



# Testing auction mechanisms for multi-attribute carbon markets

Andrew Reeson, Todd Sanderson, Alexander Krumpholz and Phil Kilby  
LEEP in 2019

[www.data61.csiro.au](http://www.data61.csiro.au)

# Carbon offsets

- Mechanism to cancel out emissions elsewhere
  - Reduced GHG emissions
  - Carbon sequestration
  - ‘Flexibility mechanism’
- Basis for voluntary markets
  - Can also be incorporated into compliance markets

# Carbon offsets

- Australian carbon markets incorporate offsets
  - Including land sector offsets – Carbon Farming Initiative
  - Large potential supply
  - Government purchases offsets
  - Voluntary market largest source of demand

# Multiple values of carbon

- Carbon credits from land sector are complex goods
- Differ by environmental and social co-benefits (or co-costs)
  - e.g. trees may provide biodiversity benefits
  - Tree planting impacts water and salinity
  - Savanna burning generates social benefits
- Many buyers care
  - Seen in previous schemes
  - e.g. 'dead koala RECs'
  - Corporate social responsibility/reputational risk

# Multiple values of carbon

- Carbon credits differ by risk profile
  - Particularly for biological sequestration projects
    - Drought
    - Fire
    - Disease risks
  - Varying spatial and temporal correlation
    - Portfolio construction

# Multiple values of carbon

- How to recognize these values?
    - Distinguish multiple types of carbon
    - Without fragmenting market
    - Multi-attribute auctions rare in practice
- Market design

# Current market context

- Major buyer does not differentiate
  - Buys lots of cheap carbon
  - Highly concentrated market
- Broader market trades ‘over-the-counter’
  - High transaction costs
- Little incentive to provide co-benefits

# Market design

- Mixed market (lucky dip)
  - Combine all types of carbon
  - Single price
  - Co-benefits not recognised
- Parallel auctions (choose your market)
  - Can submit bids for any type
  - But need to choose
  - Or run the risk of getting too many (or too few)



# Market design

- Parallel conditional auctions (express your preferences)
  - Run parallel auctions for different types
  - Buyers submit bids with AND/OR functions
  - Allows different prices for different types
    - Or a lack of preference
  - cf Klemperer product mix auction
  - Provide incentive compatible mechanism
- Combinatorial optimisation problem
  - Maximise market benefits

# Experimental market testing

- Economic experiments test alternative market designs
  - Controlled laboratory conditions
  - Real human decision-makers
  - Real incentives
- Programmed in OTREE
  - Open source experimental platform
  - Python-based
  - Can be cloud hosted
    - We used AWS

# Experimental scenario

You are the Buyer. You can bid for 15 items.

Your Resale Values are: Type A: \$15.00, Type B: \$14.00, Type C: \$16.00.

Type	Quantity	Price
Any Type	<input type="text"/>	<input type="text"/> \$

Next

You are the Buyer. You can bid for 15 items.

Your Resale Values are: Type A: \$13.00, Type B: \$16.00, Type C: \$18.00.

Type	Quantity	Price
Type A	<input type="text"/>	<input type="text"/> \$
Type B	<input type="text"/>	<input type="text"/> \$
Type C	<input type="text"/>	<input type="text"/> \$

