Evaluating Common Pools to Mitigate Shutdown and Market Risk in Multispecies Quota Fisheries with Stochastic Production Ratios

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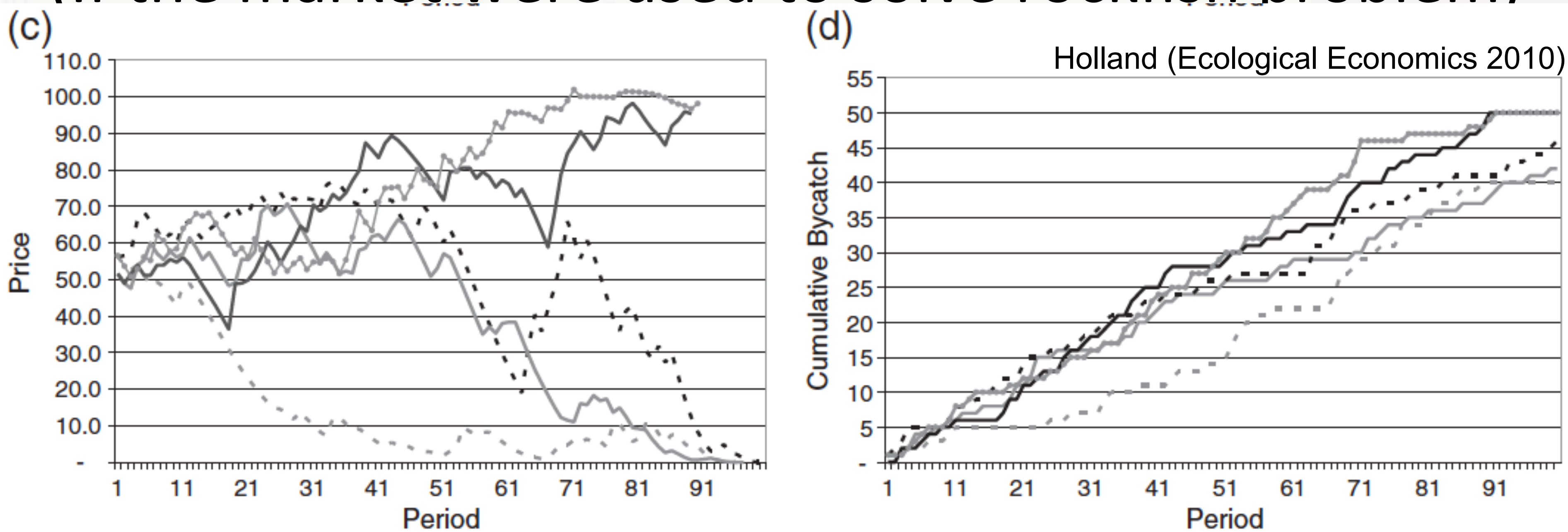
Multispecies ITQs with Choke Species

- New England Multispecies Groundfish (2010)
  - 15 species, valuable cod, flounder limited by pollock
  - Groups of harvesters (sectors) given collective quota
  - Sectors divided quota into individual allocations (ITQ)
- West Coast Groundfish (2011)
  - ~30 species, limited by certain rockfish species
  - Individual fishermen given quota (full ITQ)
  - Harvesters pooled quota for rockfish, replacing the individual right with a common pool(!)
- Why are harvesters picking different institutions for managing limiting “choke” species?
  - What factors influence when a common pool is better

Equilibrium Bycatch Quota Price Paths

(If the market were used to solve rockfish problem)



- Variation in aggregate bycatch encounters can lead to highly variable prices for bycatch quota
  - Can lead to “no trade” cases where no harvester will sell for what a harvester is willing to pay
  - When can a common pool be better than a market?

Conceptual Framework

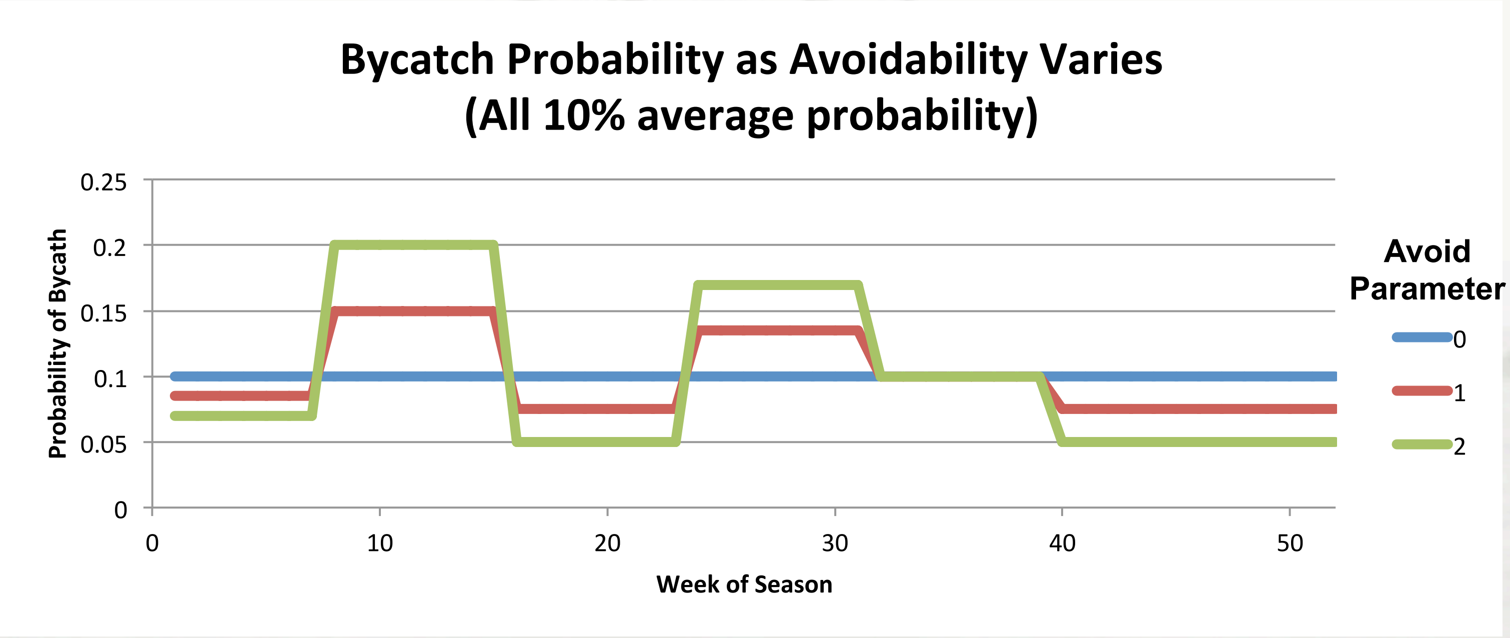
- Avoidability
  - If it is difficult to avoid the bycatch species, risk pools may be best way to avoid shutdown
- Lumpiness
  - If expected catch is realized in rare, large lumps, risk pools insure against bad realizations
- Skewness
  - If optimal avoidance leads to a skewed profit distribution, risk pools insure against bad realizations

