Measuring Economic Performance in a Fishery: An Index Number Profit Decomposition

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Abstract

A method is introduced and applied to analyse changes in productivity of firms harvesting in a multi-species fishery. The index-number technique decomposes firm profits into its contributions and can be used to assess economic performance by both regulators and individual firms across an industry and over time. Using an unbalanced panel of 47 vessels in the South East Fishery of Australia, index-number profit decompositions are obtained for productivity, an implicit output price, fuel price, labour price and a capital stock. The results indicate significant differences in productivity between small and large vessels and over the four year sample period.

1 Introduction

The measurement of economic performance at a firm level is important to both regulators and individual firms. Understanding what factors may be contributing to increases in profits and productivity provides a basis for better decision-making at a macro and micro level. The paper presents an index-number method to measure economic performance that decomposes the contributions of productivity, output prices, input prices and the capital stock to profits of a "benchmark" firm. The approach has a number of advantages to existing methods and can be used by regulators to assess the impacts of regulatory change and by firms as a means to determine what factors may be constraining their profitability. The method should prove particularly useful in highly regulated industries, such as fisheries, where assessment of productivity changes in response to regulatory change is important to ensure good decision-making.

In the following section we present the fundamentals of the profit decomposition method and justify its use. Section 3 describes the fishery where the method is applied and recent changes in regulations designed to improve economic performance. An application of the method is provided in section 4 while interpretations of the profit decompositions are provided in section 5. The paper concludes with a review of the results and their implications.

2 Index-Number Profit Decompositions (INPD)

To derive an index number profit decomposition (INPD), we must define the restricted profits of an arbitrary firm b, π^b, relative to the restricted profits of another firm a, π^a:

$$\Gamma^{a,b} \equiv \pi^b / \pi^a. \tag{1}$$

If firm a has the highest profits in the sample, its profits provide a natural denominator for comparison. This is particularly useful in fisheries where there may exist "highliners" who consistently earn profits far in excess of their fellow resource users.

To decompose and evaluate why profits may differ across firms, other indexes must also be constructed. A productivity index between firms b and a can be defined as an output index divided by an input index, as follows:

$$R^{a,b} \equiv (\Gamma^{a,b} / P^{a,b}) / K^{a,b}, \tag{2}$$

where $P^{a,b}$ is a price index for the "netputs," (i.e., a price index for the outputs and variable inputs, where inputs are treated as negative outputs), and $K^{a,b}$ is a (quasi-) fixed input quantity index, between firms a and b. Hence, $\Gamma^{a,b}/P^{a,b}$ is an implicit netput quantity index (Allen and Diewert, 1981). Consequently, productivity in (2) is the difference in the netput quantity index that cannot be explained by differences in fixed-input utilization. By rearranging Equation (2), we obtain:

$$\Gamma^{a,b} = R^{a,b} \cdot P^{a,b} \cdot K^{a,b} \tag{3}$$

where the ratio of firms' profits can be decomposed into contributions from productivity ($R^{a,b}$), price ($P^{a,b}$) and fixed input ($K^{a,b}$) differences between the firms. This profit decomposition is generated without making any behavioural assumptions or restrictions on the specific form of the technology used by firms.

Any index number can be used for constructing the price and fixed-input indexes for use in (3). However, of all possible indexes, the Törnqvist (1936) index has some nice properties in this context. Let $p^a \geq 0$ denote a price vector for firm a netput prices, so that $p^a = (p_1^a, \ldots, p_N^a)$, where there are N variable netputs, denoted by $y^a = (y_1^a, \ldots, y_N^a)$, and where $y^a > 0$ implies that the good is an output, while $y^a < 0$ implies that the good is a variable input. Similarly, let $r^a \geq 0$ be the price vector for firm a fixed-input prices, so that $r^a = (r_1^a, \ldots, r_M^a)$, where there are M fixed inputs, denoted by $k^a = (k_1^a, \ldots, k_M^a)$. Thus we can define $P^{a,b}$ and $K^{a,b}$ in (3), respectively as

$$P^{a,b} \equiv \exp\left[\sum_{n=1}^{N} \frac{1}{2}(s_n^b + s_n^a)\ln(p_n^b/p_n^a)\right], \tag{4}$$

which is a Törnqvist price index, where $s_n = (p_n y_n)/(p \cdot y)$ is the profit share of netput n, using the notation $p \cdot y = \sum p_n y_n$, and

$$K^{a,b} \equiv \exp\left[\sum_{m=1}^{M} \frac{1}{2}(s_m^b + s_m^a)\ln(k_m^b/k_m^a)\right], \tag{5}$$

which is a Törnqvist quantity index, where $s_m = (r_m k_m)/(p \cdot y)$ is the profit share of fixed input m.