Next

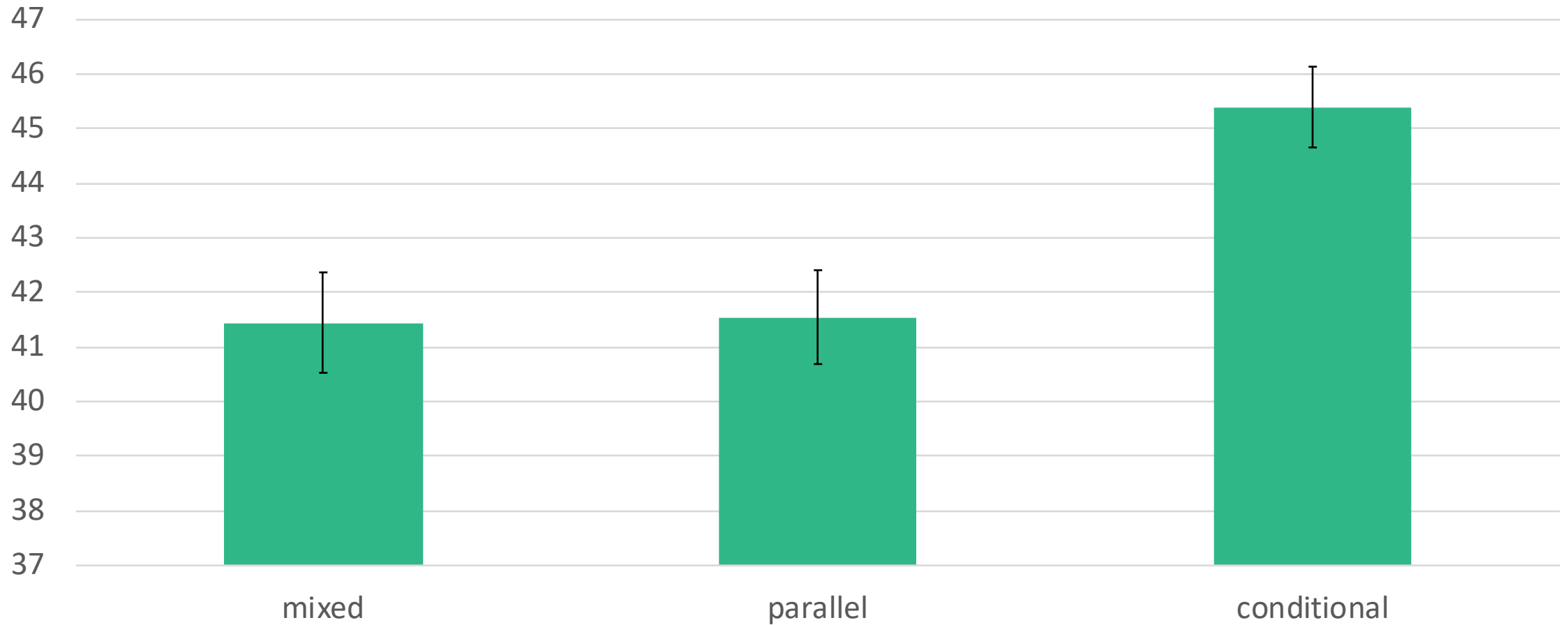
You are the Buyer. You can bid for 15 items.

Your Resale Values are: Type A: \$15.00, Type B: \$14.00, Type C: \$16.00.

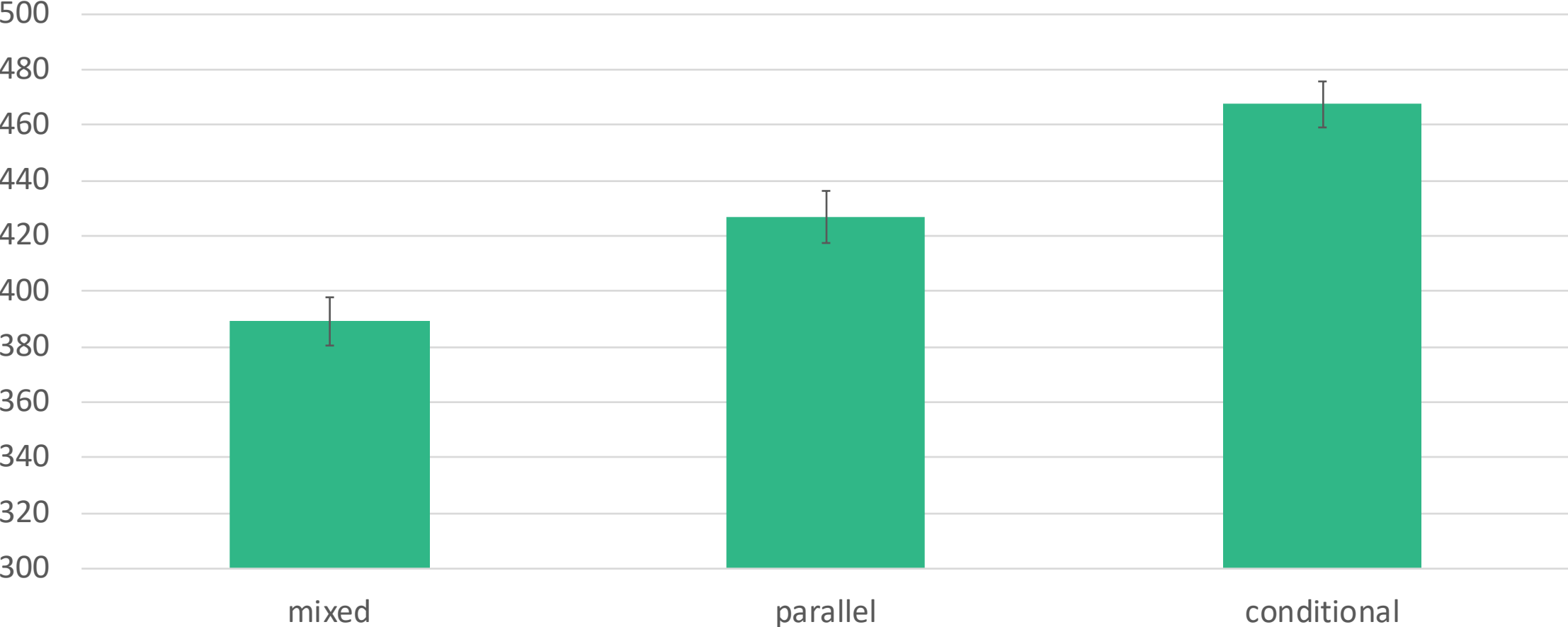
Type	Quantity	Price
Any Type	<input type="text"/>	<input type="text"/> \$
Type A	<input type="text"/>	<input type="text"/> \$
Type B	<input type="text"/>	<input type="text"/> \$
Type C	<input type="text"/>	<input type="text"/> \$
<b>MAX TOTAL:</b>	<input type="text"/>	

