Tuna Fishing, Processing and Trade : Role of the Indian Ocean

La pêche, la transformation et le commerce du thon : rôle de la zone de l'océan Indien

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Introduction

World trends in tuna fishing and the processing and trading of tuna products are influenced by a number of driving forces. While environmental factors are significant, many driving forces are also socio-economic in nature, particularly for highly migratory tuna and tuna-like species. While fishing activities are influenced by factors such as resource availability, fishing technology, and output and input prices, patterns in processing depend on relative costs, including raw fish input and labor costs. The market for tuna products is indeed worldwide, not only for canned product but also frozen tuna – even as input to canned production, and more recently in fresh form. The relatively recent expansion of the tuna fishery in the Indian Ocean has been one of several significant changes that has influenced the location of tuna fleets and processing facilities and the equilibrium quantity and price of tuna and tuna-like products.

This paper refers to basic economic analytical tools as a means to understanding global tuna production, processing and trade. The influence of variables such as relative wage rates, income, and exchange rates are discussed.

Trends in Tuna Production

Socio-economic driving forces

The production of tuna at the ex-vessel level is a function of fishing costs per quantity of tuna landed. Short-run fishing costs are influenced by resource availability, and the costs of labor, fuel, bait, ice, and tackle. In the long run, fixed costs also influence the level of production: vessel, fishing gear, insurance, and association fees. The ex-vessel supply of tuna is thus influenced by a complex relation between biological and technological factors, and is influenced by relative input prices.

Tunas are fished around the world using a variety of techniques: purse seine, bait boats, longlining, drift nets, handline, harpoon, pair trawls, bandit gear, and other means. Because of the difference in relative labor and capital costs and/or availability, what is profitable for one country – or one fishing operation – may not be so for another. In addition, variations in crew remuneration techniques may also affect the supply function for tuna.

A critical factor in the determination of fish supply at the harvesting level is fisheries management regimes. Tuna fishing may be subject to international regulation as well as domestic management programs. Regulations can affect the quantity of fish supplied, as well as the costs of producing that quantity of fish.

Traditional fisheries management includes measures that limit the productivity of fishing vessels, such as time/area closures, mesh size, the use of fish aggregation devices, or prohibitions on dolphin fishing. In addition, some tuna fisheries are subject to catch restrictions such as minimum size or quotas in order to limit the total output. Fishery management measures that reduce the efficiency of fishing operations

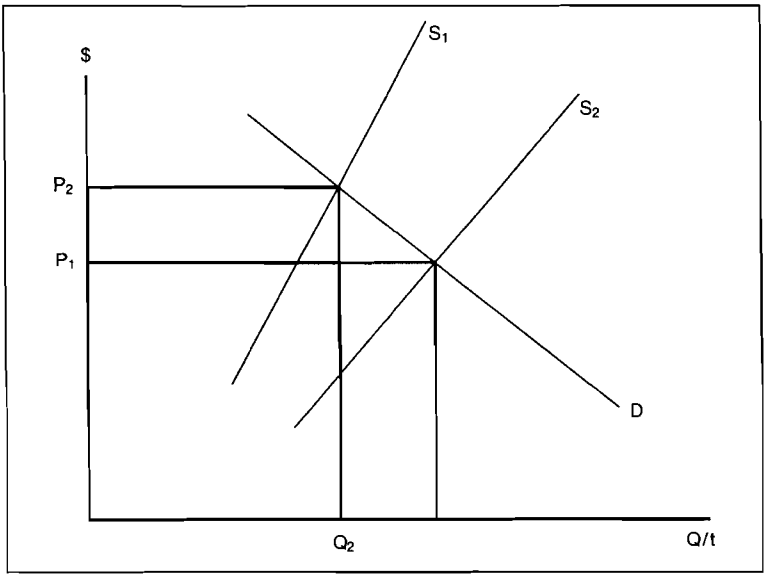

Figure 1
In competitive markets, equilibrium price (P_1) and quantity (Q_1) are determined by the intersection of demand and supply. Technological constraints often increase costs, so supply shifts upward (S_2) and price increases (P_2).

result in higher costs of producing any given quantity of fish (Figure 1). More recently, domestic management has focused on property rights-based measures, such as limited entry and individual transferable quotas.