By exploiting the log-additive property of the Törnqvist index formula and noting that each individual price index is itself a Törnqvist index, we can decompose the aggregate price index between firms a and b into a product of individual price differences:

$$P^{a,b} = \prod_{n=1}^{N} P_n^{a,b}. \tag{6}$$

Similarly, the fixed-input index in (5) can be decomposed as follows:

$$K^{a,b} = \prod_{m=1}^{M} K_m^{a,b}. \tag{7}$$

Equations (3), (6) and (7) collectively represent a detailed decomposition of profits between firms a and b that can be applied in a wide range of applications. These equations may be referred to as index-number profit decompositions.[1]

The choice of the Törnqvist index over other index numbers can be justified by its ability to easily decompose a profit ratio between two firms into its components or contributions. In addition, the use of the Törnqvist index in (3) can be supported by either the axiomatic ("test") approach to index numbers, or the economic approach to index numbers (Diewert, 1992).

3 Industry Background

The method of profit decomposition is applied to the South East Trawl Fishery (SETF) of Australia. The fishery is located in Australia's 200 nautical mile exclusive economic zone (EEZ) and stretches from a latitude south of Sydney to encompass all of the EEZ in Victoria and Tasmania and up until a longitude just east of Kangaroo Island in South Australia. The SETF is one of Australia's oldest commercial fisheries and one of its most regulated. Its one hundred or so fishers employ trawls (otter board, Danish seine and mid-water trawl) and harvest over a hundred different types of species. The fishery accounts for about one fifth of the landed value of commonwealth fisheries or over AUS$ 70 million in 1999-2000.

Over the past couple of decades the participants in the SETF have increased their vessel size and capacity. In part, these investments have been made to access deeper water and further offshore fisheries, such as the orange roughy. Due to concerns about overcapitalisation, input controls were introduced in 1986 that established vessel unitisation whereby every boat was registered in terms of its hull and engine size. Owners wishing to upgrade their vessels were required to purchase registered units from other operators with an "offset" amount to prevent overall increases in fishing power.

Despite the goal of the program, vessel unitisation failed to prevent an increase in the capital employed in the fishery. To help address this problem, individual transferable quotas (ITQs) were introduced in 1992 encompassing 16 of the major commercial species in the fishery. Unfortunately, the expected benefits of ITQs were not fully realised and in 1997 an adjustment package was implemented that had one of its aims to reduce fishing effort by 30%. In total about AUS$4 million was spent in the adjustment program that included $2.3 million of targeted assistance to 17 fishers and $1.7 million to buy out the fishing permits of 27 fishers (AMC Search Ltd.). Given these expenditures and on-going concerns over the economic performance of fishers, we address the question of what has happened to relative profits and the contribution of productivity to profits over the period 1997-2000.

4 Firm-Level Profit Decompositions

The index-number profit decomposition method is applied to the SETF using vessel-level data on the implicit output price, fuel price, price for labour and a firm-level capital measure represented by vessel tonnage. The sample data is obtained by the Australian Bureau of Agricultural and Resource Economics (ABARE) and the Australian Fisheries Management Authority (AFMA) and is an unbalanced panel of 47 vessels over the period 1997-2000 giving a total of 131 observations.[2] Due to data inconsistencies, 11 observations were dropped leaving a total of 120 observations to calculate the profit decompositions.

If fishers are price takers, profit maximisers and their technology exhibits constant returns to scale,then for each firm $p \cdot y - rk = 0$, or $p \cdot y = rk = \pi$, where p is output price, y is output, k is capital, r is the rate of return on reproducible capital and π is firm restricted profit.[3] Under these assumptions, the share of capital in profit is equal to one and the capital quantity index in (5) simplifies to

$$K^{a,b} = k^b/k^a. \tag{8}$$

In the SETF, the variable inputs are fuel (F) and labour (L). From equations (3), (6) and (7), our decomposition of the profit ratio between firm a and firm b, $(b = 1, \ldots, 120)$, $\Gamma^{a,b}$ becomes:

$$\Gamma^{a,b} = R^{a,b} \cdot PO^{a,b} \cdot PL^{a,b} \cdot PF^{a,b} \cdot K^{a,b}. \tag{9}$$

Hence, the profit of firm b relative to firm a can be decomposed to identify the sources of the difference between the firms' profits.

