Privatization and Regulation of Capacity in a Multi-Product Fishery: A Purse from a Sow's Ear?

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Abstract. Using individual firm data from before and after the introduction of ITQs in the multi-species Nova Scotia mobile gear fishery, data envelopment analysis (DEA) is used to examine issues relating to capacity and capacity utilization. The paper examines how a change in the property rights regime can affect a multi-product industry and the consequences of these changes in terms of product-specific capacity utilization, as well as aggregate capacity utilization. The results provide insights to regulators interested in using market-based approaches to improve efficiency in multi-product industries.

Keywords: capacity, multi-product fisheries, data envelopment analysis.

1. INTRODUCTION

The world's fisheries face many challenges. To help improve efficiency in the harvesting sector and reduce overcapacity, several nations have implemented individual harvesting rights or individual transferable quota (ITQ) regimes (Grafton et al., 1996). ITQs are a form of rights-based management and can provide fishers with the incentives to catch fish at the least cost and choose a level of fixed and variable inputs that maximize their returns per unit of quota (Scott and Neher, 1981). Transferability of quota also permits fishers with lower production costs to buy quota from others, and thus, reduce the number of vessels in a fishery. The potential success of ITQs to reduce excess capacity is dependent upon the existing level of overcapacity, irreversibilities in investments in fishing capital, the alternatives available for capital and labor outside of the ITQ fishery, and the intervention by regulators in buy-backs of quota and/or fishing licenses. In many fisheries where overcapacity has been considered a problem, however, the number of active fishing vessels has declined - with differing speeds of adjustment - with the introduction of private harvesting (National Research Council, 1999).

Despite the potential benefits of ITQs as a management regime for fisheries, few studies exist which evaluate the changes in fishing capacity brought about by the introduction of individual harvesting rights. Moreover, many of the existing studies on capacity in fisheries have not assessed capacity on a vessel and/or fleet basis or provided a measure of capacity that is consistent with efficient production. In the present study, we examine harvesting capacity in Canada's Scotia-Fundy mobile gear, multi-species, groundfish fishery. Our study examines the relationship between ITQs, overcapacity, and capacity utilization and addresses the following questions. To what extent was fishing capacity both at the vessel and aggregate level reduced in the fishery after the introduction of ITQs? Were there differences in these reductions according to vessel size class? What impact did ITQs have upon product-specific capacity within a multi-species fishery?

2. MEASUREMENT OF FISHING CAPACITY AND CAPACITY UTILIZATION

2.1 Conceptual Issues

Economists have long been interested in measuring fishing capacity. Much of the literature equates fishing capacity with the capital stock (vessel and gear) used in the harvesting sector (Kirkley and Squires, 1999). Under this interpretation, capital is treated as homogeneous, and the prescription for reducing fishing capacity is to reduce the capital stock, often in the form of vessel buy-backs. By contrast, one strand of the economics literature defines capacity output as the maximum level of production that the fixed inputs are capable of supporting when the variable inputs are fully utilized (Johansen, 1968). Under this definition capacity is a short-run concept, where firms and industry face short-run constraints, such as the stock of capital or other fixed inputs, existing regulations, the state of technology, and other technological constraints. The two definitions of capacity are equivalent when there is a single fixed input (a single, homogeneous stock of capital), variable inputs are in fixed proportions to the fixed input, and production is characterized by constant returns to scale (Berndt and Fuss, 1989).

The Food and Agriculture Organization (FAO) of the United Nations recently defined fishing capacity as "… the maximum amount of fish over a period of time (year, season) that can be produced by a fishing fleet if fully-utilized, given the biomass and age structure of the fish stock and the present state of the technology." (FAO, 1998). Thus, the FAO definition treats fishing capacity as the short-run concept described above where fishers face constraints in terms of the resource stock and their use of fixed inputs such that capacity changes with fluctuations in the stock. The FAO definition has been termed the technological-economic approach to capacity because it is equivalent to productive efficiency, a precondition for economic efficiency, and implicitly incorporates past economic decisions about fixed factors (Kirkley and Squires, 1999).