A Simulated Fishery with Bycatch

- Choose to ***Fish*** or ***Not Fish*** in each of 52 weeks
- Non-binding target species quota, with time-varying probability of "encountering" bycatch
- Policy scenarios
  - 100% Derby (Common pool of bycatch quota)
    - Harvesters fish in every period regardless
  - 80% Derby (Common pool of bycatch quota)
    - Harvesters fish in every period with probability 80%
  - Individual quota
    - Fish optimally; shutdown when exhaust allocation
  - Individual Transferable Quota
    - Fish optimally; trade to equal allocations each period

Avoidability

- Avoidability is parameterized to scale the variance of bycatch probability, with mean preserved



Lumpiness

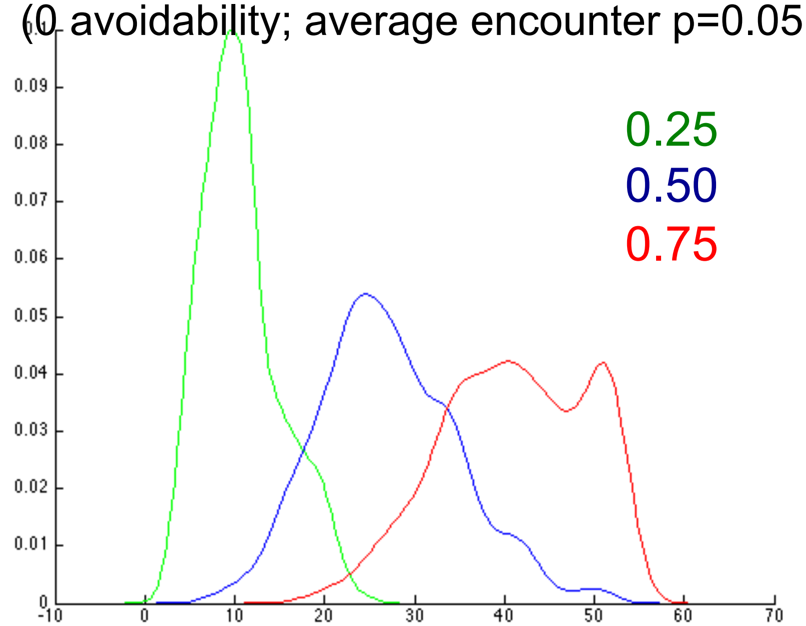
- Lumpiness is parameterized as the number of encounters a harvester with 1/N of the quota is allowed before shutdown
  - We decrease the average encounter probability to hold expected bycatch usage constant

Skewness

- Skewness is parameterized by adjusting the level of the TAC
  - The measure is the expected season length if all harvesters chose fishing strategies that exposed them to average bycatch probability

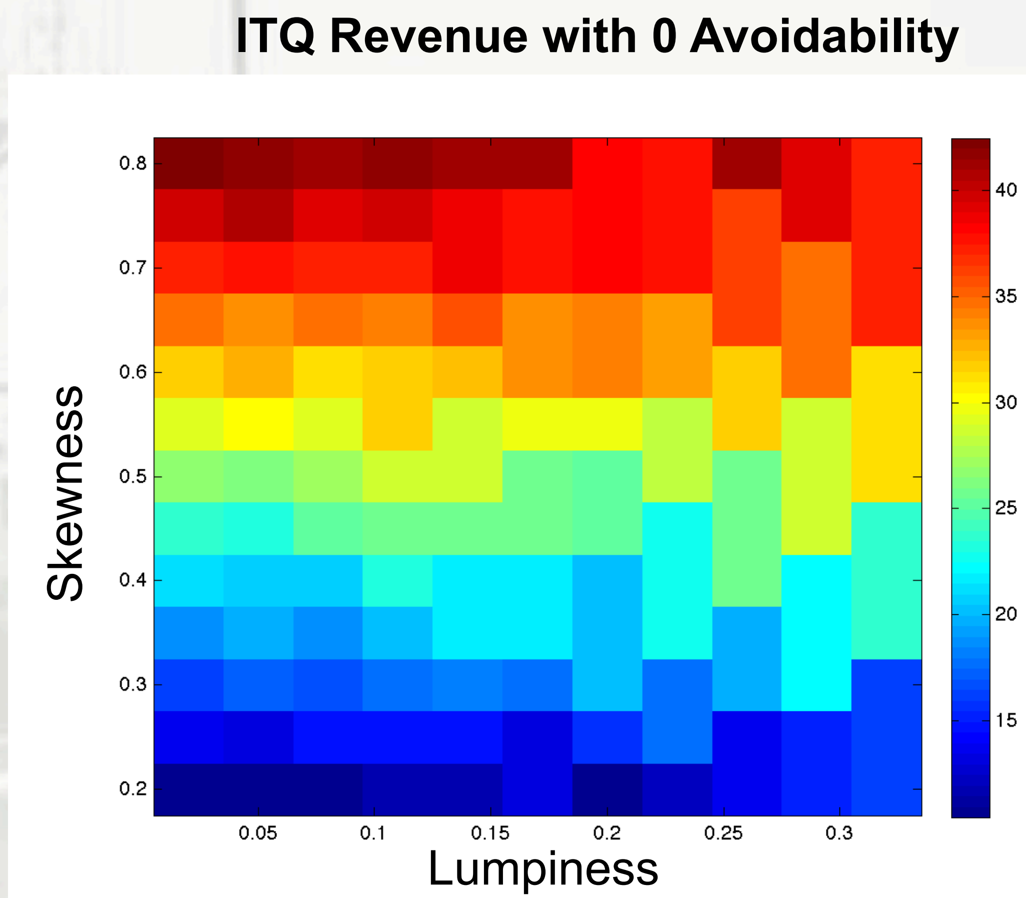
Distribution of Revenue under Different Skewness