$PO^{a,b}$ is the total value of landings of fish from vessels in the sampled divided by the total weight of the fish landed, $PL^{a,b}$ is an implicit labour price defined as total vessel labour payments divided by the number of trawling hours multiplied by the number of crew. $PF^{a,b}$ is a a recorded price of fuel for the vessels and $K^{a,b}$ is the vessel gross registered tonnage. Differences in profit can be explained by differences in productivity, $R^{a,b}$, $PO^{a,b}$, $PL^{a,b}$, $PF^{a,b}$, and the quasi-fixed factor $K^{a,b}$. The decompositions all represent contributions of the components to the profit ratio.

For common-pool resources, an important issue to consider is the effect of the natural capital stock on profits and productivity. Data limitations on the stock assessment of the species in the SETF, however, preclude us from separating out the effects of changes in biomass from other changes in the fishery over the four years of the sample data. As a result, measures of changes in productivity are not conditioned on the level of stock abundance. In turn, this limits our ability to discern what factors may have led to changes in productivity performance over the past four years.[4]

For comparative purposes, a reference firm (a) must be chosen where a different reference firm may result in different relative rankings between firms. Typically, researchers use multilateral index numbers (Caves, Christensen and Diewert 1982; Hill 1997; Pilat and Rao 1996) and comparisons are often made to an "average" firm as the denominator. Such comparisons, however, are much less interesting than an evaluation of firm performance relative to the most profitable firm. For instance, firm-level comparisons to the firm with the highest profits identifies what factors may be limiting increases in profit in the rest of the industry.

A natural benchmark or reference is the firm that maximises profit relative to all other vessels and over all periods. For the SETF sample data, the reference firm is observation 26 from a total of 28 observations in 2000. Using a benchmark that is an observed firm or vessel helps fishers to better assess those factors that are constraining profits that are under their control (such as productivity) from factors that are not (such as fuel prices).

The profit decompositions are presented in Tables 2 through 4 for the years 1997-2000. Geometric means of the index numbers are given in Table 6. To assist in the evaluation of the decompositions, the pooled index series are plotted in Figure 1, where the observations for each of the four years are separated by vertical dotted lines. When comparing the index values, if an index takes a value greater (less) than one, it contributes by expanding (contracting) the profit ratio, Γ. For the reference firm, observation 26 in 2000, its index values are unity and the index values for all other firms are relative to this benchmark.

A value of less than one for the output price index indicates that the *contribution* of the output price to profit is less than in the benchmark firm. For the SETF sample of vessels, only four observations have a PO greater than unity, and most vessels have values considerably less than unity. This suggests, therefore, that an important factor contributing to the profits of the benchmark vessel was the price it received for its output. A value greater than one for the input indexes does *not* necessarily imply that the input prices are more than for the benchmark vessel. Rather, it indicates that the contribution of that input price to the profit ratio is *greater* than for the benchmark vessel. This could arise if the input price for the given vessel is *less* than that of the reference firm as increases in the fuel price reduces profits. If the input price for a given vessel is identical to the benchmark vessel, the corresponding price decomposition index will be unity.

To illustrate that the profit decompositions are contributions to profits and *not* absolute ratios, Figure 2 presents the ratios of output and variable input prices and quantities relative to the benchmark firm. Although these ratios provide information on the variability of these measures across vessels and periods, they do not provide insight into what may be contributing to relative profitability. Moreover, these ratios cannot be used to construct a meaningful index of total factor productivity.

5 Discussion

Observation of the profit decompositions reveals a number of insights about vessel performance in the SETF. Figure 1 presents the profit decompositions by observation and by period where vessels in each period are ranked in ascending order based on tonnage. Scatter plots of the PO index suggest that the contribution to profits from the implicit output price are higher for larger vessels and that its importance for all vessels rises over time. This is confirmed in Table 6 with the geometric mean for PO for all vessels rising from 0.201 and 0.235 in 1997 and 1998 to 0.367 and 0.347 in 1999 and 2000. In addition, the mean for large vessels is higher for all years and for each year than it is for small vessels. No noticeable trends appear for any of the variable inputs (PL and PF) across vessel sizes or over time.

