Supplementary Material for Groundfish Quota Prices

A. 1. Distance Indices by stock

The figures A.1 to A.3 illustrate the distances between pairs of stocks that are used to construct the spatial weights matrices.
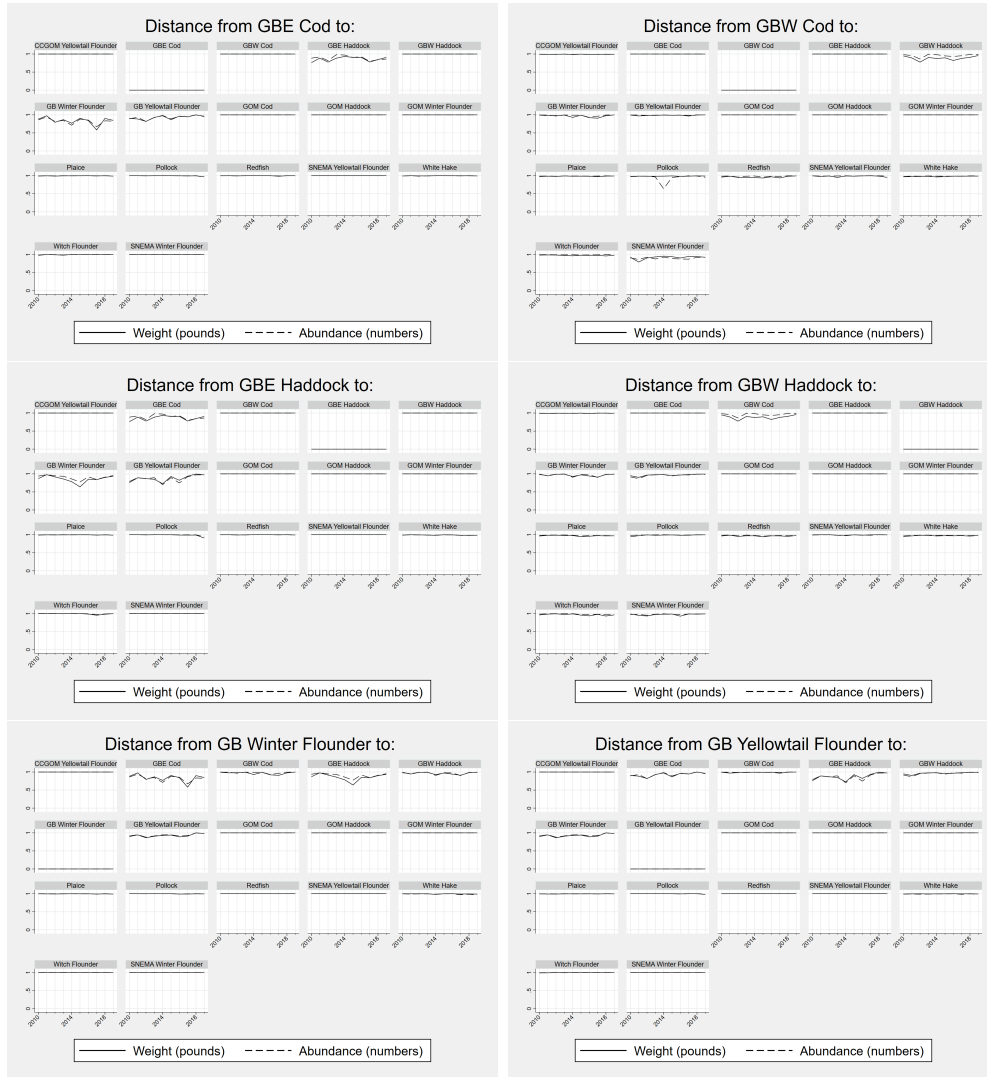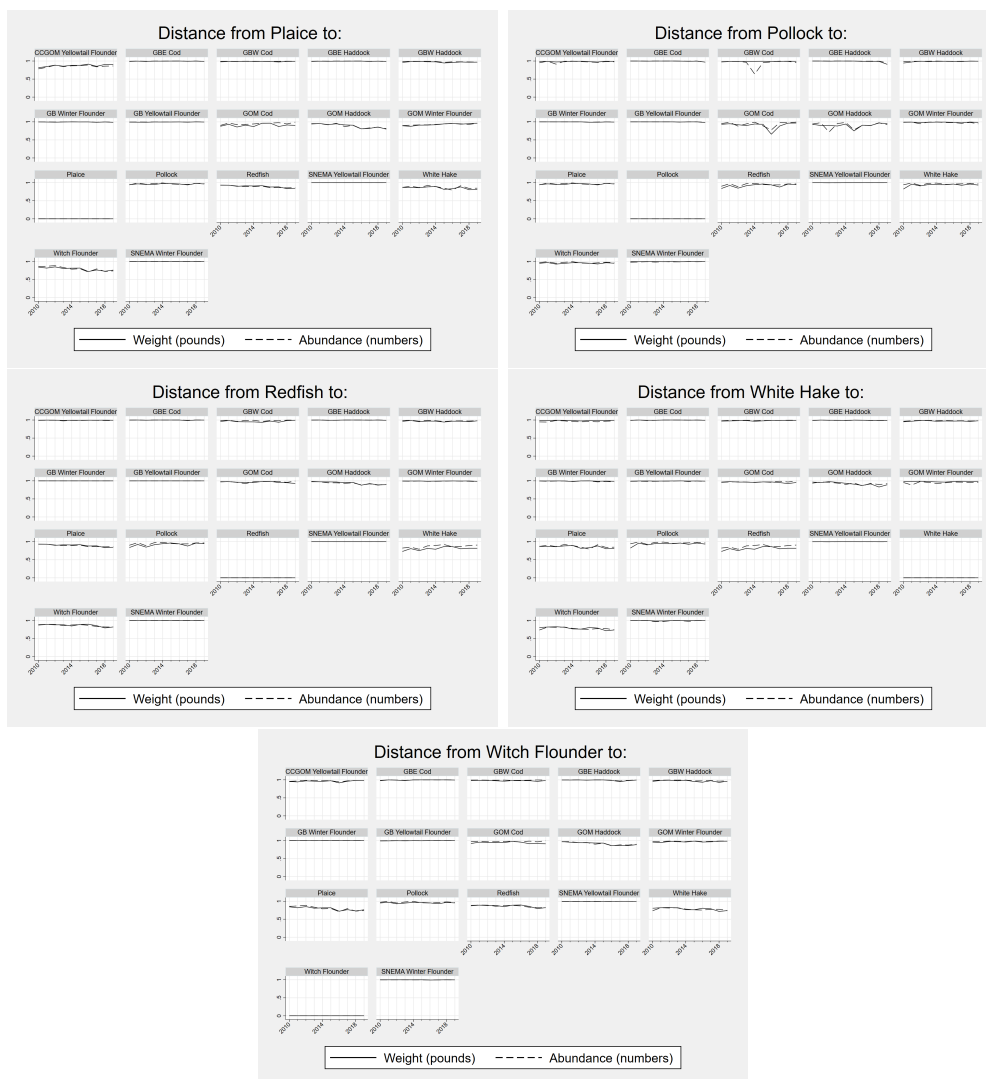

