Your revenue	5400.0
Your costs	600.0
Your profit this period	4800.0
Trader A's quantity supply	20.0
Trader A's revenue	1800.0
Trader A's costs	1000.0
Trader A's profit this period	800.0
Trader B's quantity supply	20.0
Trader B's revenue	1800.0
Trader B's costs	1000.0
Trader B's profit this period	800.0

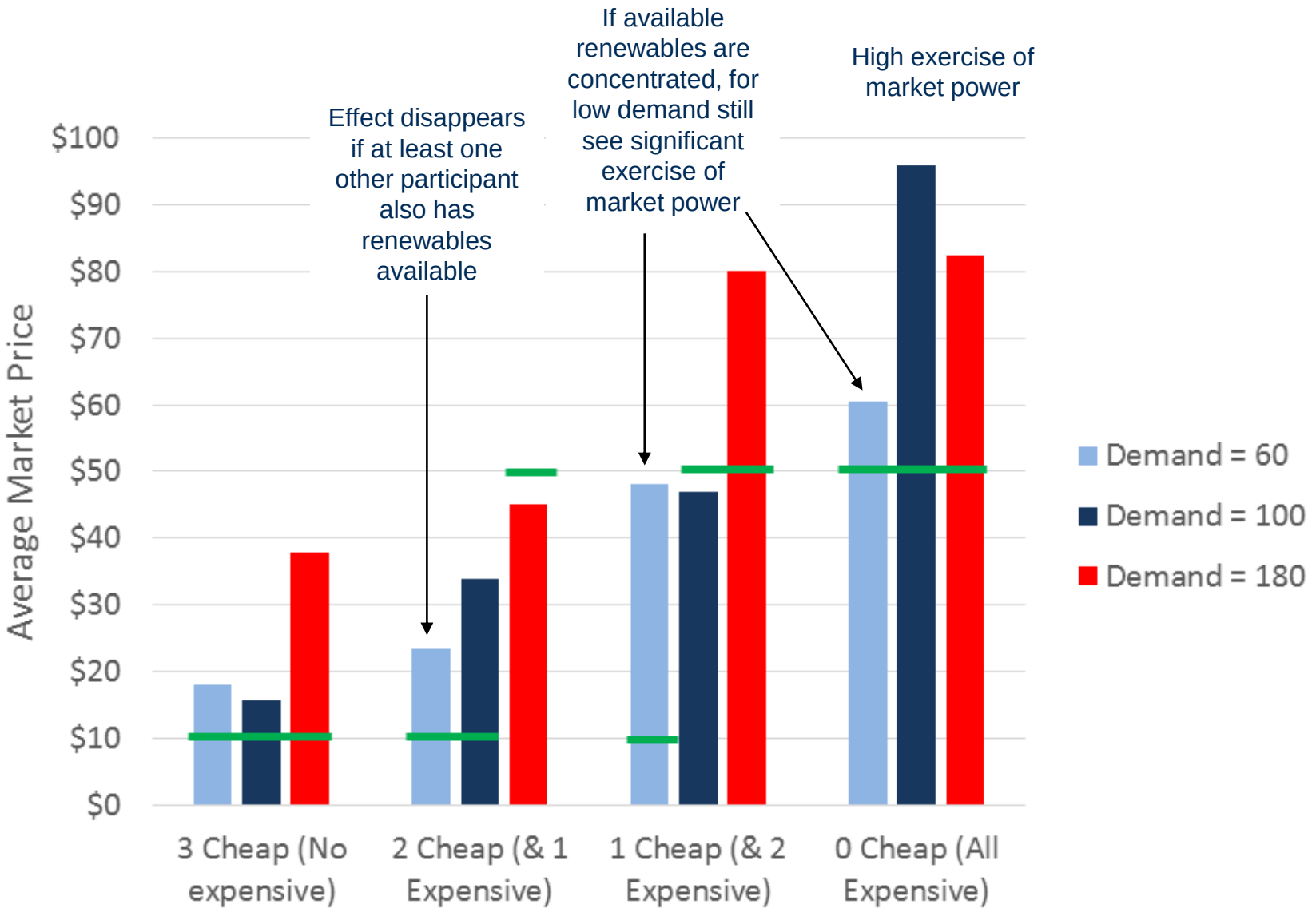


Preliminary Experimental Results (UNSW Students)