There is a discernible trend in terms of the contribution of productivity to profits. For small vessels, the geometric mean of R is 0.245 in 1997 and 1988, but for 1999 and 2000 it is almost 60% higher or 0.388. By contrast, the reverse trend appears to exist for large vessels with apparent declines in their productivity contribution to profits from 1997 to 2000. However, for every year the contribution of productivity to profits is higher for larger vessels than it is for smaller vessels. The rise in the contribution of productivity to profits of small vessels explains why the gap in the mean of the profit ratio for large and small vessels narrowed substantially between 1997-1998 and 1999-2000. In other words, improvements in relative productivity of the smaller vessels explains why the profitability of smaller vessels has increased relative to larger vessels, although large vessels still remain more profitable overall.

In sum, the profit decompositions indicate rising profitability, especially for smaller vessels. Profits have increased for both large and small vessels because of rises in the contribution of output prices and because of a large increase in the contribution of productivity for small vessels. Indeed, without increases in output prices, the profits of large (but not small) vessels would have fallen from 1997 to 2000. It would seem, therefore, that a goal of the regulator to stop further declines in vessel productivity has been realised, but only for small vessels. By contrast, for large vessels the results indicate that the contribution of productivity to profits may be in decline. A possible reason for this is as follows. Large offshore otter trawlers principally target orange roughy more than 50 kms offshore. Although there are no precise estimates, orange roughy stocks are generally thought to be in decline, and especially so in the past few years.

To what extent the profit and productivity changes are attributable to the SETF adjustment package cannot be precisely discerned because the results are not adjusted for changes in fish stocks. Nevertheless, the results do indicate an encouraging productivity trend for smaller vessels. This suggests that a goal of the adjustment program to arrest further declines in productivity has been realised for small vessels, but not for large vessels.

6 Concluding Remarks

The paper presents a method for assessing firm-level economic performance and evaluating changes in industries over time. A comparative advantage of the approach over other methods is that it uses only observed data in calculating the indices of netput prices, capital, productivity and profits and neither imposes assumptions about firm behaviour or restrictions on their technology. The method can also be justified using both the axiomatic and economics approaches to index numbers.

Applying the index-number profit decomposition to Australia's south east fishery yields interesting results. First, there is an enormous range in the relative profits and productivities of vessels within the fishery. Second, larger vessels are not only more profitable, but on average over the entire sample period their productivity provides over twice the contribution to their profits than it does for smaller vessels. Third, the mean contribution of productivity to profits for smaller vessels is about 60 percent higher for the period 1999-2000 than it was in 1997-1998 while the productivity contribution for larger vessels has declined. Fourth, both small and large vessels have benefited from a rise in the average implicit output price over the period 1997-2000. Indeed, without these increases profits would have declined for large vessels.

The results indicate potential financial problems for the large vessels in the fishery, especially if output prices were to decline. By contrast, smaller vessels have significantly improved their economic performance over the 1997-2000 period—an increase mainly attributable to a rise in the contribution of productivity to small vessel profits.

End Notes:

1. For related index-number decompositions in various contexts, see e.g., Fox, Grafton, Kirkley and Squires (in press), Fox, Kohli and Warren, (2002), and Diewert and Morrison (1986).

2. Only 17 of the 47 vessels are surveyed in all four periods.

3. Che and Kompas (2002) reject the null hypothesis of no CRTS for the fishery using the sample data when constructing a cost frontier for the fishery.