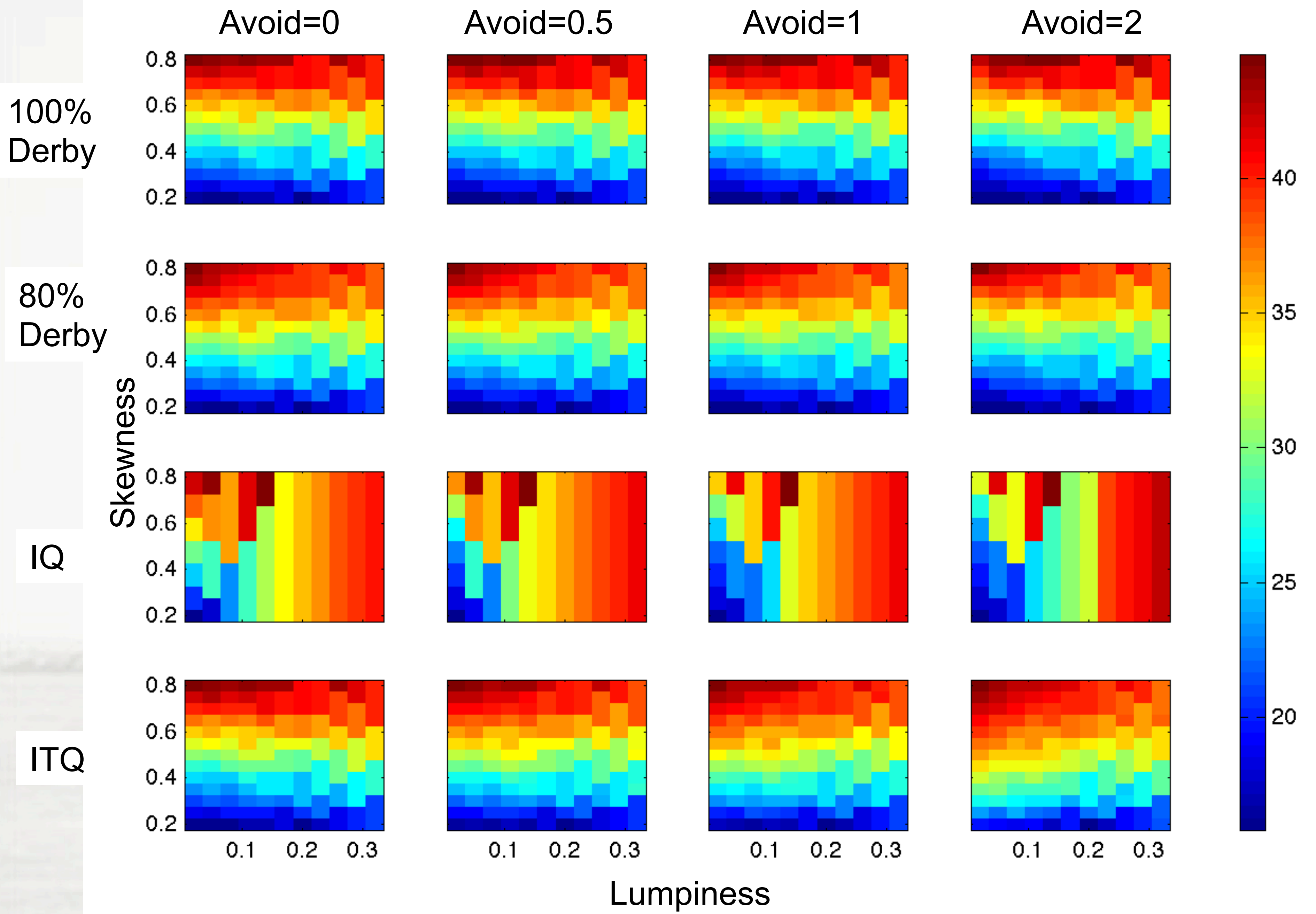
(0 avoidability; average encounter p=0.05)

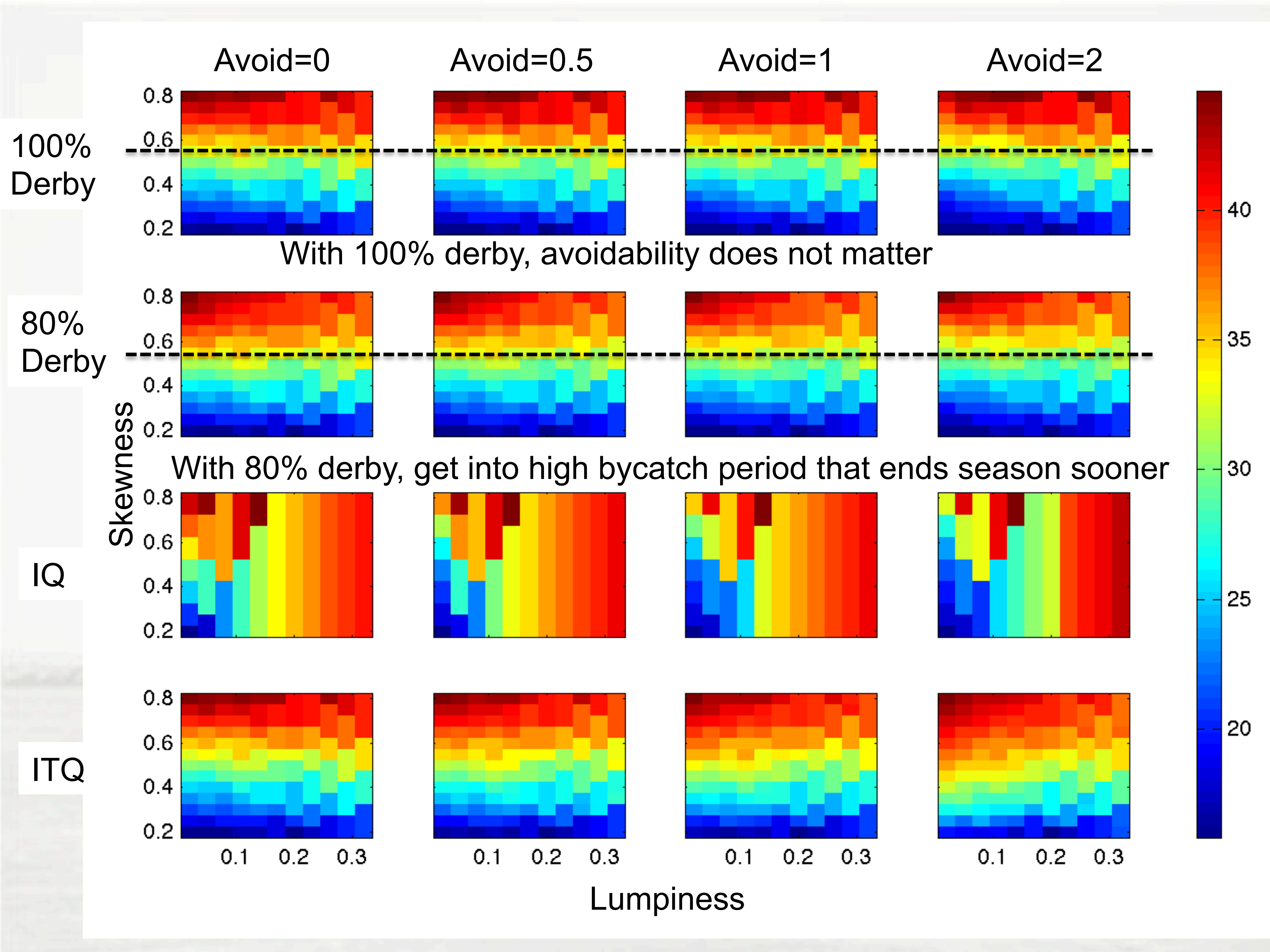


Simulation Results

- Expected profits as parameters vary
  - Higher skewness (more quota) leads to higher rents
  - Without avoidability, lumpiness does not matter much




Avoid=0
Avoid=0.5
Avoid=1
Avoid=2
100% Derby
80% Derby
IQ
ITQ
Skewness
0.8
0.6
0.4
0.2
Lumpiness
0.1
0.2
0.3
40
35
30
25
20