This study employs the technological-economic concept of capacity as the basis for determining capacity utilization and excess capacity measures. Capacity utilization (CU) represents the proportion of available capacity that is utilized and is typically measured by the ratio of actual output to capacity output (Morrison 1985, Nelson, 1989). Using the technological-economic definition of capacity output, full CU represents full capacity and cannot exceed one. However, a CU less than one indicates that firms have the potential for greater production without having to incur major expenditures for new capital or equipment (Klein and Summers, 1966).

While the definition above is used for individual firms, researchers are also concerned with being able to measure capacity and capacity utilization at the fleet level. In many fisheries, total fleet output is regulated by a total allowable catch (TAC) constraint. In this context, excess capacity exists when a fleet has the capability to harvest in excess of a desired or target level of output, such as the TAC (Kirkley and Squires, 1999). In other words, there exists an excessive use of all inputs -- including labor, heterogeneous capital, and other fixed factors -- to produce a given set of outputs.

2.2 Data Envelopment Analysis

In this paper, we use data envelopment analysis (DEA), a mathematical programming technique, to determine the maximal or capacity output of a firm given that the variable factors are fully utilized and the fixed factors, resource stock, and state of technology constrain output. DEA derives a frontier output that corresponds to an output that could be produced given full and efficient utilization of variable inputs but constrained by the fixed factors, the state of technology, and the resource stock (Färe et al., 1989; Färe et al., 1994; Kirkley and Squires, 1999.)

While there are some drawbacks to the DEA approach (Coelli et al., 1998), such as the fact that it is a non-parametric technique and estimates can be sensitive to the data, it has a number of advantages for the measurement of fishing capacity. First, it permits an examination of technical efficiency and capacity in a multiple product environment without imposing separability assumptions on the outputs. Second, it can be used when prices are difficult to define or behavioral assumptions, such as cost minimization, are difficult to justify. Third, it allows the researcher to calculate capacity output for each individual species and then the sum these individual capacities over all firms in a relevant region and time period in order to provide a measure of fleet capacity for that output and all others in a multi-species environment.

Following Färe et al. (1989) we assume that there are $j = 1,\ldots,J$ observations or firms in an industry producing M non-negative outputs, $u = (u_1,u_2,\ldots,u_M)$ using a vector of N non-negative inputs $x = (x_1,x_2,\ldots,x_N)$. Thus, u_{jm} would represent the quantity of the mth output produced by the jth producer, and x_{jn} would represent the level of the nth input used by the jth producer. A number of assumptions are made about these variables: in aggregate, positive amounts of all output are produced and positive amounts of all inputs are used, however, firms can produce a zero amount of any output and choose to use a zero amount of any input. Each firm must, however, produce at least one output using at least some of one input.

It is useful to introduce the vector $z = (z_1,z_2,\ldots,z_J)$ where each element of z is non-negative. It denotes the intensity levels at which each of the J firms or producers are operating. The z vector allows us to decrease or increase observed production activities (input and output levels) in order to construct unobserved but feasible activities. More importantly, the z vector provides weights that are used to construct the linear segments of the piece-wise, linear technology constructed by DEA.

While the DEA approach allows us to model the problem from either an input or output orientation, we use an output orientation since it facilitates the measurement of capacity and capacity utilization. The output possibilities set, P(x|C,S), can be used to construct a piece-wise technology. With two additional assumptions (constant returns to scale and strong disposability) we equation (1):

$$
\begin{aligned}
&P(x\,|C,S) = \\
&\{u : u_m \le \sum_{j=1}^{J} z_j u_{jm}, m = 1,\ldots,M, \\
&\sum_{j=1}^{J} z_j x_{jn} \le x_n, n = 1,\ldots,N, z \in R_+^{J}\}
\end{aligned}
\tag{1}
$$

By using DEA, we may construct the piece-wise technology corresponding to the output set, P(x|C,S). We define technical efficiency (TE_{oj}) as the maximum feasible or proportional expansion in all outputs and define it in equation (2) below. In this equation, θ is the inverse of an output distance function and equals the ratio of the maximum potential output to the observed output level. The value of θ is restricted to ≥ 1.0, and θ - 1.0 is the potential proportionate increase in outputs. If θ = 1.0, production is technically efficient; if θ > 1.0, production is inefficient and output levels could be increased by θ - 1.0.