4. If the data were available, a natural capital stock index could be calculated as the available biomass per unit of the allowable harvest. Thus, for a stock-flow production technology, an increase (decrease) in the biomass, holding the allowable harvest fixed and all other factors constant, should make it easier (harder) for fishers to catch the allowable harvest and tend to increase (decrease) profits. Using the stock index it is, therefore, possible to construct a resource adjusted measure of efficiency (Fox, Grafton, Kirkley and Squires, in press)

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Table 1: Summary Statistics: Data on the South East Trawl Fishery

	Mean	Standard Deviation	Minimum	Maximum
All Years				
Revenue	485730	453259	86110	2467011
Landings	229164	182048	22266	1171634
Price	2.13	0.71	1.12	4.47
Crew Hours	3562	2391	128	14095
Labour Price	75	106	15	684
Fuel Quantity	1175	1135	64	5312
Fuel Price	70	7.19	63	83
Vessel Tonnage	82	92	13	670
1997				
Revenue	390518	378994	116996	2110863
Landings	215714	191165	31531	1051230
Price	1.88	0.69	1.12	4.45
Crew Hours	4129	2963	1276	14095
Labour Price	42	24	15	129
Fuel Quantity	1056	1008	111	4078
Fuel Price	67	0.00	67	67
Vessel Tonnage	94	124	13	662
1998				
Revenue	426822	383243	86110	2094586
Landings	229111	205366	38389	1171634
Price	1.91	0.55	1.22	4.47
Crew Hours	3654	2404	128	11829
Labour Price	68	99	19	531
Fuel Quantity	1065	1001	107	4349
Fuel Price	63	0.00	63	63
Vessel Tonnage	73	52	13	196
1999				
Revenue	571656	526541	98993	2467011
Landings	241148	181019	22266	889694
Price	2.39	0.77	1.44	4.45
Crew Hours	3197	1965	360	7245
Labour Price	98	129	16	515
Fuel Quantity	1329	1296	98	4521
Fuel Price	69	0.00	69	69
Vessel Tonnage	94	123	13	670
2000				
Revenue	568177	510214	105770	2336295
Landings	231226	149968	27093	615403
Price	2.38	0.69	1.24	3.90
Crew Hours	3223	2073	360	7038
Labour Price	95	132	20	684
Fuel Quantity	1274	1260	64	5312
Fuel Price	83	0.00	83	83
Vessel Tonnage	94	124	13	662

Notes: There are 30 observations for 1997, 33 for 1998, 29 for 1999, and 28 for 2000. Landings are in the total volume of fish sold, in kilograms; Price is the average price for a kilogram of fish landed; Crew hours is the average number of crew times the number of trawling hour; Fuel Quantity is litres of fuel dispensed; Fuel Price is the average diesel price for Melbourne; Vessel Tonnage is gross vessel tonnage (GVT).

Table 2: Decomposition of Profit Ratios (Γ), 1997

Obs	Profit	Γ	R	PO	PF	PL	K
1	70758	0.045	1.063	0.167	1.018	3.713	0.068
2	44282	0.028	0.254	0.125	1.021	6.439	0.136
3	89039	0.057	0.076	0.887	1.018	4.838	0.173
4	79982	0.051	0.551	0.144	1.019	3.699	0.173
5	114085	0.073	0.471	0.216	1.020	3.985	0.178
6	41825	0.027	0.006	1.467	1.056	16.515	0.183
7	222867	0.143	0.700	0.469	1.022	2.269	0.188
8	111018	0.071	0.219	0.261	1.031	6.430	0.188
9	90375	0.058	0.281	0.155	1.035	6.498	0.199
10	103744	0.067	0.254	0.457	1.033	2.660	0.209
11	58257	0.037	0.271	0.158	1.023	4.081	0.209
12	85904	0.055	0.527	0.098	1.026	4.769	0.220
13	68112	0.044	0.312	0.136	1.029	4.361	0.230
14	230803	0.148	0.523	0.327	1.031	3.578	0.235
15	68845	0.044	0.092	0.146	1.054	12.795	0.246
16	46449	0.030	0.151	0.057	1.069	11.104	0.293
17	48848	0.031	0.018	0.080	1.127	63.301	0.314
18	82293	0.053	0.217	0.113	1.024	6.707	0.314
19	24682	0.016	0.096	0.022	1.087	21.596	0.314
20	75102	0.048	0.178	0.103	1.103	6.509	0.366
21	142183	0.091	0.473	0.102	1.061	4.898	0.366
22	70310	0.045	0.023	0.140	1.131	30.238	0.408
23	211007	0.136	0.104	0.412	1.055	6.241	0.481
24	166302	0.107	0.182	0.257	1.053	4.156	0.523
25	429122	0.276	0.416	0.321	1.046	3.400	0.580
26	280435	0.180	0.391	0.232	1.029	2.887	0.669
27	160346	0.103	0.125	0.247	1.058	4.164	0.758
28	297546	0.191	0.227	0.260	1.053	3.279	0.941
29	376475	0.242	0.308	0.191	1.028	4.164	0.962
30	1315549	0.846	1.549	0.372	1.024	1.400	1.025