Avoid=0
Avoid=0.5
Avoid=1
Avoid=2
100% Derby
With 100% derby, avoidability does not matter
80% Derby
With 80% derby, get into high bycatch period that ends season sooner
IQ
ITQ
Skewness
Lumpiness
0.8
0.6
0.4
0.2
0.1
0.2
0.3
40
35
30
25
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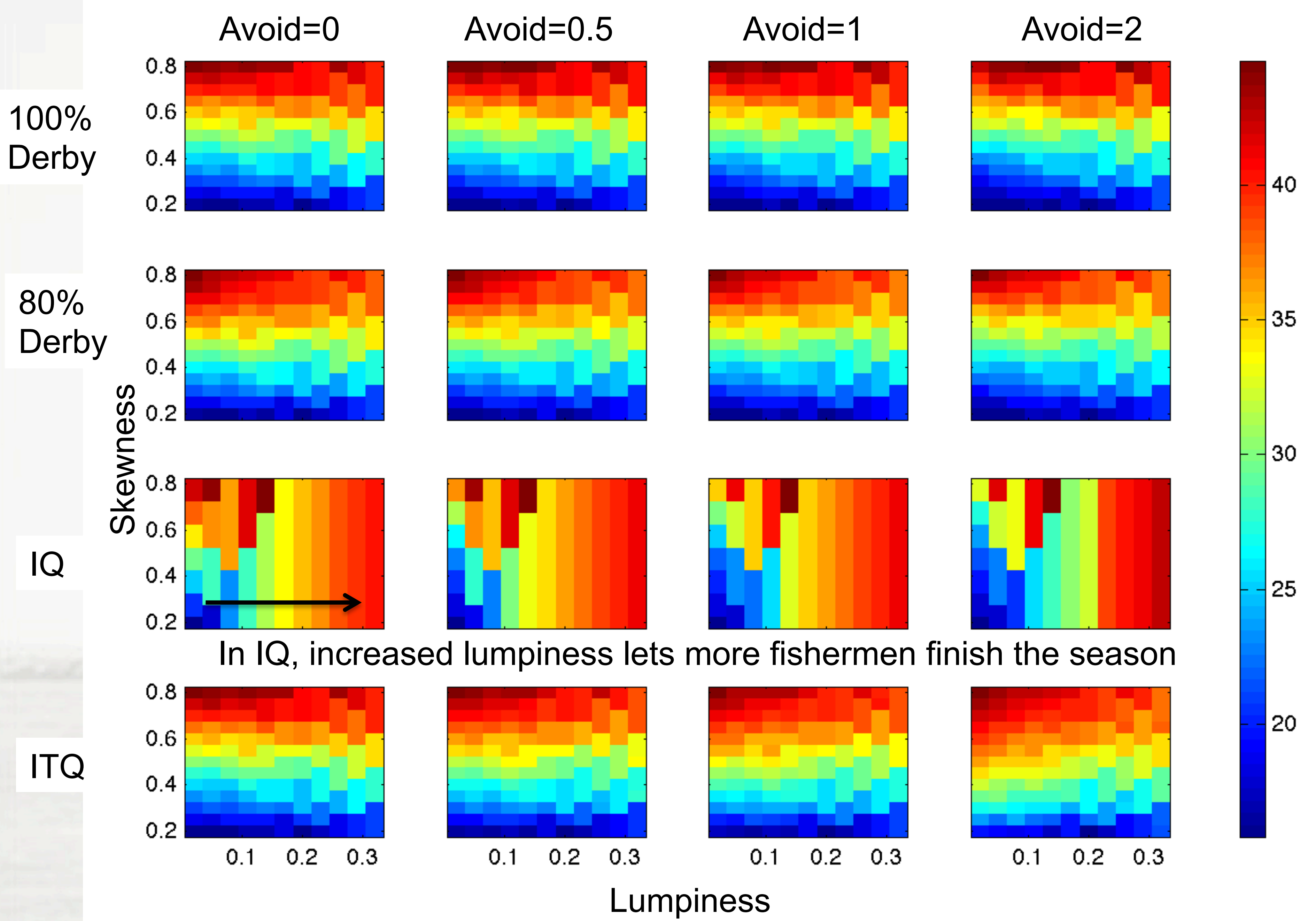
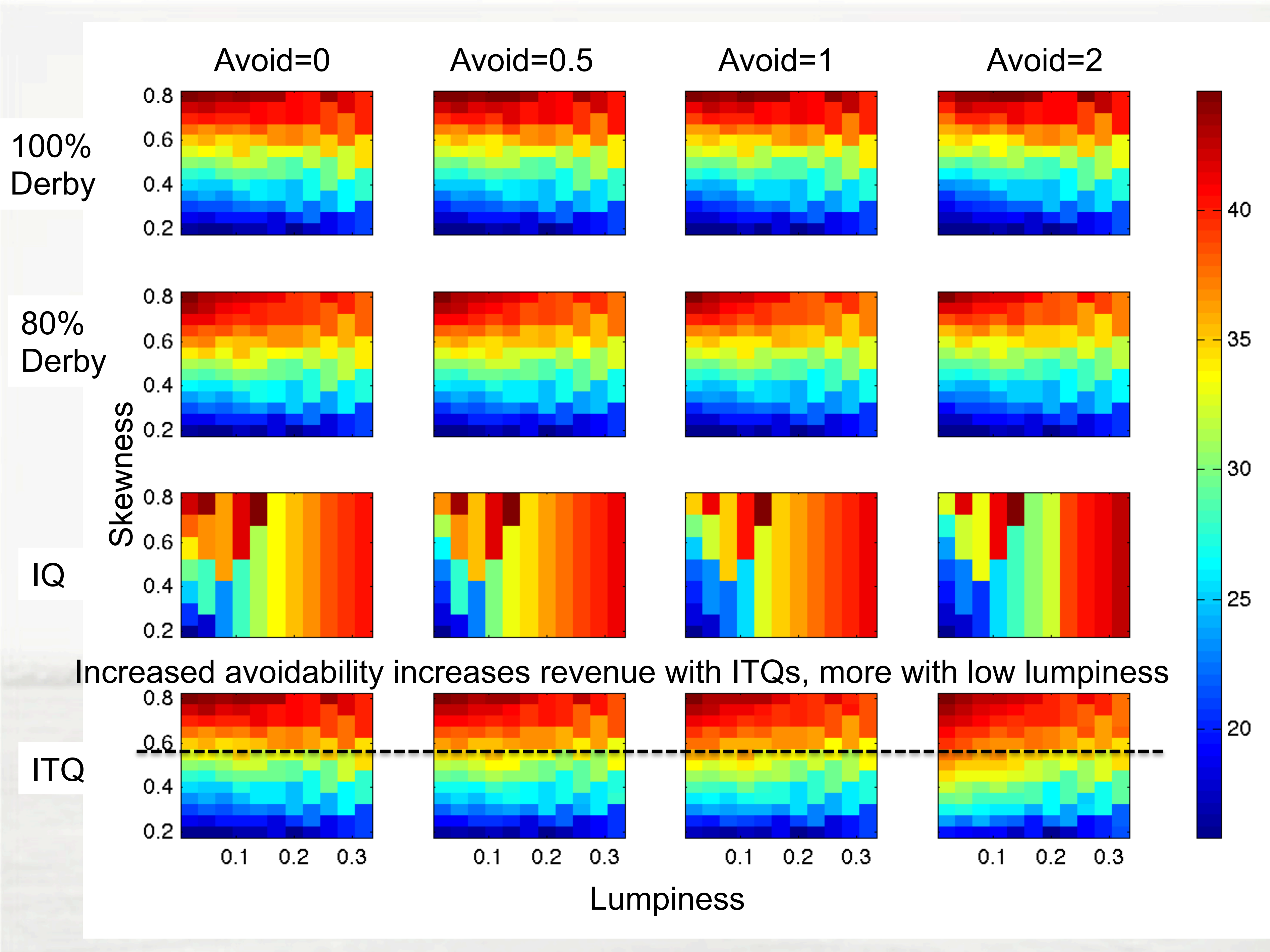


Avoid=0
Avoid=0.5
Avoid=1
Avoid=2
100% Derby
80% Derby
IQ
ITQ
Skewness
0.8
0.6
0.4
0.2
In IQ, increased lumpiness lets more fishermen finish the season
0.1
0.2
0.3
Lumpiness
40
35
30
25
20