Figure A.1: Distance of GB stocks, 2007-2019

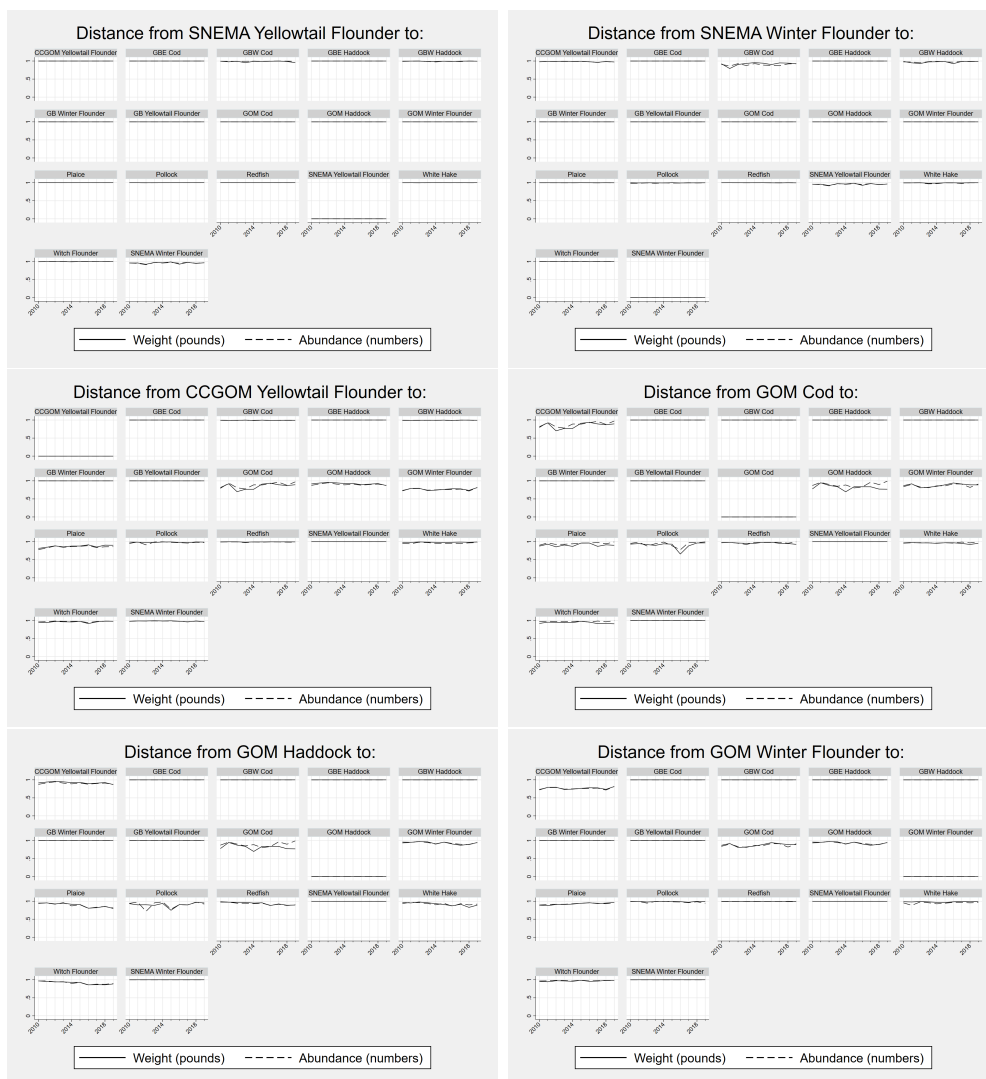Figure A.2: Distance of Unit stocks, 2007-2019

Figure A.3: Distance of GOM and SNE stocks, 2007-2019

A. 2. Robustness Checks for Stage 2

Initial specifications included a pair of cost proxies: fuel prices and an opportunity cost of labor. Because fuel make up a large proportion of total costs, the price of Number 2 Diesel fuel prices in New York Harbor was used as a proxy for trip costs[1]. While crew are typically compensated using a share system (McConnell and Price, 2006), quota prices may be responsive to the opportunity costs of labor, as measured by outside employment opportunities. Data from the Bureau of Labor Statistics's Quarterly Census of Employment and Wages is used to construct wage rate. The crew wage wage was constructed by using the average of Marine Cargo Handling (NAICS 488320), Port and Harbor Operations (NAICS 488310), Packing and Crating (NAICS 488991), and Marinas (NAICS 713930). Captains wages were constructed from Navigational services to shipping (NAICS 488330). Only regions in the Northeast US were used to construct this wage. Because vessels targeting groundfish had an average crew size of 2.8, a weighted average (a weight of 1 for the captains wage and 1.8 for the crew wage) is used to construct a labor wage. A full set of summary statistics, is contained in Table A.1.