- **Preliminary results from first runs with UNSW students doing this experiment last week**
- What is the percentage of underbidding? (understanding the game)
  - Two subjects bid at price =0 in period 1 or period 2
  - 2.7% (9 out of 330) of all observations offered a bid below their cost curve.
  - The majority understood that their bid should usually be at or above their cost.
- Is there evidence of extreme strategic bidding behaviour?
  - Eg. offering maximum quantity at price = 100, and 0 otherwise
  - 9.1% (30 out of 330) of all observations is extreme strategic.
  - Appears to imply that most decisions are rational (not below cost), and not extreme-strategic (mostly somewhere in between)

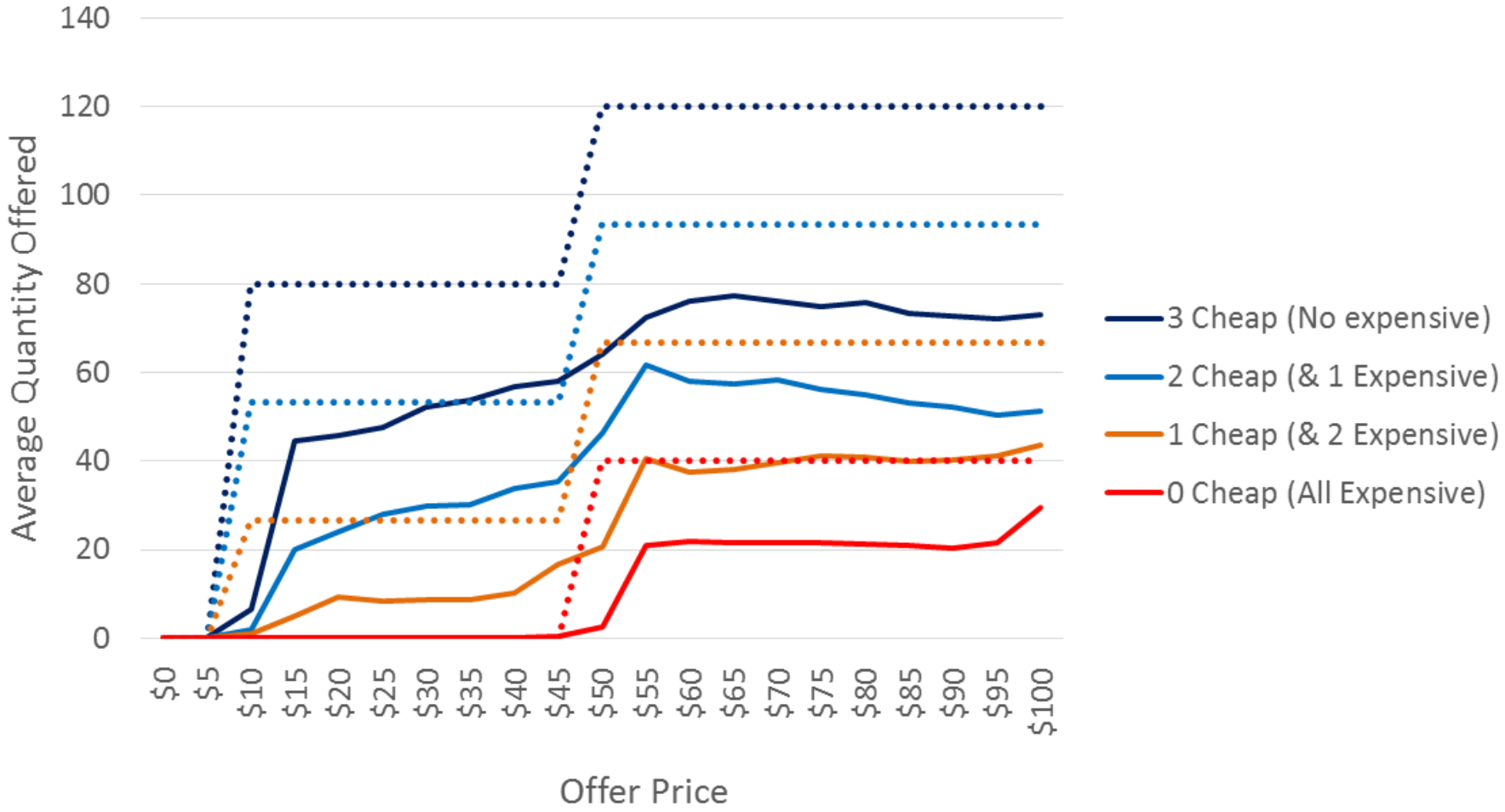
Preliminary Experimental Results (Students)

The distribution of technologies may have an important strategic effect, which does not reduce prices as strongly as actually suggested by technology