Avoid=0
Avoid=0.5
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80% Derby
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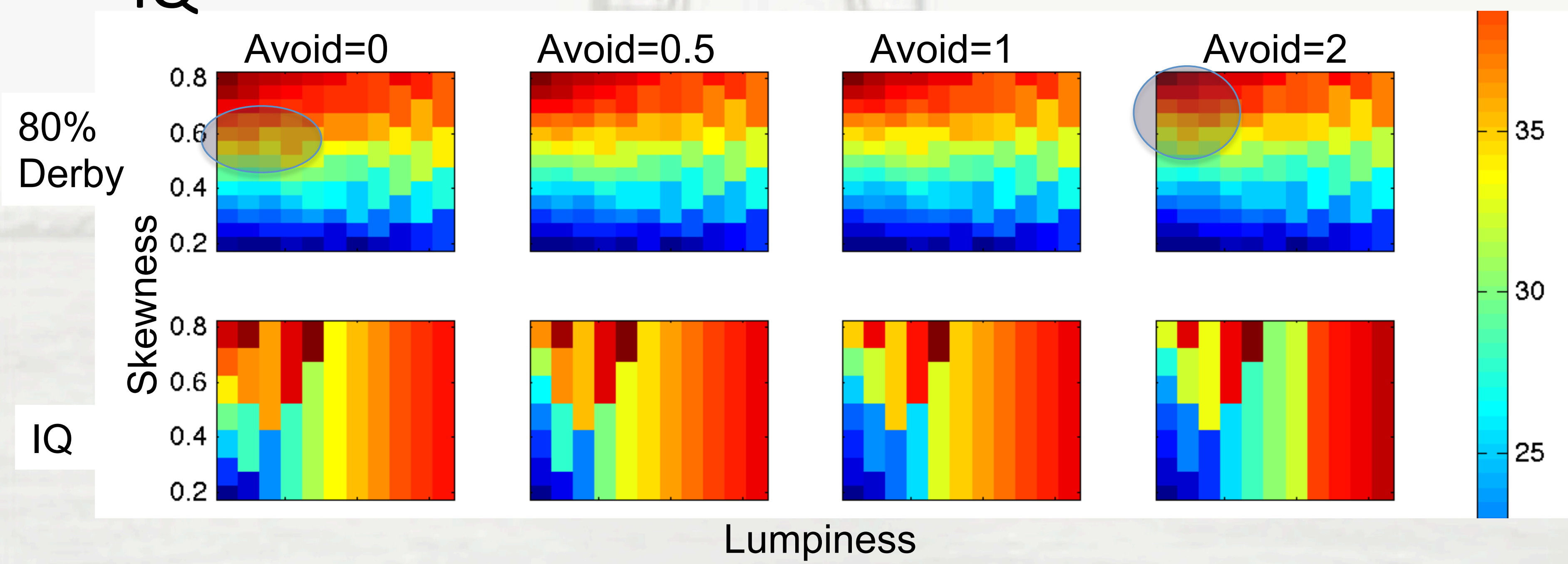
Skewness
0.8
0.6
0.4
0.2
Increased avoidability increases revenue with ITQs, more with low lumpiness
0.1
0.2
0.3
Lumpiness
40
35
30
25
20

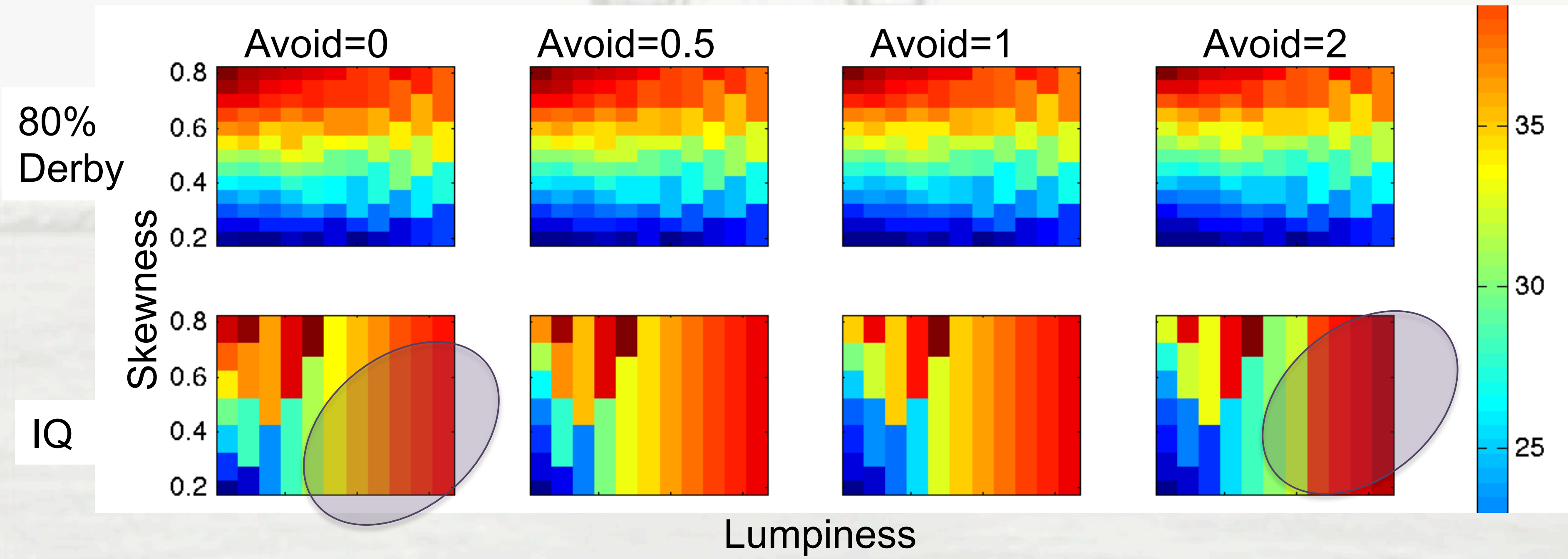
Policy Question

- When is a (attenuated) derby better than
  - A poorly functioning market? (IQ)
  - A well-functioning market? (ITQ)
- With low lumpiness and moderate skewness, 80% derby yields higher expected revenue than IQ



Policy Question

- When better with (attenuated) derby than
  - A poorly functioning market? (IQ)
  - A well-functioning market? (ITQ)
- IQ has higher revenue, but higher variance
  - Risk averse or prudent agents may prefer to insure



Implications

- Avoidability, lumpiness and skewness capture the key *biological* and *harvest* characteristics that determine whether bycatch quota is best held individually or collectively
  - Model a tool to help managers understand how to design rights-based bycatch avoidance programs
- Extensions
  - Integrate variance of outcomes by evaluating whole distribution of payoffs with risk aversion, or prudence (downside risk aversion)
  - Consider social norms that further attenuate derby

Experimental Design

- Single-season fishery with two species
  - TAC holds in steady state—how to use it?
  - Groups of 10 harvesters choose whether (0-1) to fish in each of 52 weeks of a season
  - Target fish stock yields $100/week profit
  - Bycatch fish stock
    - Binding/severely binding quota can shut down fishery
    - Time-varying encounter probability
- 6 sessions
  - Four blocks of four fishing seasons in each of four key treatments
  - Results reported from last two of each block