Access to resources can greatly affect the supply of tuna and other species harvested incidentally to tunas (Mba-Asseko, 1997). Policies regarding exclusive economic zones, and bilateral and multilateral agreements will influence harvest and processing patterns. Access to resources through fishery agreements may be traded for: reciprocal access, financial compensation; access to markets, providing employment or technological transfer, fishery data for scientific and management monitoring, or providing food. Strategies adopted by resource-owning countries vary according to their relative labor/capital availability, per capita income and food production, as well as domestic fishing capacity.

Empirical evidence

World production of the primary species of tunas reached 3.2 million metric tons in 1993, with skipjack and yellowfin accounting for over 75 % of the total by volume (Table 1). The species composition of total catch has not changed measurably over the past decade. The 1993 catch by value demonstrates the relatively high prices paid for bluefin, bigeye, and yellowfin, nearly twice the world average for fishery products (Table 2).

Catch of tuna in the Indian ocean is primarily skipjack (43 %) and yellowfin (42 %), with catches taken primarily in the western statistical area (Table 3). Atlantic catch is also dominated by skipjack and the species composition has been relatively stable over the past ten years. While landings in the Pacific are dominated by skipjack, the share of yellowfin tuna has increased in recent years. Mediterranean catch is nearly all bluefin tuna. While the tuna catch from the Indian Ocean increased nearly 22 % from 1988 to 1994, the share of catch has remained steady at about 20 % of the world total, primarily due to concurrent increases in catches from the Pacific Ocean.

Empirical evidence supports the central role of bilateral fishery agreements in tuna fishery patterns world wide. Catches under bilateral agreements represented about 60 percent of the total Spanish harvest in 1987

Species	1987	1988	1989	1990	1991	1992	1993	1994
SKJ	1 040 313	1 285 497	1 230 441	1 305 708	1 566 410	1v427 734	1 461 178	1 462 637
BFT	32 182	33 337	34 087	30 766	31 262	34 871	39 051	46 376
ALB	219 710	226 179	244 043	231 471	169 065	216 122	190 639	193 966
YFT	866 240	908 468	976 294	1 065 192	1 015 357	1 123 548	1 161 702	1 074 891
BET	248 672	230 935	239 560	273 569	261 563	271 074	281 492	293 398
LOT	83 210	140 878	132 709	166 750	133 929	115 266	127 659	101 267
SBF	25 658	23 164	18 095	16 231	12 645	12 569	14 355	12 738
TOTAL	2 515 985	2 848 458	2 875 229	3 089 687	3 190 231	3 201 184	3 276 076	3 185 273

Source: FAO Yearbook of Fisheries Statistics-Catches and Landings, Vols. 76 (1993), 78(1994). Table B-00.

Table 1
World Catch of Major Tuna Species (in metric tons).

All species	1989	1990	1991	1992	1993
1000 T	88 671	85 352	84 606	84 898	85 407
US$/T	821	885	910	945	886
Million US$	72 758	75 519	76 953	80 243	75 635
Tunas	1989	1990	1991	1992	1993
1000 T	5 %	5 %	5 %	5 %	5 %
US$/T	1 700	1 830	1 560	1 650	1 690
Million US$	10 %	11 %	9 %	9 %	10 %

Source: FAO Yearbook of Fisheries Statistics-Commodites, Vol. 77(1993), Table K.

Table 2
Tunas Percent of World Marine Catch.

	1993				1994			
	Area 51	Area 57	MT	Pct Total	Area 51	Area 57	MT	Pct Total
SKJ	231 964	17 149	249 113	38 %	239 343	17 540	256 883	43 %
YFT	300 412	28 056	328 468	50 %	226 426	27 265	253 691	42 %
BET	43 766	11 380	55 146	8 %	51 559	13 042	64 601	11 %
LOT	22 384	2 257	24 641	4 %	25 626	2 246	27 872	5 %
Total	598 526	58 842	657 368		542 954	60 093	603 047	

Source: FAO Yearbook of Fisheries Statistics-Catches and Landings, Vol. 78(1994), Table B-36.

Table 3
Indian Ocean Catch of Major Tuna Species.

(Organization of Economic Cooperation and Development) of which tuna was a major species. Longlining and pole and line tuna fishing in bilateral agreements for Japan have resulted in nearly a quarter of the labor employed in the Japanese fishing sector being found under these bilateral agreements. As fishery resources in the industrialized north were increasingly utilized, bilateral agreements became increasingly north-south rather than just between northern countries. While bilateral agreements address primarily on tuna, other species such as swordfish may be harvested based on bycatch tolerance agreements.