Fuel prices did not significantly explain quota prices. This is probably because, for each time period (quarter), fuel prices are constant across all the stocks. Wages were found to have a large, negative impact on quota prices.

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[1]https://fred.stlouisfed.org/series/DDFUELNYH. Accessed on Feb 4, 2022.

	Quota Price=0	Quota Price>0	Total
Quota Price (real)	0.00	0.70	0.37
	(0.00)	(0.63)	(0.58)
Output Price, (live pounds real dollars)	1.35	1.76	1.57
	(0.62)	(0.57)	(0.63)
Quota Remaining ('000mt)	7.73	1.25	4.29
	(9.80)	(1.98)	(7.58)
Fraction Quota Remaining	0.85	0.76	0.80
	(0.16)	(0.22)	(0.20)
Fraction of Catch Observed (stock)	0.22	0.23	0.23
	(0.09)	(0.07)	(0.08)
Fraction of Trips Observed (fishery)	0.21	0.21	0.21
	(0.05)	(0.05)	(0.05)
Spatial Lag (ID) of Quota Remaining	3.87	4.36	4.13
	(1.30)	(1.31)	(1.33)
Spatial Lag (D) of Quota Remaining	3.57	3.84	3.72
	(1.24)	(1.13)	(1.19)
Quarter 1	0.20	0.27	0.24
	(0.40)	(0.44)	(0.43)
Quarter 2	0.24	0.24	0.24
	(0.43)	(0.43)	(0.43)
Quarter 3	0.25	0.28	0.26
	(0.43)	(0.45)	(0.44)
Quarter 4	0.31	0.22	0.26
	(0.46)	(0.41)	(0.44)
Observations	300	340	640S

Table A.1: Summary statistics for the second stage, positive and zeros separately.

The strong cyclicality of wages is likely to cause this surprising result. Wages are lowest during the first two quarters and highest in the final two quarters. Quota prices have the exact opposite within-season cycle. Therefore, wages were excluded from the econometric model under the assumption that this is a spurious correlation; this caused minimal loss of fit.

Table A.2 contains robustness checks for the second stage exponential model. Model E1 reproduces the Exponential model in 5. Model E2 constructs spatial weights based on overlap of fishing revenues instead of overlap of fishery independent survey data. Model E3 omits the spatial lag terms. Model E4 uses 1 quarter lagged output prices as an explanatory variable instead of output prices. Model E5 is the largest specification estimated and includes coefficient estimates for variables that were statistically insignificant or removed the model during the specification process. Coefficients in the outcome parts of the model, particularly the price and quota remaining components, are reasonably robust to changes in model specification. The selection part of the model is the same in all specifications.

Table A.3 contains robustness checks for the second stage linear model. Model L1 reproduces the linear model in Table 5. Model L2 constructs spatial weights based on overlap of fishing revenues instead of overlap of fishery independent survey data. Model L3 omits the spatial lag terms. Model L4 uses 1 quarter lagged output prices as an explanatory variable instead of output prices. Model L5 is the largest specification estimated and