Design: Key Treatments

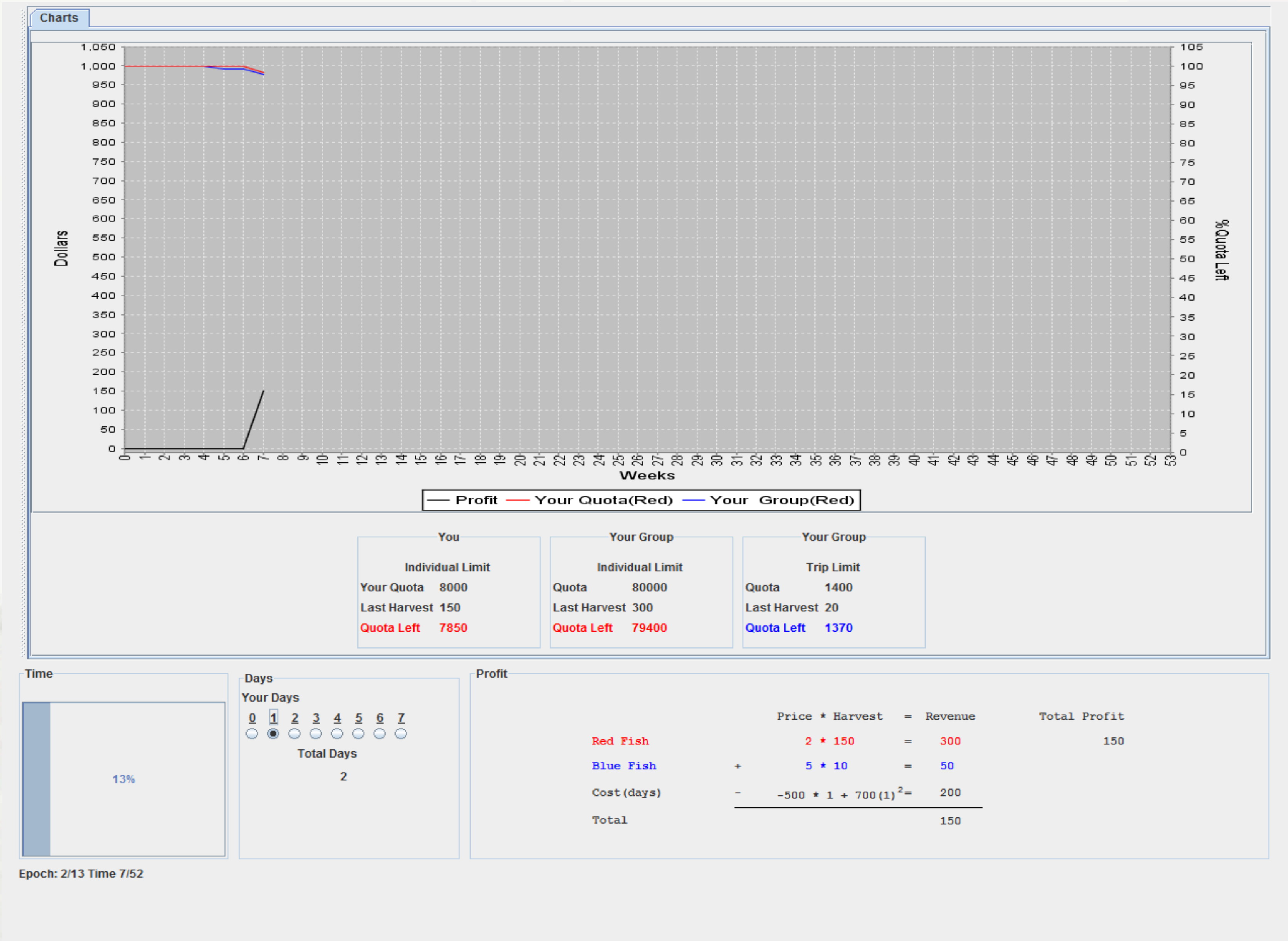
- Bycatch rates
  - Quota scaled to preserve expected IQ season length

Weeks	High Bycatch Chance	Low Bycatch Chance
1-7	49%	7%
8-15	90%	20%
16-23	35%	5%
24-31	90%	17%
32-39	70%	10%
40-52	35%	5%
Bycatch Quota Allocation	140 (14 encounters)	20 (2 encounters)

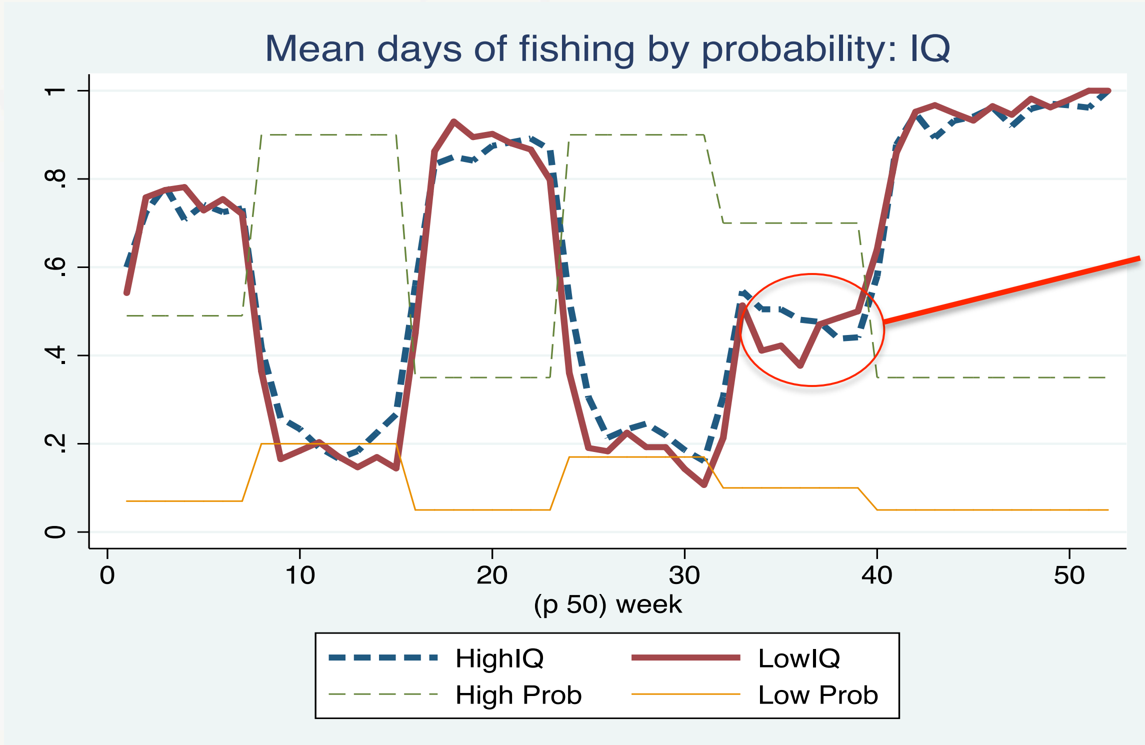
- Management of bycatch
  - Individual Quota (IQ) or common risk pool (CP)

- (Also varied fixed price to access common pool)

Subject’s Screen (Risk Pool Treatment)