Preliminary Experimental Results (Students)

- Withholding capacity at all levels
  - But is this strategic withholding?
  - Or did they just not understand the experiment very well? (distributing offers evenly – no evidence of behaviour change near key transitions))



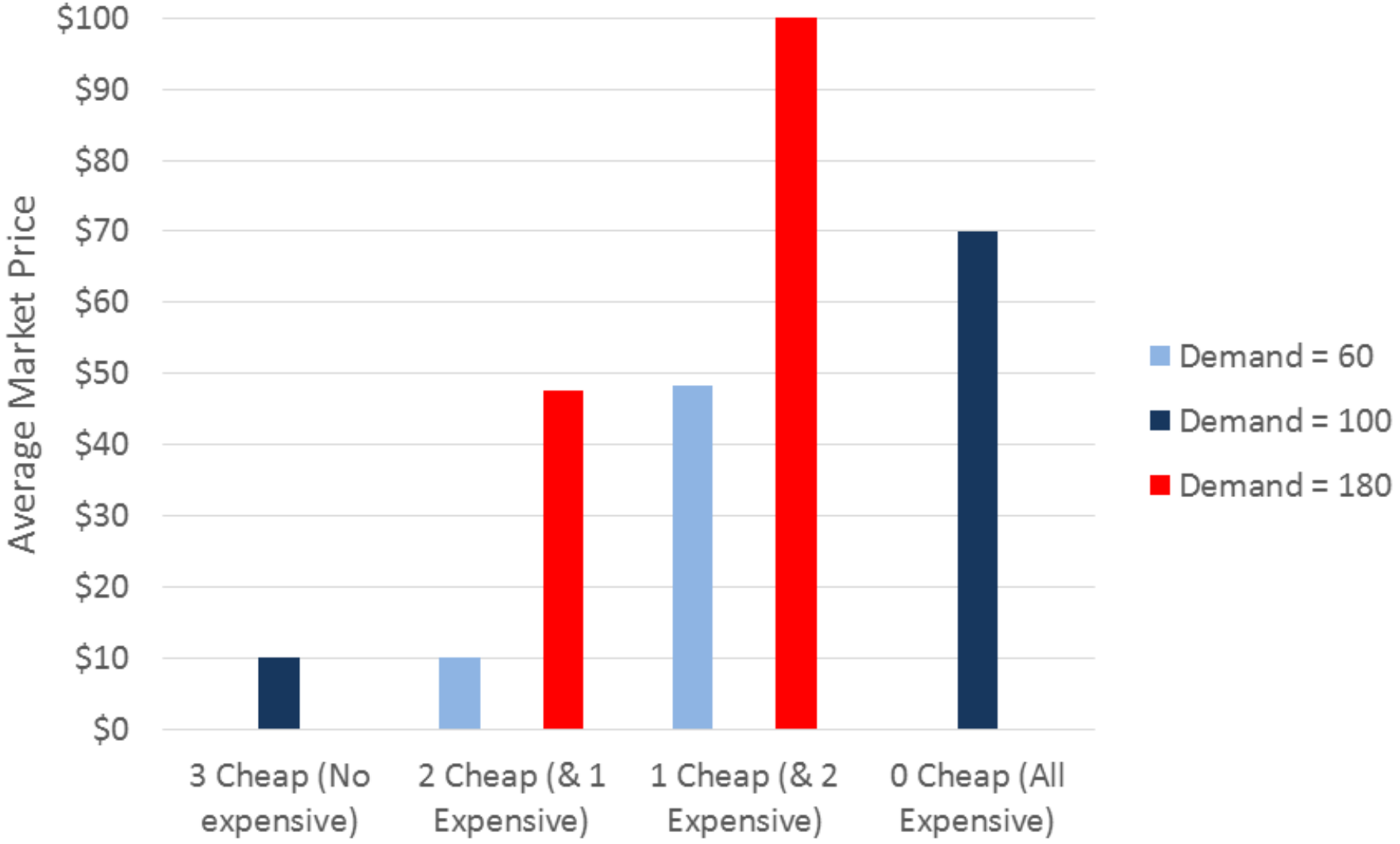
Your Results

– What did you do?

Preliminary Experimental Results (You)

- **Preliminary results from first runs with UNSW students doing this experiment last week**
- What is the percentage of underbidding? (understanding the game)
  - 0 subjects bid at price =0 in period 1 or period 2
  - 2 out of 30 of all observations offered a bid below their cost curve.
- Is there evidence of extreme strategic bidding behaviour?
  - Eg. offering maximum quantity at price = 100, and 0 otherwise
  - 1 out of 30 of all observations is extreme strategic.