$$TE_{oj}\,(u,x\,|\,C,S) = \max_{\lambda,z}\theta$$
$$subject\ to\ \theta\, u_{jm} \le \sum_{j=1}^{J} z_j u_{jm},\, m = 1,\ldots M,$$
$$\sum_{j=1}^{J} z_j x_{jn} \le x_{jn},\, n = 1,\ldots N,\, and\ z_j \ge 0,\ j = 1,\ldots J \tag{2}$$

The DEA method offers a convenient framework for estimating capacity in fisheries. Because DEA offers the option of imposing constraints, it allows the maximum potential output to be estimated conditional only on the fixed factors. Alternatively, DEA easily facilitates the calculation of the concept of capacity proposed by Johansen (1968) and made operational by Färe et al. (1989).

The Färe et al. (1989) work posits that capacity at the plant level can be estimated by partitioning inputs according to whether they are fixed (F_x) or variable (V_x) and then solving an output-oriented, DEA problem in which only fixed factors bind production. This is shown in equation (3).

$$TE_{ocj} = \max_{\theta,\lambda,z}\theta$$
$$subject\ to\ \theta\, u_{jm} \le \sum_{j=1}^{J} z_j u_{jm},\, m = 1,\ldots M,$$
$$\sum_{j=1}^{J} z_j x_{jn} \le x_{jn},\, n\in F_x \quad ; \quad \sum_{j=1}^{J} z_j x_{jn} = \lambda_{jn} x_{jn},\, n \in V_x,$$
$$z_j \ge 0,\ j = 1,\ldots J,\quad and \quad \lambda_{jn} \ge 0 \tag{3}$$

In this equation θ is a measure of technical efficiency (TE) and θ ≥ 1.0. If we multiply the observed output by θ, we obtain an estimate of capacity output. Capacity can also be estimated by solving problem (3) without the variable input constraints. Problem (3) is identical to problem (2) except the variable factors do not limit production in problem (3).

Using data, problem (3) is solved for measures of capacity output, capacity utilization and excess capacity using data from the Scotia-Fundy Inshore mobile gear groundfishery, as described in the next section of the paper.

3. THE SCOTIA-FUNDY INSHORE MOBILE GEAR GROUNDFISHERY

3.1 History of the Fishery

The Scotia-Fundy sector is one of five management sub-sectors in the Maritimes fisheries region of Canada. Its geographical location extends from the northeastern tip of Cape Breton to the New Brunswick-Maine border. Groundfish, particularly cod, have been heavily exploited in this sector and have typically accounted for 30-40 % of the total landed value in the region (DFO Web Statistics, various years). Among those fleets that have exploited this fishery, has been the inshore mobile gear fleet. It consists of vessels ranging from 35 to 65 feet in length that use otter trawls or Danish seines. During the 1970's and 1980's, fishing power and capacity increased in this fleet despite limited entry regulations and various input restrictions. By 1986, and prior to a boom in fleet capacity in 1986 and 1987, the inshore mobile gear fleet had the capability to harvest four times the total allowable catch (TAC), established using the $F_{0.1}$ level of fishing mortality (Barbara et al., 1995).

After becoming concerned about the status of groundfish stocks off Nova Scotia because there was evidence to suggest potentially severe declines in the near future biomass levels, managers closed the fishery in mid 1989 and did not re-open it until 1990. A Task Force established to examine possible solutions to excess harvesting capacity and low stock levels recommended an ITQ program for the fleet, which was introduced in January 1991.

3.2 The ITQ Fishery

Under the ITQ program, each license holder was given an initial, individual quota allocation (Barbara et al., 1995). The initial allocations were calculated on the basis of the average of the best two years harvest during the 1986-1989 fishing seasons. Initially, only some stocks in particular areas were subject to the ITQ program (cod, haddock and pollock). In 1992 and 1994 more areas and species (flounder) were added. Only 325 of the original 455 license holders chose to participate in the ITQ fishery in 1991. Fifty so-called “generalists” chose to pool their individual allocations and to fish the small quota competitively, seventy-four dual fixed/mobile gear license holders opted out of the mobile gear fishery and became part of the non-quota, competitive fixed gear, groundfish fishery and 6 licenses were cancelled.