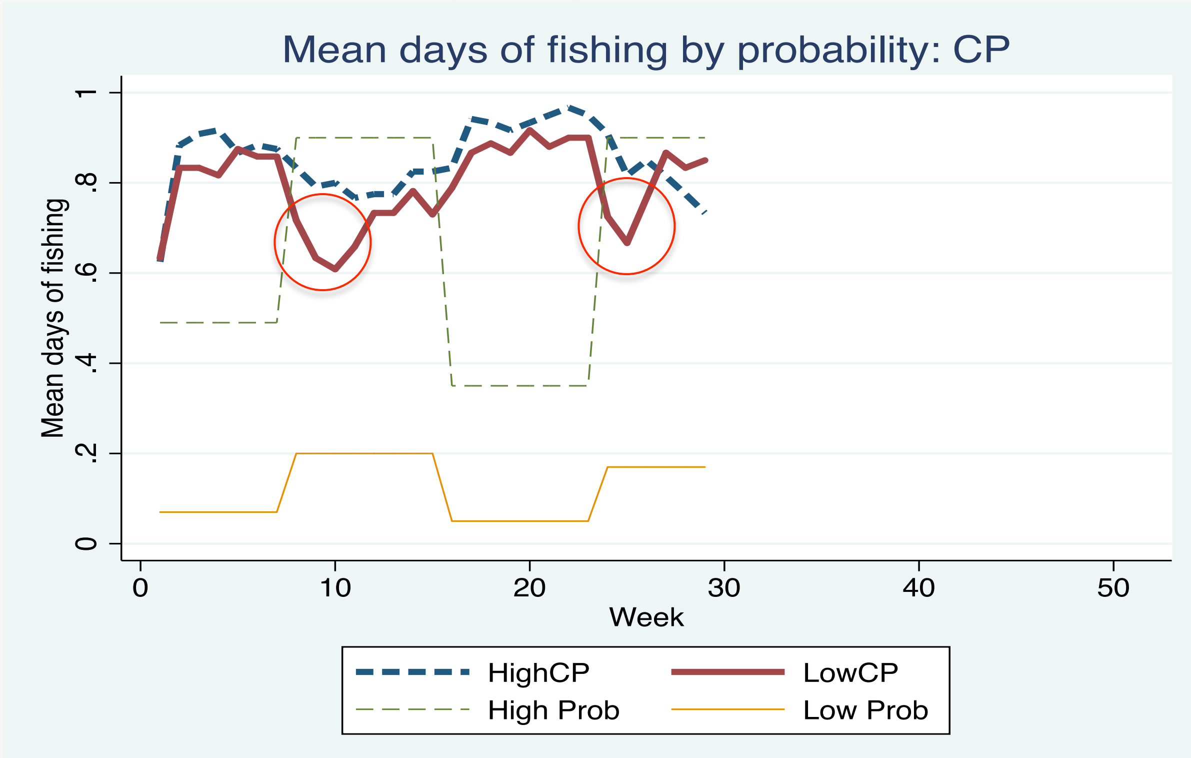
Result: Fishing Patterns in IQ



Fishing by people with high quota balances

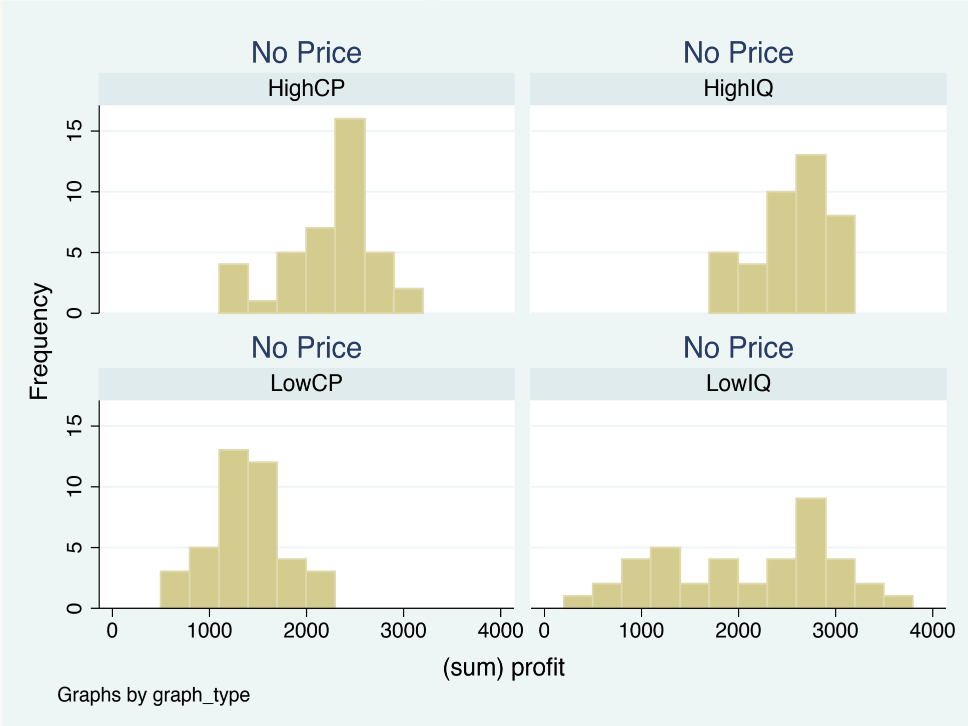
- IQ fishing shows strong avoidance behavior
  - Fish when bycatch rates are low
  - Similar in High and Low treatments, slightly stronger avoidance in Low

Result: Fishing Patterns in Risk Pool



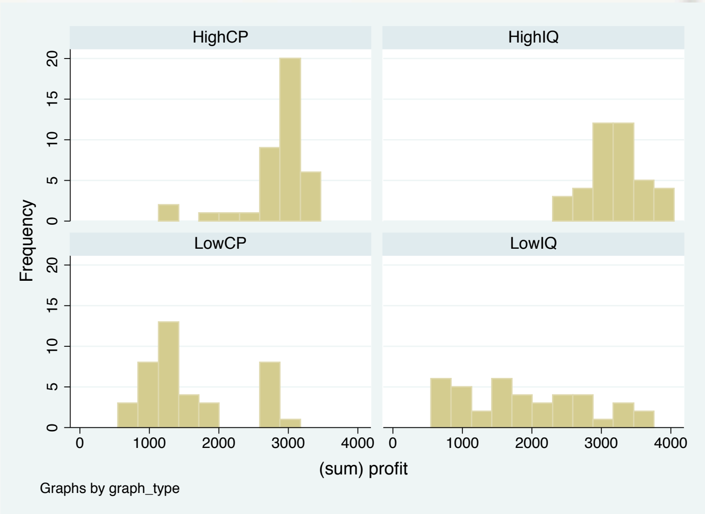
- Common pool shows weak avoidance behavior
  - Significantly more at beginning of increased bycatch periods

Result: Profits



- High treatment induces symmetric, similar profit distributions
- Low treatment is dramatically different in mean and variance
  - May be willing to trade higher mean for lower variance, lower downside risk

