Modelling multiple fish quota markets with discarding

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- Species/stock-specific quotas

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$$H = H(E)$$
$$h_i = \beta_i H, \quad i = 1, 2, \ldots, M$$
$$\frac{dC(H)}{dH} = \begin{cases} c(H) \\ c \end{cases}$$

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$$\sum_i \beta_i [p_i - r_i] - c = \lambda \geq 0$$

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- Discards are $h_i - q_i(r_i) \geq 0$

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- When all quota markets *just* clear (no excess demands)...

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- For a representative vessel, H^* satisfies

$$\beta_2 \left[p_2 - r_2\right] - c = \lambda \geq 0$$

where $r_2 = 0$ (Species 2 quota slack) or $0 < r_2 < p_2$ (Species 2 quota market *just* clears)

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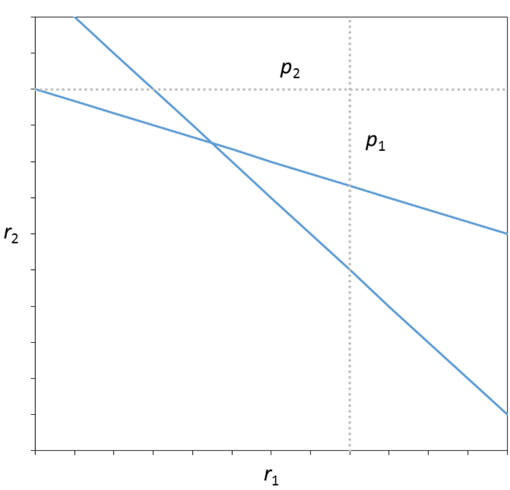
- With $r_1 = p_1$, vessels are *indifferent* between discarding and landing Species 1
- Individual demands for Species 1 quota are indeterminate

Quota prices

$$\beta_1 [p_1 - r_1] + \beta_2 [p_2 - r_2] = c + \lambda$$



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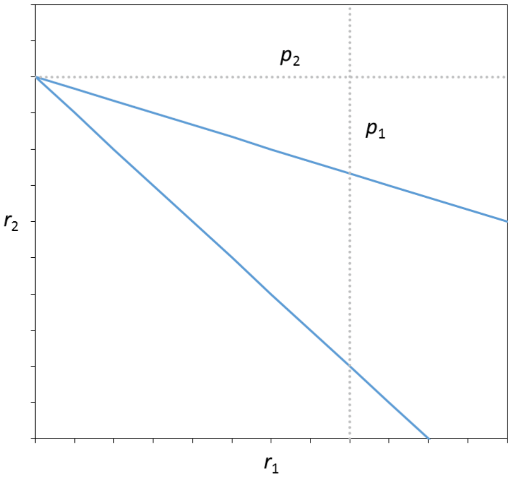

Quota prices under a discard ban

- Quota price ceiling depends on expected cost of discarding (penalty) $\phi > 0$

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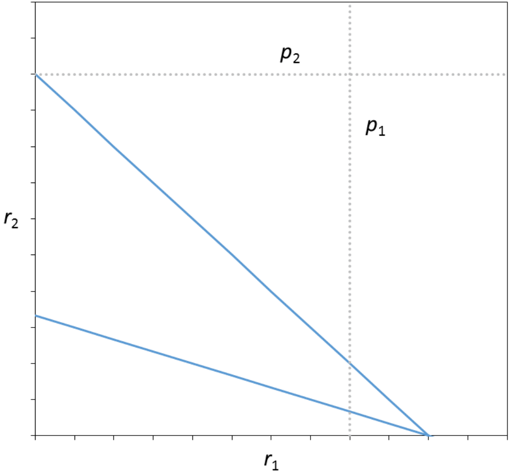

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- Industry adjusts individual species harvest rates (β_i)?
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- Imperfect/asymmetric information
- Quota prices determined out of equilibrium (heuristic)?

Simulation model

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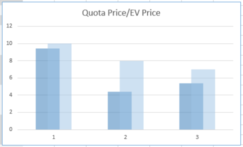
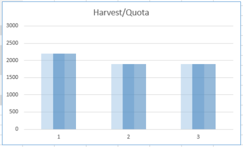
- Different betas and marginal costs
- Determine harvests and allocate quota to maximise the (static) value of the fishery
- Determine maximal (uniform, linear) quota prices...

Scenario 1

BREST Model #4 - Excel

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1		v1	v2	v3			v1	v2	v3	H max				
2	c	1.75	1.90	1.95		H	2000.00	2000.00	2000.00	2020.00				
3	b1	0.35	0.40	0.35		C(H)	3500.00	3800.00	3900.00				LO?	NO
4	b2	0.25	0.35	0.35		h1	700.00	800.00	700.00	2200.00				
5	b3	0.40	0.25	0.30		h2	500.00	700.00	700.00	1900.00				
6	p1	10.00	10.00	10.00		h3	800.00	500.00	600.00	1900.00	TAC	r max		
7	p2	8.00	8.00	8.00		q1	700.00	800.00	700.00	2200.00	2200	10.00	10.00	
8	p3	7.00	7.00	7.00		q2	500.00	700.00	700.00	1900.00	1900	8.00	8.00	
9	r1	9.40				q3	800.00	500.00	600.00	1900.00	1900	7.00	7.00	
10	r2	4.40				l1	700.00	800.00	700.00	2200.00				
11	r3	5.40				l2	500.00	700.00	700.00	1900.00				
12						l3	800.00	500.00	600.00	1900.00		r min	d max	
13						d1	0.00	0.00	0.00	0.00		0.00	10000	
14	2200					d2	0.00	0.00	0.00	0.00		0.00	10000	
15	1900					d3	0.00	0.00	0.00	0.00		0.00	10000	
16	1900					v1	7000.00	8000.00	7000.00					
17						v2	4000.00	5600.00	5600.00					
18	2300					v3	5600.00	3500.00	4200.00		total			
19	1600					profit	13100.00	13300.00	12900.00		39300.00			
20	2500													
21						r1q1	6580.00	7520.00	6580.00					
22						r2q2	2200.00	3080.00	3080.00					
23						r3q3	4320.00	2700.00	3240.00					
24							13100.00	13300.00	12900.00		39300.00			
25														
26							0.00	0.00	0.00		0.00			