Table 3: Decomposition of Profit Ratios (Γ), 1998

Obs	Profit	Γ	R	PO	PF	PL	K
1	86829	0.056	1.241	0.226	1.027	2.845	0.068
2	16898	0.011	0.042	0.155	1.133	13.313	0.110
3	55508	0.036	0.183	0.196	1.030	7.104	0.136
4	100832	0.065	0.396	0.193	1.027	4.791	0.173
5	94219	0.061	0.513	0.210	1.031	3.167	0.173
6	107753	0.069	0.435	0.228	1.034	3.808	0.178
7	71117	0.046	0.025	1.377	1.061	6.739	0.183
8	249416	0.160	0.783	0.451	1.036	2.328	0.188
9	60510	0.039	0.138	0.140	1.121	9.516	0.188
10	155553	0.100	0.673	0.206	1.039	3.501	0.199
11	108173	0.070	0.281	0.364	1.054	3.081	0.209
12	71802	0.046	1.401	0.209	1.032	0.732	0.209
13	112869	0.073	0.384	0.224	1.031	3.736	0.220
14	94994	0.061	0.424	0.207	1.036	2.927	0.230
15	175170	0.113	0.399	0.284	1.050	4.031	0.235
16	106950	0.069	0.175	0.214	1.070	6.974	0.246
17	105070	0.068	0.257	0.201	1.028	4.864	0.261
18	71132	0.046	0.235	0.135	1.078	4.559	0.293
19	94300	0.061	0.191	0.170	1.034	5.739	0.314
20	42500	0.027	0.154	0.079	1.106	6.466	0.314
21	157209	0.101	0.304	0.251	1.077	3.365	0.366
22	162236	0.104	0.569	0.113	1.088	4.074	0.366
23	124993	0.080	0.082	0.355	1.092	6.188	0.408
24	403648	0.260	0.600	0.363	1.049	2.441	0.465
25	423410	0.272	0.347	0.512	1.048	3.037	0.481
26	299533	0.193	0.390	0.298	1.063	2.982	0.523
27	575114	0.370	0.508	0.479	1.047	2.502	0.580
28	231265	0.149	0.308	0.158	1.112	4.116	0.669
29	158076	0.102	0.196	0.148	1.096	4.230	0.758
30	88383	0.057	0.013	0.184	1.134	22.644	0.899
31	346500	0.223	0.277	0.316	1.062	2.544	0.941
32	525067	0.338	0.358	0.290	1.045	3.244	0.962
33	1242506	0.799	2.496	0.301	1.041	0.997	1.025

Table 4: Decomposition of Profit Ratios (Γ), 1999

Obs	Profit	Γ	R	PO	PF	PL	K
1	95612	0.061	0.640	0.525	1.018	2.676	0.067
2	78348	0.050	0.183	1.223	1.030	2.019	0.108
3	170551	0.110	1.241	0.229	1.017	2.223	0.170
4	158788	0.102	0.713	0.369	1.020	2.166	0.176
5	75908	0.049	0.130	0.291	1.040	6.862	0.181
6	319083	0.205	2.328	0.231	1.073	1.909	0.186
7	176897	0.114	0.518	0.360	1.025	3.031	0.196
8	150846	0.097	0.683	0.231	1.018	2.781	0.217
9	138419	0.089	0.951	0.185	1.016	2.186	0.227
10	139477	0.090	0.195	0.564	1.018	3.367	0.238
11	52075	0.033	0.054	1.308	1.039	1.895	0.243
12	274419	0.176	0.764	0.280	1.053	3.101	0.253
13	163293	0.105	0.631	0.199	1.015	3.197	0.258
14	293310	0.189	0.546	0.457	1.037	2.612	0.279
15	232226	0.149	0.395	0.435	1.040	3.000	0.279
16	80927	0.052	0.145	0.319	1.049	3.719	0.289
17	143426	0.092	0.346	0.235	1.021	3.588	0.310
18	818644	0.526	1.975	0.941	1.021	0.853	0.325
19	118230	0.076	0.131	0.240	1.060	6.315	0.362
20	67930	0.044	0.037	0.224	1.088	11.726	0.413
21	257383	0.165	0.194	0.656	1.038	2.723	0.460
22	192546	0.124	0.071	0.387	1.073	8.886	0.475
23	384738	0.247	0.826	0.242	1.038	2.311	0.516
24	186784	0.120	0.110	0.367	1.077	4.108	0.671
25	660626	0.425	0.458	0.677	1.033	1.821	0.728
26	81921	0.053	0.020	0.134	1.129	19.779	0.888
27	1001635	0.644	0.958	0.663	1.033	0.970	1.012
28	340356	0.219	0.128	0.436	1.072	2.862	1.278
29	1450059	0.932	0.513	0.605	1.029	0.835	3.502