	E1	E2	E3	E4	E5
selection					
Quota Remaining	-0.146***	-0.146***	-0.146***	-0.146***	-0.146***
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
Fraction of Catch	1.535	1.535	1.535	1.535	1.535
Observed	(1.16)	(1.16)	(1.16)	(1.16)	(1.16)
FractionQuotaRemaining	-3.559***	-3.559***	-3.559***	-3.559***	-3.559***
	(0.67)	(0.67)	(0.67)	(0.67)	(0.67)
Quarter 2	-0.756***	-0.756***	-0.756***	-0.756***	-0.756***
	(0.16)	(0.16)	(0.16)	(0.16)	(0.16)
Quarter 3	-1.161***	-1.161***	-1.161***	-1.161***	-1.161***
	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)
Quarter 4	-2.115***	-2.115***	-2.115***	-2.115***	-2.115***
	(0.28)	(0.28)	(0.28)	(0.28)	(0.28)
Constant	4.026***	4.026***	4.026***	4.026***	4.026***
	(0.70)	(0.70)	(0.70)	(0.70)	(0.70)
lnbadj_GDP					
Output Price, (live	0.774***	0.782***	0.745***	0.648***	0.707***
pounds real)	(0.14)	(0.14)	(0.15)	(0.15)	(0.15)
Quota Remaining	-0.307***	-0.311***	-0.295***	-0.315***	-0.317***
	(0.04)	(0.04)	(0.04)	(0.04)	(0.03)
Fraction of Catch	3.006***	2.976***	3.427***	3.371***	2.836***
Observed	(0.80)	(0.81)	(0.81)	(0.84)	(0.83)
Spatial Lag (D) of	-0.152**	-0.173**			-0.278
Quota Remaining	(0.06)	(0.07)			(0.19)
Spatial Lag (ID) of					0.124
Quota Remaining					(0.17)
Quarter 2	-0.304***	-0.308***	-0.260***	-0.292***	-0.429***
	(0.10)	(0.10)	(0.10)	(0.11)	(0.12)
Quarter 3	-0.459***	-0.463***	-0.381***	-0.334***	0.115
	(0.11)	(0.11)	(0.11)	(0.11)	(0.32)
Quarter 4	-0.556***	-0.565***	-0.409***	-0.539***	-0.414
	(0.13)	(0.13)	(0.12)	(0.12)	(0.31)
FractionQuotaRemaining					-0.663
					(0.48)
Diesel Fuel Price					-0.114
(real)					(0.11)
Hourly Wage (real)					-0.246***
					(0.08)
Constant	-1.600***	-1.594***	-2.313***	-2.081***	6.109**
	(0.41)	(0.43)	(0.40)	(0.39)	(2.53)
lnsigma					
Constant	-0.222***	-0.223***	-0.203***	-0.184***	-0.244***
	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)
R^2	0.315	0.322	0.286	0.254	0.330
AIC	915.5	915.1	926.3	939.4	908.7
BIC	986.9	986.5	993.2	1,006.3	997.9
N	640	640	640	640	640
Log-Likelihood	-441.8	-441.6	-448.1	-454.7	-434.4
k	16	16	15	15	20

Table A.2: Robustness checks for the second stage exponential model

includes coefficient estimates for variables that were statistically insignificant or removed the model during the specification process. Coefficients in the outcome parts of the model, particularly the price and quota remaining components, are reasonably robust to changes in model specification. The selection part of the model is the same in all specifications.

In the preferred specification, when quota prices could not be estimated in the first stage, the prices were assumed to be zero. Alternatively, these could be omitted from the model; Table A.4 contains precisely those results. For the two hurdle models, only the "participation" equation coefficients are different. This is because the "outcome equation" only uses positive observations and therefore is not affects. Results are similar to the results in Table 5.