Next

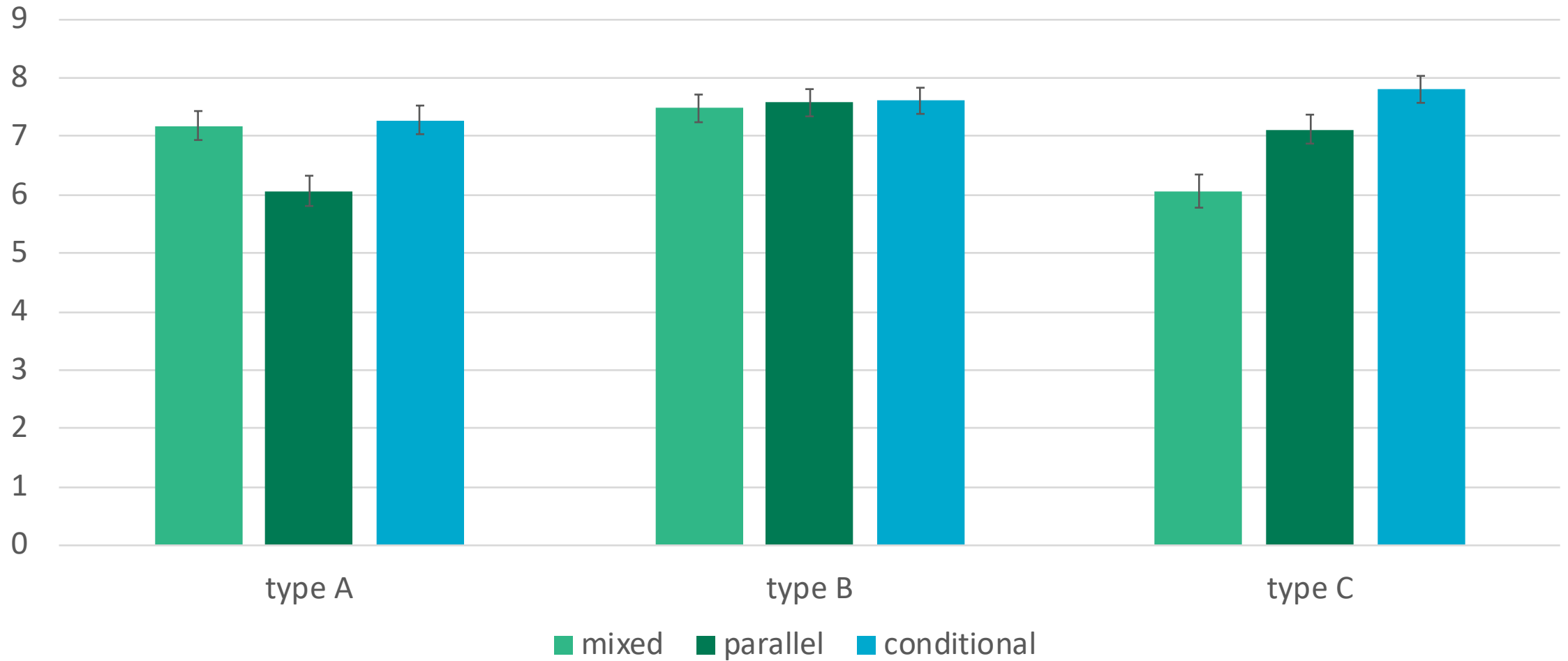
# Volume by auction type



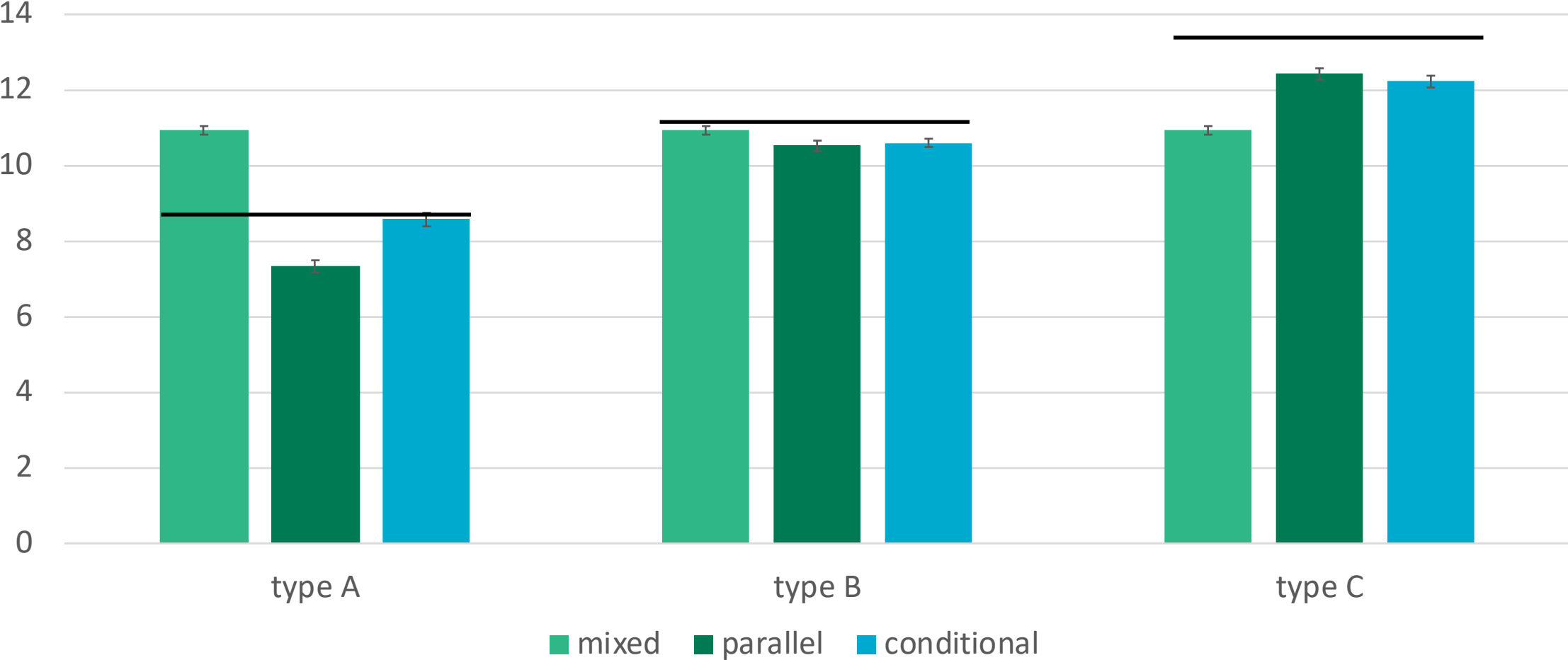
# Profit by auction type



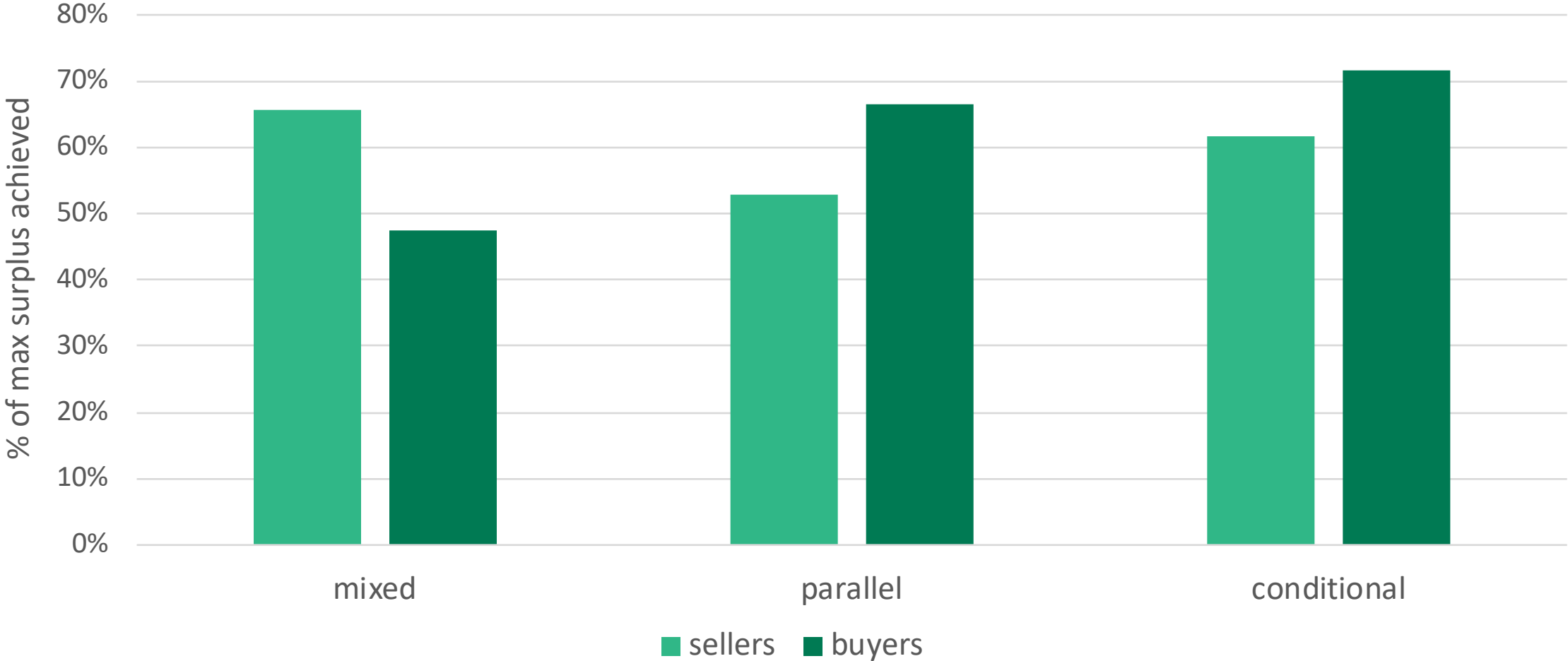
# Volume by carbon type



# Price by type



# Distribution of surplus





# Conditional parallel auctions

- Provides the most efficient outcomes
  - Also the most equitable
  - Both buyers and sellers do well
  - More high quality trades supported
- But mechanism is complex
  - 25% still used lucky dip in the conditional auction
  - Buyers need to know their preferences

# Conditional parallel auctions

- Conditional mechanism scales
  - Could incorporate multiple types at low transaction cost
  - And provide price signals across any type
  - Though combinatorial optimisation gets harder...
- Alternatives do not
  - Also require defining types
- Could potentially support quality through carbon market
  - And other multi-attribute environmental goods



# Thank you

Dr Andrew Reeson

[andrew.reeson@csiro.au](mailto:andrew.reeson@csiro.au)

[www.data61.csiro.au](http://www.data61.csiro.au)