Table 5: Decomposition of Profit Ratios (Γ), 2000

Obs	Profit	Γ	R	PO	PF	PL	K
1	64913	0.042	0.354	0.607	1.000	2.932	0.066
2	51205	0.033	0.180	0.717	1.000	2.375	0.107
3	174455	0.112	1.032	0.257	1.000	2.507	0.168
4	85654	0.055	0.788	0.132	1.000	3.057	0.173
5	52302	0.034	0.096	0.244	1.000	8.014	0.179
6	185908	0.120	1.057	0.230	1.000	2.682	0.184
7	210768	0.136	0.546	0.461	1.000	2.776	0.194
8	183056	0.118	0.920	0.260	1.000	2.295	0.214
9	123742	0.080	0.809	0.226	1.000	1.940	0.224
10	147108	0.095	0.321	0.481	1.000	2.613	0.235
11	62293	0.040	0.090	1.046	1.000	1.779	0.240
12	345517	0.222	0.670	0.513	1.000	2.589	0.250
13	121216	0.078	0.394	0.200	1.000	3.880	0.255
14	347852	0.224	0.677	0.447	1.000	2.682	0.276
15	237970	0.153	0.442	0.426	1.000	2.950	0.276
16	72522	0.047	0.124	0.302	1.000	4.365	0.286
17	138227	0.089	0.404	0.209	1.000	3.427	0.306
18	786485	0.506	3.040	0.697	1.000	0.743	0.321
19	120919	0.078	0.162	0.224	1.000	5.993	0.357
20	94309	0.061	0.027	0.289	1.000	16.867	0.454
21	146312	0.094	0.093	0.146	1.000	14.770	0.469
22	281465	0.181	0.736	0.177	1.000	2.720	0.510
23	542030	0.349	0.524	0.416	1.000	2.415	0.663
24	496239	0.319	0.291	0.738	1.000	2.065	0.719
25	129089	0.083	0.023	0.491	1.000	8.549	0.878
26	1555275	1.000	1.000	1.000	1.000	1.000	1.000
27	268126	0.172	0.072	0.530	1.000	3.601	1.262
28	899473	0.578	0.193	0.681	1.000	1.273	3.459

Table 6: Decomposition of Profit Ratios (Γ), Means

Obs	No.	Profit	Γ	R	PO	PF	PL	K
All Years	120	234625	0.099	0.278	0.281	1.038	3.828	0.318
Small	73	121619	0.068	0.299	0.260	1.042	4.172	0.201
Large	47	401174	0.182	0.217	0.304	1.063	4.006	0.648
1997	30	173551	0.073	0.207	0.194	1.046	5.728	0.303
Small	19	88535	0.049	0.197	0.182	1.039	6.503	0.203
Large	11	320398	0.145	0.227	0.218	1.058	4.601	0.602
1998	33	203622	0.089	0.288	0.238	1.061	3.995	0.306
Small	20	99080	0.056	0.285	0.223	1.052	4.298	0.195
Large	13	364457	0.181	0.293	0.265	1.073	3.568	0.608
1999	29	286361	0.126	0.319	0.379	1.042	2.968	0.337
Small	17	161388	0.092	0.429	0.364	1.031	2.806	0.204
Large	12	293173	0.196	0.209	0.402	1.057	3.213	0.686
2000	28	283015	0.120	0.317	0.371	1.000	3.076	0.331
Small	17	153218	0.083	0.408	0.345	1.000	2.913	0.202
Large	11	483611	0.211	0.214	0.415	1.000	3.346	0.709

Note: The arithmetic mean is used to average over the profit values, while the geometric mean is used to average over the indexes. Vessel tonnage (K) is used to split up observations into "small" and "large" vessels. Small vessels are defined as those being lighter than the sample average($K < 0.318$), and large vessels are defined as those being heavier than the sample average ($K > 0.318$). "No." denotes the number of vessels in each year/size category.