Western Pacific access strategies vary by country as well. The Philippines adopted certain agreements, while other countries such as Thailand have been less forthcoming on such agreements. Still other nations have adopted joint venture-type approaches (e.g. Indonesia). There is recent evidence that tuna-rich Somalian waters may soon be accessible to fishing vessels from foreign fleets under agreements involving primarily fees.

Processing

Socio-economic driving forces

Cost functions for processing firms are also defined by cost and technological relationships between output and the level of inputs. Economies of scale are a critical aspect of seafood processing, which occurs when there are declining long-run average costs in industries for which the entry costs are relatively high. Economies of scale may be due to indivisibilities in plant and equipment, from the marketing advantage of having a larger firm. Generally, a firm faces lower average costs if the quantity produced corresponds to the optimal level of capital investment in the firm. Delgado and Lent (1992) found evidence of economies of scale in estimated supply functions for seafood and other animal protein products in Côte-d'Ivoire, particularly frozen products.

Vertical integration is a primary feature of ex-vessel seafood markets, stemming from the desire of processors to have adequate supply for high entry-cost processing (e.g. canning). Contractual arrangements between fishing vessel operators and processors affect the functioning of ex-vessel markets for tunas and tuna-like species. Arrangements can be backward of forward integration, trading products and/or services, along with buyer-seller loyalty. Concentration in input and/or output markets are also affected by vertical integration.

Empirical evidence

Despite an increasing trend in the consumption of fresh tuna products, particularly in higher income countries, some 80% of tuna is still sold in cans. Canned tuna production patterns reveal an increasing reliance on foreign sources of raw input (international trade of frozen loins), and a shift of canning facilities to countries with relatively low labor costs.

The Pacific tuna industry was subject to considerable backward integration until the late 1970's, in response to the need for a steady supplies of tuna to processors. These arrangements also ensured secure markets for the harvests of U.S. vessels, and additional benefits to vessel operators. A vertically-integrated operation was thus established, rather than reliance on a risky marketplace for input supply. However, when fleets from several other countries began to expand their purse seine operations, an additional and relatively secure source of raw tuna input for U.S. processors was available. U.S. processors returned to the marketplace, and terminated contractual and financial arrangements with U.S. vessels.

Since the mid-1980s there has been a dramatic increase in canned tuna production worldwide (FAO 1993, 1994). While significant investment in canneries has taken place in Pacific coastal states, there has also been expansion in the Indian Ocean area, particularly in Thailand. Although most of the raw material for Thai canneries is harvested in the Pacific Ocean, increased production and exports of canned tuna from countries in the western Indian Ocean are an indication of the vertical integration that has occurred in recent years. While frozen tuna production by Indian Ocean coastal states increased considerably from 1988 until 1992, declines in 1993-94 are further indication of the shift to localized cannery operations.

The lack of economies of scale in fresh and fresh-frozen tuna production has resulted in less market concentration than in canning operations. The capital investment to purchase, «process», and ship the fresh and frozen product is low relative to canning and thus may increase the number of firms and competition. A greater number of ex-vessel buyers and wholesale sellers may be found for fresh/frozen product, along with greater price competition.

Trade

Socio-economic driving forces

Markets may benefit from international trade when supply and/ or demand factors result in a price differential. The major factors influencing trade may be demonstrated via a simple two-country graphical model (Figure 2). Trade interaction is represented by excess demand and supply functions on the international market. These schedules are based on the difference between quantity demanded and quantity supplied in each of the two countries at prices below (or above) the domestic price. The world price is determined by the intersection of excess demand and supply. Quantity demanded is increased (decreased) in the importing (exporting) country, and the quantity produced is decreased (increased) in the importing (exporting) country. Prices will be equal in all countries except for transactions costs, which includes transportation.

Exchange rate variations affect relative world price and quantity traded, as demonstrated by a shift in the curves in the graphical model. Exports (imports) are encouraged by devaluation (appreciation) and imports (exports) are discouraged by imports (exports).

