Modelling multiple fish quota markets with discarding

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FAERE Workshop, Brest, 11-12 May 2017

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- Control over landings, not harvest
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- Species/stock-specific quotas

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$$H = H\left(E\right)$$

$$h_i = \beta_i H, \quad i = 1, 2, ..., M$$

$$\frac{dC\left(H\right)}{dH} = \begin{cases} c\left(H\right) \\ c \end{cases}$$

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- Given quota (lease) prices r_i, the profit maximising harvest H^* satisfies

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

where λ is the shadow price of maximum harvest/effort

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$$q_i(r_i) \leq h_i$$

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$$q_i(r_i) \leq h_i$$

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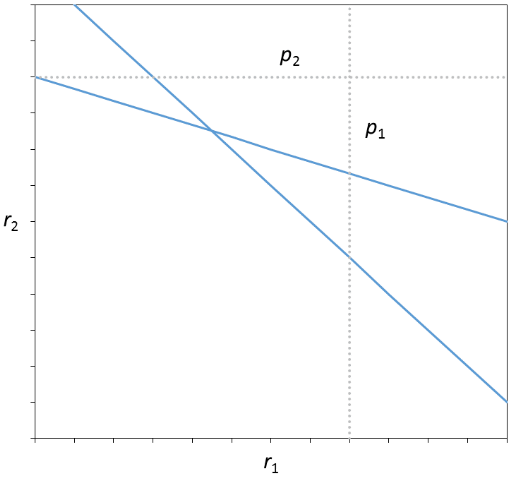
- With $r_1 = p_1$, vessels are *indifferent* between discarding and landing Species 1
- Individual demands for Species 1 quota are indeterminate

Quota prices

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



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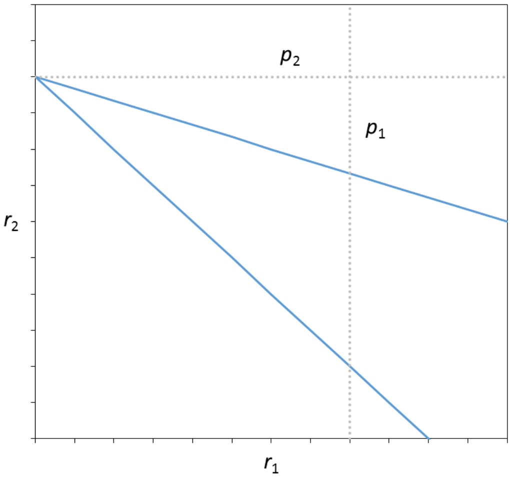

Quota prices under a discard ban

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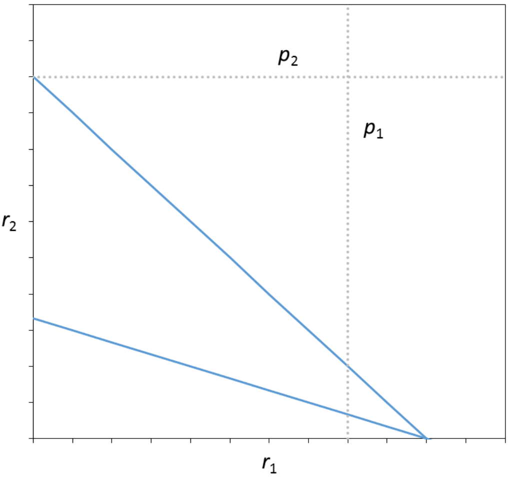

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- Quota prices determined out of equilibrium (heuristic)?

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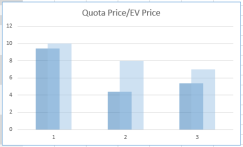
- Different betas and marginal costs
- Determine harvests and allocate quota to maximise the (static) value of the fishery
- Determine maximal (uniform, linear) quota prices...

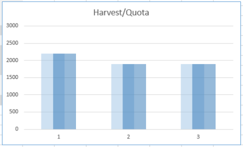
Scenario 1

BREST Model #4 - Excel

	A	B	C	D
1		v1	v2	v3
2	c	1.75	1.90	1.95
3	b1	0.35	0.40	0.35
4	b2	0.25	0.35	0.35
5	b3	0.40	0.25	0.30
6	p1	10.00	10.00	10.00
7	p2	8.00	8.00	8.00
8	p3	7.00	7.00	7.00
9	r1	9.40		
10	r2	4.40		
11	r3	5.40		
14	2200			
15	1900			
16	1900			
18	2300			
19	1600			
20	2500			

	F	G	H	I	J	K	L	M	N
1		v1	v2	v3	H max				
2	H	2000.00	2000.00	2000.00	2020.00				
3	C(H)	3500.00	3800.00	3900.00				LO?	NO
4	h1	700.00	800.00	700.00	2200.00				
5	h2	500.00	700.00	700.00	1900.00				
6	h3	800.00	500.00	600.00	1900.00	TAC	r max		
7	q1	700.00	800.00	700.00	2200.00	2200	10.00	10.00	
8	q2	500.00	700.00	700.00	1900.00	1900	8.00	8.00	
9	q3	800.00	500.00	600.00	1900.00	1900	7.00	7.00	
10	l1	700.00	800.00	700.00	2200.00				
11	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	d2	0.00	0.00	0.00	0.00		0.00	10000	
15	d3	0.00	0.00	0.00	0.00		0.00	10000	
16	v1	7000.00	8000.00	7000.00					
17	v2	4000.00	5600.00	5600.00					
18	v3	5600.00	3500.00	4200.00		total			
19	profit	13100.00	13300.00	12900.00		39300.00			
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			
26		0.00	0.00	0.00		0.00			



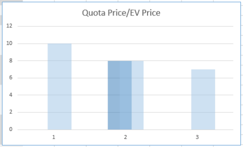


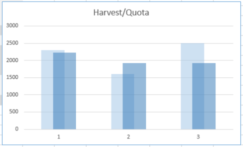
Sheet1

READY

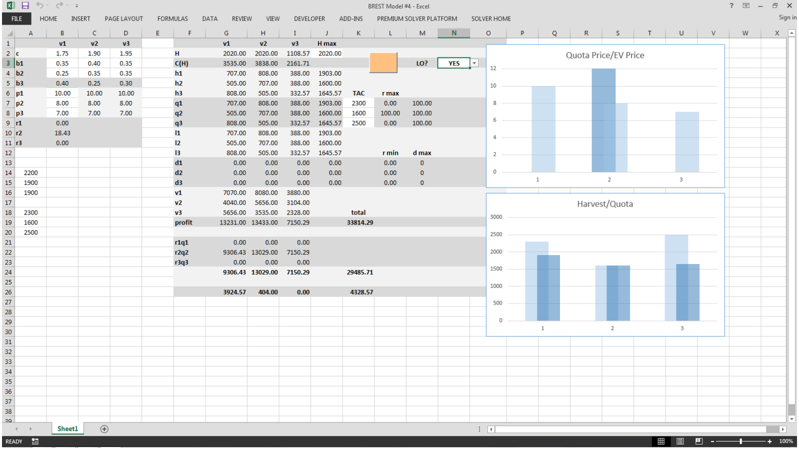
Scenario 2

	A	B	C	D	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			





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...