Result: with Quota Price



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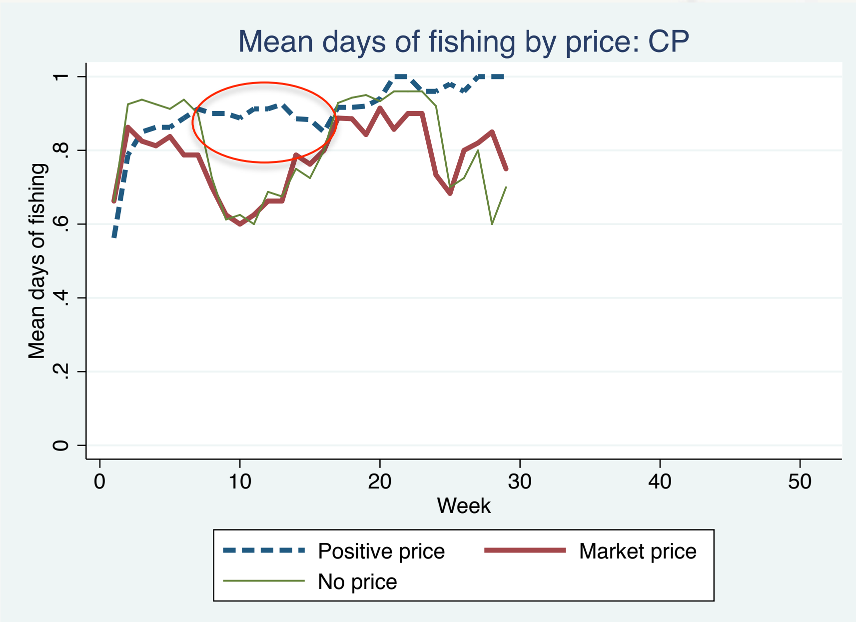
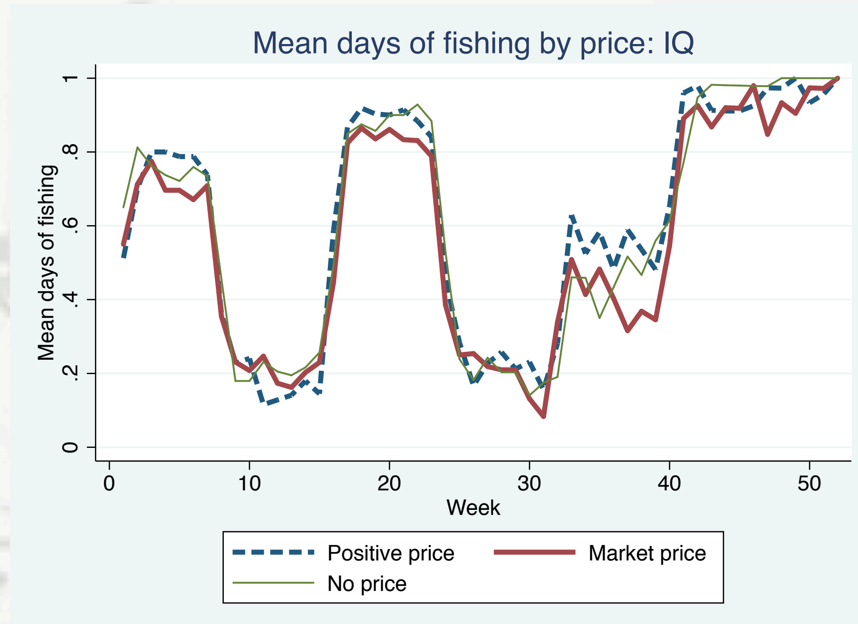


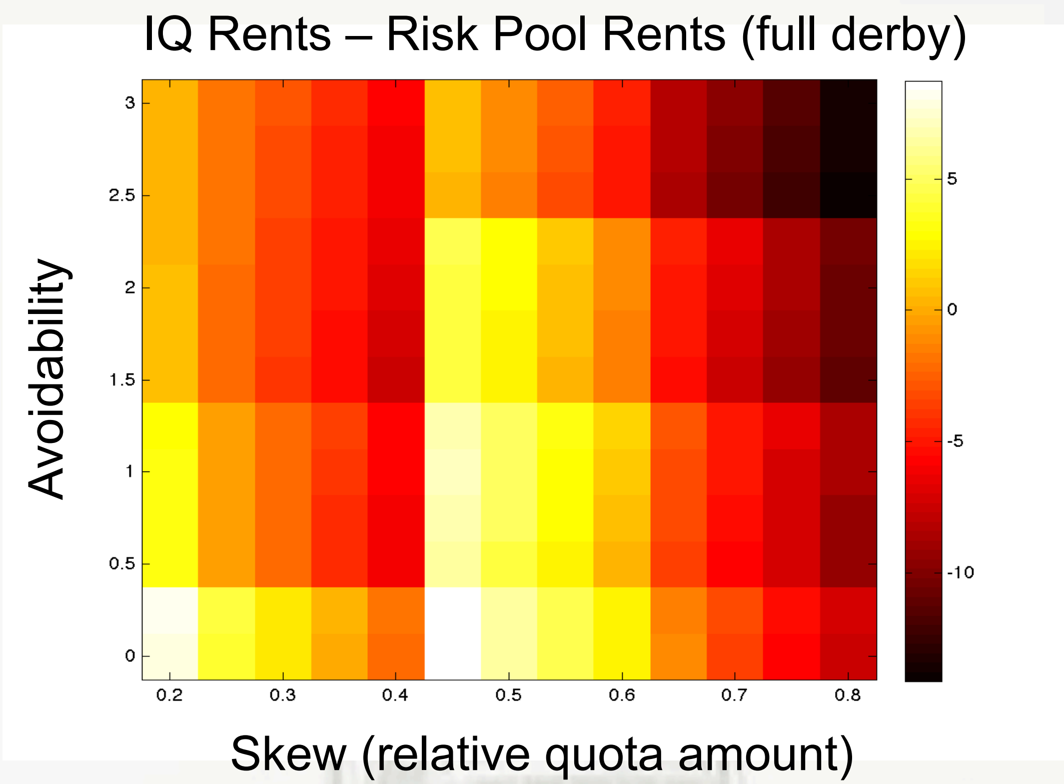


- Avoidance in CP does not happen when bycatch is profitable, but charging ex ante market price for quota access does not differ from charging revenue-neutral (ex-vessel) price

Organizing Framework

- Whether risk pools may be better function of:
  - Avoidability
    - Within-season variation of bycatch probability from mean
    - Whether harvesters can choose to fish in a way that reduces their exposure
  - Lumpiness
    - The fraction of the quota bycatch in each encounter
    - Less lumpiness means each shutdown is a “larger sample” and thus easier to predict; little to insure
  - Skewness (of the ex ante distribution of profit)
    - The downside risk (from early encounters and shutdown) traded off against finishing season with quota; takes into account costly avoidance, biological parameters

Calibrated Simulations



- When skew and avoidability are high, Risk Pool yields higher average rents
  - Harvesters practice excessive avoidance, so pool insures them against individual shutdown more than derby increases likelihood of shutdown
  - With lower skew (quota binding) and high avoidability, RP does better because it forces fishing in early season, when IQ holds out for lower bycatch periods later in year

Going Forward

- Conduct experiments with market prices for quota
  - Test for "insurance" behavior in individual quota holdings
- Develop simulations, calibrated to lab derbies and risk attitudes, to identify parameter combinations where risk pools may be more efficient
- Test these parameter combinations in the lab
- Provide guidance on when the biological conditions of a fishery suggest retaining common pool properties can lead to better outcomes