The impact of individual quotas on technical efficiency: does quality matter?*

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APPENDICES

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Appendix 1

Allocation formula for individual maximum harvest limits in the pelagic fisheries off central-southern Chile

The individual maximum harvest limit (MHL_i) for each fishery unit is defined as:

$$MHL_i = c_i \times TAC \qquad (A.1)$$

where c_i represents the participation coefficient of vessel owner i and TAC is the annual total allowable catch quota for the industrial sector in the fishery unit. The relative participation coefficient for each of the pelagic species included in the pelagic fisheries off central-southern Chile is calculated as the simple average of coefficients for relative harvest (h_i) and for vessel capacity (b_i), that is:

$$c_i = \frac{h_i + b_i}{2} \qquad (A.2)$$

The coefficient of relative harvest considers the vessel owner's relative participation in total landing reports between 1997 and 2000 for each species included in the analysis. The coefficient that considers the vessel owners' adjusted vessel capacity (b_i) is calculated considering an indicator for each vessel's capacity (in cubic meters). This indicator is adjusted by the ratio between the length of the coastal zone in which the vessel is authorized to target the species of interest *versus* the total length of the coastal zone for the fishery unit related to each species (Law 19.713, Art. 4).

Appendix 2

Decomposing changes in fleet technical efficiency

The fleet technical efficiency in time t is a weighted average of the individual technical efficiency of all vessels active in the fishery in that period. The weights should measure the vessel's "participation intensity" in that period. That is:

$$E_t = \sum_{i=1}^{I} e_{i,t}\phi_{i,t} \tag{A.3}$$

where E is the (average) fleet efficiency, e is the individual efficiency, ϕ is the weight (e.g., participation of the vessel in total number of trips, v, of the fleet), the subscript i indicates the vessel, and I is the total number of active vessels in period t.

Since ϕ is a relative weight:

$$\sum_{i=1}^{I} \phi_{i,t} = 1 \text{ for any } t. \tag{A.4}$$

Let us assume that we can observe N of the i vessels active in period t to be active in both periods t and $t+1$. The number of non-active vessels in period $t+1$ that were active in period t will be M, where $I = N+M$.

We can define the weight (ϕ) given to each vessel in period t as:

$$\phi_{i,t} = \frac{v_{i,t}}{\sum_{i=1}^{I} v_{i,t}} = \frac{\sum_{i=1}^{N} v_{i,t}}{\sum_{i=1}^{I} v_{i,t}} \frac{v_{i,t}}{\sum_{i=1}^{N} v_{i,t}} \equiv \gamma\phi_{i,t}^{N} \tag{A.5}$$

where γ is the participation of the N vessels in the total fishing activity in period t, and ϕ_{it}^{N} is the weight of active vessel i in the total fishing activity of the N vessels in period t. Similarly, we can define $\phi_{it} = (1-\gamma)\phi_{it}^{M}$, where ϕ_{it}^{M} is the weight of active vessel i in the total fishing activity of the M vessels in period t.

Thus, fleet efficiency in period t can be written as:

$$E_t = \gamma \sum_{i=1}^{N} e_{i,t}\phi_{i,t}{}^{N} + (1-\gamma) \sum_{i=N+1}^{I} e_{i,t}\phi_{i,t}{}^{M} = \gamma E_t^N + (1-\gamma) E_t^M \qquad \text{(A.6)}$$

where the superscripts *N* and *M* in *E* indicate that the average is taken over the *N* and *M* subsamples, respectively.

In an analogous manner, fleet efficiency in period *t+1* can be defined as:

$$E^N{}_{t+1} = \sum_{i=1}^{N} e_{i,t+1}\phi^N{}_{i,t+1} \qquad \text{(A.7)}$$

The change in fleet efficiency between period *t+1* and *t* is:

$$\Delta = E^N{}_{t+1} - \gamma E_t^N - (1-\gamma) E_t^M \qquad \text{(A.8)}$$

With a little algebraic manipulation, the change in fleet efficiency can be decomposed as:

$$\Delta = (E^N{}_{t+1} - E_t^N) + (1-\gamma)(E_t^N - E_t^M) \qquad \text{(A.9)}$$

The first right-hand term represents the change in fleet efficiency due to the change in individual efficiency of the vessels active in both periods. This change, in the context of this study, is the effect of the regulatory change on individual vessel efficiency. The second right-hand term reflects the change in fleet efficiency due to the difference in average efficiency in period *t* between the vessels that remain active and those that leave the fishery after the regulatory change. This decomposition is used in the main text.

Appendix 3

Table A1. Estimation results for the Probit model

Dependent Variable: Vessel selection for fishing from non-specialized and sardine-anchovy (SACH) samples

	NON-SPECIALIZED		SACH	
Variable	*Coefficient*	*Standard Error*	*Coefficient*	*Standard Error*
Constant	-7.41E-02	0.2347	1.66E+00	0.4772
GRT	7.73E-04	0.0001	1.70E-03	0.0005
EP	1.44E-04	.485180D-04	-3.46E-04	0.0002
AGE	-2.14E-02	0.0019	-2.26E-02	0.0035
BIOMASS	2.13E-03	0.0003	3.25E-03	0.0007
FISHPRICE	6.06E-04	0.0002	1.09E-03	0.0004
OILPRICE	-4.99E-03	0.0006	-8.80E-03	0.0013
MHLxGRT	8.59E-04	0.0004	-6.43E-04	0.0010
MHLxEP	6.29E-04	0.0002	-4.04E-05	0.0004
MHLxAGE	-1.42E-03	0.0003	-1.65E-02	0.0085
MHLxBIOMASS	4.73E-03	0.0007	5.71E-04	0.0019
MHLxFISHPRICE	-1.16E-04	.626413D-04	1.69E-03	0.0015
MHLxOILPRICE	-1.51E-02	0.0026	7.64E-03	0.0017
JAN	-5.21E-02	0.0661	9.09E-02	0.1410
FEB	4.94E-02	0.0715	-1.86E-01	0.1541
MAR	-7.1E-02	0.0702	-4.01E-02	0.1598
APR	6.76E-02	0.0680	-1.65E-01	0.1580
MAY	6.08E-02	0.0656	-6.21E-02	0.1542
JUN	-1.28E-01	0.0652	-5.16E-01	0.1649
JUL	-1.21E-01	0.0650	-5.99E-01	0.1533
AUG	-1.7E-01	0.0653	-7.37E-01	0.1552
SEP	-1.99E-01	0.0688	-3.07E-01	0.1481
OCT	-5.50E-02	0.0759	-2.07E-01	0.1509
NOV	-1.04E-01	0.0738	-3.93E-01	0.1562
MHL	-1.70E+00	0.3276	-3.82E+00	1.0615
Log Lik funct	-6321.905		-1115.832	
Rest. Log Lik funct	-8496.632		-2262.514	
Chi-Squared Stat	4349.453		2293.364	
Degrees of freedom	24		24	
Number of vessels	132		42	
Number of months	93		72	
Total Number of Observ	12275		3906	
Tests	Statistic	Critical Value	Significant	
Homogeneity test	411.9	χ2(50) 95%= 71.42	Yes	