Figure 1: Profit-Ratio Decomposition

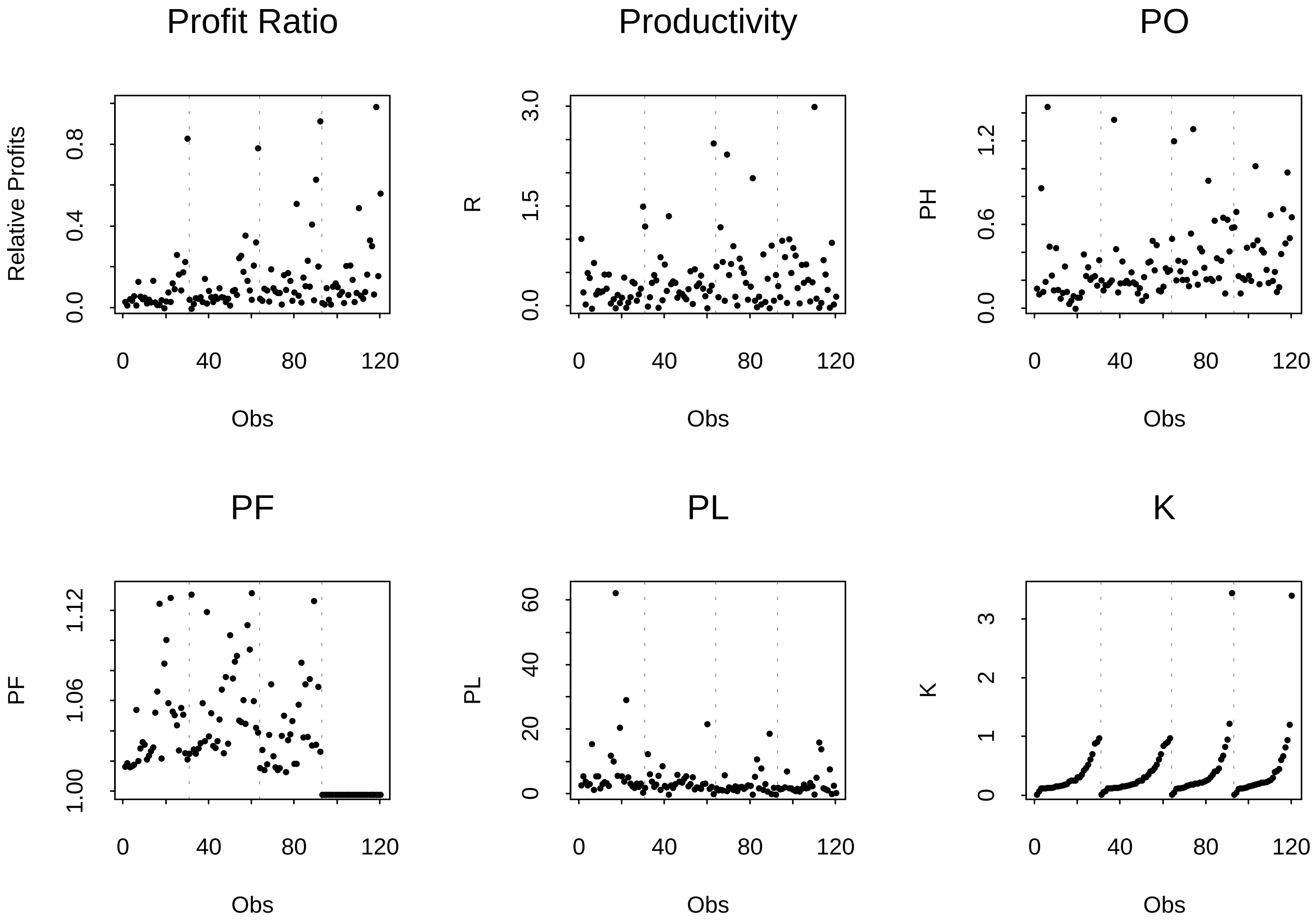

Figure 2: Price and Quantity Relatives