At the outset, the program allowed unlimited trading of quota among eligible quota holders, and fishers could acquire quota up to 30 days after landing the catch. In addition, fishers were subject to 100 percent dockside monitoring by a private company. Initially, the Department of Fisheries and Oceans paid for administration and funding of the dockside-monitoring program but in 1992 the cost of the program was transferred completely to the fishers.

Since the introduction of the ITQ program, there have been substantial changes, at the aggregate level, to the size of the mobile gear groundfish fleet. These changes have occurred in a manner consistent with expectations regarding the impact of an ITQ program. Namely, the number of active quota holders in the fishery has decreased. At year-end in 1991 (the end of the first year of the quota program), 321 vessels had licenses with quota shares (i.e., the right to catch fish to some specified limit). At the end of 1998, only 249 licenses continued to have quota shares (Cindy Webster, Commercial Data Division, Fisheries and Oceans, Halifax, personal communication). In addition, the number of active ITQ vessels fell steadily from 268 in 1991 to 137 in 1998. The number of generalist vessels also decreased from 50 in 1991 to 28 in 1998. Dupont and Grafton (1999) discuss developments in this fishery in greater detail.

In part, the change in the number of generalist vessels was a response to the introduction of ITQs for flounder in 1994. These generalist vessels primarily fished flounder in 1991 and caught cod and haddock only as by-catch. Although ITQs were required for harvesting both cod and haddock, the quantities caught of these quota species were small enough that operators of the generalist vessels were willing to fish these species competitively from a pooled allocation of their own ITQs. Given the reductions in overall quota for these species due to biomass declines, the competitive fishing system broke down. As a result, almost half of the original 50 vessels withdrew from the generalist pool in order to be able to fish their own ITQs.

3.3 Data Used to Solve DEA Problem

In order to examine the impact of the adoption of ITQs at the level of individual fisher level, we analyze vessel-specific data from three different fishing years: 1988, 1990 and in 1991, the year the ITQ program was introduced into the fishery. Data include gear ownership and vessel characteristic information obtained from the Vessel Performance Questionnaire implemented by DFO and made available by the DFO Program Coordination and Economics Branch, Scotia-Fundy Region. The coverage of vessels varies by year. For 1988, the information is available on 42 individual vessels, which represents 11 percent of the entire licensed fleet at that time. For 1990, data on 66 vessels is used, and for 1991, the data are for 81 individual vessels, which represents 26 percent of the total number of active vessels in the fishery in that year.

Using these data the DEA problem in equation (3) is specified as an output-oriented, variable returns to scale model. Output is defined as the round weight in kilograms (kg) of each species landed per vessel per day fished. The fixed input is taken to be the capital stock of each vessel and measured by its length overall (LOA). The DEA model also includes biomass levels for cod, haddock, and pollock as additional fixed environmental parameters where the biomass of each species is divided by the number of days fished by each vessel so as to be consistent with the specification of output on a daily basis. The inclusion of the biomass data controls for changes in resource abundance that provided discrete shifts in the stock-flow harvesting technology (Squires, 1992).

Solutions to the DEA model provide estimates of capacity and CU on a per vessel per day fished basis for three ITQ species -- cod, haddock, and pollock--, as well as for two other species groupings -- flounder (non-ITQ) and a Divisia index for all other species, including shellfish. To extrapolate the daily measures to an annual basis for each vessel, we multiply the capacity per day by the number of days at sea. This approach gives full utilization of the variable inputs and accounts for the annual differences in season length, especially before and after the introduction of ITQs. An estimate of the total annual fleet capacity is obtained by multiplying the maximum annual potential catch per vessel by the number of vessels in the fleet.

We also calculate a ray capacity utilization measure (Segerson and Squires, 1990) that restricts CU to a ray from the origin such that the capacity output of each species is obtained with identical proportionate expansions over all outputs. This implies that the multiple outputs are kept in a fixed-proportions relationship and essentially enables the multi-product DEA problem to be solved as a single-product problem.