Preliminary Experimental Results (You)



Preliminary Experimental Results (You)

- Withholding capacity at all levels
  - But is this strategic withholding?
  - Or did they just not understand the experiment very well? (distributing offers evenly – no evidence of behaviour change near key transitions))

Confidence in experimental results

- For millenia the sun rises every morning. Yet, this does not allow you to make the inference that tomorrow morning the sun will rise again. Nevertheless, almost all people believe this. This confidence is the essence of induction.
- No experiment and no other empirical result whatsoever can prove that under the same circumstances the same regularities will prevail.
- Yet, if many experiments have shown that – given a certain set of conditions – robust and replicable regularities emerge, we can have faith that the same regularities will occur in reality given that the conditions are met.
- Therefore, an honest sceptic who doubts the external validity of an experiment, has to argue that the experiment does not capture important conditions that prevail in reality. ***Response: Try to implement the neglected conditions.***

Advantages of (Lab) Experiments I

- Subjects are **randomly assigned** to the treatment conditions – rules out selection bias.
- It is known which variables are exogenous and which are endogenous – allows to make **causal inferences**.
- Experimenter can make *ceteris paribus* changes in the exogenous variables – allows for the isolation of true causes.
- Many variables that cannot be directly observed in the field can be observed in the lab.
  - Reservation wages, anticipated versus non-anticipated money supply shocks.

Advantages of (Lab) Experiments (II)

- **Information conditions** and exogenous stochastic processes can be controlled (e.g. important for testing asymmetric information).

- Better direct controls are often a substitute for complicated econometric methods.

- **Replicability** – provides the basis for statistical tests. Critics can run their own experiments.

- Enhanced control opportunities often imply that the experimenter knows the predicted equilibrium exactly.
  - Equilibrium and disequilibrium actions can be explicitly observed.
  - Quick or sticky adjustment can be explicitly observed.

Series of experiments

- Replication is not the same as repetition!
  - Repetition: do the exact experiment again
  - Replication: test the generality of results by varying the experimental environment: parameters, institutions, other controls …
- Series of experiments
  - Allow to show the robustness of a phenomenon
  - But also its limits, the conditions under which it does not appear
  - → reliability of conclusions

Objections to lab experiments (I)

- **Internal validity**: Do the data permit causal inferences?
  - Internal validity is a question of proper experimental controls and correct data analysis.

- **External validity**: Can we generalize our inferences from the lab to the field?
  - Problem of induction: Behavioral regularities persist in new situations as long as the relevant underlying conditions remain essentially unchanged.

Internal versus external validity

- **Obtaining internal validity**
  - Implementing “ceteris paribus” – change only one parameter at a time, keep everything else constant
  - Implement a model to be tested as close as possible
  - Think about your auxiliary hypotheses
- **Obtaining external validity**
  - capture the *relevant* aspects of the real world situations you want to generalize to
  - Use monetary incentives for *economic* decisions

  …
- There is a **tradeoff** between internal and external validity:
  - The more control internally, the more “artificial” the situation. So the less can be concluded for the real, lab-external world

Objections to lab experiments (II)

- Lab experiments are **unrealistic** and **artificial**
- Most economic models are unrealistic in the sense that they leave out many aspects of reality. However, the **simplicity** of a model or an experiment is **often a virtue** because it enhances our understanding of the interaction of relevant variables. This is particularly true at the beginning of a research process.
- Whether realism is important **depends on the purpose** of the experiment. Often the purpose is to test a theory or understanding the failure of a theory. Then the evidence is important for theory building but not for a direct understanding of reality.

Objections to lab experiments (III)

- Participants are just students – lack of representativeness
- The stakes are small
- The number of participants is small
- Participants are inexperienced

- Response
  - Take other subject pools (workers, soldiers, CEOs)
  - Conduct representative experiments
  - Increase the stakes
  - Increase the number of participants
  - Invite experienced participants

Summary

- **Economic theory** needs strong **assumptions**
- Experiments help as they solve the empirical evaluation problem through randomization and implementation of “ceteris paribus”

- A result in the lab does not automatically confirm or reject a hypothesis: it has to be evaluated in view of all **auxiliary hypotheses** made during implementation.
- **Internal validity** is increased by tight control, **external validity** by “realism”, this is the challenge for the experimenter

THANK YOU VERY MUCH FOR YOUR ATTENTION !