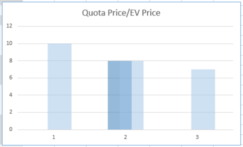


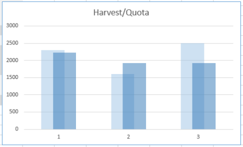
Sheet1

Scenario 2

BREST Model #4 - Excel

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1		v1	v2	v3			v1	v2	v3	H max				
2	c	1.75	1.90	1.95		H	2020.00	2020.00	2020.00	2020.00				
3	b1	0.35	0.40	0.35		C(H)	3535.00	3838.00	3939.00				LO?	NO
4	b2	0.25	0.35	0.35		h1	707.00	808.00	707.00	2222.00				
5	b3	0.40	0.25	0.30		h2	505.00	707.00	707.00	1919.00				
6	p1	10.00	10.00	10.00		h3	808.00	505.00	606.00	1919.00	TAC	r max		
7	p2	8.00	8.00	8.00		q1	707.00	808.00	707.00	2222.00	2300	0.00	10.00	
8	p3	7.00	7.00	7.00		q2	505.00	388.00	707.00	1600.00	1600	8.00	8.00	
9	r1	0.00				q3	808.00	505.00	606.00	1919.00	2500	0.00	7.00	
10	r2	8.00				l1	707.00	808.00	707.00	2222.00				
11	r3	0.00				l2	505.00	388.00	707.00	1600.00				
12						l3	808.00	505.00	606.00	1919.00		r min	d max	
13						d1	0.00	0.00	0.00	0.00		0.00	10000	
14	2200					d2	0.00	319.00	0.00	319.00		8.00	10000	
15	1900					d3	0.00	0.00	0.00	0.00		0.00	10000	
16	1900					v1	7070.00	8080.00	7070.00					
17						v2	4040.00	3104.00	5656.00					
18	2300					v3	5656.00	3535.00	4242.00		total			
19	1600					profit	13231.00	10881.00	13029.00		37141.00			
20	2500													
21						r1q1	0.00	0.00	0.00					
22						r2q2	4040.00	3104.00	5656.00					
23						r3q3	0.00	0.00	0.00					
24							4040.00	3104.00	5656.00		12800.00			
25														
26							9191.00	7777.00	7373.00		24341.00			





Sheet1

Scenario 3

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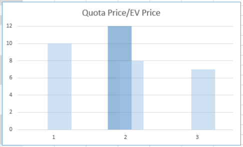
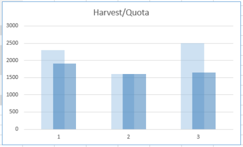
1		v1	v2	v3		v1	v2	v3	H max				
2	c	1.75	1.90	1.95	H	2020.00	2020.00	1108.57	2020.00				
3	b1	0.35	0.40	0.35	C(H)	3535.00	3838.00	2161.71				LO?	YES
4	b2	0.25	0.35	0.35	h1	707.00	808.00	388.00	1903.00				
5	b3	0.40	0.25	0.30	h2	505.00	707.00	388.00	1600.00				
6	p1	10.00	10.00	10.00	h3	808.00	505.00	332.57	1645.57	TAC	r max		
7	p2	8.00	8.00	8.00	q1	707.00	808.00	388.00	1903.00	2300	0.00	100.00	
8	p3	7.00	7.00	7.00	q2	505.00	707.00	388.00	1600.00	1600	100.00	100.00	
9	r1	0.00			q3	808.00	505.00	332.57	1645.57	2500	0.00	100.00	
10	r2	18.43			l1	707.00	808.00	388.00	1903.00				
11	r3	0.00			l2	505.00	707.00	388.00	1600.00				
12					l3	808.00	505.00	332.57	1645.57		r min	d max	
13					d1	0.00	0.00	0.00	0.00		0.00	0	
14	2200				d2	0.00	0.00	0.00	0.00		0.00	0	
15	1900				d3	0.00	0.00	0.00	0.00		0.00	0	
16	1900				v1	7070.00	8080.00	3880.00					
17					v2	4040.00	5656.00	3104.00					
18	2300				v3	5656.00	3535.00	2328.00		total			
19	1600				profit	13231.00	13433.00	7150.29		33814.29			
20	2500												
21					r1q1	0.00	0.00	0.00					
22					r2q2	9306.43	13029.00	7150.29					
23					r3q3	0.00	0.00	0.00					
24						**9306.43**	**13029.00**	**7150.29**		**29485.71**			
25													
26						**3924.57**	**404.00**	**0.00**		**4328.57**			





Modelling work in progress...