Variable	**All Vessels – 1988**		**All Vessels – 1990**		**All Vessels – 1991**	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Length overall (LOA)	49.71	9.40	50.76	9.15	49.69	9.17
Total Days at Sea	109.67	39.99	96.39	36.19	100.48	34.61
Ray Capacity Utilization	0.76	0.23	0.66	0.24	0.69	0.27
Cod Capacity (Daily)	1673.79	1098.10	2044.19	1224.52	1636.99	1142.82
Haddock Capacity (Daily)	813.89	578.75	576.00	406.76	501.70	372.44
Pollock Capacity (Daily)	617.00	527.88	566.68	508.71	538.62	679.57

Table 1: Summary Statistics on Vessels in the Nova Scotia Mobile Gear ITQ Fisheries - 1988-1991

Year/Species	**Capacity**	**TAC**	**Excess Capacity**
COD			
1988	83522	42797 (actual catch)	40725
1990	89653	39322 (actual catch)	50331
1991	61682	17128 (quota)	44554
HADDOCK			
1988	40613	16165 (actual catch)	24448
1990	25262	11209 (actual catch)	14053
1991	18904	Bycatch only	18904
POLLOCK			
1988	30788	14254 (actual catch)	16534
1990	24853	14257 (actual catch)	10596
1991	20295	9839 (quota)	10456

Table 2: Aggregate Capacity and Excess Capacity in the ITQ Fisheries

Null Hypothesis	**Sign Change From First Item**	χ^2	**Sig.**	**Reject Equality at 10 %? (Y/N)**
88 Small = 90 Small	-	0.88	0.35	N
88 Small = 91 Small	-	0.84	0.36	N
90 Small = 91 Small	+	0.01	0.92	N
88 Large = 90 Large	-	4.95	0.03	Y
88 Large = 91 Large	-	1.29	0.26	N
90 Large = 91 Large	+	1.92	0.17	N
88 Small = 88 Large	+	2.34	0.13	N
90 Small = 90 Large	+	0.04	0.84	N
91 Small = 91 Large	+	2.65	0.10	Y

Table 3: Tests of Equal Capacity Utilization by Year and Vessel Size Class

4. RESULTS

4.1 Capacity Measures for the Fishery

Table 1 provides measures of the mean capacity per vessel per day over the three years of data: 1988, 1990, and 1991 for each of the ITQ species. In addition, it presents mean ray CU measures for each year. In calculating these capacity measures biomass is included as a constraint. Given a mean ray CU over all vessels during the period of 0.69, we can conclude that, on a daily basis, vessels did not fully utilize their capacity over the entire period 1988-1991. Moreover, CU in the first year of the ITQ program was on average lower than prior to the introduction of ITQs. However, its standard deviation increased. This was likely caused by the severe biomass reductions over the period.

The aggregate impacts of fleet capacity are provided in Table 2. Capacity, in metric tons, is found by taking the product-specific capacity output per day per vessel, multiplying this by the average number of days for a particular year from Table 1, and then multiplying the result by the number of vessels in the fishery in that year. For 1988 and 1990, the number of vessels is 455 (estimate from DFO) and for 1991 the number of vessels is 375 (the number of quota-holding vessels in the fishery). TAC is total allowable catch. This is taken to be the actual catch in each of the pre-ITQ years. For 1991 it is assumed to be the allowable quota for the fishery. Excess Capacity is the difference between capacity and TAC (or quota). For the three ITQ species fleet capacity fell over the period, especially for haddock. Most of the decrease came about from the combination of a lower capacity per vessel per day and the decline in vessel numbers due to the introduction of ITQs in 1991.