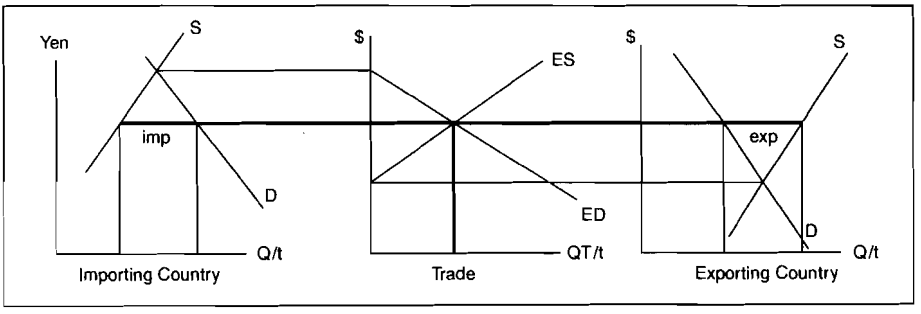

Figure 2
Excess demand is generated from prices higher than the equilibrium price in the importing country. The higher world price leads to excess supply in the exporting country. Trade occurs if the price difference is greater than transportation/transaction costs.

Empirical evidence

The world leading importer of fresh/frozen tunas is Japan (Tables 4, 5), with the United States and the EU being the most important importers of canned tunas (Table 6). Canners in many countries rely increasingly on the use of frozen imported product for input to canning processing. The location and operation of canning facilities have been increasingly affected by the development of the loining process and trade in frozen loins.

Appreciation of the Yen greatly affected the position of Japan on the international seafood market. For example, Japanese tuna exports were reduced by the appreciation of the Yen during the 1970's (FAO, 1991). The relative value of the dollar has also had impacts on the trade of seafood products, including tuna products.

Conclusions

Social and economic sciences provide an important set of analytical tools for reviewing major driving forces behind trends in production, processing, and trade of fishery products. Modeling these driving forces is fundamental to sound management of tunas at both the domestic and international level. Stock assessment scientists should consider the role of socio-economic factors in determining trends in fishing patterns and catch per unit effort data. A thorough understanding of the fishery, including the behavior of its participants, is fundamental to formulating and implementing management recommendations.

The development and management of the tuna resources of the Indian Ocean are subject to the same socio-economic driving forces as the major tuna fisheries in other ocean areas. Thus, nations and firms participating in the Indian Ocean tuna fisheries will have to assess the relative costs of several types of fishing operations : longline, purse seine, trolling, pole and line, fish aggregation devices, etc. Resource access agreements may continue to be useful for coastal nations to secure market access or technology transfer. Relative labor

IMPORTS	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
Quantity (mt)	44 974	76 680	61 762	67 737	107 729	165 968	115 875	125 830	142 427	155 058
Value ($1000)	112 954	144 602	187 996	242 631	350 729	472 500	502 152	598 075	706 222	822 447
Percent of Total Quantity										
Japan	47 %	26 %	41 %	49 %	33 %	26 %	44 %	46 %	46 %	47 %
USA	—	—	—	—	—	31 %	23 %			
Italy	1 %	0 %	2 %	1 %	27 %	7 %	0 %	2 %	3 %	2 %
France	5 %	2 %	3 %	3 %	2 %	1 %	2 %	2 %	2 %	3 %
Top 5 Total	99%	60%	79 %	81 %	93%	87 %	87 %	85 %	77 %	84 %
EXPORTS	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
Quantity (mt)	96 932	133 371	209 420	222 228	195 012	257 098	333 060	267 883	384 217	491 626
Value ($1000)	170 489	193 281	295 231	356 596	415 940	567 444	645 172	582 812	903 805	1 465 012
Percent of Total Quantity										
Other Asia	78 %	64 %	56 %	56 %	67 %	62 %	63 %	60 %	73 %	78 %
Indonesia	0 %	0 %	1 %	1 %	2 %	3 %	4 %	7 %	5 %	7 %
Mexico	0 %	17 %	31 %	32 %	12 %	11 %	6 %	7 %	5 %	4 %
Spain	3 %	2 %	1 %	2 %	2 %	3 %	3 %	4 %	2 %	2 %
Japan	16 %	14 %	8 %	6 %	10 %	9 %	7 %	10 %	5 %	2 %
Top 5 Total	96 %	98 %	98 %	98 %	94 %	89 %	83 %	88 %	91 %	93 %

Source: FAO Yearbook of Fisheries Statistics – Commodities, Vol. 77 (1993), Table J19.

Table 4
World imports and exports of tunas – fresh or chilled.