	L1	L2	L3	L4	L5
selection					
Quota Remaining	-0.146***	-0.146***	-0.146***	-0.146***	-0.146***
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
Fraction of Catch	1.535	1.535	1.535	1.535	1.535
Observed	(1.16)	(1.16)	(1.16)	(1.16)	(1.16)
FractionQuotaRemaining	-3.559***	-3.559***	-3.559***	-3.559***	-3.559***
	(0.67)	(0.67)	(0.67)	(0.67)	(0.67)
Quarter 2	-0.756***	-0.756***	-0.756***	-0.756***	-0.756***
	(0.16)	(0.16)	(0.16)	(0.16)	(0.16)
Quarter 3	-1.161***	-1.161***	-1.161***	-1.161***	-1.161***
	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)
Quarter 4	-2.115***	-2.115***	-2.115***	-2.115***	-2.115***
	(0.28)	(0.28)	(0.28)	(0.28)	(0.28)
Constant	4.026***	4.026***	4.026***	4.026***	4.026***
	(0.70)	(0.70)	(0.70)	(0.70)	(0.70)
Quota Price (real)					
Output Price, (live	0.823***	0.920***	0.882***	0.797***	0.720***
pounds real)	(0.21)	(0.22)	(0.21)	(0.22)	(0.19)
Quota Remaining	-0.740**	-0.850**	-0.738**	-0.865**	-0.713***
	(0.30)	(0.34)	(0.32)	(0.35)	(0.27)
Fraction of Catch	4.739***	4.022***	4.590***	4.742***	4.888***
Observed	(1.41)	(1.36)	(1.50)	(1.64)	(1.75)
Spatial Lag (D) of	-0.904***	-0.519**			-0.805***
Quota Remaining	(0.28)	(0.23)			(0.26)
Spatial Lag (ID) of	0.689***	0.284**			0.578***
Quota Remaining	(0.21)	(0.14)			(0.20)
Quarter 2	-0.430**	-0.459**	-0.394**	-0.569***	-0.499**
	(0.18)	(0.19)	(0.18)	(0.21)	(0.20)
Quarter 3	-0.617**	-0.684**	-0.558**	-0.602**	0.139
	(0.29)	(0.29)	(0.24)	(0.26)	(0.47)
Quarter 4	-0.782**	-0.852**	-0.597**	-0.953***	-0.419
	(0.36)	(0.37)	(0.29)	(0.35)	(0.51)
FractionQuotaRemaining					-0.260
					(0.58)
Diesel Fuel Price					-0.260
(real)					(0.21)
Hourly Wage (real)					-0.270**
					(0.12)
Constant	-1.009	-0.895	-1.725**	-1.445**	7.437**
	(0.64)	(0.71)	(0.69)	(0.70)	(3.64)
lnsigma					
Constant	-0.245	-0.219	-0.181	-0.138	-0.271
	(0.17)	(0.17)	(0.18)	(0.18)	(0.17)
R^2	0.367	0.370	0.312	0.281	0.372
AIC	931.8	936.7	947.3	955.2	930.8
BIC	1,007.6	1,012.6	1,014.2	1,022.1	1,020.0
N	640	640	640	640	640
Log-Likelihood	-448.9	-451.4	-458.7	-462.6	-445.4
k	17	17	15	15	20

Table A.3: Robustness checks for the second stage linear model

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	Exponential	Linear	OLS
participation			
Quota Remaining	-0.132***	-0.132***	
	(0.03)	(0.03)	
Fraction Quota Remaining	-2.909***	-2.909***	
	(0.96)	(0.96)	
Fraction of Catch	-0.847	-0.847	
Observed	(1.29)	(1.29)	
Quarter 2	-0.351	-0.351	
	(0.25)	(0.25)	
Quarter 3	-0.449	-0.449	
	(0.33)	(0.33)	
Quarter 4	-1.353***	-1.353***	
	(0.46)	(0.46)	
Constant	4.349***	4.349***	
	(1.01)	(1.01)	
outcome			
Live Price	0.774***	0.823***	0.410***
	(0.14)	(0.21)	(0.07)
Quota Remaining	-0.307***	-0.740**	-0.047***
	(0.04)	(0.30)	(0.01)
Fraction of Catch	3.006***	4.739***	1.679***
Observed	(0.80)	(1.41)	(0.55)
Distance Lag of	-0.152**	-0.904***	-0.386***
Quota Remaining	(0.06)	(0.28)	(0.12)
Inverse Distance Lag		0.689***	0.337***
of Quota Remaining		(0.21)	(0.11)
Quarter 2	-0.304***	-0.430**	-0.086
	(0.10)	(0.18)	(0.06)
Quarter 3	-0.459***	-0.617**	-0.097
	(0.11)	(0.29)	(0.08)
Quarter 4	-0.556***	-0.782**	-0.140
	(0.13)	(0.36)	(0.09)
Constant	-1.600***	-1.009	-0.320
	(0.41)	(0.64)	(0.28)
R^2	0.288	0.360	0.287
AIC	566	582	648
BIC	630	650	683
N	400	400	400
Log-Likelihood	-267	-274	-315

Table A.4: Second stage estimation results from two hurdle and one OLS specification

References

McConnell, K.E., Price, M., 2006. The Lay System in Commercial Fisheries: Origin and Implications. Journal of Environmental Economics and Management 51, 295–307.