4.2 Testing for Changes in Overall Capacity Utilization Measures

In conducting the analysis of capacity and CU we decided to break down the measures according to two different vessel size classes in the fishery. In the earlier discussion about the fishery no mention was made about how regulations have led to the creation of two size classes: small vessels (between 25 and 45 feet LOA) and large vessels (between 45 and 65 feet LOA). We were particularly concerned about size since the literature on ITQs suggests that there might be potential for larger vessels to take advantage of provisions of the ITQ system that encourage exploitation of returns to scale. In order to examine this hypothesis a second-stage analysis is conducted to evaluate the effects of ITQs upon fishing capacity and CU by taking the vessel-specific capacity per day and CU measures from the DEA analysis and regressing them upon dummy variables for year and vessel size class. This approach captures the effect that ITQs have on the actual production process and incentives of fishers through elimination of the technological stock and congestion externalities. These measures capture average maximum potential output per day (average product per unit of effort) rather than fisher behavior at the margin. So, we recalculated the mean capacity measures for the two size classes separately. It is these data that are used in this second stage analysis. Given space limitations more detailed tabular presentations such as those in Table 1 are not included in this paper, however, vessels in the two size categories appear to have responded differently to the introduction of the ITQs.

The explanatory variables are annual dummy variables for 1988 (D88) 1990 (D90) and 1991 (D91), and further variables that are the product of the annual dummy variables and dummy variables for the two size classes of vessels. Thus, we are tracking cohorts of vessels defined by vessel size class. In all cases, Tobit regressions are used because they allowed for censoring of the dependent variable. For example, when the dependent variable is CU, it is censored at zero and one. When each species' capacity output is the dependent variable, the Tobit regression allows for the possible censoring of capacity output at zero because under joint harvesting of multiple species, not all species are necessarily harvested. Each equation is estimated separately, rather than as a system utilizing Zellner's (1962) seemingly unrelated regression, because the independent variables in each equation are the same (Kmenta, 1971). This approach allows us to account properly for the data set as a time series of cross sections rather than as a panel data set, in which cohorts are tracked over time rather than individual firms (Deaton, 1995).

The effects of "privatizing the fishery" are evaluated by significance tests of the null hypothesis of no changes in capacity utilization or capacity output between three pairs of time periods (1988-1990, 1990-1991, and 1988-1991) and for a given vessel size class or cohort (large and small). Thus, D88SM - D91SM = 0 tests the null hypothesis of equal capacity utilization (or a given species capacity output) for small vessels between 1988 and 1991. With Tobit regressions, the appropriate test of the hypotheses of no change in capacity and CU is the Wald test using a χ^2 statistic. If the χ^2-value is significant for a capacity utilization or species capacity output measure (given a single linear restriction and hence one degree of freedom), then the null hypothesis of equal capacity for a species or ray capacity utilization is rejected.

Table 3 presents these results and as it shows there was very little significant change between the three years 1988-1991. The only significant differences across the periods were in terms of the ray CU for large vessels, which fell significantly over the period 1988 to the 1990. A significant difference between small and large vessels in the ray CU was also found in 1991, the first year that ITQs were introduced into the fishery. The evidence suggests that large vessels had significantly greater CU rates than did small vessels. The result supports the hypothesis that the ITQ program may have promoted efficiency more for the large vessels than small vessels because of their greater scope in modifying their operations.

	Cod Capacity				Haddock Capacity				Pollock Capacity			
				Reject Null? (Y/N)				Reject Null? (Y/N)				Reject Null? (Y/N)
Null	Sign Chng.	χ^2	Sig.	10%	Sign Chng.	χ^2	Sig.	10%	Sign Chng.	χ^2	Sig.	10%
88S = 90S	+	0.01	0.96	N	-	4.50	0.03	Y	-	2.69	0.10	Y
88S = 91S	-	0.68	0.41	N	-	7.71	0.01	Y	-	6.03	0.01	Y
90S = 91S	-	0.90	0.34	N	-	0.29	0.59	N	-	0.55	0.46	N
88L = 90L	+	3.40	0.07	Y	-	6.25	0.01	Y	+	0.20	0.66	N
88L = 91L	+	0.23	0.63	N	-	9.08	0.01	Y	+	2.09	0.15	N
90L = 91L	-	2.89	0.09	Y	-	0.39	0.53	N	+	1.54	0.21	N

Table 4: Tests of Significance --Is Capacity by Species the Same by Year and Vessel Size Class?