IMPORTS	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
Quantity (mt)	503 617	603 135	807 435	896 595	1 038 546	1 099 307	1 248 769	1 390 561	1 209 436	1 231 089
Value ($1000)	753 751	813 308	1 115 420	1 379 192	1 948 605	2 080 800	2 223 246	2 358 609	2 349 899	2 436 901
Percent of Total Quantity										
Japan	20 %	23 %	17 %	21 %	20 %	18 %	19 %	18 %	21 %	24 %
Thailand	4 %	8 %	24 %	17 %	25 %	29 %	30 %	36 %	35 %	33 %
USA	37 %	31 %	26 %	23 %	17 %	16 %	11 %	10 %	9 %	10 %
Italy	16 %	17 %	14 %	13 %	8 %	10 %	10 %	8 %	8 %	7 %
Spain	3 %	2 %	3 %	9 %	12 %	10 %	13 %	11 %	5 %	8 %
Top 5 Total	81 %	82 %	84 %	83 %	82 %	83 %	83 %	82 %	79 %	82 %
EXPORTS	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
Quantity (mt)	433 556	467 603	636 562	569 613	883 048	920 494	911 198	1 000 145	857 350	960 602
Value ($1000)	521 198	507 395	616 495	775 998	1 318 909	1 479 330	1 284 430	1 217 762	1 127 215	1 295 143
Percent of Total Quantity										
Korea Rep	20 %	18 %	29 %	25 %	16 %	16 %	17 %	20 %	22 %	14 %
Other Asia	4 %	3 %	2 %	9 %	15 %	16 %	19 %	17 %	16 %	19 %
Spain	5 %	6 %	8 %	6 %	12 %	13 %	11 %	11 %	6 %	8 %
Singapore	7 %	6 %	6 %	8 %	6 %	6 %	7 %	6 %	6 %	4 %
France	8 %	13 %	13 %	14 %	9 %	12 %	11 %	12 %	17 %	19 %
Top 5 Total	44 %	46 %	58 %	63 %	59 %	62 %	65 %	66 %	68 %	64 %

Source: FAO Yearbook of Fisheries Statistics – Commodities, Vol. 77 (1993), Table J20.

Table 5
World imports and exports of tunas – Frozen.

IMPORTS	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
Quantity (mt)	178 688	209 752	247 379	278 138	323 960	415 207	397 666	494 325	520 181	502 613
Value ($1000)	419 790	465 989	575 898	679 587	925 930	1 108 793	1 091 251	1 318 707	1 338 322	1 280 005
Percent of Total Quantity										
USA	33 %	35 %	34 %	28 %	30 %	37 %	32 %	33 %	29 %	22 %
France	18 %	18 %	14 %	17 %	17 %	12 %	14 %	13 %	12 %	15 %
UK	13 %	11 %	15 %	12 %	15 %	16 %	14 %	14 %	13 %	14 %
Germany	11 %	9 %	10 %	11 %	9 %	8 %	10 %	9 %	9 %	8 %
Canada	6 %	5 %	7 %	8 %	6 %	6 %	4 %	5 %	4 %	5 %
Top 5 Total	82 %	79 %	81 %	77 %	76 %	78 %	74 %	74 %	67 %	63 %

EXPORTS	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
Quantity (mt)	200 366	243 586	305 928	304 882	391 781	442 877	442 840	549 988	468 146	502 429
Value ($1000)	468 372	550 563	740 202	778 153	1 095 437	1 142 089	1 144 543	1 379 130	1 138 294	1 218 862
Percent of Total Quantity										
Thailand	20 %	36 %	46 %	48 %	53 %	51 %	53 %	50 %	52 %	46 %
Philippines	11 %	10 %	9 %	9 %	9 %	11 %	10 %	8 %	10 %	11 %
Cote d'Ivoire	11 %	9 %	8 %	10 %	8 %	9 %	9 %	9 %	9 %	10 %
Senegal	11 %	8 %	6 %	6 %	5 %	5 %	5 %	6 %	3 %	4 %
Japan	23 %	14 %	10 %	5 %	2 %	1 %	0 %	0 %	0 %	0 %
Top 5 Total	76 %	78%	79 %	77 %	77 %	76 %	78 %	74 %	75 %	71 %

Source: FAO Yearbook of Fisheries Statistics – Commodities, Vol. 77 (1993), Table J19.

Table 5
World imports and exports of tunas – Prepared or preserved.

costs and the cost of capital will determine the feasibility of further investment in local canneries as opposed to supplying raw material input to existing canneries in the western Indian Ocean or Southeast Asia. Development of suitable air links could foster additional trade in the fresh tuna market which will likely continue to be most significant in Japan and other east Asian nations. Exchange rates, income trends and demand preferences in major market countries must be considered long term planning for investments in harvesting, processing and marketing.

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