	Cod CU				Haddock CU				Pollock CU			
				Reject Null? (Y/N)				Reject Null? (Y/N)				Reject Null? (Y/N)
Null	Sign Chng.	χ^2	Sig.	10%	Sign Chng.	χ^2	Sig.	10%	Sign Chng.	χ^2	Sig.	10%
88S = 90S	-	1.86	0.17	N	-	0.48	0.49	N	-	0.43	0.51	N
88S = 91S	-	0.42	0.52	N	-	1.15	0.28	N	-	0.59	0.44	N
90S = 91S	-	0.69	0.41	N	-	0.12	0.72	N	+	0.01	0.94	N
88L = 90L	-	2.70	0.10	Y	-	5.60	0.02	Y	-	2.40	0.12	N
88L = 91L	-	1.37	0.24	N	-	3.06	0.08	Y	-	0.80	0.37	N
90L = 91L	+	0.37	0.54	N	+	0.62	0.43	N	+	0.71	0.40	N

Table 5: Tests of Significance --Is Product-Specific CU the Same by Year and Vessel Size Class?

4.3 Testing for Changes in Product-Specific Capacity and Capacity Utilization

In order to investigate the impact, if any, of the ITQ program upon individual species sought in the fishery, we regressed both product-specific capacity and capacity utilization measures upon year and cohort dummies. Results of the Wald tests (at a 10 % significance level) associated with these regressions are shown in Tables 4 and 5. The important results with respect to the ITQ fisheries are that cod capacity increased over the 1988-1990 period for large vessels in the fleet but not over the period 1988-1991. The sign change was negative, but insignificant, for small vessels. Haddock capacity fell significantly for both types of vessels over the 1988-1990 period. Pollock capacity fell significantly for small vessels over the 1988-1991 period and rose (although not significantly) for large vessels. Thus, capacity changes were generally significant over the period. With respect to product-specific CU, none of the changes for pollock were significant, although CU fell for both vessel types over the 1988-1991 period. There was also a significant decrease in haddock CU for large vessels over the same period, as well as a non-significant reduction in cod CU.

5. CONCLUDING REMARKS

This paper has presented the first comprehensive assessment of capacity and capacity utilization measures from a Data Envelopment Analysis of a multi-species fishery. Using data from the Scotia-Fundy mobile gear ITQ groundfishery, we calculate mean daily capacity utilization measures for large and small vessels, as well as the fleet in aggregate. We find little evidence of significant change in individual, vessel-specific, capacity utilization measures over the time period--- 1988, 1990, and 1991, but this is not surprising since the ITQ program began only in 1991. We do find, however, a greater degree of heterogeneity of vessels present in the fishery post-ITQ. In particular, we find differences in responses according to vessel size. Large vessels have statistically higher levels of capacity utilization than do small vessels, suggesting that the former may be better placed to take advantage of changes in technology.

We also show that there has been fairly substantial excess capacity for each of the three ITQ species (cod, haddock, and pollock) at the aggregate level for the Scotia-Fundy mobile groundfishery. In 1988, excess capacity for each of the species was over 50%. By 1991, although actual capacity for the cod fishery had fallen by 26%, excess capacity had risen slightly. The increase is likely attributable to the rapid decline in biomass that substantially reduced the total allowable quota available for this species. For the other two ITQ fisheries (haddock and pollock), however, substantial reductions in both actual capacity and excess capacity were observed. This was largely driven by the presence of the ITQ program that promoted the exit of 80 vessels from the groundfishery, or about 18% of the pre-ITQ fleet size.

Since 1991 more vessels have either left the fishery or become inactive. For example, two years after ITQs were introduced, only 255 vessels were active in the fishery. If we assume that daily capacity and the number of fishing days were the same for 1993 as in 1991, then cod capacity, for example, would have been only 46,079 metric tonnes. For that year, the total cod quota was 11,977 metric ton. In these circumstances, excess capacity would only have been 34,102 tons, which would represent a 23% decrease in excess capacity from the first year of the ITQ program. Thus, it would appear for this fishery that ITQs may be instrumental in encouraging the reduction of excess capacity at the aggregate level, although whether this also occurs at the vessel level cannot be examined without further data.

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